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Using Science Against Famine:
Food Security, Famine Early Warning
and El Niño

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Message from the Special Editor -

Michael H. Glantz

This special issue of IJAS contains papers from a conference held in Budapest, Hungary in late 1993. Several of the papers have been updated and a couple of new contributions have been added.

The conference was the first in a series of "Usable Science" workshops designed to investigate the use of information about El Niño events in the equatorial Pacific Ocean in designing food security systems in sub-Saharan Africa. It was supported by the Climate Unit of the United Nations Environment Programme, the Office of Foreign Disaster Assistance of the United States Agency for International Development (USAID), and the Environmental and Societal Impacts Group (ESIG) of the US National Center for Atmospheric Research (NCAR).

Each of the the Usable Science workshops was developed and chaired by Michael Glantz. Given the apparent recurrence of natural and human threats to food security in various countries in sub-Saharan Africa, it is hoped that the publication of these discussion papers on "Usable Science: Food Security, Early Warning and El Niño" will help to reduce the frequency and intensity of such threats.

For more information on other Usable Science workshops, the reader may refer to the ESIG home page.

---Michael H. Glantz

This Special issue of IJAS is dedicated to the memory of our colleague Joseph Kinuthia, whose contribution to the workshop was invaluable.

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Making the task of generating public awareness and concern about this recurrent phenomenon somewhat difficult is the fact that the term - El Niño - originally used to describe a regional oceanic current and, later, the seasonal warming of surface waters off the coasts of Peru, Ecuador, and Chile, has recently become attached in many circles to the broader atmospheric-oceanic process known as the Southern Oscillation, thus ENSO. Whereas El Niño, as originally perceived, had been viewed as a regional phenomenon, ENSO is considered a hemispheric or global one. The problem is that the term "El Niño" has entered into the vernacular as interchangeable with "ENSO," "ENSO event," or "warm event," these latter terms being used to describe the larger-scale phenomenon.

This has created some confusion within the scientific community as well as for the media, which must present correct information about this recurring event and its impacts on ecosystems and societies. By the middle of the 1980s, El Niño was on its way to becoming a household word, in the sense that many people were made aware of its existence as a large-scale phenomenon with global teleconnections. This occurred as a result of attention from the popular printed and electronic media following what may have been the largest ENSO event in a century (1982-83). Yet, El Niño has become a misnomer when applied to the larger equatorial phenomenon (ENSO) in which scientists have become increasingly interested.

Some scientists use El Niño and ENSO interchangeably. Others use the phrase "warm event" to describe a warming of the surface waters in the central and eastern equatorial Pacific, and "cold event" to denote the opposite phase of the Southern Oscillation. The GLOSSARY which follows is provided to help the reader sort out these concepts.

**El Niño**

El Niño is a term originally used to describe the appearance of warm (surface) water from time to time in the eastern equatorial Pacific region along the coasts of Peru and Ecuador. It was once suggested that minor El Niño events occurred about every two to three years and major ones about every 8 to 11 years. Today, scientists note that El Niño has a return periods of four to five years. When an El Niño event occurs, it often lasts from 12 to 18 months.

**La Niña**

La Niña refers to the appearance of colder-than-average sea surface temperatures (SSTs) in the central or eastern equatorial Pacific region (the opposite to conditions during El Niño). Many scientists do not like the use of this term and prefer to call it a cold event (described below).

**A Warm Event**

A warm event refers to the anomalous warming of SSTs in the central and eastern equatorial Pacific. This term is being used to avoid confusion over the use of other terms like ENSO and El Niño. A warming in the regions mentioned is accompanied by a relative cooling in the western equatorial Pacific.

**A Cold Event**

A cold event is one where the SSTs become anomalously colder compared to the long-term average for the central and eastern equatorial region. (It is the opposite of a warm event in that
region). It has been referred to in the past as anti-El Niño and, more recently, as La Niña. La Niña, however, unlike the restrictive view of El Niño, is applied to Pacific basin wide phenomena.

**Southern Oscillation**

The Southern Oscillation is a see-saw of atmospheric mass (pressure) between the Pacific and Indo-Australian areas. For example, when the pressure is low in the South Pacific high pressure cell and high over Indonesia and Australia, the Pacific trade winds weaken, upwelling of cool water on the Pacific equator and along the Peruvian coast weakens or stops, and SSTs increase in these areas where the upwelling weakens.

**Southern Oscillation Index**

The Southern Oscillation Index (SOI) has been developed to monitor the Southern Oscillation using the difference between sea level pressures at Darwin, Australia, and Tahiti, although other stations have sometimes been used. Large negative values of the SOI indicate a warm event, and large positive values indicate a cold event (also referred to as La Niña). It is important to note that there is not a one-to-one correspondence between the occurrence of Southern Oscillation events and El Niño events, using the spatially restrictive original definition of El Niño.

**ENSO**

ENSO is the term currently used by scientists to describe the full range of the Southern Oscillation that includes both SST increases (a warming) as well as SST decreases (a cooling) when compared to a long-term average. It has sometimes been used by scientists to relate only to the broader view of El Niño or the warm events, the warming of SSTs in the central and eastern equatorial Pacific. The acronym, ENSO, is composed of El Niño-Southern Oscillation, where El Niño is the oceanic component and the Southern Oscillation is the atmospheric component of the phenomenon. The broader definition of El Niño has sometimes been used interchangeable with ENSO, because ENSO is less well known in the popular electronic and printed media.

**Teleconnections**

Teleconnections can be defined as atmospheric interactions between widely separated regions. They have been identified through statistical correlations (in space and time). Some of these correlations have been used to generate hypotheses about geophysical processes related to teleconnections. The occurrence of droughts in India and floods in Southeast Brazil during major warm events of the Southern Oscillation are examples of such teleconnections. Most countries in the world are, or should be, interested in this aspect of the Southern Oscillation.

Some examples are provided in the following maps.
What is Food Security and Famine and Hunger?

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From the outset, it is important to note that food security and famine and hunger are different concepts, although they deal with the same, most basic, need of life: food. Food security indicates the availability of food, while famine and hunger refer to the effects of the non-availability of food. Famine and hunger, in other words, are the result of food insecurity. This discussion paper deals with the concepts of food security and famine and hunger, and then attempts to relate them to famine early warning systems.

Concept of Food Security

Food security, as an issue, became prominent in the 1970s and has been a topic of considerable attention since then; thirty definitions of it have been identified by Maxwell and Frankenberger (1992). Originally, there was a tendency to understand the issue of food security only from a supply point of view. In 1979 the World Food Programme Report conceptualized food security, equating it with an "assurance of supplies and a balanced supply-demand situation of stable foods in the international market." The report also emphasized that increasing food production in the developing countries would be the basis on which to build their food security. This would mean that the monitoring by famine early warning systems for food insecurity should focus on the availability of food in the world marketplace and on the food production systems of developing countries. However, global food availability does not ensure food security to any particular country because what is available in the world market (or the surplus in the US or Canada) cannot be accessed by famine-affected people in African countries, as the economies of these countries, in general, cannot generate the foreign currency needed to purchase food from the world market.

The concept of food security would have more meaning if it were understood in line with the legal commitments of the United Nations: the Universal Declaration of Human Rights (1948), which accepts the "right to adequate standard of living," including food; the International Covenant on Economic, Social, and Cultural Rights (1966), which ensures "an equitable distribution of world food supplies in relation to need"; and the Universal Declaration on the Eradication of Hunger and Malnutrition (1974), which declares that "every man, woman, and child has an inalienable right to be free from hunger and malnutrition." Each of these tenets (as quoted by Maxwell and Frankenberger, 1992) suggests implicitly or explicitly the distribution of world food to the needy.

Had these United Nations declarations been adhered to by all nations, the availability of food at the global level would have been one basis for food security in the proper sense of the concept, as defined by the World Bank in 1986. Although member countries accepted these declarations, responding to food needs of other countries is left to the discretion of individual surplus-producing countries. The UN has no power to enforce such declarations. Therefore, a global concept of food security does not guarantee food security at either the household or the national level.

By the same token, an increase in national food production does not by itself guarantee food
security. Availability of food at the national level is but one factor for food security. Supporters of this idea try to work out a food balance sheet for a given country and, if food availability is more or less equal to the food needs of the country's population in general, they conclude that the country is food-secure. Given this perspective of food security, the basis for famine early warning would then be the monitoring of food production at the national level and may not take into consideration other important and relevant social, political, and cultural factors.

The assumption underlying this perspective is that whatever food is produced in the country will be evenly distributed to each region and to each household. But the facts are different. Those who failed to produce will have access to the surplus in the country (through the markets) if, and only if, they have purchasing power. In most poor countries, however, many people do not have such power. National governments, too, often lack the necessary financial resources to purchase the surplus and to distribute it to the have-nots, especially when millions become destitute. Therefore, food availability at the national level does not provide food entitlement to households and individuals.

Food security at the household level has been defined by Eide (quoted in Maxwell and Frankenberger, 1992) as "access to adequate food by households over time." This implies that each member of the household is secure, if the household in general has access to food. The assumption here is that household members' strong family ties would ensure that food is shared equally by each. The basis for early warning of food insecurity (famine and hunger) would then rest on the identification of the inadequacy of food supplies at the household level. It would focus on monitoring the food stock of the households.

Although food availability at the household level is a key issue, there are intra-household factors that may affect equitable and adequate access to food by all members. Maxwell and Frankenberger (1992) have said that "it is misleading to assume that household members share common preferences with regard to (a) the allocation of resources for income generation and food acquisition or (b) the distribution of income and food with the household."

The head of the household may have more power in determining the use of food resources and may misappropriate it. Moreover, household members' nutritional requirements may vary, for example, if some exert more energy in work than others. Cultural factors can also deprive members of the household (i.e., women and children) from getting an equitable share. Thus, the concept of household-level food security, in general, does not fit into the accepted definition of food security.

One of the most influential definitions of food security is that of the World Bank in 1986. The Bank defined it as the "access by all people at all times to enough food for an active and healthy life." This definition encompasses many issues. It deals with production in relation to food availability; it addresses distribution in that the produce should be accessed by all; it covers consumption in the sense that individual food needs are met in order for that individual to be active and healthy. The availability and accessibility of food to meet individual food needs should also be sustainable. This implies that early warning systems of food insecurity should monitor indicators related to food production, distribution, and consumption. The performance of these indicators, therefore, will detect whether a certain area or population is food secure or insecure in relation to the spirit of the above definition. This is now a conventional concept of food security. What, then, are famine and hunger?

Famine and Hunger
Food security, on the one hand, and famine and hunger on the other, are inversely related concepts. Ensuring food security is equated to avoidance of famine and hunger. Famine and hunger result from the lack of food security. Famine is an absolute lack of food affecting a large population for a long time period. Famine is a disaster of food insecurity. Robert Klinterberg (1977) described famine as "an event which disrupts the functioning of a community to such an extent that it cannot subsist without outside assistance." According to Wolde-Mariam (1984), famine is a "general hunger affecting large numbers of people ... as a consequence of non-availability of food for a relatively longer time." Wolde-Mariam described it as a human tragedy: "a husband has eaten his wife, a mother has eaten her babies ... and free men have turned themselves into slaves. This is famine." This tragedy can be avoided.

The one "good" thing about famine is that it does not strike unexpectedly, but builds up slowly and provides a lead time before it occurs. In other words, the predictability of famine makes it possible to prevent it. If a food shortage develops to the scale of a famine, it must therefore be the weakness of society in general and government in particular. In this sense, famine is a man-made disaster (Ayalew, 1988).

Hunger is not famine. It is similar to undernourishment and is related to poverty. Mainly in poor countries, there are always undernourished and hungry people. In many poor countries there is seasonal hunger, usually in the months just before the coming harvest. People become weakened as a result of not having had adequate food for days. When hunger persists for a longer period, covering a large number of the population and resulting in mass migration and death, it then becomes famine.

Famine and hunger are both rooted in food insecurity. Food insecurity can be categorized as either chronic or transitory. Chronic food insecurity translates into a high degree of vulnerability to famine and hunger; ensuring food security presupposes elimination of that vulnerability. Vulnerable populations can reach the stage of famine with slight abnormalities in the food production-distribution-consumption process. Therefore, in conditions of chronic food insecurity there is always an impending famine.

Transitory food insecurity is a temporary or seasonal shortage of food because of unexpected factors for only a limited period. In a chronically food-insecure society or in situations of chronic hunger, it may lead to famine, whereas in normally food-secure populations, it does not turn into famine because of the resilience of the population. Repeated seasonal food insecurity, however, could deplete the assets of the even seemingly secure societies, exposing them to a higher level of famine vulnerability. If this is the relationship between famine and food insecurity, is there any relationship between food security systems and famine early warning systems (few\w)? [Famine Early Warning System (FEWS) refers to the USAID-sponsored system. When referred to using lower case letters (few\w), it means generic early warning systems focused on famine.]

Food Security and Famine Early Warning Systems

As noted in the preceding sections, food security is a broad concept dealing with production, distribution, and consumption vis-a-vis food entitlement for all household members. Famine early warning is specific to the monitoring of selected indicators of food insecurity. Famine early warning systems are tools and components of food security systems because early information on the decline of food to all could enable a timely counteraction. However, as an early information system, a famine early warning system (few\w) alone does not contribute much to food security. It contributes to the higher systems (e.g., food security systems), as long as those higher systems are linked with response mechanisms. It is the response component that will put few\w in a better position to ensure food security
at the household and national levels. Thus, in order not to conceptualize separately FEWS and a response to FEWS, should one think of a Famine Early Warning and Response System (FEWRS) as a single system? Should those involved in such an expanded system be responsible for both warning and response? Does this assume that any institution that develops a warning should also have the capacity to respond, or are the resources with which to respond under the authority of others? These issues, among others, must be considered with the development of a combined system of FEWS and response.

What about the credibility and timeliness of FEWS? Some FEWS focus heavily on food production, while others concentrate only on leading indicators such as rainfall. Meteorological drought is a phenomenon which does not necessarily lead to a famine or even to a food shortage. Unless it occurs repeatedly, a single drought will not result in famine within food-secure populations, as they will likely have some carryover stock from past harvests. Drought, however, can affect food production, particularly in rain-fed agricultural areas, and can trigger famine within vulnerable populations, even within countries that may be considered to have food security at a national level.

Moreover, increased production in general (e.g., at a national level) does not avoid the possibility of famine in local areas. A focus on production neglects the role of distribution or exchange and fails to address the issue of entitlement, which is a core aspect of food security.

The relatively better FEWS are those which have tried to observe all indicators related to production, exchange, and consumption. On the production side, they tend to focus on rainfall, pastures, water, pests, agricultural inputs, crop performance, etc.; on the distribution and exchange side, they tend to focus on food prices, purchasing power, market and market prices, etc.; on the consumption side, the focus has been on health and nutritional status. The performance of these indicators will tell whether there is an impending famine in a given area and also will help to estimate the number of people likely to face acute food shortage or famine. Who the specific adversely affected individuals in that area are, is not necessarily known because the targeting of individual at-risk victims is a problem when responding to early warnings.

Would existing FEWS help to identify individuals likely to be affected? This is an important issue that modern FEWS should investigate, as it challenges the timeliness and precision of a FEWS.

In relation to timeliness, the main problem is not the time lag of problem identification, but the time spent to screen the population and identify those in real need. This problem exists because FEWS is not very precise on facts about households and individuals.

Famine early warning systems, therefore, should include other inputs in addition to what they now use, such as a vulnerability analysis. As impending famine exists in a vulnerable population, a warning of possible famine should start when a society is acknowledged to be chronically food insecure or vulnerable. This would be the earliest famine warning. It would require the development of an area-specific vulnerability profile that includes, among other things, trends in production, price and nutritional status, coping mechanisms, rainfall patterns of past years, changes in soil fertility, environmental status, income, household food stocks, endemic diseases and pests, the culture of food allocation and consumption within a household, household size, and other basic information on households. The analysis of these basic data and determination of degree of vulnerability would provide a warning of impending famine well ahead of the actual onset of the famine process that may be triggered by a slight deviation from the norm of rainfall or other factors adverse to food production.
Record-keeping of household data for use in vulnerability analysis will also facilitate the timely identification of households that would need external assistance when famine strikes. It also facilitate the identification of likely famine-affected populations, by monitoring the performance of only a few well-selected indicators that are known to affect people’s livelihoods. It could also provide the best and most reliable mechanism for monitoring food security (or insecurity) at the household level.

But, one must ask, would there be adequate resources to keep records of all basic data, updating them periodically? Would the direct involvement of communities help to reduce resource requirements? Would the cost of such an exercise be reduced once vulnerable areas and populations have been identified, as the follow-up would tend to concentrate only on food-insecure areas? Does it need a demonstration in order to establish the feasibility of baseline vulnerability assessments in terms of credibility, timeliness, and cost effectiveness? These, and the approach itself, are issues for serious discussion among those seeking to bring an end to famine in Africa.

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World Food Programme, 1979: Food aid policies and programmes: Role of food aid in strengthening food security in developing countries. UN FAO, Rome, Italy, 22-31 October 1979.
What is a Famine Early Warning System? Can it Prevent Famine?

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What is a Famine Early Warning System?

Defining a famine early warning system

A famine early warning system (fews) can best be defined as a system of data collection to monitor people’s access to food, in order to provide timely notice when a food crisis threatens and, thus, to elicit appropriate response (Davies et al., 1991).

Monitoring "access to food" may be interpreted as the straightforward monitoring of food production. However, more accurately, it refers to a wide range of determinants of food security, taking the demand side into account as well as the supply side, and monitoring food entitlement, which may be measured through the use of a range of socioeconomic and other indicators.

The definition includes the ultimate objective of an early warning system (EWS): to elicit an appropriate response. This is based on the view that an EWS should not be a process of data collection and analysis, which is regarded as an end in itself, but must be seen as part of a whole system which is geared to respond to food crisis and to prevent famine. This said, there is no single best model of an EWS.

Recognizing an early warning system

There is a whole range of different EWSs in existence, fulfilling slightly different functions and designed and suited to fit slightly different environments. An evaluation of an EWS must take as its starting point "what is the EWS supposed to achieve?" rather than a pre-conceived notion about what an EWS should look like.

This study is focused on formal systems of early warning (EW), because they are the ones we have all spent time working with; huge amounts of resources have been invested in formal EWSs over the last decade, and they now play a very significant role in informing and warning decisionmakers about impending food crises or disasters. Formal systems of early warning are usually designed according to western criteria of what constitutes an information system, with an emphasis on the written word as the principal means of communication.

But we should not forget the role of informal EWSs. Many societies may have their own highly developed information systems which do not fit the conventional view of an EWS. They are often ignored, although they are sources of potentially valuable information. More and more research has exposed the complex, often sophisticated, indigenous information systems and knowledge base of
pastoralists and agriculturalists who face the possibility of drought each year, and who must rely on their own sources of information, sometimes for their very survival (e.g., Watts, 1987; Borton and York, 1987; De Waal, 1989). As Walker (1989, p. 34) suggested, "local understanding of famine often contrast(s) starkly with the West's commonly accepted monolithic picture of famine."

The now widely held view is that the best form of EWS is an open and democratic political system, which allows freedom of the press. This is seen by some as the surest way of preventing famine, and India and Botswana are often cited as evidence to support the argument (Dreze and Sen, 1989). However, it is debatable whether the media can be relied upon to provide genuine early warning, as a famine story is rarely newsworthy before the famine is fully blown. (This is borne out, for example, by the timing of national newspaper coverage of drought-induced food crisis in parts of northern Kenya in 1992. The press had recently been freed from the shackles of censorship, but only picked up the news of the food crisis many months after the formal EWS had warned of impending famine.)

Different Levels of Early Warning

EWSs can be classified according to the level at which they operate, which strongly influences how an EWS is designed. The objectives of EWSs at different levels can range from global allocations of food aid to the targeting of a variety of interventions to individual households or villages (see Table 1).

<table>
<thead>
<tr>
<th>Level</th>
<th>Example</th>
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<tbody>
<tr>
<td>Global</td>
<td>Global Information and Early Warning System (GIEWS)</td>
</tr>
<tr>
<td>Regional</td>
<td>Southern African Development Community (SADC);</td>
</tr>
<tr>
<td></td>
<td>Comité Permanent Inter-états de Lutte contre la Sécheeresse dans le Sahel (CILSS)</td>
</tr>
<tr>
<td>National</td>
<td>The majority of early warning systems (EWSs) in Africa</td>
</tr>
<tr>
<td>Sub-national</td>
<td>Save the Children Fund (SCF-UK), Darfur, Sudan</td>
</tr>
<tr>
<td>Local</td>
<td>Suivi Alimentaire Delta Seno (SADS), Mopti, Mali</td>
</tr>
</tbody>
</table>

The issue is not that one type of system is inherently better than another or that, for example, all national systems should be replaced by local ones; each system has been set up to serve a specific set of objectives and should be judged against those criteria. Rather, the challenge today is how best to integrate systems operating at different points in the hierarchy to provide a better and more comprehensive information system. For example, how can aggregated data about weather patterns and rainfall be made specific enough and thus relevant to local-level EWSs? And how can global, regional or even national EWSs make the best use of a wealth of very detailed and often location-specific data from a local-level EWS to improve their aggregate forecasts?

A typology of EWSs

Of course, EWSs are multidimensional in character and cannot be neatly fitted into two or three discrete categories. Table 2 provides a typology of EWSs. Although most systems fall somewhere along the continuum between the two extremes described under each heading in Table 2, this typology provides a useful analytical tool for classifying different EWSs and for showing how much they may vary. This chapter selects a couple of these characteristics for further discussion - the scope of the EWS and the response system to which it is geared and the determinants of food security which the EWS is trying to monitor.
Table 2. Typology of EWSs

<table>
<thead>
<tr>
<th></th>
<th>Conventional Famine Early Warning System</th>
<th>Alternative Food Information System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope</strong></td>
<td>Famine-oriented</td>
<td>Food Security oriented</td>
</tr>
<tr>
<td><strong>Determinants of food security</strong></td>
<td>Food production</td>
<td>Access to food</td>
</tr>
<tr>
<td><strong>Level of operation</strong></td>
<td>Macro centralized</td>
<td>Micro decentralized</td>
</tr>
<tr>
<td><strong>Unit of analysis</strong></td>
<td>Geographic, e.g. nation/districts</td>
<td>Socio-economic, e.g. vulnerable groups</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td>Top-down</td>
<td>Bottom-up</td>
</tr>
<tr>
<td></td>
<td>Data-centered</td>
<td>People-centered</td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>Food-aid oriented</td>
<td>Sustainable improvement in access to food</td>
</tr>
</tbody>
</table>

Source: Davies et al., 1991

Famine-oriented vs. food-security-oriented EWSs

The majority of EWSs fall into the "famine-oriented" camp, especially national-level EWSs set up in Africa in the wake of the 1984-85 famine; at that time the overriding objective was to prevent such a catastrophe from happening ever again. However, as many of these EWSs have evolved over the years, they have strayed away from being strictly famine-oriented and have developed a broader range of indicators which are relevant for continuous food-security monitoring. Indeed, large-scale famine is, fortunately, quite a rare event in most countries, which means that a purely famine-oriented EWS would be redundant much of the time.

Nevertheless, these EWSs tend to continue using famine as their reference point to describe food security conditions, and to make recommendations which implicitly respond to famine, e.g., the distribution of free food aid. This is largely a function of how the international relief system works, which many EWSs are set up to serve (see section B. below). The drawback is that the EWS is used for very narrowly defined objectives, which no longer fully exploit its predictive capacity. It could be used more usefully to detect localized pockets of acute food stress, and to recommend a variety of more appropriate interventions. The challenge is how to broaden the remit of EWSs, away from a restricted famine orientation, while still maintaining the capability to warn of large-scale famine, should it occur.

As a generalization, local-level EWSs are usually the least "famine oriented," and the most "food security oriented," partly because they are not so strongly linked into the international relief system, and partly because they are often part of a development, rather than relief, project or program, e.g., the SADS in Mali.

Categorizing EWSs according to how they measure food security

Many EWSs set up in the 1970s started off with a strong supply-side focus, measuring food
production and other determinants of food supply, because these were seen to be the main causes of food insecurity. In many ways, EW capability in terms of food production and food supply forecasts is still the best-developed capability, and a number of EWSs still tend to be food-supply driven.

During the 1980s, research which contributed to an improved understanding of the causes of famine shifted the focus of attention to factors which determine "access to food" and purchasing power. Analysis also became more "people-oriented," in terms of understanding a local people's sequence of coping strategies in the face of increased food insecurity. This has had an influence on recent developments in EW. Many EWs have now developed multi-indicator models, and have incorporated a much wider range of socioeconomic indicators than ever before. Some of these indicators are hard to quantify and, indeed, are difficult to monitor. More work needs to be done on ways of recognizing and measuring coping strategies, and on using qualitative information which is often accorded low credibility by information users and is, therefore, overlooked.

Famine in Africa is increasingly associated with conflict, worst of all when it coincides with drought. So far, this is uncharted territory for formal EWSs. The challenges of providing EW of famine in conflict situations are immense, not least because of political sensitivities which could undermine the "technical neutrality" that most EWSs strive to preserve. Yet there are already growing demands for EWSs to enter this arena. This may be the direction EWSs are pushed toward, at least in many countries in Africa in the next several years.

*The limitations of EWSs: What they are not*

EWSs may warn of impending famine or food crisis, but they are no guarantee that it will be prevented. It is important to recognize that they are not some kind of "technical fix." After widespread famine in Africa in the mid-1980s, it was easy to blame a lack of information for the failure to launch timely responses. The second half of the 1980s was a boom-time for the industry of famine early warning. But has this made us any better at preventing famine? We can rarely claim any more that "we don't know" when famine or food crisis threatens, but the record of timely response does not seem to have matched the improvements in predictive capabilities.

Secondly, information is not a pure public good. On the contrary, it has potential political value. This is very important in determining how the information is used - indeed, even if it is allowed to be freely circulated. The heated, acrimonious, and (in terms of time lost) wasteful debate at the end of 1990 about food security conditions in Sudan is a good example. EW information became a pawn in political wrangling between the Sudanese government and donors: was this a food gap, or a fully blown emergency, and what public statements had to be made before the international relief system felt able to intervene (Buchanan-Smith and Petty, 1992)?

Finally, formal EWSs in Africa are rarely run by the people whom they are supposed to serve - the potential victims of famine. This is important in terms of the accountability of the EWS. The people running it do not necessarily have the same vested interest in making it work, because their very survival does not depend upon its success. Yet the real victims of famine are usually far removed from the process of decision-making, on the basis of data extracted from them by those involved in the EWS. Although African national governments have an interest in preventing famine within their own countries, that interest is part of a wider political, economic, and social agenda. In many cases, these governments are not directly accountable to famine-prone populations.
Can an EWS Prevent Famine? - Constraints on the Effectiveness of an EWS

As mentioned earlier, the principal problem is no longer not knowing why, when, or where food crises are threatening; it is ensuring that the information is used to best advantage, to elicit a timely and appropriate response. A research project carried out by the Institute for Development Studies (IDS) and Save the Children Fund - UK (SCF-UK) in five countries in the Sahel and Horn of Africa looked at how EW information was used, particularly within donor agencies. The following issues emerged as some of the key determinants of whether, and how, EW information has been translated into timely action: (For a full list of triggers and barriers to information use and these research results, refer to the project's documents, especially Buchanan-Smith, Davies and Petty, 1992).

1. Ownership of information

Who "owns" an EWS is critical to how the information is used. An EWS which is entirely "owned" (conceived, staffed, and funded) by a national government is unlikely to hold sway with international donors. This is especially so where donor/government relations are strained. For instance, this was the case in Ethiopia for years, especially under the Mengistu regime, where EW information from the national EWS was treated with skepticism by the international donor community, which more or less ignored it. The information upon which the international donors depend usually has to have the imprimatur of the Food and Agricultural Organization (FAO) or the World Food Programme (WFP) in order to be viewed as credible (Buchanan-Smith and Petty, 1992).

This can seriously undermine a national EWS, and can be wasteful of planning time if national EW information is held in abeyance until the respective UN agency has done its own harvest- or food-needs assessment. Is the answer to go for joint ownership of an EWS, where both national government and international donors have a vested interest, and are therefore more likely to heed the system's warnings?

2. Simplified use of a single indicator

While many EWSs have become increasingly sophisticated and have developed multi-indicator models, it is perhaps surprising to find that information-users pay so much attention to a single indicator, the harvest assessment. This indicator is usually presented in the form of the food-balance sheet, which seems to be particularly influential, at least in triggering relief decision-making related to relief efforts.

The harvest assessment is usually performed by FAO, thus fulfilling the requirement described above in point (1): it bears the international stamp of credibility. However, it also appears that decisionmakers are often swamped with information and tend to gravitate toward simple, straightforward messages. Crop production indicators are believed to be non-controversial, are quantitative, and provide a good basis for comparison. Yet, decisions that are delayed until the harvest assessment has been undertaken do not necessarily guarantee the timely delivery of relief, especially if the relief is food aid mobilized in either Europe or the US (see point 4 below). Frequently, other indicators have warned of deteriorating food insecurity long before the harvest assessment results are available, but they have not triggered response decision-making. This was the case in both Chad and Sudan in 1990-91.

There is clearly an imbalance between what an EWS is able to provide and how the information is actually used.
3. The influence of crisis indicators

Donors appear to be most influenced by downstream rather than upstream events. There is evidence that crisis indicators have an exaggerated influence on donor decision-making, over and above genuine early warning indicators. The urgency with which a response is treated is too often contingent on signs that a crisis is already underway. Human stress is most influential as a crisis indicator, usually expressed in terms of high rates of malnutrition, or worse still - increased mortality. This defeats the object of early warning. Crisis indicators are signals of the failure to respond in time. Yet, an analysis of how EW information was used in both Sudan and Chad in 1990-91 reveals this tendency (Buchanan-Smith and Petty, 1992a; Buchanan-Smith, 1992). The danger is that those trying to trigger donor response may bid up the severity of the situation to provoke action. This tactic can eventually backfire if exaggerated prophecies are not fulfilled.

4. Lack of synchronization between need and donor-level bureaucratic procedures

The timing of donor decision-making is frequently too late to ensure that food aid - the usual relief response - can be delivered from Europe or the US to beneficiaries in Africa, before the start of the "hungry season." For example, for the Sahel and for the Horn of Africa, January is the main decision-making month, after the results of the annual harvest assessments are made available. This presupposes that the time to respond, once decisions have been taken, is less than six months. Evidence from Sudan, Ethiopia, and Chad in 1990-91 shows the time-lag to be much longer, especially where beneficiaries have to be reached far inland, often in remote areas.

In short, bureaucratic procedures in donor agency headquarters are not geared to the needs of recipient governments or people in Africa. The current schedule of decision-making and delivery time for most donor agencies - at least for the Sahel and the Horn of Africa - fundamentally undermines the purpose of early warning: most of the food simply arrives too late.

How to ensure EW information is better used

In developing EWSs, a tension sometimes exists between how the generators of the EW information feel they can improve their product and what the users of information actually want. It is clear from the points made above that there exists a gulf between the broad range of EW information that is currently available and the narrow range of information that tends to be used.

The dilemma for EW practitioners is whether they should simply be responsive to the demands of decision-makers, or whether they should be proactive and try to influence how their information is used and the kinds of interventions launched in response.

How far should an EWS expand its remit beyond issuing early warnings, to making recommendations for action and even entering the decision-making domain? To what extent should we continue perfecting EW indicators, and to what extent should we turn our attention to the response agenda and focus our efforts on improving that? Or should moves in both directions proceed hand-in-hand? These are some of the issues we need to address to make sure better EW information leads to improved famine prevention.

References


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Is a Better Forecast the Answer to Better Food Security?  
To Better Early Warning? To Better Famine Prevention?

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Introduction

According to the dictates of conventional wisdom, the more accurately we are able to predict short- and long-term changes in climate (and weather), the more likely we are to be able to manage the impact of these changes on food security, particularly among the poor and vulnerable. This conviction, moreover, has given rise to an entire industry dedicated to more effective forecasting. In view of the persistence of food insecurity and famine in many parts of the world, however, valid questions may be posed as to whether greater investment in the forecasting industry really does lead to more effective early warning systems and hence to the reduced threat of famine. Still further questions may be posed as to whether the mere existence of effective early warning systems does not, in some respects, distract attention from the more fundamental determinants of poverty and hunger, and whether forecasting focuses undue attention on the symptoms of famine rather than on its causes.

In examining this issue we need to desegregate the various components of the question - forecasting and early warning, food security and famine prevention - and thereafter establish what linkages (if any) exist between them.

What Are the Causes of Famine?

Inverting the order of questioning, it is useful to reconsider what the primary determinants of famine are believed to be. Distinctions are sometimes drawn between so-called "man-made" famines and those that are caused "by nature." This approach attempts to distinguish between those famines precipitated by some natural event (such as a drought or a flood), and those which occur as a consequence of some form of social change (for example, war or the collapse of local or regional markets). However, while it is necessary to recognize the approximate impact of nature in the development of famine, it is profoundly misleading to draw a distinction between famines that are precipitated by "natural" forces and those that emerge as an outcome of human activity. This is because we know that famine is, first and foremost, a social phenomenon (the inability of large segments of a society to gain access to food), which may be mediated by natural forces or social processes (singularly or in tandem). The impact of a natural occurrence such as drought, thus, is likely to depend more on the way in which a society is organized than on the natural event itself. This is perhaps most obviously illustrated by the fact that many societies continue to survive and thrive in areas of endemic drought or where there is little or no rainfall.

It was Amartya Sen, in his seminal work, Poverty and Famines (1981), who drew public attention to the fact that famine can, and often does, occur where there is no overall shortage of food. Sen pointed out that when an individual household’s "entitlement" (that is, its ability to acquire food through the legal means available in a society) is eroded because of a fall in asset ownership (crops, livestock,
property, job, etc.) its members will, if not protected by some form of social security, face starvation no matter what the prevailing food situation might be. To an extent, Sen shifted the focus of attention from a geographic region to a household unit of analysis. This approach went some way in theorizing what now seems obvious: why drought affects different groups in different ways within the same locality.

Household Food Security and Vulnerability

The manner in which households secure access to food (their entitlement) varies considerably within and between communities in any given country. While some secure their needs through domestic production, others achieve them through wage labor. In all instances the ability of households to mobilize resources (and hence to secure the acquisition of food) will be mediated by an array of factors including their social class, ethnicity, access to education, access to credit, markets, extension services, etc. Threats to food security, thus, are not solely a function of production failure at the household level, but also of institutional and policy failure. To that extent, household food insecurity and rural poverty cannot be seen as short-term crises but rather as the outcome of long-term trends resulting from the failure of policy, and from the political orientation and priorities of those in power. That is to say, the ability of rural households (in particular) to achieve some form of food security is as much determined by the relations of power in society as it is by physical factors such as climate and the resource endowment of the country.

Much has been written on the political economy of underdevelopment, and the debate continues. Theories on the structural determinants of underdevelopment (in whatever form), nevertheless, remain convincing and are reinforced by the fact that poverty is an enduring feature of much of the Third World. Since the poor lack resources and generally live at the margins of food security, the onset of any major (or even minor) changes in climate is likely to affect them adversely. Thus, the distinction between drought-induced poverty and chronic ("normal") poverty, much favored by drought relief planners, is unnecessarily nuanced. In any given society, it follows that there are always those households which are by their very nature vulnerable to external shocks such as drought. Such households require effective safety nets to support them through periods of hardships, perhaps more than they need an advanced warning of its advent.

It must, however, be noted that, despite the importance of Sen’s entitlement theory, the approach has tended to play down the significance of food shortage as a major determinant of famine to an excessive degree. While famines clearly can emerge in circumstances where there has been no significant decline in the availability of food, recent studies (Adams, 1993; Devereux, 1993) have shown that a decline in the overall availability of food (for example, through drought-induced crop failure) can, both directly and indirectly, precipitate famine. This causal chain is illustrated, for example, in situations where poor harvests due to drought lead to a decline in wage labor opportunities and, hence, both to declining entitlements of wage laborers and also to rising food prices. This caveat notwithstanding, entitlement theory has alerted us to the fact that it is not possible to predict the likelihood of certain types of famines from purely natural trends. Furthermore, knowledge of the onset of adverse climatic conditions or even of recurring trends, of itself, is insufficient to reduce the risk of famine. What is of critical importance in this context, is how the information generated is received and how it is acted upon.

Early Warning Systems - Are They Early and Do They Warn?

One of the most favored governmental responses to threat of famine is the establishment of an early warning system. Walker (1989), in an examination of early warning systems, identifies four key
components of a successful system. These are as follows:

1. Detecting, evaluating and predicting a hazard: This involves the array of "tools" used in the process of forecasting, including those related to climate (e.g., remote sensing) and food availability (e.g., nutritional surveillance, food balance models);

2. Constructing a forecast or warning message: This entails the preparation of warnings that are easily understood, which specify the exact nature of the impending threat, which identify those most at risk, and which are consistent in their emphasis (i.e., not contradictory);

3. Spreading the warning message: To be effective, information on an impending hazard must not only be accurate but must also be communicated through the correct channels;

4. Creating effective preparedness and mitigating responses.

For a warning system to operate effectively, all of the above conditions must be met. Thus, no matter how efficient meteorological forecasts might be, their impact is likely to be muted if the message is inaccurately or improperly transmitted. At the same time, accurate warnings will have little effect, if the right forms of intervention are not made or if the population is so ill-prepared that it is incapable of coping with exogenous shocks.

Over and above the unavoidable fact that early warning systems tend to treat symptoms rather than causes, their effective implementation is always problematic in societies which lack resources and in which administrative capacity is limited. Typically, coverage at the national level is partial (e.g., more remote communities, which are often amongst the most vulnerable, are monitored irregularly), or data collection is not accurate (e.g., the collection of anthropometric data, for example, is frequently inaccurate), or it is not timely, is not well processed, or is not disseminated to policymakers, or, if received, is not acted upon.

There is also the added danger that the establishment of an early warning system can serve political ends as much as it serves as a guide to famine prevention. In this respect it is noteworthy that most early warning systems are set up after a country has experienced a major drought. This is in part due to the availability of drought relief aid at the time (which is often targeted towards the establishment of warning systems), and in part to the government's attempts to reassure the general public that it has the situation under control and will not again be caught unawares. In such circumstances, the establishment of an early warning system may, in practice, prove to be a mandate for inaction, since equivalent attention is seldom paid to the primary determinants of famine and starvation: underdevelopment, household food insecurity, and vulnerability.

Conclusion

By its very nature, the forecasting process tends to focus on the natural determinants of famine, and in so doing it distracts attention from the factors which shape societal and household vulnerability to famine, the majority of which are determined by human activity. That is to say, there is frequently a danger that forecasting can become an end in itself, detached from many of the social processes that give rise to hunger and starvation. The arguments raised in this discussion, however, are not intended to dismiss the need either for forecasting or for early warning systems. Rather, they are an attempt to place these activities in a truer perspective. The existence of better forecasting and better early warning will
facilitate the implementation of better anti-famine measures, but only if a range of other factors are met. Most obviously, the more food secure and less vulnerable communities are, the more effective will such systems be in preventing famine.

References


ENSO and Its Prediction:
How Well Can We Forecast It?

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Introduction: What Is ENSO and What Does It Do?

The weather this season is not the same as it was a year ago, and common experience leads us to expect that it will also be different a year hence. None of us, including the experts in long-range forecasting, have a reliable idea of how it will differ.

Some of the year-to-year variations in climate are the result of random sequences of events, just as a series of coin flips will occasionally produce a long run of heads. A region may experience a dry spell because no storms happen to pass that way for a time. Prediction of such random events is not possible. However, many climatic variations are part of patterns that are coherent on a large scale. Skillful prediction is a possibility in such cases, especially when the patterns are forced by observable changes in surface conditions such as sea surface temperature (SST).

The most dramatic, most energetic and best-defined pattern of interannual variability is the global set of climatic anomalies referred to as ENSO, an acronym derived from its oceanographic component, El Niño, and its atmospheric component, the Southern Oscillation. The 1982-83 ENSO event was the most extreme in at least a century. Equatorial waters from the South American coast to the dateline warmed by an average of 2 deg C, with the warming along the coast exceeding 6 deg C. The trade winds actually reversed. The climatic consequences of this event were often devastating (See Figure 1). In Australia the worst drought ever recorded spawned firestorms that incinerated whole towns; normally arid regions of Peru and Ecuador were inundated by as much as 3 feet of rain; the beaches of California were rearranged by the unusual winter storms; drastic changes in the tropical Pacific Ocean resulted in mass mortality of fish and bird life. All in all, it has been estimated that the 1982-83 ENSO event was responsible for $8 billion in damages and the loss of two thousand lives (Hilts, 1983).

On the average there is an ENSO event about every four years, but the cycle is highly irregular. Sometimes there are only two years between events, sometimes almost a decade. There are great variations in amplitude. Though each episode has its own peculiarities, all follow a general pattern. At an early stage, anomalously warm surface waters are found in the western equatorial Pacific. Associated with the warmer surface temperatures is an increase in convective (cloud-producing) activity, and at a certain stage, a persistent slackening of the normally westward-flowing trade winds. Following this is a dramatic and expansive warming of the tropical Pacific Ocean from the dateline to the South American coast, and a further disruption of the trade winds. Very heavy rains fall in normally arid regions of Peru and Ecuador, while droughts are experienced in Australia and anomalous tropical cyclones occur in regions such as French Polynesia and Hawaii. Farther away, there are often disruptions of the Indian monsoon; the seasonal rains of northeast Brazil, and in more severe instances, regional climates over much of East and Southeast Asia, North America, and southern and northeastern Africa are affected.
Figure 1. Effects of El Niño. The maps show the climatic anomalies attributed to the 1982–83 El Niño, and which persisted for a season or longer in the 1982–84 period. Similar departures from normal occurred during previous ENSO events. As a rule, the anomalies in and around the tropical Pacific are invariable accompaniments of El Niño, while those in the rest of the tropics are usual, and those in temperate latitudes are frequent occurrences in El Niño years.

Figure 2. The correlation (X10) of the annual mean sea-level pressures with those for Darwin, Australia (After K. Trenberth). Note the high negative correlations over Tahiti, which show the basis of the Tahiti-Darwin pressure difference as a Southern Oscillation Index (SOI).

Figure 3. Curves for an index of El Niño (standardized Puerto Chicana, Peru, sea surface temperature (SST) anomalies – solid curve) and the Southern Oscillation (Tahiti minus Darwin surface pressure-difference anomaly – dashed curve). The values have been "standardized" by dividing the monthly anomaly values by their long-term standard deviation. (After E. Rasmusson)
Figure 4. Prediction of El Niño one year in advance: Comparison of observed sea surface temperature anomalies (SSTA) for January 1987 and that predicted by the Lamont atmosphere-ocean model from one year ahead.
Historically, El Niño refers to a massive warming of the coastal waters off Ecuador and Peru in the eastern equatorial Pacific Ocean. This warming leads to widespread mortality of fish and sea birds, and has in the past had crippling effects on national as well as local economies. The heavy rainfall associated with the event results in catastrophic flooding in coastal land areas, especially in northern Peru. El Niño occurrences have been documented, through the use of proxy information, as far back as 1726 by some researchers (Quinn et al., 1987). It appears that El Niño rainfall a century earlier made it possible for the conquistadors to cross an otherwise impenetrable desert (Sears, 1895).

The atmospheric component of ENSO, the Southern Oscillation, is a more recent discovery. The seminal figure in delineating it was Sir Gilbert Walker, the Director-General of Observatories in India. Walker assumed his post in 1904, shortly after the devastating Indian famine that resulted from the failure of the monsoon in 1899 (an El Niño year); he set out to predict the monsoon's fluctuations, an activity begun by his predecessors after the disastrous monsoon of 1877 (also an El Niño year). Walker was aware of work indicating swings of sea level pressure from South America to the Indian-Australian region and back over a period of several years (Figures 2, 3). In the next 30 years he added correlates from around the globe to this primary manifestation of the Southern Oscillation. For example, he found that periods of low Southern Oscillation Index (Figure 3) are characterized by heavy rainfall in the central equatorial Pacific, drought in India, warm winters in southwestern Canada, and cold ones in the southeastern U.S. No conceptual framework supported the patterns he found; Walker's methods were strictly empirical. Probably the very thoroughness of his search, together with the short duration of the records then available, made it easier for others to dismiss his findings as mere artifact.

Within the past few years Walker's global correlations have been re-examined with decades of new, independent data and were found to hold. Walker did not consider El Niño, and although both El Niño and the Southern Oscillation had been known at the turn of the century, it was only in the 1960s that the close connection between the two was finally appreciated (see Figure 3). It was principally through the work of Jacob Bjerknes that this relationship came to be appreciated.

Bjerknes did more than point out the empirical relation between the two; he also proposed an explanation which depends on a two-way coupling between the atmosphere and ocean. His ideas were prompted by observations of large-scale anomalies in the atmosphere and the tropical Pacific Ocean during 1957-58, the International Geophysical Year. A major El Niño occurred in those years, bringing with it all the atmospheric changes connected to a low Southern Oscillation Index. It is implausible that a warming confined to coastal waters off South America could cause global changes in the atmosphere, but the 1957 data showed that the rise in sea surface temperature (SST) was not confined to the coast. Bjerknes suggested that this feature was common to all El Niño events; he was correct, and the term "El Niño" is now often used to denote basin-scale oceanic changes. In his account of the connection between the ocean and atmosphere, the coastal events constituting El Niño are incidental to the important oceanic change, the warming of the tropical Pacific over a quarter of the circumference of the Earth.

Bjerknes suggested a tropical coupling between El Niño and the Southern Oscillation; he also proposed that the changes in atmospheric heating associated with tropical Pacific SST anomalies cause changes in mid-latitude circulation patterns. This teleconnection idea is consistent with the global nature of Walker's Southern Oscillation. However, in his theory the causes of ENSO are rooted solely in the coupling of the atmosphere and ocean in the tropical Pacific. They are internal to the climate system, not responses to volcanic eruptions, solar variations, biological activity, etc.

Work in the past two decades, especially that under the auspices of the international TOGA
(Tropical Ocean Global Atmosphere) Programme, has provided theoretical and observational support for Bjerknes’ concept. An essential addition, equatorial ocean dynamics, was introduced by Klaus Wyrkti in the 1970s on the basis of data from a network of Pacific island tide gauges. The first model to successfully simulate ENSO, that of Zebiak and Cane (1987), was based explicitly on the Bjerknes-Wyrkti hypothesis.

This numerical ENSO model depicts in a simplified manner the evolution of the tropical Pacific Ocean and overlying atmosphere. It is a dynamical model, rather than a statistical one: that is, it relies on the governing physical equation rather than simply a sequence of observations. Such dynamical models also provide a means for physical interpretation and understanding of whatever they simulate. One of the most significant results of the model simulations was the recurrence of ENSO at irregular intervals as a result of strictly internal processes; that is, without any imposed perturbations. Analysis of the model helped in developing a now widely accepted theory that treats ENSO as an internal mode of oscillation of the coupled atmosphere-ocean system, perpetuated by a continuous imbalance between the tightly coupled surface winds and temperatures on the one hand, and the more sluggish subsurface heat reservoir on the other.

**Prediction**

_Predicting ENSO_ - This theory has a number of implications for the prediction of El Niño events. First, since the essential interactions take place in the tropical Pacific, data from that region alone may be sufficient for forecasting. Second, the memory of the coupled system resides in the ocean. Anomalies in the atmosphere are dissipated far too quickly to persist from one El Niño event to the next. The surface layers of the ocean are also too transitory. Hence, the memory must be in the subsurface ocean thermal structure. The crucial set of information for El Niño forecasts is the spatial variation of the depth of the thermocline in the tropical Pacific Ocean. (The thermocline is the thin region of rapid temperature change separating the warm waters of the upper ocean from the cold waters of the abyssal ocean.)

Starting with experimental studies in 1985, our group at Lamont-Doherty Earth Observatory of Columbia University has used the Zebiak-Cane model not only to simulate, but also to predict El Niño. As noted above, theory argued for a deterministic origin of ENSO; that is, a systematic evolution throughout the cycle rather than a sequence of random events. However, even deterministic systems that are chaotic have limited predictability, and in this case the situation was made worse by a very poor observational base over vast regions of the tropical Pacific. It was with some skepticism that we first undertook retrospective forecasts.

_Retrospective Predictions_ - Forecasts were made by utilizing observations of surface winds over the ocean, beginning in 1964. On the basis of these wind data we ran the ocean component of the model to generate currents, thermocline depths, and temperatures that served as initial conditions for forecasts - a necessary step because of the lack of direct observations of oceanic variables. Each forecast then consisted of choosing the conditions corresponding to a particular time and running the coupled model ahead to predict the evolution of the combined ocean-atmosphere system. By making predictions based on past periods, we could compare forecasts directly with reality. This we did, starting with 1970. The results clearly demonstrated a predictive skill at least times longer than one year. This set the stage for the first predictions of the future, made in early 1986, which called unambiguously for an El Niño occurrence later that year.

1986 _El Niño Predicted_ - Making public forecasts did not receive universal approval at the time, as
Figure 7. The performance of the coupled general circulation model (Ji et al., 1994) for forecasts with August initial conditions (a), December initial conditions (b) and March initial conditions (c). Plus and minus one r.m.s. error is shown by the height of the vertical line on each point. Each point represents the monthly mean forecast SSTA in the Niño-3 region for consecutive months of a forecast. In each cluster of points the first point is the mean SSTA of the first month of the forecast (zero lead forecast).
Figure 5 Model forecasts (dashed line) and observed (solid line) NINO3 SST anomalies (C), from 1970 to 1989. The zero-month lead forecast is actually the initial condition generated by the ocean model forced by observed winds (From Cane, 1991).

Figure 6 A summary of the forecasting skill of the ZC model based procedure of Cane et al. (1989). Shown is the correlation coefficient of forecast and observed NINO3 SST anomalies at lead times for 0 to 24 months. The correlation values are also shown. A value of 0.5 marks a forecast with the same error variance as a climatological forecast.
even the notion of climate predictability on the time scale of a year was not generally accepted. After what seemed like imminent failure during mid-year, however, conditions evolved rapidly into El Niño during the fall. Figure 4 shows the sea surface temperature anomalies for January 1987 as observed, and as predicted, in early 1986. Differences in timing and other details showed that the prediction scheme was far from perfect, while the mere appearance of El Niño proved it successful.

Figures 5 and 6 illustrate the overall performance of the Lamont forecasts in terms of a widely used index of ENSO events, the sea surface temperature anomaly in the NINO3 region of the eastern equatorial Pacific (90 deg W-150 deg W, 5 deg S-5 deg N). The model has generally been successful in forecasting the major events (1972, '76, '82, '86 and '91) a year or more ahead but has little skill in predicting smaller fluctuations (some of which may influence climate elsewhere on the globe).

Over the past years, truly remarkable strides have been made in mobilizing climate prediction. There are presently several research groups doing routine ENSO prediction using a variety of methods. Regular observational updates for the tropical Pacific and summaries of forecast results are published monthly in the Climate Diagnostics Bulletin (available from the Climate Analysis Center of NOAA, Washington, D.C.). This information has been used by groups in Peru, Northeast Brazil, India, China, Ethiopia, the United States, Australia, and elsewhere to suggest actions to mitigate the effects of the local climatic variations associated with ENSO.

**Future Prospects**

More sophisticated and effective prediction procedures are emerging rapidly. Figure 7 shows the performance at six-month lead time of one of these, the coupled general circulation model being run at the U.S. National Meteorological Center (NMC). The atmospheric component of this model is taken from the NMC weather prediction system. A state-of-the-art procedure for creating fields of oceanic initial conditions takes advantage of the vastly expanded tropical Pacific Ocean data sets available from the observational network brought into being by the TOGA programme (whose primary objective is the prediction of climate on time scales of months to years). This prediction scheme successfully forecast the warming in early 1993, a feature all other schemes failed to predict correctly.

The future is bright. The possibility of long-range climate prediction has been demonstrated. There is much room for improvement in prediction models, and rapid strides are being taken to incorporate existing technologies from weather prediction and elsewhere. A better observing system is critical but is attainable if the momentum generated by the TOGA programme can be sustained. Finally, an international group of scientists has put forward a proposal for an International Research Institute for Climate Prediction (IRICP) to capitalize on the progress of ENSO prediction and ensure that it is adapted to the needs of all impacted nations.

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Early Warning and Response

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While the themes put forward in this chapter are not new, I believe that they need to be considered in any discussion of famine early warning systems. "Lessons learned" do not necessarily equal "lessons applied." Above all, this relates to the statement that early warning systems are of little value, if the capacity by societies or organizations to respond is not present. Disaster-prone areas must have available not only the ability to forecast natural calamities, but also the resources to react promptly and effectively when disaster does strike.

There is a great deal of attention and discussion under way focused on how to implement the continuum, - that is, to identify ways to forge the linkages among relief, recovery, and development activities. While this dialogue is very important, it is not enough. Too often the essential "front-end" elements of the continuum - mitigation, prevention, and preparedness - are overlooked, as are their relationships to the longer-term development goals of disaster-prone countries.

Against a backdrop of what some people see as increasing levels of socioeconomic vulnerability, growing gaps between food needs and domestic production, apparent increasing variability in global climate patterns (e.g., less predictability from one year to the next), and unprecedented (and still rising) demands on donor resources for emergency relief, disaster response must be made as effective and cost-conscious as possible.

Of all the natural disasters affecting Africa, drought imposes the greatest toll in human suffering and economic loss. The 1991-92 drought in southern Africa was the worst this century, placing the lives of at least 20 million people at risk to starvation. Unprecedented regional and international coordination, combined with the mobilization of significant resources by the Southern African Development Community (SADC) countries themselves and coping mechanisms by drought-affected individuals and communities, averted a major famine. Although the relief operation in southern Africa could be considered successful in many respects, it is important not to become complacent. The drought underscored just how vulnerable the economies of the region are to variations in rainfall, given their heavy reliance on rainfed agriculture and livestock production. As drought is a recurring phenomenon, efforts are underway to identify ways to enhance the capacity of the region to better stand on its own the next time such a disaster strikes.

It must be stressed that in 1992, early warning systems were successful in "sounding the alarms" with respect to the drought emergency. The message went out not only from the SADC early warning system (which comprises national units [NEWSUs] and a regional unit [REWU]) but also through the US Government's Famine Early Warning System. Responses to those alerts, however, varied considerably at the national, regional, and international levels. While some SADC governments took prompt action to mobilize resources for the emergency, a number of them lost valuable time before developing a national strategy or formally appealing for assistance. Although the US Government took steps very quickly to supply food to the region, many donors waited until the full extent of the drought had been confirmed.
A World Food Programme/SADC assessment in 1993 recommended that some improvements should be made in the method of estimation of food deficiencies used by the early warning systems and in the means for revising estimates as the relief efforts proceed. Given that a number of different early warning systems now provide information to sometimes different audiences, a strategy must be developed to integrate the outputs in such a way as to strengthen the credibility of the estimates of food deficits, thereby encouraging positive responses by donors to resource mobilization efforts.

At the onset of the 1991-92 drought, few countries in southern Africa had established disaster management capabilities. The drought served as a focus for national and local governments to work toward building a coordinated emergency response. A concern was expressed, following the return of the rains to most of the region in the following year, similar to those expressed following other drought emergencies - that the emergency coordination structures were demobilized prematurely. Experience that has been gained in a given drought episode is soon lost, as individuals seconded for these activities are redeployed to other emergency situations, and whatever management capacity (albeit limited) that did exist soon becomes dissolved.

In an effort to assist the governments of southern Africa to create and maintain quick-response capacities and effective emergency coordination mechanisms, SADC has assessed responses to the 1991-92 drought by its member states and organized a series of regional and national workshops to focus on the identified strengths and weaknesses in order to set an agenda for future preparedness action.

Of the principal natural disasters, drought is unique in terms of the length of time between the first indications that a drought may be developing and the point at which it begins to have an impact on populations of the affected areas. Although it cannot be prevented, its impact can certainly be lessened through properly designed and implemented preparedness measures. The SADC initiative builds on and complements efforts in the region by the Department of Humanitarian Affairs (DHA)/UNDP Disaster Management Training Programme which has been working with government, SADC, UN, and nongovernmental organization partners to develop country-specific disaster management plans.

In preparing the Drought Emergency in Southern Africa (DESA) appeal, it was clear that the southern African drought was not a one-dimensional emergency that could have been resolved by food aid alone. Donor assistance was also needed in order to prevent deterioration in the health and water sectors, in protecting livestock, and in ensuring the availability of agricultural inputs for the planting of crops for the next growing season. In this type of emergency, all partners in a relief effort must look closely at ways to reduce longer-term societal and household vulnerability and not simply to respond to a drought episode as an isolated crisis to be resolved on an ad hoc basis. They are recurrent phenomena.

Policy at both the national and regional levels must be redirected to incorporate planning for recurring drought. In recognition of the fact that drought has the potential to nullify rather rapidly hard-earned development gains and to impose severe costs, not only on groups that are directly affected, but also on the wider economy as a whole, donors and international financial institutions must encourage drought-prone countries to view drought management in the context of their longer-term development objectives. Similarly, there is a need to take a closer look at the possible implications of economic reform in the development context and the relationship to longer-term drought (as well as other disaster) mitigation activities. At a SADC workshop in the early 1990s, concern was expressed that structural adjustment programs (SAPs) may have reduced the capacity of governments in the region to support economic diversification, thereby increasing their vulnerability.
While development-based mitigation must be seen as a priority, it is also equally important not to re-invent the wheel. A substantial body of knowledge already exists in the Sahelian countries, in India, and elsewhere, on natural resource management and on agricultural research such as drought-resistant crop varieties. In efforts to foster South-South cooperation, the African Humanitarian Initiative proposed in the early 1990s was designed to promote collaboration in the areas of continent-wide capacity building, information exchange, and partnership with a focus on natural disasters and complex emergencies. Attention must be paid to the optimal utilization of available scarce resources.

One obvious, but necessary, statement is that preparedness capacities must be developed through an integrated multi-sectoral approach. Regional food reserves and strategic stockpiles for emergency relief distribution are elements that should be considered. Equally important, however, are preparedness plans for clean water supplies and for the strengthening of the health infrastructure. The recent droughts in southern Africa highlighted a number of structural needs in the health sector that were directly relevant to the effectiveness of emergency relief operations. National programs for general and supplementary feeding, as well as those for disease control, need the support of adequate systems of nutritional and epidemiological surveillance. The absence of quality baseline data was one of the factors which led to problems in targeting beneficiaries (e.g., at-risk groups) during the relief phase.

One sector in which the region had invested substantial resources prior to the drought-logistics turned out to be critical to the welfare of millions. Importing 11.6 million tonnes of food (a six-fold increase above normal) into the SADC region, a region which included six landlocked countries, necessitated a well-coordinated strategy utilizing all ports, land, and rail corridors. Much of the logistics system had benefited from donor-funded rehabilitation programs prior to the drought, and the enhanced capacity of the infrastructure was instrumental in the success of the relief operations.

It is important that partnerships forged among governments, regional organizations, the UN, and governmental and nongovernmental donors to combat regional drought be sustained to improve the quality of disaster preparedness, including early warning and response. Much remains to be done. Finding adequate resources required will not be easy. Both donors and national governments themselves must be convinced to invest in preparedness. Failing to do so ignores the reality that drought not only increases food insecurity but carries the potential for serious social, political, and economic disruptions. This is one of those very important lessons learned that must be applied.
Local-Level Data for use as Early Warning Indicators

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There is considerable debate on the appropriate design of early warning systems for the prediction of drought and famine in Africa. Much of the debate centers on the ability of current or prospective indicators to provide information that is location-specific, timely, and cost-effective. While macro-level environmental data are generally agreed to be useful, they are unable to distinguish with sufficient lead time those individual communities most in need of relief. The use of local-level indicators has, therefore, been suggested to provide information on deteriorating economic conditions and food supply at the village or sub-district level. However, the choice of indicators and how they are to be monitored in any given area remains controversial. This chapter presents some of the issues that surround the choice of appropriate local-level early warning indicators. It then examines a number of such indicators currently in use or suggested for use in Africa, concentrating on the role of economic, nutritional, and behavioral data in predicting crises.

What Should Indicators Do?

While there is general agreement that early warning indicators should predict food crises, there is little consensus on exactly what this means or how it should be accomplished. Issues still to be resolved in this debate include exactly what is to be predicted when, and for whom. Clearly, indicators should be chosen for their ability to discriminate among situations that need help from those that do not, a debate sometimes framed in terms of the specificity and sensitivity of different types of data (De Waal, 1988). A sensitive indicator is capable of picking out a high proportion of those situations where crisis will develop; a specific indicator identifies only those and no others. However, the ability of indicators to perform effectively is critically dependent on the definition of what is to be predicted.

What should indicators predict?

Early warning systems are oriented toward the prediction of famine, drought, or food shortage. Although these terms have the same underlying implications, they are not the same thing and may lead to differing expectations of what early warning indicators (and systems) should do. Global climatic data are increasingly used to predict drought, but drought may occur without famine and vice versa. Similarly, a food shortage may be widespread and long-term without being labeled a crisis. Even the term "famine" has numerous definitions. A perusal of Robson's (1981) volume on the ecology of famine produces at least seven different definitions of famine, all with differing implications for the triggering of relief efforts.

Most definitions of famine emphasize mortality. Cox, for example, defines famine as "the regional failure of food production or distribution systems, leading to sharply increased mortality due to starvation and associated disease" (Cox, 1981, p. 5). Similarly, Alamgir cites the United Nations Research Institute for Social Development (UNRISD) in defining famine as "a societal crisis induced by the breakdown of the accustomed availability of and access to basic foods, on a scale sufficient to
threaten the lives of a significant number of people" (Alamgir, 1981, p. 30). However, other definitions are less specific. Masefield (1963) includes definitions from the Shorter Oxford English Dictionary and the UN Food and Agriculture Organization (UNFAO); the former defines famine simply as extreme and general scarcity of food, while the latter specifies "a food situation in which there are clear indications, based on careful and impartial study, that serious catastrophe and extensive suffering will occur if international assistance is not rendered." In fact, D'Souza (1989) has argued that famine proper is largely characterized by massive social and economic disruption, and that it does not always lead to starvation.

While governments often treat famine as an event, Glantz (1994, p. 86) defines famine as "a process during which a sharp decline in nutritional status of at-risk populations leads to sharp increases in mortality and morbidity, as well as to an increase in the total number of people at risk." This emphasis on process underlines the importance of factors that predispose a population to acute food shortage. For early warning systems, the question then becomes one of defining where in the process intervention should be mounted. Should famine indicators merely identify the existence of a population at risk, or should they warn of a probable progression to increased mortality, or of irreversible economic and social damage to a community?

While the goals of early warning systems have been variously stated, most are designed in theory to give warning of impending serious food shortage for some population. The implication is that early knowledge of food scarcity will allow intervention before large numbers of people are seriously affected. Operationalizing these concepts will require agreement, first, on when a food shortage is serious. Some authors have insisted that only an increase in mortality can be used as a measure of serious shortage, while others use criterion measures such as increasing incidence of child malnutrition or decreased food availability for a high proportion of the population (De Waal, 1988; Mason et al., 1987). While at some level, the prevention of deaths is the goal, deaths occur late in the process and are the result of conditions other than lack of food. The indicators that will best predict generalized mortality are not likely to be those that will best predict short-term, widespread declines in food consumption.

For whom is prediction needed?

This is a question of spatial resolution, because different indicators provide information on potential food supply at different geographic scales. Macro-level data cannot necessarily be scaled down to provide information at the micro-level. For example, there is a large gap between information that might be provided by regional climate models and the information needed for purposes of the provision of food relief at the village or household level. Climatic information is available at the regional or sub-continental scale and may be useful for the prediction of rainfall patterns. At the national scale, food balance sheets, crop-climate models, volumes of crop sales, and market prices for crops and livestock provide data on aggregate food availability (Atwood, 1991). However, since national-level statistics are often compiled from district reports, they have the potential to be used in a disaggregated form. Indicators of economic activity (e.g., markets; prices) and health status (e.g., mortality; malnutrition) at the district level have been useful in targeting populations in need of relief efforts (Cutler, 1985; Morgan, 1985). Finer spatial resolution of such data, i.e., at the subdistrict or village level, may not be possible with existing structures for data collection and reporting. Given the variability of rainfall in time as well as space and the existing infrastructure within African countries, however, food supplies can vary considerably from one community to another. As Campbell (1990) argues, behavioral data such as asset sales or migration may provide a sensitive reflection of changing food availability at the village
or subdistrict level.

When are predictions needed?

There is considerable variation in the definition of "early" for early warning indicators. In addition, while information on changes in available food supplies should provide enough lead time for adequate response, the time needed for response at the national level (e.g., in order to pursue an increase in imports) may be very different from that needed for response at the local level. Again, climatic data and food balance sheets may provide relatively early indicators of potential problems, while social, behavioral, and mortality data may lag.

Morgan (1985) has made the useful distinction between "input" and "output" indicators. Input indicators include measures of food production potential, including rainfall, soil conditions, and crop and livestock growth, whereas output indicators deal with the food supply situation or the results of scarcity. Classes of output indicators include nutritional indices, behavioral indicators, and signals of economic activity. In general, one can say that input indicators provide earlier warning but only of the potential for problems.

While output data are considered more expensive to collect and more problematic to use, they provide information on actual conditions in specific areas and, thus, are essential for effective and efficient intervention in food crises. The remainder of this discussion considers the potential for using three types of output indicators as predictors of local-level food scarcity: (1) economic activity, (2) nutrition and health indices, and (3) behavioral strategies.

Local-Level Indicators

Economic activity

Market activity at the national, regional, and local levels has been used to signal an impending food shortage. In general, two aspects have been monitored: amounts of grain or livestock being traded, and changes in the prices of these commodities in the marketplace. These two aspects are, of course, connected, as changes in the volume of commodities brought to market affect their prices. One indication of impending famine is an unusually high or rapid increase in the price of staple food grains, as fewer farmers feel that they have surplus grain to sell (McCorkle, 1987; Walsh, 1986). At the same time, distress sales of livestock may result in a rapid drop in the market price of herd animals.

As with all local-level data, the interpretation of price changes in agricultural markets depends very much on local circumstances. Normal seasonal fluctuations in prices need to be considered, when assessing the meaning of sudden market shifts. Only increases that significantly exceed those expected for a given season can be considered as signs of unusual stress or food shortfall. In addition, livestock play very different roles in different subsistence systems, and, thus, their increased sale may denote different stages of distress (Cutler, 1986). For agriculturalists, sale of small stock may be a relatively early response, while pastoralists may resist the sale of stock until other preferred alternatives have been exhausted.

Variations in local circumstances mean that economic activities, as famine indicators, do not function equally well for all populations. Cutler (1985) shows that both the retail price of coarse rice and the demand for fertilizer served as accurate warning signals for famine conditions in Bangladesh in
1979. Similarly, McCorkle (1987) argues that flux in market prices of cereals and livestock is one of the most promising quantitative markers of famine onset in West Africa. Using data from Burkina Faso, she shows that the food crisis of 1983-84 was accurately signaled by a tripling of the price of sorghum, a sharp fall in the selling price of cattle, and an increase in the number of farmers defaulting on their advance sales agreements with grain merchants. By contrast, de Waal (1988) argues that economic indicators were poor predictors of famine for Darfur, Sudan, in 1984-85. Despite two complete harvest failures in northern Darfur and one in southern Darfur, economic data proved to be neither sensitive to nor specific in the prediction of increased mortality.

Market data are probably the most widely accepted (and sometimes the only) type of local-level data used for famine prediction. It is, therefore, worth examining de Waal's argument in greater detail. For his purposes, famines are divided into "famines" (food dearth) and "famines that kill." For him, only famines that produce excess mortality deserve early warning attention. He rightly notes that an effective early warning indicator should be reliably associated with the development of famine conditions. It should generate few responses to situations where famine does not actually develop ("false positive" responses) and should not fail to respond when an actual famine is approaching ("false negative" responses). In addition, the indicator should be truly early, that is, it should respond before excess deaths occur.

In Darfur, grain prices have so far generated no false negative predictions (de Waal, 1988) but have resulted historically in about 90% false positives. That is, grain prices in this region have often risen in response to shortages that did not result in excess deaths. In addition, the major price increase in 1984 occurred after the increase in child mortality had begun. Although prices rose 6-12 months before peak mortality, this was after the regional government had already predicted famine. The collapse in livestock prices did not occur until mid-1985, when the famine was at its peak and relief grain had already begun to arrive. Ironically, de Waal argues that the knowledge of impending famine on the part of peasants and herdsmen kept them from selling livestock until so far into the crisis that they were in dire need.

The Darfur case shows the importance of the definition of famine for judging the appropriateness of a given early warning indicator. There may be many other cases where unusual market activity signals an impending food shortage, but where traditional coping strategies function to prevent excess mortality. Clearly, market data will not serve to predict famine in cases where most grains and livestock are consumed within the household, or are otherwise not sold. In Botswana, the small portion of household production that is sold goes to the Agricultural Marketing Board, which provides producers with a guaranteed floor price (Morgan, 1985). Since much of Botswana’s grain is imported, prices for traded food are largely determined by import prices, rather than by local conditions. Similarly, cattle prices are affected mainly by the condition of export markets in Europe and South Africa. Thus, the utility of market data for famine prediction is highly dependent on local conditions.

**Nutritional and health indices**

Nutritional indices, such as weight-for-age or weight-for-height in children, are logical indicators of a worsening food supply. Such data have been used in early warning systems but are not without problems. The primary problems are (a) the timeliness of the warning, (b) the usefulness of the sample, and (c) the specificity of the information provided.

**Timeliness**
Measures of nutritional status can be both leading and lagging indicators. In a general sense, aggregate measures of nutritional status can serve as early markers of populations likely to be at risk of mortality if food scarcity occurs. High rates of growth faltering, as measured by low height- or weight-for-age, indicate that a population is already under stress and, thus, is one that may not have the resources to cope with crop failure or livestock loss. High background rates of stunting or underweight in preschool children may indicate chronic or recurring energy deficiency. They can be considered as overall markers of quality of life and are often associated with populations in remote areas or those with poor infrastructure, little access to land or cash (e.g., income), and inadequate sanitation and health services. Programs of nutritional surveillance can provide information on location, extent, and causes of background undernutrition, either through repeated sample surveys or through administrative records, e.g., from ongoing child-health services (Mason and Mitchell, 1987).

As measures of acute food shortage, nutritional indices are relatively late indicators. In contrast to chronic deficiency, acute shortage is reflected in ratios of weight to height. Since nutritional data for early warning systems often use administrative data, weight-for-height may not be available, and rates of low weight-for-age may have to be used. This is a less sensitive measure, but has the advantage of being widely collected by hospitals, clinics, and mother-child health services. Because of their relative lag, indicators of acute undernutrition are often seen as fail-safe or verification measures, that is, as indicators that stress in a given target area has already occurred, rather than as an early warning of potential food-related stress. Mason et al. (1987) have advocated the use of nutritional indices to test the predictive ability of other indicators. In Botswana, for example, deficits of groundwater and the condition of cattle were useful predictors of increases in child malnutrition. Excess malnutrition in July through January could be predicted by agricultural indices in May, but not by nutritional data until July (Mason et al., 1987).

Finally, the timeliness of warning depends not only on the behavior of the phenomenon being measured, but on the ability of the early warning system to collect and analyze data quickly. Nutritional data are often collected by health-care facilities and reported to the district or national level. Time lags may be introduced at each step of the process, from reporting at the clinic level to data analysis and dissemination at the level of a central bureaucracy.

Usefulness of the sample

For nutritional data to be useful as early warning indicators, they would have to provide information on the populations in need. If these are the rural poor in remote locations, increased prevalence of undernutrition may not come to the attention of data collectors. Furthermore, such populations may not be represented in data drawn from clinics or schools. Repeated special surveys may be the only way to monitor nutritional status in remote regions or among the truly vulnerable subgroups. Such surveys are considerably more expensive and time-consuming than the routine collection and use of administrative data, and may be seen as overtaxing the resources of many African countries.

Specificity of information

Measures such as height and weight are often used to indicate nutritional status, in that they are the outcomes of growth and nutrient storage. However, while adequate food is necessary for continued growth, it is not sufficient. Thus, measures of nutritional status based on body size are affected by many factors other than food consumption. Infectious disease is a major factor affecting rate of growth and body size, and has a well-known interaction with nutrient requirements. The increase in numbers of
underweight children during the rainy season in many tropical populations is the result less of food intake than of diarrheal disease. Respiratory and acute childhood infections may also cause weight loss and temporary growth faltering. Thus, it is difficult to interpret increased rates of malnutrition in a given area as solely meaning that food supply in that area has been compromised. Mason et al. (1987) suggest the use of deviations from the normal level of malnutrition at the worst season as an indicator of food shortage. This practice would serve to control for seasonal fluctuations in food supply, as well as background levels of weight loss because of illness.

As early warning indicators, infant and child mortality have many of the same drawbacks and provide much of the same information as measures of nutritional status. Aggregate statistics on infant mortality are underreported at best, and often reflect only hospital mortality. Census data, health-system reports, and special surveys can be used to target populations at risk, but mortality increases late in the onset of a food crisis and, thus, is of little use for advance warning. As in the case of growth-faltering, mortality in young children reflects overall living conditions and not just food supply. In the context of early warning systems, mortality data might best be used to validate the predictive capacity of other indicators.

*Behavioral indicators*

A number of authors have argued for the use of local-level behavioral and social science data as indicators of changes in food supply (Campbell, 1988; McCorkle, 1987; Torry, 1988). These data have the advantage of accurately reflecting conditions and responses at the level of the individual community, and should, therefore, be useful for targeting areas in need of intervention. While prices and other market data have been monitored at the local level, in general their behavior is too unpredictable to form reliable indicators of food crisis (Campbell, 1990). Instead, it may be desirable to monitor coping responses, that is, the sequential strategies that households use to fend off hunger and preserve their productive assets. Because these household responses are invoked hierarchically, they are useful indicators of the stage of crisis reached by different households within a community.

Watts (1983) has described the sequence of responses to drought in the West African Sahel as proceeding along a dual continuum of increasing commitment of household resources and decreasing reversibility. Using data from Watts and others (Cutler, 1986; De Waal and El-Amin, 1986; Rahmato, 1987), Corbett (1988, p. 1107) outlines three stages of coping responses during the onset of famine. This model provides a tool for analyzing the economic behavior of households as food shortage becomes an increasing threat.

**1. Stage One -- Insurance Mechanisms**

Changes in cropping and planting practices
Sale of small stock
Reduction of current consumption levels
Collection of wild foods
Use of interhousehold transfers and loans
Increased petty commodity production
Migration in search of employment
Sale of possessions (e.g., jewelry)

**2. Stage Two -- Disposal of Productive Assets**

Sale of livestock (e.g., oxen)
3. Stage Three -- Destitution
Distress migration

The stage that a household has reached by the time that relief is supplied has important implications for that household's economic recovery. Stage One responses involve little commitment of productive assets and, thus, are relatively reversible once a crisis (or threat of crisis) is past. These are the types of strategies that are often employed to ride out regularly recurring or seasonal shortages. Thus, because they do not discriminate between regularly experienced and crisis conditions, they may not be especially useful as early warning indicators. However, the further a household proceeds into Stage Two, the less likely it is to be able to recoup losses. An effective early warning indicator should, therefore, reflect the transition from Stage One to Stage Two for a substantial number of households. The early sale of plow oxen or agricultural tools might be such an indicator. Sale of household items such as corrugated roofs or metal cooking pots may be a transitional indicator in other areas. Insurance mechanisms such as wild-food use may also indicate the stage of desperation, in that many wild famine foods are unpalatable, toxic, or time-consuming to collect and process. The hierarchy of use of famine foods should proceed from those that are most desirable to those that are increasingly dangerous and difficult to process (Huss-Ashmore and Johnston, 1994). The use of toxic seeds and tubers may be a sign that food shortage has become serious.

A number of other factors need to be considered in the use of coping responses as early warning indicators. One is the variation within a particular population or community in the use of coping strategies (Campbell, 1990). Economic and social status, age, and gender alter the strategies available, their effectiveness, and the timing of their use in a developing food crisis. For an early warning system, it is important to determine whose responses permit the greatest reliability and the most timely warning of food shortage.

The poor generally have a smaller repertoire of alternatives available to them, both in terms of disposable assets and in terms of networks and food reserves. They are, therefore, more vulnerable than wealthier people to food shortage, and may reach the point of distress sales or migration earlier in the crisis. Similarly, the very young and the very old are more vulnerable. Children may drop out of school or be sent to eat or live with relatives, while the old may be seen as a burden. De Garine (1993) reports that, during famines among the Massa and Mussey of Cameroon, the elderly may be used as food tasters, to test the toxicity of wild foods. Since they are considered expendable, Maasai elderly in Kenya may simply leave their village during famine and go out to die (Campbell, 1984). Men and women may also respond differently and at different times. Campbell and Trechter (1982) reported that women responded during the first phase of shortage by seeking help from friends and relatives and then by reducing their own food intake. Such responses among men may indicate a more advanced stage of crisis.

A second consideration is the degree to which coping strategies change over time. Watts (1983) has argued that traditional strategies for coping with food shortages have become less effective as a result of colonial and post-colonial development. For example, Ogle and Grivetti (1985) have shown that knowledge of wild plant foods in Swaziland has declined from older to younger generations, as
education has been taken over by Western-style schools. In other areas, the difficulty of processing wild foods, as well as their unpalatability, have led to their abandonment if food can be bought instead (Laferriere, 1992). Where wage labor is available, it has often become the strategy of choice with young men and, then, other household members migrating in search of work (Campbell, 1990). Interestingly, while rural-urban migration is an increasingly common strategy, there is essentially no information on the coping strategies of urban residents during food crises. Urban residents in Africa are often closely tied to rural areas through economic and kinship links, but their role in food crisis management remains unexplored. The changing nature of options needs to be considered in any monitoring system, to ensure that the behavior being monitored reflects the opportunities that actually exist in a given area.

A third set of issues is the credibility of local behavioral data and the channels for its collection and transmission. Campbell (1990) suggests that behavioral data are more likely to be taken seriously if they are collected and reported by teachers or agricultural officers, individuals recognized by the central bureaucracy and the villagers as responsible observers with minimal political motive. The cost-effectiveness of simple behavioral observations for prediction of famines needs to be tested in varied settings and with different channels of communication to determine how these indicators perform.

Conclusion

While input indicators are generally accepted as accurate, reliable, and useful measures of potential food shortage, discussion continues on the appropriate use of output indicators, especially those that reflect conditions at the micro-level. Questions of timeliness, accuracy, and cost-effectiveness remain for many output indicators, including those based on measures of health and child nutrition. Behavioral indicators are hierarchically employed as famine worsens and, thus, may provide accurate information on local-level conditions. Since behavioral indicators may vary somewhat by location and by age/sex/income categories, local observers may be needed to decide the meaning of scarcity responses. The most effective way to collect and transmit such local information for use by early warning systems remains to be worked out and must be a priority for research and discussion.

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Eradicating Famines in Theory and Practice: Thoughts on Early Warning Systems

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Interest in Famine Early Warning Systems

In the foreword to J.O. Field’s recent book on famine, Jean Mayer, noted nutritionist and educator, wrote that “famine is the ultimate public health catastrophe. It is unfortunately a recurrent human phenomenon, even in modern times. Since the end of World War II, there has not been one year in which there was not a famine” (1993, p. ix). Lal Jayawardena, in his foreword to Hunger and Public Action (Dreze and Sen, 1989) noted the following:

No social or economic problem facing the world today is more urgent than that of hunger. While this distressing state of affairs is not new, its persistence in spite of the remarkable technological and productive advances of the twentieth century is nothing short of scandalous (p. viii).

Yet, despite the annual outbreak of famine somewhere on the globe, the need for famine early warning systems (FEWS) only recently captured the serious attention of various governments after the droughts throughout Africa of the early 1970s and, once again, as a result of the return of devastating African droughts of the mid-1980s. By now, tens of millions of dollars have gone into their formal development and maintenance.

Early warning systems clearly sound like a good idea whose time has come. With all the current talk about information revolutions and an information superhighway, in addition to improved remote sensing capabilities and Geographic Information Systems (GIS), it seems that (at least in theory) there is a way to end famine - but is there the will to do so?

Do we already know enough about famine’s causes, effects, indicators, and at-risk populations to block its occurrences? Do we really need more sophisticated and detailed information that would be generated by famine vulnerability maps, GIS, elaborate household food security surveys, and even famine early warning systems? Is the problem really a lack of detailed information? Or is it that we could use existing information in a more effective way? In other words, are we building a better mousetrap when we already know how to catch the mouse?

Famine, Hunger, and Food Security

Famine has many definitions. In this paper, it is viewed, in general, as a process during which a sharp decline in nutritional status of at-risk populations leads to sharp increases in mortality and morbidity, as well as to an increase in the total number of people at risk. It has also been viewed as an event; that is, an acute food shortage that has ended in widespread deaths and migration in search of
food. Although most people (myself included) tend to see these as conflicting definitions, J.O. Field (1993, p. 2) suggested that these views are complementary: "seeing famine as a process is important to detection and preemptive intervention. ... Seeing it as an event helps to define its emergence and also helps to distinguish famine from chronic malnutrition." Although they are not synonymous, the word "famine" has been used interchangeably with "hunger" and "food security."

_Hunger_ is the chronic food deprivation and resultant poor nutritional status of a given population, regardless of cause. O'Neill (1986) noted that: "The larger part of hunger is not dramatic. It shows itself in malnutrition, illness, and expectations of life which remain obstinately low and is the core of persistent and desperate poverty. Famine episodes are only the tip of an iceberg whose invisible and large part is endemic hunger and deprivation" (p. 12). She also noted that "the toll of famine is more spectacular and intense, that of destitution more widespread and persistent" (p. 1). Reinforcing this view, Lappé and Collins (1986, pp. 2-3) noted that, while chronic hunger doesn’t make the evening news, it takes more lives than famine." The demand for improvements of nutritional status among such a population in the Third World is growing. Therefore, in regions of chronic hunger, any additional food inputs could quickly be absorbed.

With regard to _food security_, "the most commonly used definition is that of the World Bank: 'food security' is ... access by all people at all times to enough food for an active, healthy life. Food insecurity, in turn, is the lack of access to enough food" (Davies et al., 1991, p. 5). Household food security suggests that a family can provide itself with adequate food supply without having to sell its productive assets (such as its oxen), referred to by Mortimore (1991, p. 12) as "a loss of productive capital and recovery capability (e.g., breeding livestock, seed or tree stocks, tools, perhaps soil fertility)." At the national level, food security refers to a country’s ability to maintain food supplies adequate to avoid any severe food shortages that might emerge.

**Early Warning Systems**

According to Murton (1991, p. 169), "the purpose of a warning system is to inform as many people as possible in an area-at-risk that a dangerous and/or damaging event is imminent and to alert them to actions that can be taken to avoid losses." And according to Field (1991, p. 152), "the practical challenge is not merely to anticipate a famine before it occurs, a daunting task in its own right, but to locate it spatially and socially so as to intervene on behalf of the people who most need protection." Definitions of famine can affect the operational goals of an early warning system (Davies et al., 1991, _passim_). What is to be monitored (nutrition, prices, income, rainfall, etc.) and when to intervene would be determined in large measure by the perception of what a famine is or about when to intervene. For example, as noted earlier, some view famine as an event (the onset of widespread starvation), while others see it as a slow process. Is the overriding goal of a system to forewarn national decisionmakers of acute food shortages that, in the absence of their intervention, could lead to starvation on a large scale? Or is it to warn donors about potential demands on their food aid supplies?

Some governments have earnestly sought to eradicate hunger within their borders. Some of them have shown concern for their hungry citizens by supporting the development of an early warning system. Some governments set up such systems just to know where the food-related problems might occur, without necessarily seeking to prevent or mitigate them. Others want to know where these problems might arise in order to resolve them. The monitoring of different combinations of perceived key indicators would be required for these and other differing goals.
Famine and Hunger Linkages

Governments are hard-pressed to argue against the notion of early warning of famine or against the strengthening of food security. They would also be unable to deny, as one of their goals, the eradication of hunger within their borders. Why, then, isn’t there a hunger early warning system?

The apparent truth of the matter is that, while there is seemingly a great interest in avoiding the outbreak of famines on one’s territory, there appears to be less real interest in resolving issues related to chronic hunger. Perhaps famines are seen by government bureaucrats as tractable problems, whereas hunger and food security are amorphous issues, requiring constant and considerable attention as well as resources.

How to end hunger has been plaguing rich and poor societies for millennia. Yet, acute food deprivation still occurs in all parts of the globe, although not among all parts of society. The rich, for example, are seldom inconvenienced by acute food shortages. If the avoidance of such deprivation had been an overriding concern of the international community, then the necessary political and financial resources would have been mustered to end chronic hunger.

Focusing on famines, however, may be easier for governments to accept. Famines are episodic events which have often been blamed, rightly or wrongly, on natural hazards such as droughts. In fact, famines usually erupt out of hunger and poverty. Hunger and poverty issues, however, are much more problematic for governments to deal with, as they are strongly linked to political issues such as land ownership and use, class dominance, politics, and economics. (Addressing those issues will also get at the roots of famines. Famines are to hunger as jacqueries are to revolutions. A jacquerie is an uprising to address a specific grievance, e.g., a sharp increase in the price of bread. Once their specific demand has been met by governments, the dissidents end their uprising. By analogy, once a famine has been ended, little attention goes to the deep roots of the problem.) As Dreze and Sen (1989, p. 261) noted, "endemic deprivation is also a more complex social condition, involving deep-rooted economic and social deficiencies. Eliminating it is a more difficult task than preventing famine."

Dreze and Sen (1989) distinguished between strategic choices related to famine and those related to hunger:

In the context of famine prevention the crucial need for speedy intervention and the scarcity of resources often call for a calculated reliance on existing distributional mechanisms ... to supplement the logistic capability of relief agencies. In the context of combating chronic hunger, on the other hand, there is much greater scope for slower but nonetheless powerful avenues of action such as institution building, legal reforms, asset redistribution, or provisioning in kind (pp. 7-8).

Strategies, tactics, and objectives for dealing with chronic hunger vary from one society to the next. There are many suggestions on how such objectives might be pursued, depending on national development strategies. For example, a government might choose to pursue an export-led development strategy, relying on the sale of its exports to finance its food purchases and agricultural development needs. Or it might seek self-sufficiency in food production, pursuing all-out food production in good years, and food storage in anticipation of poor production years (see Dreze and Sen, 1989, p. 18).
A famine early warning system could be viewed as the tactical part of a larger strategic plan to eradicate hunger. It is, in a strict sense, a system to identify when large numbers of chronically hungry people become stressed to the point that they become at higher risk to starvation. An early warning system provides a safety net to assure that famines, regardless of cause, do not develop. Thus, along with support for motherhood and the national flag, famine early warning systems (at least in theory) are held in high regard. Debates about them usually start over how they are used, or how well they operate, or how cost-effective they might be. Differences of opinion within and among researchers as well as governments on issues such as these tend to adversely affect the operations of such systems, thereby starving them of the funds necessary for effective operation.

One concern has been that in the absence of famines (regardless of the reasons for that absence), governments tend to lose interest in continuing their support for early warning activities. This may result from a belief that their policies have minimized the possibility of a future famine outbreak. Or, it may be because those operating an early warning system have difficulty proving that the reason that no famine occurred was the result of their system, as opposed to the fact that perhaps a famine had not really been in the making in the first place. J.O. Field (1991, p. 155) suggested that "the earlier the intervention, the less clear it is that a famine will actually occur. The fact that false positives abound is a political disincentive to act preemptively." This raises the issue of having to make decisions in the face of uncertainty. What is the tradeoff that is acceptable to decisionmakers between waiting for greater certainty that a famine might occur and timely action? On this, Field (p. 156) noted that "the dilemma facing early warning is that it is very difficult, perhaps impossible, to be definitive, clear, and compelling about something that does not yet exist. Ambiguity is inherent in famine prediction."

Early Warning Linkages to Long-term Development

Today, societies are faced with several "creeping" environmental problems such as air pollution, acid rain, ozone layer depletion, global warming, tropical deforestation, and soil erosion. One key characteristic they share is that a change in environmental quality today is not very different from yesterday's environmental quality and will likely not be that much different from tomorrow's. Yet, the quality of a slowly eroding environment in a few years will be noticeably different (Glantz, 1994).

More specifically, what are the long-term, low-grade, slow and cumulative physical and social changes that can adversely affect the sustained ability of a country or region to meet the food needs of its people, or to protect the land that feeds it? Such physical changes include, but are not limited to, the following: soil erosion, tree and bush cutting for firewood and construction, livestock grazing, multiyear and decadal-scale changes in climate variability (e.g., alternating wet and dry periods). (Decadal-scale changes in the frequency of ENSO events, and global climate change and its impacts on regional climate characteristics are also in this category.) Slow societal changes include, but are not limited to, population changes (voluntary and forced), changes in land-use preferences (e.g., conversion of rangelands to farmland), changes in land-use practices, and changes in food preferences.

Each of these physical and social changes reduces (imperceptibly at the time) the ability of the land to support the next and future generations. In addition, some of these changes place populations at increasingly higher risk to acute food deprivation during future droughts. (The notion of "drought follows the plow" provides an example. "Drought follows the plow" is based on the premise that the best rain-fed agricultural land is already in production, or has been put off-limits to production, for political or socioeconomic reasons. As the need for increasing the amount of farmland grows, people will tend to move into as-yet-uncultivated areas that are most likely increasingly marginal for sustained agricultural
production - marginal because of climatic, soil, and topographic factors. In the absence of necessary adjustments to these increasingly marginal areas by farmers' and governments' expectations about the types of crops to be grown and technologies to be used to grow them, farmers and their families will likely be at higher risk to acute food shortages in the event of drought. Such demographic changes, as people expand their human activities into marginal areas, need to be considered in the output of early warning systems.

Could the inclusion of such creeping changes in early warning systems provide a bridge that is needed to link rapid responses to famine early warnings with long-range development planning? Often, activities related to famine and to hunger are handled by separate bureaucracies, as well as mind-sets, with many observers seeing them as separate issues. Yet, they are clearly connected. Short-term responses to famine should be compatible with long-range development planning, lest they impair, if not preclude, the success of such planning. Hans Hurni (1988) wrote that:

the role of ecology in the creation of famines must be seen in its long-term rather than its short-term impacts. Due to millennia-old traditional land management and use, land resources and productivity potentials have already been considerably reduced in many parts of Ethiopia through deforestation, soil erosion, and fertility decline. This contributes considerably to the present level of famine vulnerability. Long-term trends ... give an even worse scenario indicating increased vulnerability in the future (p. 2).

To greatly reduce the risk of famines, the hunger issue one must be addressed and resolved. To eradicate hunger, food security issues must be resolved at the local and national levels. O'Neill (1986, p. 12) has asked, "how are episodes of famines linked to endemic" hunger? Could it be that "remedies appropriate for acute famine, such as food aid, may be useless or even harmful for those living whole lives on the edge of hunger"? Thus, early warning systems must be linked with longer-term development activities.

Concluding Comments

The truth of the matter is that famine early warning systems no longer focus solely on averting famines. Such events are "relatively" rare occurrences in any given location, and so the concept of a "famine early warning system" has implicitly become broadened to encompass national as well as household food security, which in turn are hunger issues. While the general public in donor countries has become quite attentive to pleas for assistance in famine situations, it seems to be less concerned about coping with food security and chronic hunger problems in other countries. As a result, many who deal with the latter issues feel compelled to make famine a part of their concerns in order to get the attention of policymakers as well as a share of the resources allocated to famine relief.

Another concern with early warning systems in the 1990s is an apparent tendency toward emphasizing "system" as opposed to "early." Increasingly, larger and larger databases are being brought into early warning systems. One must ask, however, when enough information is in hand to "do the job." For example, anecdotal information receives little attention from those in charge of formal early warning systems, most likely because such information does not readily fit into a quantitatively based warning system. Do journalists and photojournalists, for example, have a role to play in famine early warning? Dreze and Sen (1989) note:
The role of newspapers and public discussions, which can be extremely crucial in identifying famine threats (an energetic press may be the best "early warning system" for famine that a country can devise), can also help to keep the government on its toes so that famine relief and preventive measures take place rapidly and effectively (p. 19).

Such information may be among the earliest warnings that provoke public pressures for government action. On the other hand, satellite imagery may be very useful and interesting, but may not be timely. Is it as useful for food security concerns as for famine early warning?

After reading articles about famines in general and about specific famine situations throughout history, one can only wonder why we still have meetings to discuss them. Careful perusal of the extant literature shows similar arguments and complete awareness of the debates that rage over just about every aspect of famine. Even the use of similar phrasing by independent sources is noticeable.

Hunger and famine continue to plague societies around the globe and will likely continue to do so well into the future. We know that famines (if not hunger) can be eradicated in various locations. Famine plagued China in the 1920s and is no longer a problem in that country. In the 1940s, it was India that was forced to cope with famines, and today they do not occur on a large part of the Indian subcontinent. In the 1970s and 1980s, the West African Sahel and Ethiopia were considered famine hot spots, along with Mozambique. While we do not as yet hear of famines in these countries in the mid-1990s, we do know that widespread hunger persists in them.

I would like to suggest that one should question the utility of transferring lessons about famines and famine early warning systems from one region to another (including responses to those warnings). It is highly questionable that a plan developed specifically for one region can be transferred to other regions for direct application. In fact, experiences gained during a food crisis (regardless of cause) in a given region may not be as useful as one might wish, even when the same region is faced with a similar situation at a later point in time. Thus, case study experiences related to famines should be viewed as heuristic information that can generate new ideas about different situations but should not necessarily be used as a package of information to be applied elsewhere, without a high degree of scrutiny and caution.

How can we build on the knowledge that we now have? How can we avoid "bean counting" (i.e., going into increasingly detailed assessments of a problem we already understand), in the name of addressing the issues central to famine and hunger? How can we convert "paper" platitudes in the UN Charter and in national constitutions into action concerning the inalienable rights of people to an adequate food supply? Anatol Rapoport (1987), in his book on operational philosophy, suggested that people have a common demand of their governments: the right to shelter, procreation, food, and protection. Many governments have failed to provide one or any of these rights to their citizens. Can such a situation be changed?

References


Warning and Intervention:  
What Kind of Information Does the Response Community Need from the Early Warning Community?  

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*To realize the benefits of early warning, response is the issue, not developing ever more sophisticated indicators*  
(IFRC 1995, p. 34)

Were it not for earthquakes, climate prediction could be called the last frontier in natural disaster early warning. Early warning systems have been developed for many natural hazards and, while neither the systems nor the options for response are perfect, there has been progress over the past several decades toward using early warning in preventing, or at least mitigating, some kinds of natural disasters. Volcano monitoring, for example, coupled with civil defense preparedness, led to the timely evacuation of the vicinity around Mount Pinatubo in the Philippines immediately prior to its 1991 eruption, saving thousands of lives. Storm warning systems that prompt the evacuation of coastal areas prevent loss of life, even during storms strong enough to inflict devastating property damage. Locust monitoring and spraying kill larvae before they can swarm and cause widespread crop damage.

Earthquake prediction efforts have yet to yield reliable early warning. If reliable prediction methods emerge, however, civil defense and evacuation response options will presumably become as viable for earthquakes as they are for other localized natural hazards. Given the current state of the art, even approved building codes and seismically resistant construction techniques, when adopted, have proved effective at minimizing loss of life.

Climatic hazards -- especially droughts and floods -- have not only proved so far difficult to predict, but their widespread and multisectoral impacts pose challenges for effective societal response. Historically, droughts and floods have affected more people worldwide than any other cause of disaster (IFRC 1995, p. 102). These hazards affect food security, especially in poor areas where options for coping with disaster are limited. El Niño /Southern Oscillation (ENSO) forecasting is a scientific advance with the potential to provide drought and flood early warning. At the least, it can suggest regions of the world where, depending on ENSO activity in the equatorial Pacific, the probability that climate conditions will tend to favor drought or flood conditions for various locations around the globe is heightened or reduced. This chapter discusses strategies for reducing the impacts of such climate-related shocks on food security and the role that ENSO-based early warning information can play.
In nonindustrialized countries in particular, climate affects food security both directly, through its impacts on food production, and indirectly, through the impacts of climate variations on people’s livelihoods. Human health consequences of climatic conditions or events also relate to food security. Good health is necessary for individual food security through the ability of the body to use food. Health also affects household food security though its impacts on productive members’ ability to produce and earn income. Climate conditions favorable for vectors can promote the transmission of disease. Sanitation problems that accompany flooding or large concentrations of displaced people affect health and nutrition.

When adverse conditions, climatic or otherwise, overwhelm the capacity of large numbers of people to cope, an international response may ensue. Major international disaster response organizations include the United Nations, donor countries, international Private Voluntary Organizations (PVOs), and national institutions in the affected country. During disasters, emergency assistance is provided by international agencies over and above normal development assistance (and sometimes exceeding it). A large portion of U.S. humanitarian assistance goes to Africa -- over $500 million in fiscal year (FY) 94 (October 1993 to September 1994) -- a continent afflicted with poverty, conflict, pests, drought, and floods. Expanding rural populations in many African countries increase pressures on fragile lands, increasing the sensitivity of food production systems and the livelihood of growing numbers of people to climate variations.

In regions where climate shocks, particularly drought, are linked to ENSO events, ENSO forecasting has the potential to provide the response community with an early warning during which to mobilize a more timely and coordinated response. More importantly, the ability to anticipate hazardous climate events through ENSO forecasting gives ENSO-affected regions the opportunity to increase their own capacity to withstand climate shocks and reduce human suffering, economic losses, and the need for outside assistance. For ENSO forecasts to promote food security in food-insecure areas through improved early warning, two-way communication is needed between the early warning and response communities. Responders and affected populations must generally understand the scientific basis for regional climate prediction, its possible applications, and its uncertainties. Climate forecasters must, in turn, understand options and strategies for disaster management available to the international response community and affected populations, and their limits. If these preconditions are met, early warning information can be translated into effective actions to reduce disastrous climate-related impacts.

When Disaster Triggers Response

According to the *U.N. Human Development Report* (UNDP, 1994), in the 45 least developed countries, 46% of the population lacked access to health services, 55% lacked safe drinking water, the average daily calorie supply per capita was 91% of requirements, and 64% lived in absolute poverty. Official international development assistance constitutes an ongoing response to this situation. Humanitarian assistance, or disaster relief, is a special category of additional assistance during acute crises. Humanitarian responses are usually precipitated by an identifiable triggering event, such as a conflict or a drought. A disaster occurs when a triggering event strikes a vulnerable population. Vulnerability is a relative term and may be a function of exposure to hazards, or of the capacity of an individual, group, or society to cope with the hazard. In other words, it is a function of exposure both to risks and the consequences thereof (Downing 1991, p. 372). Vulnerability can be a chronic condition and/or episodically acute. Where the vulnerability of many people is high, even a modest triggering event can cause significant loss of life and destruction. A population whose vulnerability is low can withstand events of greater magnitude without experiencing loss of life and socioeconomic disruption.
leading to a disaster requiring outside assistance.

The criteria vary for determining whether a given event constitutes a disaster. The U.S. offers humanitarian assistance to other countries, when a disaster is declared by the Chief of the U.S. Mission in the affected country (OFDA 1993, p. 15). The Center for Research on the Epidemiology of Disasters uses the criteria of 10 people killed and/or 100 affected, and/or an appeal for assistance to define a disaster (IFRC 1995, p. 93). Affected countries can declare a disaster and appeal for outside assistance. The United Nations also issues emergency appeals.

There is overwhelming evidence that the climatic events that trigger some of these disasters are linked to ENSO. ENSO impacts on regional climates and food supply are well-documented. An ENSO index has been shown to be strongly correlated with maize yields in Zimbabwe (Cane et al., 1994) and in Oaxaca, Mexico (Dilley, 1996). ENSO impacts on crops in Australia have been identified (e.g., Nicholls 1985; 1986). Droughts corresponding to ENSO warm events have been shown to be associated statistically with disasters in Southeast Asia/Oceania and southern Africa (Dilley and Heyman, 1995). Drought impacts on agricultural production and water resources have been reported in southern Africa in 1995 in association with a moderate ENSO warm event (FEWS, 1995a; FEWS, 1995b). Temperature and precipitation variations associated with ENSO have been associated with outbreaks of contagious disease (Epstein, 1994). Flooding affects sanitation and the prevalence of waterborne disease. The adverse economic impacts of these climatic hazards also affect food security, by lessening people’s ability to purchase food as well as to produce it.

Given the increasingly large numbers of emergencies worldwide, international organizations must prioritize where to respond, and with what level of resources. The following criteria from the USAID Office of U.S. Foreign Disaster Assistance (OFDA, 1994) are representative:

- Where can OFDA resources assist the greatest number of victims? Can OFDA’s resources reach the victims?

- To what degree is security of relief workers and relief supplies adequate to undertake and sustain a relief operation?

- What is or will be the level of cooperation from the governing authorities?

- What is the level of commitment and funding from other donors?

- What is the ability of OFDA and its implementing partners to respond in a timely fashion with appropriate interventions?

- What is the level of interest of the U.S. government?

- What is the level of interest of the American people?

With the resources of international disaster response organizations increasingly being consumed by the needs of refugees and people displaced by conflict, and with response organizations having to make tough choices, it is imperative that countries in regions exposed to predictable natural hazards begin to improve their understanding of the nature of those hazards, assess their vulnerability, and take appropriate (i.e., effective) measures to reduce their own vulnerability.
Linking response to early warning involves both short- and long-term actions, representing two strategies that use ENSO information in different ways. Short-term (tactical) uses of early warning -- of the actual warning itself -- generally involve preparedness. In the case of floods, for example, shelters can be built, evacuation plans prepared, and civil defense procedures defined. When the warning is given, these preparedness measures permit the population to be effectively warned and to seek shelter. Early drought warning allows disaster response organizations to initiate the programming and transport of food aid, so that aid will arrive where and when it is needed. However, in the short period of time between the early warning and the actual outbreak of crisis, the response alternatives of international disaster response agencies are limited. Basically, they are limited to providing goods, cash, services, or information. These are often delivered in the form of disaster relief through PVOs, who, funded by the international donors, design and implement relief and rehabilitation interventions. Donors must decide among expensive alternatives, the positive effects of many of which will be short-lived. Considerations used by OFDA for evaluating relief interventions include but are not limited to the following:

- Is the intervention necessary/appropriate? And will it save lives and reduce suffering?
- Is the project technically sound?
- Can the activity be implemented, and in a timely manner?
- What is the likelihood of success, given the location within the country of the proposed activity?
- Given its location, how important is it to the most urgent relief requirements? To the largest concentrations of people?
- Is the organization requesting funding capable of delivering the assistance?
- Is the intervention duplicative?
- Can other donors be encouraged to provide the assistance in a timely manner?
- Is the relief or emergency rehabilitation activity appropriate for OFDA funding?
- Is management and coordination expertise (usually UN coordination) required on the ground to assure success of the relief effort? Is it available or will it be available in a timely manner?
- Is the intervention compatible with existing or anticipated development programs?
- Is the intervention likely to be acceptable to the government or, in conflict zones, to the insurgent groups?
- What is the duration of the activity (not more than 12 months) (OFDA, 1994)?
- In the initial phase of an emergency response, relief is a higher priority than rehabilitation.
- OFDA discourages heavy capital investments to initiate relief programs.

For these interventions to be fully effective, it is essential that they reflect the priorities of the
Figure 1—Countries where declared drought disasters are significantly more frequent during the mature phase of ENSO warm events than in other years (from Dilley and Heyman, 1995).
affected population (Cuny, 1983). The chaos of a disaster situation, however, can be a difficult time to establish the links between responders and local institutions and communities. Opportunities for engaging the beneficiary population in reducing their own vulnerability to disasters are greater when early warning information can be incorporated into their decision-making processes over the longer term.

When a natural hazard is explainable and predictable (e.g., the possibility offered by regional climate prediction based on forecasts of ENSO or other large-scale climate forcing factors), opportunities for long-term approaches to disaster prevention and mitigation increase. Natural disaster prevention and mitigation strategies succeed by reducing vulnerability, since the magnitudes and timing of natural hazard events are not subject to human control. Vulnerability reduction over the long term is part of the development process undertaken by the society at risk, ideally with the cooperation of international donors. This process begins well in advance of a triggering event or early warning but can capitalize on the existence of an early warning system.

Since the risk of exposure to the hazard cannot easily be lessened, attempts must be made to increase coping capacity and reduce the consequences of the exposure. Both faces of vulnerability — risks of exposure to a hazard and, especially, risks of consequences from that exposure — are often related to poverty. Food insecurity is very related to poverty. Reducing poverty and, therefore, chronic food insecurity is an objective of sustainable development. The task in disaster prevention and mitigation is more specific than broad-based poverty reduction (a desirable but overwhelming objective). Mitigation efforts are targeted at those vulnerable to a particular hazard, based on an understanding of who is vulnerable, and how and why they are vulnerable. This analysis creates opportunities to take steps to reduce that specific vulnerability. An early warning system provides information inputs for this task, provided that flexibility can be built into food production and economic systems to use early warning information in ways that help people to anticipate, prevent, and, if not prevent, at least mitigate, negative climatic impacts. This requires coordination between the early warning and the response communities.

What Information Is Needed from the Early Warning Community?

ENSO impacts are felt in teleconnected regions worldwide, especially in the tropics. Many of these regions have the resources to cope with climate fluctuations and/or have developed strategies to withstand them without experiencing severely adverse food security consequences. While all teleconnected regions can benefit from understanding ENSO’s impacts, areas where ENSO has disastrous impacts on food security deserve particular attention from the early warning community. For example, countries in two regions — southern Africa and Southeast Asia/Oceania — have historically been forced to declare drought disasters during ENSO warm events (Figure 1). For these two regions, ENSO forecasts provide valuable information for response, because the countries within them tend to experience climate-related disasters during the mature stages of ENSO warm events but not at other times. The occurrence of a warm event increases the possibility that a drought disaster will occur. In addition, this pattern provides evidence that countries in these regions have not taken adequate steps to reduce their drought vulnerability. Some countries that experience ENSO-related hydrometeorological droughts but are not forced to declare disaster have apparently already succeeded in reducing their vulnerability sufficiently to withstand ENSO-related climate shocks. Greater focus on southern Africa and Southeast Asia/Oceania, in terms of providing information about what ENSO is and what its regional impacts are, could be a step toward mobilizing action to reduce vulnerability.
Since the drought of 1991-92 in southern Africa, awareness in both the early warning and disaster response communities of ENSO impacts on regional climates — particularly of droughts and floods — has been sharply improved. Heavy rains and flooding in the U.S. throughout the early 1990s, associated by some observers with a prolonged ENSO warm event, has made ENSO a nightly feature of televised weather reports. This sort of broad-based public education, along with special concentration on key groups of specialists (e.g., potential users of ENSO information), is an important outreach component of climate science to both the general public and the response community. It is important to sustain this educational effort, so that increased awareness is enhanced by better understanding of both ENSO’s impacts and the current limitations of scientific research focused on ENSO. (NOAA’s Report to the Nation, El Niño and Climate Prediction [UCAR, 1994] provides a good example of how a basic understanding of ENSO and its impacts can be effectively communicated.) Disseminating basic knowledge about ENSO creates a context in which ENSO-based early warnings can be heard and understood. In poor countries, where vulnerability is high, achieving this level of public awareness poses special challenges. Potential mechanisms for promoting ENSO awareness include disaster training and education programs, scientific and policy workshops, classrooms, agricultural extension, and the media.

A main vehicle for early warning based on ENSO forecasts is a regional climate forecast. However, regional climate forecasts need to be qualified in at least two ways: How reliable is the forecast of an ENSO event (this is what climatologists in the region need to know); and how reliable is the regional climate prediction (this is what decisionmakers need to know)? The accuracy of an ENSO forecast depends on a "correct" interpretation of sea-surface temperature and atmospheric sea-level pressure indicators in the equatorial Pacific, and on numerical climate modeling. An improved ENSO forecast should indicate both the likely strength of the event and the location of the anomalous warm pool in the central or eastern equatorial Pacific. In turn, regional climatologists in teleconnected regions can take a general ENSO forecast and tailor it to their regions, taking into account observed regional climate conditions, seasonality, and the behavior of regional synoptic factors. A reliable, regional, ENSO-related forecast that includes an analysis of impacts across multiple sectors of society will help bridge the gap to potential users. Early warning systems analysts can convert the forecast into terms relating it to the implications for food security.

What Actions Can Be Taken on the Basis of ENSO-Based Early Warnings?

Specific strategies for preventing, mitigating, or preparing for (e.g., adapting to) ENSO-related disasters depend on prevailing socioeconomic conditions and institutional resources in each region, and the nature (e.g., strength, reliability) of the teleconnection. In regions whose teleconnections pose a high risk of exposure to climatic hazards, vulnerability assessments can be undertaken. The risk of exposure can be assessed, geographically identifying those areas particularly likely to experience the hazard. The risk of consequences can also be assessed (e.g., which social groups are likely to suffer consequences), as well as which sectors (e.g., agriculture, livestock, water and sanitation, health). The assessment of the risks of consequences from a climatic hazard associated with ENSO may be expressed spatially, according to where people live who have been identified as particularly vulnerable to consequences of regional ENSO impacts. Vulnerability assessments provide information for targeting development and mitigation activities in order to reduce chronic vulnerability among the most vulnerable populations.

The following examples focus on drought, although measures to prevent, mitigate, and prepare for floods can also be identified. Preparedness strategies are feasible for international response organizations, national governments, and affected populations. International response organizations that are aware of ENSO events (for example, the USAID Famine Early Warning System or the Southern
Africa Development Community [SADC] Regional Early Warning System) can, however, act earlier to anticipate food-aid needs. Hence, they can prepare to provide assistance prior to drought disasters, as was done on the basis of ENSO signals during the 1994-95 drought in southern Africa. The training of disaster responders at the national level also provides a means by which national and municipal governments can become better partners in a response. In Latin America, disaster management training has been extremely effective in decreasing the need for outside assistance in responding to regional disasters. Perhaps most importantly, public awareness campaigns and information dissemination can both educate the general public and provide it with information useful for decisionmaking at the individual and household levels. This approach empowers the affected population to take control of its own response to the potential crisis. Australia has pursued this strategy by providing ENSO information to support farmer and herder decisionmaking in the face of probable droughts.

Mitigation strategies strengthen the coping capacities of vulnerable groups. Some approaches capitalize on the availability of an early warning system and seek to maximize food production or income, based on a regional climate forecast. Planting dates can be adjusted and drought-tolerant crops planted when rains are expected to be delayed or inadequate. Livestock can be sold to reduce herd sizes and to maximize returns prior to a drought. Water conservation measures can be undertaken. National food policies can be adjusted to ensure adequate food stocks or regional trade linkages. Mitigation objectives can also be achieved through sustainable development efforts that seek to promote food security. Creating access to markets through road construction is a prerequisite for enabling the destocking of herds prior to the onset of droughts. Drought-tolerant crops such as cassava can be promoted through agricultural extension and PVO projects. Natural resource management, soil and water conservation, and irrigation resource development are all strategies that can be implemented at the local level with funding channeled through PVOs. Small-scale irrigation not only provides drought protection but also diversifies and protects income-generation possibilities, an important aspect of food security (e.g., capacity-building at the local level). During a disaster, it is a good time to promote mitigation, while the hazard is fresh in everyone’s mind. Thus, disaster relief can be used to promote longer-term food security. Well improvement, for example, is a low-cost measure that permits a well to provide water through dry periods, providing longer-term protection against drought. International responses can distribute drought-tolerant seeds. Even "appropriate" food aid can contribute, by helping to develop tastes and markets for sorghum or other drought-tolerant cereals.

Conclusion

Information exchange between the early warning and response communities requires a two-way flow. For its part, the response community must continue to be exposed to and learn about ENSO, i.e., what it is and its impacts in particular regions. The early warning community must understand the limitations of humanitarian assistance and constraints on, and opportunities for, disaster prevention, mitigation, and preparedness. Such communication will promote sharing of ENSO information relevant for reducing vulnerability and food insecurity. For the purposes of early warning and response, it is less necessary, for example, to gain a complete understanding of the entire hydrologic cycle of a region than it is to engage in outreach and public education. General scientific information may be "good enough" as a basis for decisionmaking under certain conditions, where detailed analysis of systems could obscure the main point. By keeping the end-use in mind, scientific knowledge about ENSO can be put to use toward linking ENSO forecasts to disaster early warning and, therefore, to disaster reduction.

References


What Does the Famine Early Warning Community Need from the ENSO Research Community?

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NOAA/CAC ENSO Advisory, 10 August 1993:

"Since atmospheric and oceanic conditions indicate that the effects of the 1991-1993 warm episode have greatly diminished, this will be the last in this series of advisories. Additional advisories will be issued only if there is a significant redevelopment of warm episode conditions."

NOAA/CAC ENSO Advisory, 13 October 1993:

"The persistence of anomalously warm water in the central equatorial Pacific (NINO4 region) during the next two months increases the likelihood that mature warm episode conditions will redevelop by the end of 1993."

The USAID Famine Early Warning System (FEWS) Project*

*[The U.S. AID-funded Famine Early Warning System (FEWS) Project is often known as FEWS (upper case). It is one of several famine early warning systems, referred to here as fews (lower case), all of them food-related early warning systems (referred to here as cws)].

A note is in order on FEWS, because the geographical scales on which FEWS operates will guide my comments and suggestions. Early warning systems operate at many scales, from local systems such as in Turkana, Kenya through to national food-balance approach of the UN FAO GIEWS (Global Information Early Warning System). As of the early 1990s, FEWS principally covered ten countries in Africa (Mauritania, Mali, Burkina Faso, Niger, Chad, Ethiopia, Kenya, Malawi, Zambia, and Zimbabwe), and to a lesser extent, Sudan, operating with a regional mandate but carrying out analysis at a subnational level. FEWS operates in the realm of monitoring for potential changes to levels of food security, as represented by both the availability of food and a household’s access to food (see, for example, FEWS 1993a, 1993b). The basic role of FEWS in terms of directing a response to an emergency would be to identify how many people are in need, where they are, and how great is the need.

FEWS has extensive experience in the analysis of physical data (climate and remotely sensed vegetation index imagery) because, in terms of food availability in a rainfed agriculturally based economy, this approach gave the greatest immediate return. Now that those aspects are mostly understood (but always with room for improvement), FEWS has moved further into the arenas of economic analysis and household income, essentially the components of access to food. Our work concentrates around a theme of vulnerability to famine, which in reality translates to a need to
understand food security. We would also rather see our data being used in development initiatives, which would improve general levels of food security and reduce the incidence of famine.

FEWS looks at issues of food security in a broad, multidisciplinary manner. Up to the early 1990s, ENSO had been treated by FEWS as a small part of the total picture, a climatic shock with relatively short-term impacts on the local production and availability of food. While the implications of impacts on general levels of accessibility to food, caused by changes in the frequency of ENSO events, had been touched upon in FEWS, it would be true to say that such a time scale had not yet permeated the FEWS program. It is my personal view that climate change impacts should be considered more explicitly.

So What Do We Need?

The first question might be whether the early warning community wants anything at all from the ENSO community. This is really a non-question, as the answer has to be positive. To illustrate the point, consider the ENSO-related drought in southern Africa in 1991-92. It has been estimated that, in responding to the effects of the phenomena (for reasons more than those of food security), the US contribution was on the order of $800 million. This is not to say that ENSO cost the US Government $800 million. Rather, ENSO acted as a trigger of events, the complex solution of which was economically very costly.

FEWS acts as an information system, and we note that the need for information flow is not uniform. If nothing is going wrong, the decision-makers are somewhat content for FEWS to keep a watching brief. However, if there is a developing problem, the hunger for information increases almost exponentially. Given the impact of the 1991-92 drought in southern Africa, the release of the above-quoted October ENSO Advisory (quoted at the outset) precipitated the demand for more and more detailed information.

A Question of Style

A seemingly trite request, though meant seriously, is one for a change of format in ENSO-community reports. For example, both the ENSO Advisories and the UK Meteorological Office (UKMO) Sahel forecast put their conclusions at the end of the text-piece, after a discussion that may not be overly technical for the ENSO community, but has been unclear to non-specialists. While putting the conclusion before the reasoning may be an unscientific presentation, it is acceptable in the information-brokerage business.

Timeliness

How early can the ENSO community provide a stable forecast? From a FEWS perspective, when a request for emergency food aid comes to Washington, D.C. from an African country, it takes four months or more, after the request has been approved, for the food to be delivered to the recipient country. FEWS provides input to the approval process by informing USAID over the progress of a season and by increasing the general level of awareness of the problem. An increased understanding of the developing situation comes from information about a society’s ability to cope in general (e.g., access to food), combined with the shock of, let us say, drought-induced crop loss (e.g., availability).

The common understanding of a problem is developed by the repeated use of information products, principally Bulletins and briefings. So, as a problem comes to a head, the USAID audience is informed and sensitive to the issue.
In terms of the economic aspects of early warning, the earlier the response and shipping of food aid, the less likely is the need for airlifts to circumvent long delivery routes or inaccessibility, often ironically due to the resumption of a rainy season to those communities at risk to famine. Comparative costs for delivering a ton of grain, once it has arrived in a country, range from $200 by truck transport, to $1,400 by airlift, to $2,500 for helicopter delivery. While helicopters are rarely used, airlifts, sadly, are all too common.

Spatial Resolution

This takes us into the realm of identifying how many people are at risk and where they are located. The early warning community makes use of spatial analysis, ranging from complex geographical information systems (GIS) to documentary field assessments. In many cases we have population data for our areas of interest. So, an ENSO-impacts forecast should be as spatially discrete as possible. The southeastern Africa region of ENSO-impact described in Ropelewski and Halpert (1987) is general, by virtue of the scale of analysis and presentation. The fews community needs more spatial specificity for analyses to be more useful.

Another example can be drawn from the UKMO seasonal forecast for the Sahel. While this is not totally an ENSO-related forecast, it serves a purpose here. Up to but not including their 1993 forecast, only one "magic number" was produced, that being an assessment for the season as a whole over an area stretching across the Sahelian zone from the Atlantic Ocean to the border of Ethiopia. The real-world climatic variation in that region is significant, and must be taken into account. However, the UKMO, by dividing the region into five subregions, took a step in the right direction in its 1993 forecast (see also Ward et al., 1989).

Temporal Resolution

There is a need for an early forecast. Now I want to stress the need for an improved temporal resolution in the forecast. If fews are told that the rainy season is going to be 80% of normal, what does that mean -- low throughout the season; a poor start; an early end? Each of these scenarios has different implications for crop production prospects. Giving a better temporal resolution would help, even a breakdown into early, mid-, and late-season effects (with the incumbent poorer accuracy), allowing us to move the reliability of projections along in the area of agricultural production based either on more realistic scenarios or agrophysical modeling.

In countries with complex climatological patterns, such as Ethiopia and Kenya, the need for temporal resolution is even greater. Different effects in different seasons have to be accounted for in order to forecast food production as part of the more complex picture of food security, and for the ENSO and fews communities to maintain their credibility.

General Requests

One thing that the 1991-92 southern Africa drought did was to increase awareness of the potential importance of the ENSO phenomenon within USAID. FEWS received many requests, most of them informal, for forecasts of weather in other parts of Africa. FEWS does not make seasonal forecasts per se; we use those produced by others. However, the scientific literature can be used to give general comments on relationships that have already been found.
There is, therefore, an ongoing need for the ENSO community to publish details of research results on teleconnections, so that the fews community can better identify and educate potential users of its information (e.g., Ropelewski and Halpert, 1987; Farmer, 1988; Ogallo, 1988). A general request here is for the development of confidence limits for the ENSO-climate relationships. Tell us how accurate predictive models have been in the past, so that we know to what extent we can, or should, rely on them. Information requests are often provided with broad estimations; the ENSO community can help to keep such estimates reliable.

A given forecast has to be related to how the user can fully utilize it. Take, for example, the 1993 UKMO Sahel forecast, which puts the Sahelian region in a DRY/VERY DRY category. Now, the training period for the regression approach considers equi-probable categories over 1941-85. The boundary for DRY/VERY DRY is in fact around 100% of the 1971-90 average. When a fews approaches a "customer" with such information and says that there is a high probability that rainfall will be below the mean of the last twenty years, more detailed information is often requested. In this case, perhaps a new training period is needed.

One final request is for the ENSO and fews communities to consider their combined efforts in terms of climate impact on society. This has started to happen for related issues (Hulme et al., 1992a,b). ENSO-related "usable science" workshops will likely stimulate further interaction between the fews and ENSO communities, as suggested by the comments of USAID Administrator J. Brian Atwood:

The first workshop, held in Budapest in October 1993, focused on El Niño and famine early warning. The result was a landmark article in the scientific journal Nature, linking El Niño events to changes in maize yields in Zimbabwe. This result was widely reported in the media, including the New York Times. Subsequent research at USAID demonstrated the links between El Niño and drought disasters in Southern Africa and Southeast Asia.

As a result of this work, USAID's Office of Foreign Disaster Assistance, Food for Peace, our Africa Bureau, our Famine Early Warning System, and our missions in Southern Africa are all working without local counterparts to plan for El Niño-induced droughts in the future. Through appropriate planning of agriculture, water management, and health services, the region hopes to prevent disaster and the need for costly relief when drought next occurs. El Niño forecasts are central to this effort.

Summary

What do we, the fews community, need? Earlier forecasts, better spatial resolution, better temporal resolution, more details on confidence limits, changes in style, and so on. What do you, the ENSO community, and we, need? Better communication.

It is clear that the ENSO community has been pursuing its work while not thinking specifically, if at all, of the fews community, because there has been no mandate for it to have done so in the past. Now that we are looking at fews as a customer for ENSO products, there is a need for much more interaction.

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What Are the Potential Contributions of El-Niño-Southern Oscillation Research to Early Warning of Potential Acute Food-Deficit Situations?

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Ethiopia and the 1888 El Niño

A major El Niño occurred in 1888. Drought struck Brazil and Australia, resulting in considerable damage. The country most tragically affected by the 1888 El Niño-Southern Oscillation was, however, Ethiopia. Detailed contemporary descriptions of the 1888 drought and the ensuing famine are available (Pankhurst, 1966). The 1888/89 Ethiopian famine provides a background for discussing how research into El Niño-Southern Oscillation could contribute to famine early warning systems for Africa.

Pankhurst reports that 1888 was excessively hot and dry in Ethiopia, and unsatisfactory for agriculture. On 16 November 1888 there were reports that lack of rain had caused a large proportion of the crops to perish. By 8 January 1889, in certain areas, all the crops had been burned up by the sun. The harvest failure had reduced much of the country to misery by late in February. There was no grain production at all in some usually productive areas. The resulting famine was later exacerbated by a major epidemic of cattle plague (rinder-pest) and an outbreak of locusts and caterpillars.

The failure of the Ethiopian harvest led to a doubling of the price of provisions by November 1888. In fact, it was very difficult to obtain food at any price. People were so discouraged that they made no efforts to save themselves but merely waited to die of hunger. Others were reduced to cutting up cow skins into pieces, which they dried, ground, and made into cakes. Various "unnatural practices," including the eating of traditionally forbidden food, the abandonment or sale of children by their parents, self-enslavement, suicide, murder, and cannibalism emerged all over the country. The famine was accompanied by the outbreak of epidemics and a sharp rise in the death rate through illness. Enfeebled famine victims often lacked the stamina to resist infection. The existence of large numbers of unburied corpses led to a substantial deterioration of sanitary conditions. Smallpox, typhus, cholera, influenza, and dysentery made their appearance in many parts of the country and killed large numbers. The famine and subsequent epidemics are believed to have resulted in the death of one-third of the entire population of the country. In certain areas perhaps 80% of the total population was lost, leading to the total desertion of some previously well-populated areas.

Does the El Niño-Southern Oscillation Cause Famine?

All countries suffer from droughts. Not all are affected by famine. Does the influence of the El Niño predispose countries such as Ethiopia to the threat of severe drought and famine? El Niño-Southern Oscillation substantially affects the climate of much of the Indian-Pacific region. Although not every area is affected severely in each episode, El Niño does lead to an increased
likelihood of substantial climate anomalies in each of these areas. It tends to amplify the climate variability, impose a specific temporal pattern on droughts and heavy rainfall periods, and allows some predictability of these variations. Nicholls (1988) found that the relative variability of annual rainfall was typically one-third to one-half higher for rainfall stations in areas affected by the El Niño-Southern Oscillation, compared with stations with the same mean rainfall in areas not affected by El Niño-Southern Oscillation.

Nicholls and Wong (1990) confirmed, on recent data and using the coefficient of variation as a measure of relative variability, that the El Niño-Southern Oscillation does amplify rainfall variability in the areas it affects, relative to elsewhere. This effect was strongest at lower latitudes and low rainfalls and so is especially relevant to the semi-arid areas of Africa. The amplification factor is substantial. The variance of annual rainfall in an area strongly affected by the Southern Oscillation might be, depending on latitude and mean rainfall, more than double that in an area with similar mean rainfall that is not influenced by the Southern Oscillation. The higher climate variability (i.e., more severe droughts and floods) in countries affected by El Niño-Southern Oscillation may provide a partial explanation of why in these countries droughts can lead to severe food shortages.

This is not to say that the high relative climate variability in countries affected by El Niño-Southern Oscillation will necessarily lead to famine. Social, economic, and political factors may exacerbate or mitigate the potentially higher climatic hazards. A highly variable climate can provide the frequent severe droughts and floods which set the scene for potential food shortages and even famine. But social, economic, and political factors must operate to realize this potential. There are countries with high relative climate variability (e.g., Australia) where severe droughts did not lead to famine. In some other areas affected by El Niño-Southern Oscillation (most notably northern China and India), the famine-drought nexus appears to have been broken in the past few decades, at least at the national level. In other El Niño-affected countries (e.g., Ethiopia), not every drought leads to famine.

The influence of social, economic, and political structures in determining whether climate anomalies in a particular region will lead to severe societal impacts can explain why some countries with a climate strongly affected by El Niño-Southern Oscillation do not suffer food shortages that lead to famine and why in others, the inexorability with which famine followed drought during the nineteenth and early twentieth centuries has now been broken. The conclusion that nonphysical factors may determine whether the potential health problems caused by climate anomalies will be realized in a specific country or at a specific time does not, however, invalidate the point that increased climate variability associated with the El Niño-Southern Oscillation heightens the potential for severe societal impacts. It is important, therefore, to consider whether our current knowledge would enable the development of systems for the early warning of climate variations which could increase the potential risk for famine. It is instructive to consider the case of the 1888 Ethiopian drought and famine in this respect.

Could the El Niño-Southern Oscillation Have Provided Early Warning of the 1888/89 Ethiopian Famine?

The Southern Oscillation Index (SOI) is a commonly used indicator of the state of the El Niño-Southern Oscillation. Large negative values indicate El Niño episodes. From about May 1888 through into 1889, the SOI was strongly negative, indicating a developing El Niño. Given some knowledge of the typical behavior of the El Niño-Southern Oscillation, predictions of the 1888/89 Ethiopian drought and famine could have been made some months in advance of the worst impacts. El
The SOI in July (scale reversed) and the number of New South Wales (Australia) districts in drought the following year (bars).
Niño episodes typically start around March-May and last about twelve months. If the SOI is strongly negative by around June-July, then an El Niño has usually commenced and will last into the following year. This was the pattern during the 1982/83, 1991/92, and 1994/95 El Niño episodes, as well as in 1888. Since the worst impacts of the 1888 El Niño appeared late in the year in Ethiopia, simply monitoring the SOI could have provided some advance warning of potential problems in the areas it usually affects, including parts of Ethiopia.

Figure 1 shows that this strategy of monitoring the SOI can be used to predict the likely severity of droughts in Australia (Australian droughts, like those in parts of Africa, tend to occur during El Niño episodes). The figure plots the number of districts in the state of New South Wales, in eastern Australia, and the SOI some 9-10 months earlier. The years when much of the state is in drought have usually been preceded by periods of low values of the SOI, indicative of the start of an El Niño. Similar diagrams could be prepared, if the data were available, for those parts of Africa affected by droughts during El Niño episodes, including Ethiopia and parts of southern Africa.

It is important to note that monitoring the SOI, as described above, can provide drought "predictions," given our current state of knowledge. However, this approach is limited by the existence of a "predictability gap" early in the calendar year. It is difficult, with this simple approach, to provide useful forecasts before about July. Predictability across the March-May interval is limited by unknown factors. Improvement of predictions across this interval would be the most importance advance for increasing the utility of the El Niño-Southern Oscillation in famine early warning systems, because it would allow forecasts of drought 12-18 months in advance. This would enable more substantial and timely interventions to reduce the deleterious effects. The remainder of this paper examines the current state of El Niño-Southern Oscillation prediction and the research necessary to improve predictability across the "predictability gap."

Predicting the El Niño-Southern Oscillation

There has been a consistent effort recently to develop methods for predicting the El Niño-Southern Oscillation at longer lead times than is possible just through monitoring indices such as the SOI. The main focus has been on predicting the onset and evolution of El Niño episodes. Occasionally, one sees claims of the discovery of a possible El Niño "trigger" (volcanic eruptions either on land or on the ocean floor are popular). In fact, the concept of a "trigger," i.e., an identifiable event that causes an El Niño, is irrelevant in a quasi-cyclic system such as the El Niño-Southern Oscillation. It is quite feasible for an initial small anomaly in a coupled ocean-atmosphere system to grow into a major El Niño. El Niño (and La Niña) episodes thus arise naturally because of the feedback between the ocean and the atmosphere. No external "trigger" is needed. Even if such a trigger did exist, its role (which could only cause the initial anomaly) would be unimportant relative to the feedback between the tropical ocean and atmosphere which amplifies the initial anomaly.

The key to predicting El Niño, then, is not to find an elusive "trigger" but to develop a model that either identifies the anomalies in the ocean-atmosphere system as early as possible, or includes the various feedback processes and can thus mimic the inflating of initial small anomalies and the quasi-cyclic nature of the El Niño-Southern Oscillation. Three very different types of models have been developed to predict El Niño: statistical models, ocean models forced by observed winds, and coupled ocean-atmosphere models. All three kinds of models showed some success in forecasting the El Niño of 1986-87 (Barnett et al., 1988), and of 1991-92. They were, however, less successful in predicting the onset of the 1994-95 El Niño, although it was clear by mid-1994 that an El Niño was developing.
Models for Forecasting El Niño

1. Statistical models

There have been efforts for several decades to identify statistical precursors to El Niño episodes. These precursors are not "triggers" or "causes" of El Niño episodes. They are, rather, indicators of the relatively early stages in the ocean-atmosphere interaction leading to El Niño. The best-established precursors appear in the tropical Pacific surface wind field and the global sea level atmospheric pressure field. Skillful forecasts could be expected from this sort of model at lead times of several months, although the expected skill varies throughout the year. Little skill is evident for forecasts for the Southern Hemisphere autumn and early winter.

2. Simple dynamical ocean models forced by observed winds

The next step in sophistication is to express ocean response to the atmosphere in terms of the physical laws that govern that response, rather than use statistical relationships (e.g., Busalacchi and O'Brien, 1981). Here the ocean physics are described in terms of a linear transport model of the equatorial Pacific, driven by observed winds, and with solid walls at the meridional (north-south) boundaries and limited vertical resolution. Such models can reproduce many observed features of El Niño episodes, even though they are linear and without thermodynamics. They do not predict sea surface temperatures (SSTs) but rather a closely related variable, the thickness of the upper layer of the ocean. A statistical decision-making process, derived from inspection of model performance over a prior record, can be used to predict the onset of an El Niño. The problem with using ocean models driven by observed winds is that the winds can change quite rapidly over a period of a month or two. So the forcing of ocean models by observed winds can only provide short-term forecasts, i.e., up to a few months. A method to predict the interaction between the atmosphere and the ocean is needed, if we are to forecast with long lead times.

3. Coupled ocean-atmosphere models

Several relatively simple (or "low-order") coupled ocean-atmosphere models of the equatorial Pacific have been developed to predict El Niño. The best-known is that of Cane and Zebiak (1985), which uses an ocean component similar to that used by Busalacchi and O'Brien (1981) with the addition of an Ekman layer and thermodynamics. Although the dynamics are linear, the equation predicting SST evolution is nonlinear (i.e., includes interactions between the variables governing the evolution of SST anomalies and the SST anomalies themselves). The SST anomalies are dynamically forced by surface wind stress anomalies (i.e., deviations of wind intensity and direction). The atmospheric model calculates surface wind anomalies that occur in response to SST anomalies. It has steady-state dynamics and a nonlinear heating parameterization to simulate the warming of the atmosphere by latent heating associated with precipitation. The heating depends on both the SST prescribed by the oceanic component and the surface wind convergence calculated within the atmospheric model. The ocean model has very coarse vertical resolution. When the components are coupled, the atmospheric heating depends on the model SSTs which, in turn, are determined by the surface winds generated by the atmospheric model. In operation, the coupled model is forced by observed winds up to the time of forecast, and then both the atmospheric and oceanic components of the model are allowed to evolve.

There are a variety of other low-order coupled models, with rather different parameterizations of the ocean-atmosphere interactions. Models of this type have simulated some aspects of the El
Niño-Southern Oscillation, including the time scales and spatial structures of SST anomalies, and have been used in experimental forecast tests, with some success (e.g., in 1991-92). More complex coupled models have also been developed (e.g., Philander et al., 1992; Latif et al., 1993). These models consist of an ocean model coupled to an atmospheric general circulation model (GCM), and show promise in their simulations of the El Niño-Southern Oscillation. Some "hybrid" models have also been developed, consisting of an ocean GCM and a statistical atmosphere. The final word in predicting El Niño will probably come with the development of coupled models with higher spatial resolution. These would be able to resolve adequately the equatorial waves but would also include better representations of other features of the tropical ocean and atmosphere than can low-order models. Their use in a prediction mode will require the development of schemes to assimilate ocean and atmosphere observations into the model.

Will El Niño Forecast Models Be Useful for Famine Early Warning Systems?

Current forecast systems, and expected improvements to these systems and models, can provide forecasts of climate anomalies such as droughts with some skill. However, the availability of such forecasts does not necessarily mean that they will be useful in efforts to mitigate the adverse consequences of the climate anomalies. In particular, such forecasts may not necessarily help mitigate famines, even if they are incorporated into famine early warning systems. The utility of improved El Niño forecast systems in famine early warning will depend on a number of factors:

- **The accuracy of the forecasts.** Coupled-model experimental forecasts of El Niño episodes have been promising, but not perfect. For instance, the "re-emergence" of the El Niño in late 1992 was not predicted (e.g., Kerr, 1992). The imperfect nature of the forecasts means that care must be taken in their application. In particular, it is crucial that the forecasts be expressed as probabilities, rather than categorical, reflecting the less-than-perfect expected skill. Equally important is that users develop decision-making skills enabling them to use probabilistic forecasts.

- **Variations in impacts between El Niño episodes.** The 1888 episode impacted Ethiopia severely; the 1877 episode mainly affected India and China. Variations from episode to episode continue to confuse the picture of the impacts of the phenomenon. These variations emphasize the need to express forecasts derived from the El Niño-Southern Oscillation in probabilities, and to use them appropriately.

- **The way in which the forecasts are used.** There is a tendency for forecast users either to dismiss forecasts or to take excessive actions based on the forecast. These approaches fail to take account of the level of skill of the forecast. No forecast system for El Niño will be perfect, so a method for "hedging" is necessary in any application of the forecasts. This would be facilitated by the use of probabilistic forecasts, but methods for the correct application of probability forecasts in decisionmaking are required.

- **Multiple sources of forecasts.** Many organizations and individuals are now issuing El Niño forecasts. How can a user decide which is the "best" forecast?

- **Confounding effects of climate change.** Drought in Ethiopia in the past was clearly related to El Niño episodes. In recent decades this relationship has been confounded by the downward trend in rainfall in this area. A similar effect has occurred in parts of Australia. Are these trends a temporary aberration, or will they continue to confound the El Niño-drought relationships? In
recent decades the SOI has been low, while global temperatures have increased. Is there a causal relationship? If so, how do we design decision-making systems to take account of both El Niño-related climate variability and climate change?

What Other Aspects of the El Niño-Southern Oscillation Are Important to Famine Early Warning Systems?

Phase-locking to the annual cycle

Extended periods of drought or extensive rains do not occur randomly in time, in relation to the annual cycle, in areas affected by the El Niño-Southern Oscillation phenomenon, and rainfall fluctuations associated with it tend to be "phase-locked" with the annual cycle, i.e., they start and finish around the same time in each event. El Niño events usually start early in the calendar year and finish early in the following year. The droughts associated with such events also tend to occur around the same time of year in each event, although the preferred time of year varies geographically. The phase-locking means that a "timetable" for prediction for famine early warning can be developed. In Australia, for example, if widespread drought associated with an El Niño has become established by mid-year, it is reasonable to expect, based on historical data, that the drought will continue until at least the end of the year. If, however, there is no sign of drought or El Niño at mid-year, then widespread drought is unlikely to develop in the next six months.

Biennial cycle

This phase-locking is related to a biennial cycle which is a fundamental element of El Niño-Southern Oscillation variability. There is also a lower frequency variation, but it is the biennial mode which captures the major features associated with El Niño-Southern Oscillation episodes. The biennial cycle is observed over the equatorial Pacific and Indian Oceans and is tightly phase-locked with the annual cycle. It varies in amplitude from cycle to cycle and sometimes changes phase. The biennial mode means that El Niño events are often preceded and/or followed by the wetter conditions associated with La Niña events. The change from El Niño-related drought to La Niña-related wet conditions can be rapid. These rapid changes can lead to further problems. For instance, a rapid onset of wet conditions, after an extended El Niño drought, can lead to severe soil erosion and complicate planting. Further research is needed to identify the impact of the biennial and phase-locked nature of El Niño on Africa.

How Could the Results of El Niño-Southern Oscillation Research Contribute to FEWS?

Despite the problems mentioned earlier, increased skill of forecasts of El Niño episodes, through improved coupled models, should be useful for early warning systems. It is certain that, during an El Niño, at least some parts of Africa will be severely impacted. Some aspects of these impacts are predictable with current models (statistical and dynamical). Thought needs to be given to the appropriate institutional arrangements (national and international) to enhance the skill of these models, and to ensure that the forecasts are used to reduce the likelihood of climate-related famine. With appropriate arrangements, and current models, much of the anguish of the 1888-89 Ethiopian famine might have been avoided. With improved institutional arrangements and models, the devastating impacts of El Niño can be minimized. Unless such arrangements are instituted, future El Niño events might again result in disastrous consequences for Africa.

References


Can We Get Policymakers to Take Notice of Information on Drought and Imminent Food Shortages?

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Why Should Policymakers Be Interested?

Policymakers will be interested in the effect of drought and food shortages on a population if their political superiors are interested in it. That will depend very much on who owns the state. Does the state have a need to defend the interests of rural dwellers? Possibly, but does it have a need to be concerned about the poor and vulnerable in rural areas? Such people by their nature lack power over resources, including political power. In most countries they are easy for the powerful to ignore or to denigrate, until their numbers become too large, or until the media, national or international, make too much fuss about them.

Perhaps, then, we need to turn the question around. Can we make the state interested? Or, more likely, can we set up a system for collecting information on the vulnerability of different groups to food shortages that alerts other people at the same time, who are interested enough to put pressure on the state to find the needy and provide relief to them? It will depend not only on the political interests of the state, but also on its resources, its ideology - interventionist or laissez faire - and on competing demands. Many states, of course, have a rhetoric of assisting the poor, but are nevertheless not particularly interested in doing so. They are unlikely to have set up surveillance methods, or to pay them much attention. Only pressure from outside the state, which has to include the turning of its rhetoric against it, will prevail. Others - and here I would include Botswana in the 1980s - have a more explicit free-market approach, but nevertheless have the resources and feel the political need to provide resources to a largely rural population, resources that include excellent surveillance and a genuinely redistributive response to rural poverty and drought. I will consider the Botswana example below.

In these days of declining willingness by many states to intervene on behalf of the poor, one of the best arguments for effective surveillance is that it allows for good targeting of at-risk populations, and thus for reduced costs of aid, provided that the surveillance itself is not costly. But at the same time, we must not allow the "free marketeers," who would have us leave the poor to their fate, to assume that free market economics support the argument that the poor will gain from the free interplay of the market. As one economist (Streeten, 1993) has recently commented:

Perhaps the most serious problems arise, ... not from market failure but from market success, not from government failure, but from government success. If it were a matter of correcting failures, the task would be relatively easy. But if the signals propagated by the market are based on a very unequal distribution of land, other assets, and income, it is market success in responding to these signals that causes the trouble. Amartya Sen [1981] has analyzed famines and shown that often total food supply was adequate, but that the purchasing power (or, more generally, the entitlements) of a particular group of poor people had
declined. In those conditions the market is all too successful in its signals, incentives and allocations, while people starve ... What is needed then is fundamental structural change, a redistribution of assets and of access to power.

How can we who are concerned with monitoring systems help this process? By making sure that surveillance is reported at many different levels, both within state structures and outside. Nutrition surveillance of children through clinics should be analyzed at the clinic level, and at the district, regional, and national levels. People can soon learn of their sensitivity to food shortages (or ill health - malaria, for instance, can give rise to increased levels of undernutrition among children, but it is not difficult to eliminate it as a cause). Districts can argue for increased levels of support within regional or national structures. Better still, if nutrition statistics - so innocuous but so telling - can be reported regularly to local village committees, or district development forums, or any other public or semi-public arena, they soon become public property, and a means to pressurize the system. Again, that was seen in Botswana.

What Kind of Information Do Policymakers Take into Consideration?

This is an important question. Recent work by UNICEF found that policymakers tend to stick to data sources they know well, and to disregard new ones. They also, of course, tend to stay with the kind of information they know best. Since the response to drought and food shortages often has large budgetary implications, economists are often involved in the decisions about that response. Such people are likely to be more alert to financial arguments than arguments about reservoir levels, cattle deaths, expected crop yields, or human undernutrition. This was particularly well seen in the 1993 'drought assessment' in South Africa. The team that moved around the country meeting officials consisted largely of economists, and only later did it agree to take along a member of the Consultative Forum on Drought and Rural Development, where there had been ongoing attempts to monitor the actual effects of drought. And still, the main discussion was about the costs of the programs, not the severity of the effects of drought. Such an approach is bound to reduce targeting, for there is little attention to cause and to the location of effect.

But if we want policymakers to look at different types of data, we have to ask how good the data are, how appropriate they are, and what the appropriate response to the data would be. I am an advocate of simple data, simply presented (probably graphically), and with the cause, effect, relevance, and appropriate response spelled out. I also consider that different types of data from different sources (ministries of meteorology, agriculture, health, water, etc.) should be reported together, so that their relevance to each other can be brought out. It is not useful, for instance, to deliver, as relief, dry foods that require mixing with water to people in areas that have little or no water, as happened in the Venda area of South Africa in 1992. Drought has multifarious and interacting effects which are best analyzed together for appropriate action.

So, if we have worked to produce graphic, well-analyzed data, and the appropriate response to the data, can we persuade the decisionmakers to take it seriously? Even with the political will behind them, there is the problem of inertia. With many competing demands on one's time, why deal now with a problem that will produce its worst results in a few months' time? Few countries appear able to plan forward well. Partly this is a problem of uncertainty: Are the data right? Could the situation right itself? Will I even be in this job in a few months' time to deal with the consequence of not acting now? Partly, it is a problem of lack of accountability. Partly, it is choice about which actions will have the best returns to my time and energy today.
Once again, it seems that the best response is to get the data and the analysis into the public domain, to initiate pressures from outside the government. This is difficult in a secretive government, or in one like South Africa, which has much preferred not to know the results of drought, or of policy itself, on the poor and their access to food. I do not pretend to have the answers. But we who have some idea of the strength of good data have to push very hard to get the state to collect it and then to make it available, for then we can hope to shame the state into action.

**The National Early Warning System (NEWS) in Botswana**

The Botswana NEWS was set up nationally to be a useful tool for the drought program in the 1980s. There was a general expectation that the 1980s would have poor rainfall after the excellent rains of the 1970s (following the work of Professor Tyson et al. (1975) on the Southern African rainfall cycles), and so it proved. The Inter-Ministerial Drought Committee (IMDC) was set up to manage the relief programs, and the Early Warning Technical Committee (EWTC) was to keep it well informed.

The EWTC consisted of representatives from:

- Agro-meteorology (who brought the monthly rainfall maps and the crop forecasts created with the FAO water balance model);
- Agriculture (with crop reports and forecasts, and livestock and rangeland reports, including water availability for livestock);
- Nutrition (bringing district nutrition rates, comparisons with the previous months, and best and worst areas, as well as reports on the feeding programs for the children under five years old);
- The office running the work programs; and
- Wildlife department (which requested to join latterly).

The coordinator of the EWTC was from the Rural Development Unit in the Ministry of Finance. She would monitor food prices around the country (data collected monthly by the Central Statistics Office) and the level of reserve food stocks. The head of the Unit was chair of the IMDC.

Each representative would provide a brief report. The group would discuss these and agree on the major issues. If any recommendations to the IMDC were required, these had to be agreed upon. Thereafter, the coordinator had 24 hours to write a short, pithy report, graphical where possible, and have it distributed onto the desks of all members of the IMDC three days before each (six-weekly) IMDC meeting. The report was also sent out to another 120 officials in the districts, each concerned in some way with the drought program.

Thus, the EWTC used monitoring systems that had already been created in the appropriate ministries, and did not create any new systems. It was, however, supplemented by reports from each district drought committee. Finally, each year in the middle of the rainy season, the EWTC, supplemented to include a water engineer, traveled to each district to have a meeting with the district drought committee and assess both the weather and its effects on agriculture, water, and human conditions, and the effects of the relief programs. On the basis of its report to the IMDC, planning was carried out for the relief programs of the following year, where necessary.
Thus, the EWTC obtained standard information (which was cheap), put it together, and provided it in a timely fashion to the appropriate personnel. Within the Ministry of Finance, personnel in the Rural Development Unit were able to start lobbying for funds for the relief programs quickly each year. The report to the IMDC was also modified slightly to go to the donors as quickly as the future year's program had been agreed upon by the IMDC and the Ministry.

Another feature of the program was that it emphasized the effects of the drought on household food security, not on national food security. When Botswana joined the SADC food security program, there was a requirement for the first time that annual estimates should be made of "national food requirements." These were very difficult, and not of the slightest interest in Botswana, where food can be freely imported across its long international borders. The Customs Department took up to two years to estimate the food imports. As a desert country with easy foreign exchange controls, Botswana is food-deficit in most of the staple food crops. National food security is assured if food can be freely imported to all populated areas where regional production has been insufficient to meet needs; this can be monitored by prices. Then, household food security is assured, if food can be purchased by the population or if the affected population is provided with cash as relief (or food, but only as the last resort, since this competes with food imports).

It was, thus, quite unnecessary to estimate regional or national "deficits" in the major staples. Indeed, I would argue that the word "deficit" has a normative edge, implying that one should not have deficits. In Botswana this implication led the Ministry of Agriculture for many years to over-emphasize and subsidize large-scale commercial production of food (believed to improve national food security, although there was no national food security problem) in place of working to assist the bulk of the peasantry to increase their levels of production and incomes, which would increase household food security. Statistics were being used to obfuscate the real problem.

With this exception, many of the collected data were used to provide proxies for food and incomes at the household level. For households dependent on agricultural production for their incomes, the shortfall in production as a result of drought (or flood, or rat infestation) was a good indicator of the fall in income. The very good district-level nutrition statistics provided a sensitive, though somewhat late, indicator of food problems as a result of food shortage.

I would argue that the balance between data originating in different ministries was much easier than usual in Botswana, because the structures for monitoring the affects of drought were coordinated neither in the Ministry of Agriculture nor in the Ministry of Health. It is difficult for Agriculture departments to take household food security seriously, and for Health departments to look to the wider economy. Economists, on the other hand, resist incorporating units that are not strictly financial into Ministries of Finance (as we have discovered in South Africa). There are probably several compromises possible that allow monitoring and relief programs access to state resources when these are needed, while avoiding both Agriculture and Health, two of the vital contributing departments.

Conclusion: Whose Drought? Whose Food Shortages?

South Africa, which has for many years provided "drought relief" in the form of production subsidies to its large-scale (white) commercial farmers, has excellent seasonal assessment of crops in the large farm sector. Small scale (black) farmers in the Bantustans did not receive drought relief before 1992, and there are no estimates of production. Similarly, the state has not historically provided relief to
vulnerable or malnourished households, and, until recently, there are no mechanisms for identifying those households.

These are good times in South Africa to be setting up an early warning system for food security. Many civil servants know that they need to be servicing new priorities. To present the monitoring of household food security as a technical challenge shows them a way forward that uses skills that exist among them, an important aspect of gaining their positive support to a new political orientation. It was not difficult in 1993 for a strong lobby from the nongovernmental sector to obtain agreement that such a system must be set up, and that it must emphasize vulnerability, incomes, and hunger.

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Post-Impact Syndromes and Drought Response Strategies in Sub-Saharan Africa

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Introduction

In Africa, drought is a serious natural disaster and has been associated with many socioeconomic miseries. Droughts on the continent often cause large-scale water and food deficits, hunger, famine, exodus of people and animals, diseases, deaths, and many other severe, chronic societal problems. Moreover, the economies of most of these African countries rely heavily on the exports of rain-dependent agricultural products which are often seriously affected during the years of severe droughts. Thus, drought occurrences on the continent generally cause severe reductions in the foreign exchange earnings, which in turn result in the crippling of natural resources and the ability of the individual nations to cope with the negative socioeconomic impacts of such droughts.

Drought, however, is a global problem that affects many parts of the world, including the poor and rich countries as well as developed and developing ones (Table 1). The degree of vulnerability of the various nations to the negative impacts of drought vary significantly from one nation to another. The highest degree of vulnerability has been recorded in the developing countries, especially those in Africa, because of the nonexistence of proper drought preparedness programs. Many African nations seem to forget the miseries of any drought with the onset of the good rains; and those miseries usually continue from one drought to the next. Several of these nations rely heavily on post-impact remedies, such as emergency relief from food donations.

This review examines the potential use of prediction and early warning information of impending seasonal rainfall anomalies in order to minimize drought-related socioeconomic miseries in Africa. The potential use of ENSO products in the prediction of seasonal rainfall anomalies is given prominence in this review because of the current ability of some computer models to provide skillful forecasts of ENSO-related information several months in advance (Cane et al., 1986). ENSO events have been associated with worldwide climate anomalies, including those that occur in various parts of sub-Saharan Africa.

The review is divided into four major sections. The first part highlights the problems associated with basic drought concepts. Teleconnections which have been observed between ENSO in the equatorial Pacific Ocean and climate anomalies in Africa are discussed in the second part of the review, while the third part highlights the potential use of ENSO information in the prediction and early warning of possible rainfall anomalies over some parts of Africa. The last section presents some key mitigation strategies which could be used to minimize the post-impact drought response syndromes which are prevalent in many parts of the African continent.

Concepts of Drought
Drought is a complex, gradual, and cumulative process with varying degrees of impacts on ecosystems and on human activities. It has, therefore, been an extremely difficult task to provide universal definition for the term "drought." Details of the drought concepts have been discussed widely in the scientific and popular literature. No attempt will be made to develop a universal definition of drought. Details of various definitions can be obtained from the following references: WMO, 1976; Wilhite and Glantz, 1987; Glantz, 1987; Ogallo, 1989; Wilhite, 1992; Hare and Ogalo, 1993; among others. Many drought definitions have been sector-specific. The major classifications of drought include meteorological, hydrological, agricultural, and societal/economic. Many of these definitions have attempted to quantify the impacts of cumulative water deficits in each specific water-use activity. The severity of an individual drought is, however, determined by the timing of its onset and withdrawal, duration, intensity, areal extent, threshold water requirements for a specific water use, along with other considerations.

The impacts of drought also depend on the degree of preparedness of societies and governments, based on their use of historical information of regional drought characteristics. These statistics must be closely integrated with prediction and early warning information when quantifying the risks of a region to future droughts of varying degrees of intensity, duration, and so forth.

**ENSO and African Rainfall Anomalies in Space and Time**

Most regions of Africa are covered by arid and semiarid climates. Substantial parts of the remaining parts of the continent are also covered by dry sub-humid climates. The wet humid tropical/equatorial climates are generally located only over limited parts of the tropical highlands, near some of the large water bodies and in the western equatorial parts of the continent, extending from the Congo (Zaire) basin and central Africa to the coastal zones of western Africa.

The relatively drier parts of Africa have very large levels of interannual rainfall variability. Figure 1 shows typical examples of the interannual rainfall patterns of the African continent.

Time series analyses of African rainfall have not detected any large-scale trends in the interannual rainfall characteristics, except for the Sahelian region where mean annual rainfall values have persistently been below the long-term expectation (perceived as normal), except for 1988 and 1994. A number of authors have attempted to explain the general decline in mean annual rainfall in the Sahel using an albedo-biogeophysical feedback hypothesis (e.g., Otterman, 1974; Charney, 1975). Recent studies, however, have demonstrated some close linkages between some modes of Sahel rainfall anomalies and sea surface temperature anomalies over various parts of the global oceans, including the ENSO warm and cold phases (e.g., Palmer, 1986; Folland et al., 1986; Lough, 1986; Semazzi et al., 1988). Furthermore, evidence from geological records shows that such persistent negative rainfall trends had been observed before in the Sahel region (Nicholson, 1980).

With the current concern regarding the potential roles of anthropogenic activities on global, regional, and local climate, the persistent Sahel rainfall trends will continue to draw a lot of global interest and will continue to trigger many climate-change-related scientific and socioeconomic studies. Recent global concerns about anthropogenic environmental degradation of the planet have been reflected in the June 1992 United Nations Conference on Environment and Development (UNCED), and Agenda 21, together with the conventions on Biodiversity, Climate Change, and Desertification.

More specifically, the periods of strong warm and cold ENSO phases have witnessed large-scale
Figure 3 - Time series of irrigation dependent grain production for two African countries.
### Table I

**Worldwide effects of 1982–1983 ENSO**  
*(Source: The New York Times, 2 August 1983)*

<table>
<thead>
<tr>
<th>Location</th>
<th>Phenomena</th>
<th>Victims</th>
<th>Damage (US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Mountain and Pacific states</td>
<td>Storms</td>
<td>45 dead</td>
<td>1.1 billion</td>
</tr>
<tr>
<td>2. Gulf states</td>
<td>Flooding</td>
<td>50 dead</td>
<td>1.1 billion</td>
</tr>
<tr>
<td>3. Hawaii</td>
<td>Hurricane</td>
<td>1 dead</td>
<td>230 million</td>
</tr>
<tr>
<td>4. North-eastern USA</td>
<td>Storms</td>
<td>66 dead</td>
<td>-</td>
</tr>
<tr>
<td>Cuba</td>
<td>Flooding</td>
<td>15 dead</td>
<td>170 million</td>
</tr>
<tr>
<td>6. Mexico—Central America</td>
<td>Drought</td>
<td>-</td>
<td>600 million</td>
</tr>
<tr>
<td>7. Ecuador—northern Peru</td>
<td>Flooding</td>
<td>600 dead</td>
<td>650 million</td>
</tr>
<tr>
<td>8. Southern Peru—western Bolivia</td>
<td>Drought</td>
<td>-</td>
<td>240 million</td>
</tr>
<tr>
<td>9. Southern Brazil, northern Argentina, eastern Paraguay</td>
<td>Flooding</td>
<td>170 dead, 600 000 evacuated</td>
<td>3 billion</td>
</tr>
<tr>
<td>10. Bolivia</td>
<td>Flooding</td>
<td>50 dead, 26 000 homeless</td>
<td>300 million</td>
</tr>
<tr>
<td>11. Tahiti</td>
<td>Hurricane</td>
<td>1 dead</td>
<td>50 million</td>
</tr>
<tr>
<td>12. Australia</td>
<td>Drought, fires</td>
<td>71 dead, 8 000 homeless</td>
<td>2.5 billion</td>
</tr>
<tr>
<td>13. Indonesia</td>
<td>Drought</td>
<td>340 dead</td>
<td>500 million</td>
</tr>
<tr>
<td>14. Philippines</td>
<td>Drought</td>
<td>-</td>
<td>450 million</td>
</tr>
<tr>
<td>15. Southern China</td>
<td>Wet weather</td>
<td>600 dead</td>
<td>600 million</td>
</tr>
<tr>
<td>16. Southern India, Sri Lanka</td>
<td>Drought</td>
<td>-</td>
<td>150 million</td>
</tr>
<tr>
<td>17. Middle East, chiefly Lebanon</td>
<td>Cold, snow</td>
<td>65 dead</td>
<td>50 million</td>
</tr>
<tr>
<td>18. Southern Africa</td>
<td>Drought</td>
<td>Disease, starvation</td>
<td>1 billion</td>
</tr>
<tr>
<td>19. Iberian Peninsula, Northern Africa</td>
<td>Drought</td>
<td>-</td>
<td>200 million</td>
</tr>
<tr>
<td>20. Western Europe</td>
<td>Flooding</td>
<td>25 dead</td>
<td>200 million</td>
</tr>
</tbody>
</table>
rainfall anomalies over many parts of Africa. ENSO signals have, for example, been detected in rainfall time series for the Sahel region, eastern Africa, Ethiopia, and southern Africa (Folland et al., 1986; Lough, 1986; Nicholson and Etukhahbi, 1986; Ogallo, 1987, 1989; Ogallo et al., 1988; Ropelewski and Halpert, 1987, 1989; Semazzi et al., 1988).

However, the magnitude of detectable ENSO signals varies significantly, not only from one location or region to another, but also from season to season and year to year. Ogallo (1987), for example, noted that over some parts of eastern Africa, ENSO signals shifted from a positive to a negative phase from the northern summer to the autumn season. Even when strong ENSO signals are detectable in some locations, observations show that ENSO does not always account for most of the interannual rainfall variance at such locations. For example, the large-scale droughts of 1949 and floods of 1961-62, which were observed over many parts of eastern and southern Africa, had very little to do with ENSO (Ogallo, 1989).

Recent research and observational analyses have, however, detected some unique and persistent rainfall anomaly patterns over parts of southern Africa, eastern Africa, Ethiopia, and the Sahel region during the periods of strong and persistent ENSO warm and cold phases. These patterns, however, do have some specific temporal variations, depending on the time and space evolution of the specific individual ENSO event, taken together with the actual responses of the surrounding Indian and Atlantic Oceans. Careful synthesis of ENSO information related to teleconnections at the specific locations, combined with traditionally existing prediction methods used in the region, can increase the levels of prediction and the early warning skills of seasonal rainfall anomalies.

**ENSO and Early Warning Systems in Africa**

ENSO has some significant predictive and early warning potential for parts of Africa. The advantage of ENSO over many other predictors is that scientists believe that some ENSO models can provide lead times for the onset of ENSO several months in advance (Cane et al., 1986; Cane, 1991). It is important to note that Africa has very complex topographical features. Africa’s atmospheric processes are affected by other regional-to-global scale systems which control the day-to-day patterns of weather and climate. The skill of the ENSO-derived forecasts can only be improved with a good knowledge of the space-time characteristics of all these local and regional climate systems and their linkages with the ENSO phenomenon.

The close relationship between rainfall anomalies and rain-dependent cereal production is evident in Figure 2. The stability of cereal production in the few countries which have invested in irrigation is also evident in Figure 3. Thus, it is reasonable to expect that ENSO information could provide very useful information on potential adverse impacts on cereal production. Cane et al. (1994) have, for example, shown that ENSO signals during the northern summer months can be used to estimate the expected maize yield production anomalies in Zimbabwe for the preceding northern winter rainfall season.

Rainfall deficits can have severe impacts on water supply for domestic use, hydropower generation, and many other basic water use activities. The use of ENSO-related information (not just ENSO forecasts) to provide some prediction and early warning information on impending seasonal rainfall anomalies would be very useful in minimizing severe socioeconomic impacts of drought. Most of these post-impact mitigation strategies are overshadowed by emergency relief through food donations.

It has, however, been noted by FAO (1993) and many others that, apart from drought, there are
several other factors which have been associated with the pathetic economic growth in Africa and the increase in degree of vulnerability to natural disasters. Such factors include, but are not limited to, the following:

- Negative global trade balance and capital flow environments;
- Decline in the values of its primary exports;
- External debt burdens;
- Decline in the inflow of external resources from private and other sources;
- High rate of population growth which outstrips production growth;
- Civil strife in parts of Africa.

In the first section it was noted that most of the economies of the African countries depend heavily on rain-fed agriculture. The ability to provide skillful information of impending drought could help to minimize many of these economic problems.

**Key Factors on Mitigation and Early Warning Systems in Africa**

Although drought is a worldwide problem, some droughts are spatially very localized and affect only limited areas within an individual country, while others are very severe and cross many political boundaries. Apart from droughts, there are also other crucial socioeconomic factors which are causing miseries in Africa. Some of these make society more vulnerable to drought. Thus, even what one might consider a mild drought, which in previous years could have been easily cushioned by a society, can cause socioeconomic havoc because of the relatively weaker economic base of that society. In addition, droughts can also trigger a higher degree of vulnerability of society to socioeconomic problems. Although the drought/food problems must be tackled at the local and national levels, there are several regional and global dimensions to a number of crucial issues:

**Drought preparedness policy**

Drought preparedness must be an integral part of a national disaster preparedness program. Wilhite and Glantz (1987) noted that drought is not generally given the prominence which the other natural hazards have received, since it is a gradual and cumulative process. Many African countries do not have any drought mitigation policy, even after they have recognized the severe socioeconomic impacts of drought in their national economies. African Ministers of Economic Planning in the Economic Commission for Africa (ECA), for example, adopted a resolution in 1985 for the establishment of the African Center for Meteorological Application in Development (ACMAD). This intergovernmental center is expected to provide long-range forecasting. However, it is having serious financial problems due to the lack of adequate financial contributions by governments. If it were not for the WMO and other donors, the center would already have collapsed. Other sub-regional centers like AGRHYMET and the UNDP Drought Monitoring Centers (DMCs) in Nairobi and Harare have also been created to address sub-regional prediction and application problems. They, too, are experiencing similar financial problems.
While discussing the financial problems which are facing these prediction and application centers in Africa, and the lack of commitment by many governments, one should not forget the poor state of many African economies. Take, for example, the Sahel where regional precipitation has been, in general, on the decline since 1968. It will be extremely difficult for these rain-dependent economies to generate substantial resources to support the regional drought preparedness programs without external cooperation and support. One should also recognize the recent increased frequency of positive phases (warm events) of ENSO events which have been associated with frequent droughts in various parts of sub-Saharan Africa.

There are regional and global social, economic, political, and scientific forces which are much stronger, and must be addressed seriously through any discussion of regional/global cooperation.

*Prediction and early warning*

The ability to estimate the probability of drought occurrence and the various risks associated with such droughts is a crucial component of drought preparedness. The potential role of ENSO productions in the prediction and early warning of the impending seasonal rainfall anomalies has been highlighted in the text. The use of these products should, however, not be overemphasized and must be used together with other existing predictors. The ENSO signal in some regions remains weak and uncertain, and so there is an inability for ENSO to account for most of the observed interannual rainfall anomalies in all parts of Africa.

African centers like DMCs, ACMAD, and many national meteorological services are using ENSO productions in Africa. There have been several limitations to the use of these ENSO products because of the lack of equipment, technology, human resources, the timely availability of such products, and so forth. The strengthening of the regional centers is one of the most convenient collective ways of solving some of the common regional prediction and early warning problems.

*Observational network*

It is extremely expensive to maintain a good network of observations for meteorological, hydrological, and other climate-related data. A poor data network is a serious problem throughout Africa. The use of automated stations and satellite-derived estimates has been very useful, but still far from adequate for multisectoral drought monitoring activities, which sometimes require point-source information.

*Communication*

Efficient and effective communication is key to data collection, processing, dissemination, and interaction (feedback) with the users and the public. Communication is one of the most serious problems in Africa.

*Historical database*

The history of natural disasters can be obtained from the basic statistics of past events. These cannot be computed without a good and easily accessible database. Many drought monitoring indicators also require these statistics in order to enable comparisons to be given between current and past drought events. Harmonization and standardization of the database for multidisciplinary users is also very
essential.

Technology transfer

Technology has developed very fast for many monitoring and early warning activities. Some of these processes are now using computer-friendly software, Geographical Information Systems (GIS), and other complex methodologies. Nevertheless, the level of technology is still very low in most of the African countries.

In a number of cases, attempts have been made to introduce very expensive and appropriate technology, but successes have been minimized due to unsustainability of such technologies through lack of good maintenance and servicing. Many African countries do not have science and technology policies, which could provide some vision on technology transfer programs.

Human resource development

Skillful human resources are fundamental to any successful application or technical program. They are also seriously lacking in most public sectors in Africa. This includes technicians, scientists, resource managers, urban planners, environmental specialists, etc. The limited skilled manpower which exists in Africa often migrates to the developed world and is co-opted by international organizations or by the private sector because of the lack of incentives in the public sector.

Education and training

Basic education and training, often referred to as “capacity building,” are crucial components of human resource development. An educated public is also more likely to respond in an informed way to new policy changes, especially those which may directly affect societal activities or interests; for example, changes in land use or land management practices or the availability of limited food varieties during severe drought. Some African communities would rather choose to die of hunger than eat the usual varieties of emergency relief food like rice or corn meal, in the absence of their traditional diets. Education of the public could also help to minimize many traditional societal problems which sometimes increase vulnerability of some African communities.

Research

There are still many scientific and socioeconomic problems which need serious research in order to enable optimum solutions to be found to prediction and early warning problems. However, research is not a priority in many African countries. Few African governments have been able to invest some reasonable proportion of their national resources into research agriculture, health, water, energy, and other basic sectors. The actual level of investment is extremely low when compared with the 1% of the national GDP recommended by UNESCO. Yet, it is only through research that one can provide optimum solutions to complex and highly interrelated problems like those related to prediction and early warning.

Financial resources

Sustainable financial resources are fundamental to the success of most programs. The recent trends of African economies have made it extremely difficult for sustainable financial resources to be obtained
at the national level for research, human resource development, technology transfer, etc. The pooling
together of regional and global resources through some cooperative efforts has been a common practice.
Several regional and national prediction and early warning programs for sub-Saharan Africa have been
funded by FAO, the WMO, World Bank, UNDP, and bilaterally. Sustainability of these few existing
programs can only be guaranteed through proper arrangements for the future takeover of such programs
by individual nations or by groups of nations through regional cooperation.

Information exchange

The timely exchange of accurate information is an integral part of any applied program, especially for
drought disaster management. Good communication facilities and communication skills are required.
The use of computer-friendly software is increasing in the developed world, although the basic disaster
preparedness information exchange facilities are not available in many African countries.

Drought industry

There are some individuals and national, regional, and multinational organizations which have
thrived during drought periods. Some of these have delayed the development of appropriate national
plans which could kill off or curtail their drought industry.

Management

Mismanagement of resources, equipment, and personnel has led to failure of some good mitigation
initiatives in the region. The training of managers and management leadership by technical experts is a
necessity. Some technical programs in Africa are led by nonexperts who cannot provide any vision, even
though they often wield enormous power because of their political connections.

Socioeconomic problems

As noted by FAO (1993), among many others, drought is only one of the many drivers of
socioeconomic problems in Africa. There are several others which are beyond the control of the region,
yet they influence, if not determine, the day-to-day socioeconomic stresses at the national levels.

Regional/international cooperation

Some of the problems highlighted above can only be solved through regional and international
cooperation. The strengthening and use of the existing regional and international coordinating centers
like AGRHYMET, ACMAD, DMCs, and their linkages to global and national centers should be the best
way to maximize the current meager resources presently available for prediction and early warning.

Regional cooperation is also necessary for regional food security. A number of African countries
have food policies driven by self-sufficiency models which have never been realized. Several
agricultural economists have, however, preferred to rely on cost-benefit models while addressing
regional food security issues. It is unfortunate that some of the cost-benefit models which have been
"sold" to some African countries have neglected some of the food policies, socioeconomic problems,
ratios of throw-away food/grain, prices during nondrought periods to extremely high buying prices
during droughts, and many other dimensions which are sometimes extremely difficult to quantify.
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Implications of Climatic Variability for Food Security in The Southern African Development Community

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Introduction

Although it cannot be claimed irrefutably that global changes in climate have already occurred, much of the recent research suggests that the rise in the proportion of "greenhouse gases" in the atmosphere may already have set in train some irreversible changes. Certainly, there seems to be some evidence of increasing climate variability. The consequences of this for countries in the Southern African Development Community (SADC) are particularly serious. With fragile soils and with increasing population pressure pushing agriculture further into areas of less favorable rainfall and soils (Glantz, 1994), small variations in rainfall can have proportionately much larger consequences for food security.

The potential impact of climate change on food security has been examined by Downing (1992) for a number of countries, including Kenya and Zimbabwe. The results point to a possible reduction of yields and deteriorating food security as global warming occurs. It is in reaction to warnings such as this that SADC is now taking account of climate change in its long-term planning. The purpose of this chapter, therefore, is to discuss the implications of a potentially more variable climate for SADC’s food security strategies.

TABLE 1 - (The average annual rainfall for the past ninety years is 662.3 mm).

The Impact of Rainfall Variability

In most of the national economies in SADC, about 70% of the population derives a livelihood from agriculture. The pattern of agriculture is generally dualistic but, by far, the largest proportion of total populations are small-scale farmers. Clearly, if rainfall varies from the norm, both in terms of total precipitation and in timing, food security is affected. Data from Zimbabwe illustrate this nexus. Between 1960 and 1992, average annual rainfall for the whole of Zimbabwe was 662.3 mm (see Table 1). Reliable data for cereal output for the whole of that period are not available, so comparisons of output and yield have only been made for the period 1969 to 1992. As shown in Figure 1, maize yields fluctuated widely at that time, ranging from 2.4 tonnes per hectare (2.4 t/ha) in 1986 to as low as 0.4 t/ha in 1992. These wide fluctuations parallel the changes in annual rainfall. The correlation is even more marked in the case of changes in maize yields and in percentages of average rainfall (see Figure 2).

Apart from the obvious conclusion that yields depend on the amount of rainfall, the graphs highlight the variability in average output over the past two decades or so. This has serious consequences for small-scale peasant farmers whose total output is often barely sufficient to meet household food needs, let alone to allow for any sales to generate cash for such needs as school fees or clothing.
Table 1
Maize and Sorghum Yields and Rainfall: Zimbabwe

<table>
<thead>
<tr>
<th>Crop Year</th>
<th>Area ('000 ha)</th>
<th>Maize Output ('000 t)</th>
<th>Yield (kg/ha)</th>
<th>Area ('000 ha)</th>
<th>Sorghum Output ('000 t)</th>
<th>Yield (kg/ha)</th>
<th>Rainfall (mm)</th>
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</table>

Note: Years refer to crop season, i.e., 1970 means 1969/70. The average annual rainfall for the past ninety years is 662.3 mm.
Maize Yields and Rainfall: Zimbabwe

Figure 1

Maize Yield Changes and Rainfall as a Percent of Average: Zimbabwe

Note: The 90 year average of 662.3mm has been used.

Figure 2
At the national level, there is no clear trend in total output of maize during the twenty-two years to 1990. However, it is apparent that an increase in the area sown to maize in 1980 coincided with much higher rainfall to generate a record crop of 2.8 Mt (Figure 3). Increases in area and higher yields following good rains and higher prices pushed total output up to similar levels in 1984-85. Since then, rainfall, yields, and output have all trended downward.

Fluctuations in rainfall are not the only explanation of changes in yields and in total output. Since independence, the structure of Zimbabwe’s grain economy has changed significantly. Prior to 1980, the bulk of marketed maize emanated from the large-scale farming sector. This is less the case now, as expansion of the Grain Marketing Board’s operations into communal areas stimulated a marked increase in the area sown to maize (see Figure 3) and in the volume of maize marketed by small farmers. The spread of hybrids to the small-scale farming sector and further increases in their use by large-scale commercial farmers are also reflected in the generally higher average yields in the latter part of the 1980s, relative to the ten years before. But the introduction of hybrids, while raising average yields, has also resulted in the amplitude of the fluctuations in yields getting larger. In good years, hybrids yield better than local varieties. In poor years, this tends to be reversed.

One feature of the data presented in Figure 2 is the apparent downward trend in average annual rainfall in Zimbabwe relative to the average for the twenty-three years up to 1993. It is tempting also, but no doubt rather incautious, to read a ten-year cycle into the data. While such speculation may not be appropriate, variations from the average certainly occur frequently; these variations are often large. Agrometeorological and other reports from the early warning units providing estimates of output, especially in the small-scale farming areas, are, therefore, vital in planning for national and regional food availability.

On a brighter note, Figure 4 indicates that, although still influenced by the amount of rainfall, sorghum yields appear to have trended upward over the past two decades. Two implications are worth noting. The first is that improved varieties appear to be having a beneficial effect, justifying the research efforts to develop new strains. The second is that farmers in semiarid areas may now have access to a crop that will provide greater food security, especially in years when rainfall falls below the long-term average.

Several implications emerge from the foregoing, admittedly very simple, analysis. The first is that, with population pressures preventing small-scale farmers from being able to practice rotational agriculture, the structure and fertility of soils are becoming progressively degraded. This is amplified by the growing number of livestock. Second, increasing variability of yields and output means that cropping decisions (e.g., crop type, timing), storage and retention strategies, and marketing decisions will all have to change. Third, coping strategies at the household level are not well documented or understood, so considerable research is necessary to develop measures to buttress food security at the household level, not just in Zimbabwe but in the entire SADC region. Fourth, at the national and regional levels, this apparently increasing variability is occurring at the same time, as many countries are moving toward more open economies. So the capacity of SADC’s member states to use public resources to maintain reserves or to support the real incomes of small farmers is diminishing. Finally, the coincidence of a poor season in all ten SADC countries in the early 1990s resulted in severe shortages and the need for international food assistance in 1992. The region is beginning to recognize that preparedness measures are now essential. Clearly, these implications call for research and policy responses at the national and regional levels.
Policy Responses

At the regional level, SADC has responded to the potential threat of wider fluctuations in rainfall, and hence in output, by introducing a food security program aimed at promoting output at the national level, increasing availability at the regional level through trade and stocks and other preparedness measures, including accessing aid and holding reserves, encouraging the spread of marketing infrastructures, and by providing an information base for policymakers.

In SADC, food security is defined as being when sufficient food is available to meet the nutritional needs of everyone in the region and when all members of a household, nation, or region have the means to access the food they need for a normal, healthy, and active life. The food security program aims to achieve this by improving people’s access to food through measures to raise incomes and by implementing food aid programs.

In 1992, SADC adopted a revised strategy for the food, agriculture, and natural resources (FANR) sector. The new strategy attempts to meet the challenges outlined above and comprises three major programs. The first is a program to improve food security, especially at the national and household levels. Elements of these strategies are common to the agricultural development program. But in the context of food security, production-increasing strategies and providing for short-term shortages are of a shorter-term, micro-economic nature rather than longer-term development strategies.

Agricultural development is a longer-term concept. The strategies in this program are aimed at creating a more widely based sector that provides more opportunities for employment and for income generation and, eventually, stimulates a faster growth of secondary industry. Rural infrastructural projects and policy changes are also envisaged to allow resources to flow into productive agriculture-related activities.

Finally, the natural resource conservation program is designed to ensure that natural resources are used optimally and that the sustainability of agriculture and of other economic activities is assured. Environment and land-management-related projects, including the improved management of water resources, are components of this program.

Climate change, or the risk of it, impacts on all three of these programs. In the context of ensuring food security, the capacity to reduce the impact of sudden fluctuations in output on the availability of food in the region will become essential. A food reserve in the form of physical stocks or a fund to allow purchases at short notice is already being mooted. Over the longer term, agricultural development must mean the promotion of the appropriate forms of agriculture. Farm systems research will also be necessary to ensure that increasing soil erosion does not occur. So, policy planners need to be alerted to the potential changes required and the resources that would be needed to put these changes in place.

The main elements of the natural resources conservation program have been elucidated in a program prepared by SADC’s Environment and Land Management Sector. Given the likelihood that agriculture will remain the largest sector in SADC countries’ economies for the foreseeable future, land management practices will need to take into account the possibility of greater seasonal fluctuations to prevent further degradation. If the region does experience wider fluctuations in rainfall in the future, putting the right policies in place is even more urgent.

The Regional Food Security Program
The principal elements of the food security program are as follows:

- developing mechanisms for obtaining and exchanging information on the region's food security;
- establishing systems for preventing and mitigating food crises;
- assisting with the development of effective national food security strategies and reinforcing national food production capacity;
- developing mechanisms to promote food security policy analysis and research;
- establishing programs to control major regional pests and diseases;
- promoting intra-regional trade in food and other agricultural commodities;
- fostering improvements in food storage, delivery, conservation, and processing; and
- developing skilled manpower in the field of food security.

Providing decisionmakers with better information in order to enhance both short-term and long-term food security was clearly one of the major underlying concerns of the Usable Science workshop on "Food Security, Famine Early Warning and ENSO," held in Budapest, Hungary, in October 1993. It is also the first element of our program. The theme of the workshop was equally pertinent to the second element of the program - the prevention of food crises in the region.

The informational elements are essential. An important component of the latter is SADC’s Regional Early Warning System (REWS), which provides advance information on crop conditions and on the availability of staple foods so that member states are able to start importing (or exporting, as the case may be) before major problems emerge. The details of the REWS and its role during the recent SADC drought are presented in more detail in the paper by Rook in this issue.

In the context of preventing food crises, a regional financial facility to enable member States to access regional or offshore grain supplies will be built up over time to provide a first line of defense against shortages such as those experienced in 1992. Drought preparedness measures, such as those advocated by Wilhite (1989) are also planned.

In the long term, SADC’s agricultural research program will bear further fruit. Priorities for research include developing higher-yielding, drought-resistant varieties of cassava, millet, and pulses as well as of maize and sorghum. How these new varieties are cultivated will also be important. So, extension messages tied to these crops will also stress prevention of the loss of soil fertility.

Important as these elements are, it is becoming increasingly apparent that there is also a need to improve the capacity of governments to identify groups which are at risk and to devise policies that address food security problems as they relate to households, to countries, and to the region. Obviously, the size and location of these groups will change significantly within and between years. SADC has recognized that the combination of increasing population, declining per capita production of food in the region, and moves to reduce public intervention in markets will mean that the identification of such groups will become increasingly difficult. Monitoring these changes alone will strain the resources of
the region. Nonetheless, a pilot project is about to be implemented that will operate in close conjunction with the Early Warning System to provide data that will allow supportive rather than famine relief action to be taken. The pilot project is aimed at providing data on both nutritional status and the socioeconomic capacity of groups to maintain food security. The output of this system should combine with early warning reports to provide good leading indicators of areas and groups that might need assistance if food output and incomes fall.

Conclusion

The main purpose of this discussion paper has been to outline some of the implications for the SADC region’s agricultural sector that flow from the possibility of climate change and a wider range of fluctuations in rainfall. The impact of lower rainfall on yields of the major crops is greater if the rainfall is spasmodic or unevenly spaced, and hybrid maize varieties seem to be particularly susceptible to insufficient moisture. Increasing population pressures, smaller average farm sizes, expansion of crops into areas of lower agricultural potential, all point to traditional farming systems becoming progressively less able to prevent seasonal yield shortfalls from translating into food relief needs. Even small deviations from normal rainfall now have progressively greater impacts on those portions of the region’s populations that do not farm the most favorable land.

The implications for food security are now being taken into account in framing a regional approach to food security. Research into higher yielding crops that can flourish in adverse conditions is being given more priority. The management of the region’s productive soils is also becoming an issue of greater concern; this means putting in place policies that promote farming systems that do not extract more than can be sustained over the long term. Perhaps the most important associated issue is that of deriving some way of meeting the region’s need for energy without reducing still further the natural arboreal cover.

Changes in climate are hard to perceive. However, there seems to be growing evidence that the region could experience increasing variability in rainfall and the possibility of permanent, irreversible changes. Policymakers will have to take much firmer action on such issues as population growth, economic incentives, and charging for resource use, if the capacity to meet the region’s food security goals is to be achieved. The possibility that a widespread severe drought, such as occurred in 1991-92, could strike the region again is now accepted. Disaster prevention measures are, therefore, also beginning to be put in place in each member state. A better understanding of the links between climate systems in other parts of the world (such as the recurrent El Niño-Southern Oscillation [ENSO] events that occur in the central and eastern equatorial Pacific Ocean) and those of sub-Saharan Africa could well improve the effectiveness of such precautionary measures.

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Introduction

A joint contribution to the British science journal Nature following the Budapest Usable Science Workshop on "Food Security, Famine, Early Warning and El Niño" sparked a surprisingly high level of interest in forecasting seasonal conditions in southern Africa and has prompted a further burst of adaptive research. Regional and international organizations are now taking the possibility of making early, accurate predictions of southern Africa's seasons seriously. Droughts in the region in 1991-92 and again in 1994-95 have renewed as well as heightened the interest in such work.

This chapter describes the genesis of two background papers delivered at the "Food Security, Famine, Early Warning and El Niño" workshop that is the catalyst of this volume. It then outlines some work stimulated by the workshop and subsequent repercussions throughout the southern African region. It is, in effect, a confirmation of the workshop and shows how science is becoming more "usable" in the sense that Glantz anticipated when he convened it.

Background

Agriculture is the most important economic activity in SADC countries. The 1980 Lusaka Declaration, which established the framework for regional cooperation in southern Africa, gave prominence to development of agriculture and food security. Zimbabwe was given the task of coordinating SADC's food security program. In 1992, the Environment and Land Management Sector, which is coordinated by Lesotho, convened SADC's first Climate Change Conference in Windhoek, Namibia. Given the importance of rain-fed agriculture, the region's food security was a major topic. The conference drew particular attention to the need for research into more drought-resistant crops and for better understanding of the region's weather, upon which improved forecasts and food security planning could be based. The paper that appears in this issue (Buckland) expands on that theme and reiterates the need for better information for food security purposes.

Post-Workshop Developments

The time series of Zimbabwe's annual rainfall and maize yields presented by Roger Buckland (Figure 1, and Figure 2) struck a spark of recognition in Mark Cane, one of two physical scientists from outside Africa in attendance at the workshop. Cane's research specialty is El Niño and its prediction (his
contribution to this volume). As outlined here, his work and that of others has made possible the skillful predictions of extreme events in the ENSO cycle as much as a year ahead. But since the forecasts, though certainly skillful, are nevertheless imperfect, one may question whether they are accurate enough to be useful. We will return to this issue below in the context of southern Africa.

What Cane saw in the rainfall and maize yield data was the imprint of the ENSO cycle. Having lived with the latter long enough to know its ups and downs by heart, he recognized its pattern in the Zimbabwe data. He immediately concluded that the maize yield in Zimbabwe is predictable some months ahead - certainly before the planting season. Not surprisingly, the workshop participants greeted this statement with considerable skepticism.

Their skepticism was well founded in agronomical and social considerations which could be expected to disrupt any simple relation between ENSO and crops. Many plausible reasons why such a relationship would not survive, based in part on the participants' comments, are listed in the letter to Nature (Cane et al., 1994).

In fact, the relation of ENSO to Zimbabwe rainfall is very strong, and the relationship to maize yield is even stronger. This is immediately evident from Figure 1 of the Nature paper. Though we still cannot say with certainty why nonclimatic factors fail to assert themselves, the empirical evidence of Figure 1 clearly tells us they do not interfere strongly with the dependence of maize yield on a global climatic anomaly - ENSO. Once this is established, the small additional step of combining the empirical connection of Zimbabwe maize yield to ENSO with the demonstrated ability to predict ENSO generates a crop prediction. The level of skill in such predictions is illustrated in Figures 2 and 3 of the letter to Nature (Cane et al., 1994).

Thus, the exchange of ideas and information between the food security experts and the climate scientists at the Budapest workshop quickly bore fruit. Cane obtained the Zimbabwe data from Buckland, and with the help of a graduate student, Gidon Eshel, correlated it with an ENSO index, i.e., the average eastern equatorial Pacific sea surface temperature in the region known as NINO3. The results showed the anticipated connections, and encouraged them to document the ability to actually predict maize yield for Zimbabwe. The results were interesting enough to warrant publication of a joint letter to Nature.

Recent Responses

Publication of the letter in Nature elicited strong interest from the popular media. There were numerous features on radio and television, and a large number of publications carried stories about the article, including The New York Times, New Scientist, and the edition of Newsweek that circulates in southern Africa.

At a grassroots level, interest in El Niño and its impact on the region manifested itself in the publication of numerous short articles in farming magazines in the region and in newspapers. Officials of the Regional Early Warning System (REWS) sponsored further research by two meteorologists in Harare. Considering the whole of southern Africa, they delineated spatially coherent areas of interannual summer rainfall variability and then calculated relationships between the Southern Oscillation Index and the summer rainfall. The general conclusion was that the SOI was a useful predictor for some areas when strongly negative but was less useful in moderate low phases. This result is consistent with other ENSO prediction studies in showing skill for the extreme events, but only for the extreme events.
At the same time, the US National Oceanic and Atmospheric Administration was proposing a global program for seasonal-to-interannual climate prediction. Researchers and food security personnel in southern Africa responded to this initiative with enthusiasm and are now looking forward to being part of a worldwide research program with special relevance to the region. An August 1995 meeting in Washington, DC, initiated several pilot activities for the region and generated plans for a workshop in southern Africa in October 1996. The general strategy has been to build on the institutions already in place in the region, enhancing cooperation in the application of climate monitoring and forecasting to food security, health, and, ultimately, to other impacted economic sectors.

**Discussion and Future Outlook**

In some respects the response to the letter in *Nature* was surprising. After all, the connection between ENSO and southern African climate variability had been well-known and extensively documented for quite some time, not only in numerous works by specialists on the region, but also in the widely cited compendium of global ENSO connections of Ropelewski and Halpert (1987). Furthermore, no one should be startled by the notion that crop yields depend on rainfall. The major unanticipated scientific result of the work is that the connection of ENSO to maize yield is stronger than that to rainfall. (Consistent with the reactions of the workshop participants, we expected the relationship of ENSO to maize to be degraded by other factors.) Interesting as this is both scientifically and practically, it hardly accounts for the public’s interest in the *Nature* letter.

In retrospect, what captured the popular imagination was the direct connection of agriculture to global climate variations. That, and the appeal of forecasts of a harvest well in advance for a region where food security is a serious concern. The few prior works connecting ENSO to agriculture appeared in specialized journals and concerned Pacific Rim countries in ENSO’s immediate thrall.

Our work aimed to produce a practical application of pure and applied research: Usable science. The commentary in *Nature* characterized its advance in this direction as a “sea change.” We believe that this assessment of the practical value (and novelty) of our work is generous. It may be, however, that the wide publicity it received did markedly advance the cause of usable science. It made food security and other relevant governmental units aware of the possibilities for using ENSO science to advantage. By bringing news of these scientific advances to the attention of local farmers, it began to build a broad constituency for usable science.

The potential for improving long-range forecasts of summer rainfall is heartily welcomed by the SADC Food Security Sector. The models currently employed by the REWS are predominantly for crop forecasting. They involve the analysis of data such as soil moisture, cumulative rainfall, inputs, and crop development. The remote sensing component of the REWS provides cumulative data on rainfall in the region and of vegetation growth. Satellite pictures of the position of the Inter-Tropical Convergence Zone give those skilled in interpreting such data an idea of what rainfall is likely in the region for the next few days or even weeks. But no way of forecasting what the rains are going to be like well ahead of the season (i.e., in September or October) with a high degree of certainty is available yet. Clearly, if we can achieve such forecasts ahead of the season, the job of food security planners, farmers, and relief agencies would be very much easier.

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Global Warming and Climate Impacts in Southern Africa: How Might Things Change?

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Introduction

The states in southern Africa can be divided into two groups. The first group includes the southwestern countries bordering the Kalahari Desert (Angola, Botswana, Zimbabwe, Namibia, and South Africa). The climates of these countries range from semi-arid and sub-humid in the east, to hyper-arid in the west (Darkoh, 1989). The second group of countries is mainly in the eastern part of the continent (Tanzania, Malawi, Mozambique, Swaziland, Lesotho, and the five Indian Ocean islands), where the climates range from semi-arid in most parts to sub-humid.

The region is sandwiched between subtropical high pressure cells to the west and east (the Atlantic Ocean and Indian Ocean anticyclones). Southern Africa as a whole is prone to frequent droughts and uneven rainfall distribution in time and in space. Generally, there are two distinct seasons - the wet season with the Intertropical Convergence Zone (ITCZ) as the major synoptic feature causing rainfall (November to April) and the dry season (May to October). If the global consensus is correct - that global warming will make dry areas drier and wet areas wetter (IPCC, 1990, 1995), - then most of southern Africa would become drier.

Global Warming

Climate has always been a major determinant of the activities of humankind. How people dress, how they build their homes, when they go on vacation, what kind of crops they grow, as well as many other human activities, are all dictated by climate. This is true throughout the world, and has been so throughout time. But over the last two centuries, the activities of humankind have increasingly become a determinant of climate on a global scale.

It has long been known that human endeavors such as the building of cities, erection of factories, and so on, may modify climates on a local or regional scale. Slowly the realization has dawned that large-scale anthropogenic activities throughout the world may have global consequences, transgressing continents as well as national boundaries. Through modification of the chemical composition of the atmosphere, particularly by increasing those gases that absorb the earth’s infrared radiation, the atmosphere is warming. This anthropogenically induced global warming will present people and governments everywhere with real challenges in the future, particularly in terms of pollution control, regional water management policies, and food production.

Global climate models (Canadian Climate Centre, CCC; Geophysical Fluid Dynamics Laboratory, GFDL; and UK Meteorological Office, UKMO) are predicting a 3.5 to 4.0 deg C increase in the average global temperature, and a 4-9% increase in precipitation globally with a doubling of carbon dioxide
(CO₂) (IPCC, 1990). Using the same models, the regional climate predictions for southern Africa during summer suggest a warm season increase of 2 deg C to 4 deg C over the subcontinent, with the doubling of CO₂ and the predictions of precipitation changes being much more variable. Tyson (1990) stated that these predicted values are slightly lower than those of some of the earlier models, and that by about 2030 the global climate may warm by 2 deg C to 3 deg C. Almost all climate simulations to date use the radiative equivalent of doubling CO₂ in the atmosphere. (Carbon dioxide, nitrous oxide, CFCs, and methane are trace gases that contribute to the so-called greenhouse effect.) Wang et al. (1991), in their preliminary work, suggested that using the actual trace gases (Scenario A of the 1990 IPCC Report) has the effect of increasing warming in some regions. Houghton et al. (1992) suggested that additional warming in excess of 2 deg C may be produced using trace gases.

Time series analysis of temperature records for Harare (Zimbabwe) shows no definite trend over the last 100 years. In the 1980s, however, we saw an upward temperature trend. Yet, there is no evidence to link this increase in temperature exclusively with climate change, as it could be a manifestation of natural climatic variability as opposed to change. Despite this lack of a definite trend, the models used to predict the temperature change for southern Africa confirm that the region will not escape the effects of global warming and that the predicted warming will be less than suggested previously by earlier estimates used in the 1990 IPCC assessment.

All indications to date are that southern Africa will be affected by warming in both summer and winter, that rainfall may diminish somewhat in certain areas, and that soil moisture will probably decrease more generally with a doubling of CO₂. The findings also suggest that the global increase of greenhouse gases would bring about few, if any, changes in the effects of ENSO on southern African rainfall (Tyson, 1991).

Climate Impacts

The subtropical nature of the southern African climates controls the nature of the socioeconomic activities that are practiced in the region. The two main climatic parameters that determine the socioeconomic prospects as well as problems in the region are the annual rainfall (its spatial and temporal distribution) and temperature fluctuations. Some socioeconomic constraints manifest themselves in the following sectors:

- Highly variable yields in arable agriculture (both rain-fed and irrigated);
- Livestock production faces the problem of poor and variable rangeland productivity and desertification processes;
- Afforestation activities are negatively affected by deficient rainfall;
- Generation of hydroelectric power at Kariba (Zimbabwe) can be adversely affected. For example, the Kariba Hydroelectric Power Station on the giant Zambezi River was unable to provide the normal supply of electrical energy to both Zambia and Zimbabwe during the 1991-92 drought; and
- Decimation of wildlife population through recurrent droughts and expansion of human settlements.

Impacts on Agriculture
Agricultural production constitutes a significant percentage of the Gross Domestic Production (GDP) of most southern African countries. The impacts of climate change on agriculture are not well understood in this region. Seasonality is a decisive factor in the agriculture of southern Africa. Hence, to better understand the interaction of climate variability and food production in southern Africa, there is a need to carry out an integrated regional climate impact assessment for the agricultural sector. The study would require the following data sets:

- Soil and population maps for different countries in the region;
- Sample surveys (area planted and yields) and rainfall data; and
- Use of Geographic Information System (GIS) techniques to obtain optimal results on smallholder vulnerability and to develop effective response strategies to climate impacts.

The southern African assessment should also examine changes in food entitlements (e.g., Sen, 1981). The typical wet and dry years in southern Africa (for example, the 1980-81 and 1991-92 growing seasons, respectively) could serve as reference points for a climate impact study of smallholder agriculture. Conclusions emanating from such a study should shed more light on the nature of the likely impacts of climate variability on food security at the household level. Such conclusions would be useful to the regional policymakers.

**Impacts on Irrigation**

Studies of climate impacts related to agriculture should also examine the likely effects of climate change and variability on the irrigation potential of southern Africa. Such a study would provide useful indicators of possible future changes in the region’s water balance. Currently, there is a strong attraction toward the development of irrigation projects in the region. This is largely the result of the growing incapacity of the region to feed itself (as a result of land degradation and recurrent droughts), as well as the desire of governments in southern Africa to generate foreign currency through the export of cash crops such as tobacco. Irrigation projects are most developed in Zimbabwe (130,000 hectares), Tanzania (25,000 hectares), and Malawi (19,000 hectares). The main irrigated crops are wheat, cotton, maize, tea, and sugar. The irrigation potential is interwoven into the socioeconomic fabric of the southern African states. It, therefore, becomes imperative to study present and future trends associated with irrigation practices, that is, the depletion of surface and underground water. In addition, irrigation of large tracts of land may lead to the uprooting of local people from their traditional lands in addition to adverse environmental impacts of reservoir development, including downstream effects.

Some studies on the effects of anthropogenically induced climatic changes on irrigation water consumption were conducted by the Food and Agriculture Organization (FAO), along with the UK’s Institute of Hydrology, for the Malibamatsama Basin, 3,240 km 2 in Lesotho (Nemec, 1989; Institute of Hydrology, 1988). Future climate change simulations for this region have been accomplished using a general circulation model with a doubling of CO₂. The model’s output indicated a 6 deg C increase in mean monthly temperature, a 4-23% decrease in monthly precipitation from December to May, and a 10-15 % increase in monthly precipitation from June to November. This research suggested that with a doubling of CO₂, changes in meteorological conditions in the basin would lead to a 65 % increase in water demands for irrigation, bringing about the shrinkage of irrigated areas from 37,500 ha at present to 20,000 ha.
Impacts on Livestock Production

Livestock production depends on a balance between pasturage and water supplies. Droughts of varying geographic scope, periodicity and intensity often recur in southern Africa. In spite of such droughts, Botswana, South Africa, Zimbabwe, and Namibia are involved in large-scale livestock production, which enables them to export meat to the European Economic Community countries. The recommended parameters which may be used (Downing, 1987) in impact assessments on livestock production are:

1. Milk output (volume/unit time) during poor, average, and good seasons;

2. Live-weight gain over a year. This parameter is a function of the length of time for which suitable grazing pastures are available. The number of decades (ten-day periods) with rainfall which exceeds 20 mm is a better indicator of the condition of grasslands than total seasonal rainfall.

Conclusion

Existing climatic prediction models are too coarse for the development of reliable and credible regional climatic scenarios. There is a significant uncertainty regarding the climate change scenarios for sub-Saharan Africa with conflicting scenarios about which areas will get wetter and which will get drier. The only thing that seems clear at this time is that global temperatures will increase but we do not know what will happen at the regional level. This makes it more urgent for the southern African inhabitants to be adaptive in the face of uncertain trends in climate-related socioeconomic activities of the region. Nations must learn to cope with climate variability and then cope with climate change. However, on the basis of both limited resource capacity in relation to present-day population, and of the possible future diminution of the region’s agricultural resource base as a consequence of reduced water availability for crop production, southern Africa appears to be one of the regions most vulnerable to climatic change.

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A Forecast Is Just a Forecast: It's Not a Guarantee

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Introduction: Misinterpretations and Misuses of Forecasts

Hazards and their forecasts

Concern about the forecast, mitigation, and analysis of impacts of climate-related hazards has increased markedly since the early 1970s and has become an important element in international cooperation (El-Sabh and Murty, 1988; Ghali, 1992). The beginning of this sharp increase in interest can be connected with dramatic climate anomalies such as devastating drought, which accelerated desertification processes and sparked severe food shortages and famine in the West African Sahel and in the Horn of Africa. Anomalous climate in the eastern equatorial Pacific manifested itself through devastating impacts of El Niño (actually El Niño-Southern Oscillation) along parts of the western coast of South America. Improvements in monitoring and forecasting such hazards are essential for improving early warning systems and for lessening the adverse effects of these hazards (El-Sabh and Murty, 1988).

ENSO is one of the most important large-scale natural phenomena for which analysis can assist in the development of a general framework for climate-related impacts management. In 1987 Nicholls observed that "El Niño has apparently been given a place among widely acknowledged natural disasters, such as floods, severe storms, tidal surges, typhoons, and earthquakes that merit close scientific monitoring and investigation. ... This new-found awareness will grow as attention focuses on the impacts of this natural event on society and on the environment, and as scientists continue to unravel its mysteries."

Famine is a relatively rare phenomenon and presents special problems to those attempting to
forecast its occurrence for at least two reasons. First, the occurrence of famine depends on the sequence (and/or coincidence) of many causal factors, both natural and social, each of which requires monitoring, evaluation, and modeling. Each of these factors, separately or in combination, can result in significant reductions of food production which, if they persist over a long enough period, may lead to famine. This complexity of "predictors," their dynamics (evolution), and the limited resolution of the applied forecasting system (e.g., model grid dimensions) result in considerable uncertainty about whether famine will or will not occur. Second, these events and their forecasts attract a great deal of attention from those concerned with mitigating the event. This results in high expectations of the forecasters’ ability to produce reliable forecasts and the temptation to apply these forecasts in the formulation of a response mechanism or strategy.

In the context of this workshop, we are particularly interested in the application of ENSO forecasts to fews. However, it is extremely important to realize that ENSO is only one of many factors that may influence the occurrence or non-occurrence of famine. In reality, we are dealing with several forecasts: Forecasts about the trends of various indicators (e.g., nutritional status, rainfall conditions, crop yields), forecasts about ocean temperature tendencies in distant places (e.g., the central and eastern equatorial Pacific Ocean), forecasts of human response, and so forth. Moreover, droughts and floods may be ENSO or non-ENSO-related. In the case of ENSO-related drought, the influence will likely be both direct (e.g., crop yields) and indirect (e.g., migration, labor supply, acres planted, on-farm grain storage, household food consumption, food imports, and acreage devoted to crash crops [Gbeckor-Kove, 1989; Glantz, 1987]).

The misunderstanding of forecasts

There are at least three stages in the misunderstanding of forecasts. First, there are false expectations about various forecasting models and their outputs (e.g., forecasts of climate anomalies, crop-yield estimates, and food-price assessments). Various expectations (e.g., demands) are placed on these models not only by the "decisionmakers" and the general public, but also by experts of the climate-related impact field. In this sense, crop-yield modelers use harvest assessments which incorporate these output data in their models.

Second, there is often a genuine lack of understanding about the interpretation and application of a forecast to a specific case. If forecasts are used, one must decide whether or not to issue warnings about the probability of occurrence of famine or some other specified phenomenon. The seriousness of this final step in the forecast process should not be downplayed, as it will directly motivate decisionmakers, food-aid organizations, and other actors in the food security management community to respond or not. Because of the potentially severe consequences of the events being forecast, several key questions arise about the forecasters’ responsibility at all stages in the forecast process, namely: Should forecasters consult with the users or consumers of forecasts in advance to ensure that the final product will suit their needs? Should forecasters train users in the application of forecasts to "real world" problems? Should forecasters provide more insight into the conditions, assumptions, and uncertainties underpinning their analyses?

Often, the roots of "misunderstandings" about phenomena lie in the differences in how persons and organizations define, characterize, and analyze the phenomena (Wilhite and Glantz, 1985; Faragó et al., 1990). Confusing or misleading forecasts only serve to further delay action by decisionmakers and others charged with mitigating the impacts of natural and human-induced disasters.
The third stage in the misunderstanding of forecasts is in their misuse. Here, misuse refers to an inappropriate application or response based on forecast information. The overall objective of the forecast is, in general, either to maximize benefits or minimize adversity.

Uncertainty is one of the crucial factors which generates the various stages of misunderstanding. Inherent in each part of the forecast chain, there is a degree of uncertainty. When aggregated, these uncertainties are compounded. How then should users of famine early warnings apply information that they are given? How should users incorporate uncertainty in the forecast chain into the formulation of a response strategy? Regardless of how reliable, timely, and effectively communicated the forecast, an inadequate or poorly conceived response strategy will render the forecast useless or of little value. This fact emphasizes the importance of preparedness to provide the institutional capacity required to carry out a prescribed response strategy (Wilhite, 1993).

It is important to make a distinction between organizations with primary responsibility for fews and those organizations with responsibility for the various components of the system. A famine early warning system must integrate many forecasts, including an ENSO forecast. Davies et al. (1991) noted: "The question of responsibility is particularly complex because of the multiplicity of actors involved: national (and sometimes subnational) government; bilateral and international donors; NGOs; and local communities," while the "process of analysis, communication to decisionmakers, and feedback, which determine the effectiveness of information in planning and implementation, ... are ignored in the context of early warning."

Predictors, Target Variables and the Uncertainty Cascade

The famine process is a relatively long-term, low-grade, but cumulative environmental phenomenon. As discussed above, meteorological forecasts are only one of several forecasts relevant to fews. Each type of forecast has a target variable or variables (the predictands). In the case of famine prediction, the variables could be expressed in quantitative or qualitative terms. The specific indicators of fews are as follows: meteorological-climatological indicators, natural resources, agricultural, nutritional and health, and socioeconomic (Davies et al., 1991). Of course, the space and time attributes of these variables are important for the forecasting scenario. The success of fews may be determined ultimately by the cascade of uncertainty for each of the specific indicators mentioned above. In the case of meteorological forecasts, decisionmakers must understand the strengths and weaknesses of forecasts. They also need to be informed of the economic value of using meteorological forecasts and climatological information (i.e., how this information can be used as a mitigation tool to reduce potential impacts).

Decisions under Uncertain Conditions

An extremely important consideration for forecasters lies in how forecast users perceive probabilities and risks. Forecasters must know how to express the risks to the at-risk populations and to the decisionmakers responsible for their well-being. Forecasters must also learn how to communicate important scientific concepts, such as probability of occurrence, to decisionmakers so that they can incorporate this information into the decision process. Scientists must demonstrate to decisionmakers the cost of inaction when a reliable forecast has been provided. We must assist policymakers in understanding these costs. Perhaps the best way to do this is to bring decisionmakers into the different stages in the discussion process that lead to a decision to intervene or not. This approach will enable them to hedge in increments. For example, some forecasts are issued in the following stages: advisory,
warning, and watch - raising awareness at each level. This approach also allows for early action, such as the import of small amounts of food, providing an additional "buffer" for policymakers in case the situation worsens. There is a need to educate appropriate decisionmakers about risk-averse, risk-taking, and risk-making behavior. In the case of the latter, decisions made today can create risk for certain populations (but not necessarily including the decisionmakers) tomorrow. How can we educate them about the risks that they may be unknowingly creating for others?

Summary

ENSO has become recognized as an important large-scale natural phenomenon that results in significant impacts worldwide. Along with this recognition has come an urgent desire to predict its occurrence in order to reduce or mitigate some of its most severe consequences. In famine-prone areas, uncovering the linkages between ENSO and rainfall tendencies would certainly facilitate the provision of advanced warnings so that some initial steps could be taken to buffer society against potential food supply shortfalls.

An ENSO forecast may be only one of many forecasts incorporated in a fews. It is important to recognize that an ENSO forecast could be a critical link in a successful fews; however, it is only one part of a forecast chain, each component having some degree of uncertainty. In addition, the success of a fews is determined by not only the inputs to that system but also by the outputs-actions or responses that emanate from the issuance of a famine forecast. A forecast is not a guarantee; it is only a forecast. All forecasters should strive for greater reliability in forecasts, but ultimately the success of a fews is determined by scores of factors. However, given the slow-onset nature of the famine process, a reliable and timely ENSO forecast, coupled with an adequate understanding of the forecast by users, could significantly reduce the severity of the event or alter if not eradicate famine occurrence.

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Seasonal to Interannual Climate Prediction for Sustainable Development in Arid Regions: The Nordeste Region of Brazil

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Map of Nordeste Region of Brazil

Introduction

Our increasing understanding of the Earth’s climate system, of the variability within that system, and of the manifestations of that variability in terms of specific regional precipitation and temperature distributions provides an opportunity which may prove to be the fundamental underpinning of a successful paradigm for sustainable development. In many regions of the world, where precarious living conditions are constantly threatened by recurring episodes of severe drought or flood, economic development that is truly sustainable is virtually inconceivable without an effective ability to plan for these extreme variations in climate. Our emerging understanding of anomalous regional precipitation and temperature patterns associated with the El Niño-Southern Oscillation (ENSO) phenomenon and our improved ability to predict ENSO events up to a year in advance offer a glimpse at a tool of historic dimensions. It is critical, however, as physical scientists unlock a predictive understanding of the global climate, that the implications of this development be examined from a social and economic perspective. An accurate climate forecast is worthless without an understanding of how to effectively utilize the information.

The Brazilian Nordeste (Northeast) region is a revealing example of the connection between climate and society. The precarious arid conditions and the devastating episodes of periodic drought are not merely pressures on the Nordeste society, but have played a critical role in determining and perpetuating the social and economic relationships which define that region’s social structure. The fundamental importance of climate to the lives of the Nordeste population has led to a great deal of research into the causes of year-to-year fluctuations in rainfall over northeastern Brazil. This has created an effective understanding of factors which force this region’s climate on an interannual time-scale, and has provided some early successes in efforts to apply predictions of precipitation variability to various aspects of social and economic planning. An examination of the experiences of Northeast Brazil illuminates the remarkable potential opportunities in the applications of climate prediction for societies throughout the world.

In order to promote the further advancement of climate science, and more significantly, to ensure that the outputs of this advancement are most appropriately suited to the specific needs of the developing world, plans have been initiated to develop a multinational capacity for the systematic production and dissemination of seasonal to interannual climate forecasts tailored to the specific needs of those regions most impacted by ENSO-related climate variability. This initiative, for an International Research
Institute for Climate Prediction (IRICP), was proposed by the United States at the UN Conference on Environment and Development in Rio de Janeiro, in June 1992.

**Nordeste Region of Brazil**

The Nordeste is one of the five macro-regions of Brazil. It is the least-developed region, contributing only 14% of the country’s GDP, while containing a third of the nation’s population in 20% of the total area of Brazil. Although the region is ecologically diverse, the predominant environment is semiarid. Nearly 75% of the land is at risk of being turned into desert. Per capita income is very low, and is distributed unevenly across the population. Over 20 million people, about 45% of the Nordeste population, live in the semiarid region. In the Nordeste state of Ceará, 88.7% of which is classified as semiarid, there are an estimated 450,000 families who are linked to the primary sector. Of these, one-half are non-landowners extremely vulnerable to episodes of drought. Although these families depend on agriculture as a means of subsistence, they are the first to lose work when rains are inadequate to support a full crop, and are typically faced with no alternative but to migrate in search of income (Magalhães and Glantz, 1992; Magalhães, 1992). In fact, one out of every five people born in the Nordeste emigrates to another Brazilian region.

Historical evidence of the Nordeste’s long-term coexistence with drought exists back to the Brazilian colonial period. Extreme droughts have occurred in 1614, 1723-24, 1790-94, 1816-25, 1877-79, 1900, 1915, 1958, and 1983 (Magalhães, 1992). The drought which began in 1992 has been described as one of the worst in a century.

A particular drought affects various components of a society in different ways. The vulnerability of a particular social group depends on the ecological setting in which it lives; its means of earning a living; the level of its income and wealth; ownership and access to lands; and, if the people in the group are landowners, on the size of their property holdings. Depending on the combination of these economic and environmental factors, certain societal subgroups are perpetually at risk, while others are often in a position to derive significant economic gain from temporary periods of drought. Those who are at the highest risk, subsistence farmers who do not own land, are locked in a position of social and political impoverishment by the constant threat of drought-induced economic disaster.

During periods when the rainy season does not come, the rise in unemployment is instantaneous. Farmers often choose to abandon agricultural activity in the face of certain loss. This means that millions of rural workers in the Nordeste become unemployed. These groups react by searching for a means of survival: Hunting, digging wells for water, stripping the lands for natural resources including roots, fruits and cacti, looting warehouses and markets, migration to expanding urban areas, and searching for government-sponsored emergency relief programs. The results of these actions are widespread social unrest, including the stresses associated with the migration of undereducated rural populations into the existing pressures of urban expansion, and increased environmental vulnerability as a result of the further degradation of a precarious ecological balance.

The government responds by attempting to create conditions which will provide income for suffering families, secure drinking water and food, and reduce the impetus for migration. In addition to action aimed at emergency relief, the governments of the Nordeste have sought long-term plans to relieve the pressures that increase their vulnerabilities to drought. One component of this long-term approach has included an examination of the natural climate factors which create such potentially devastating variability in the Nordeste annual rainfall.
Physical Climate Affecting Nordeste

Although the El Niño-Southern Oscillation (ENSO) phenomenon seems to have a significant impact on rainfall in the Nordeste, the link appears to be complex and apparently arises through a combination of physical effects (Sansigolo, 1992, p. 2). The impact on Northeast Brazil of an ENSO warm episode is strongest when the enhanced convection generated by the anomalously warm sea surface temperature (SST) in the equatorial Pacific is in its easternmost position. The highest correlations also appear to occur with a two-month lag, e.g., January Southern Oscillation Index (SOI) with March rainfall (Gasques and Magalhães, 1987, p. 31).

The main factor responsible for rainfall in the tropics is the location of so-called convergence zones. Convergence of humidity and subsequent cloud formation caused by a confluence of winds near these zones create conditions for strong rainfall (Uvo et al., 1993). The locations of these zones are affected by ENSO-related variations in atmospheric pressure and SST. For Northeast Brazil, it is the location of the Inter-Tropical Convergence Zone (ITCZ), a thin convective band extending in an east-west direction over the equatorial Pacific, Atlantic, and Indian Oceans that largely determines precipitation. Rainfall in the Nordeste is usually concentrated in the months of March to July, when the ITCZ reaches its most southerly position. As noted by Hastenrath, conditions are most conducive to rain in the Nordeste when: (i) the ITCZ is closest to the Nordeste; (ii) the south equatorial Atlantic SST is warmest; and (iii) the perennial dipolar contrast between Atlantic warm north equatorial waters and cold waters to the south of the equator is weakest (Gasques and Magalhães, 1987, p. 31).

Applications of Climate Prediction in Nordeste

State government agencies in Brazil have organized a means of utilizing their understanding of the processes influencing the nation’s climate into an integrated effort to apply predictions and climate diagnostics to the direct benefit of affected populations. In the Nordeste State of Ceará, a mechanism has been created to provide management support for decisionmaking related to droughts based on scientific and technical information in the areas of Meteorology, Water Resources, Agriculture, and Environment. This mechanism, the Ceará-Cear Foundation for Meteorology and Water Resources (FUNCEME), has achieved a great deal of success in assimilating climate research, with input from other institutes, universities, and foreign government entities, to produce advice used widely in government planning.

During December of 1991, the Governor of Ceará, alerted by FUNCEME of the likelihood of an impending poor rainy season, went into the arid interior of his state, along with his Secretary of Agriculture and the President of FUNCEME, to persuade the people to plan according to a forecast of drought. His goal was to convince his constituents of the value of the forecast, to explain that the prediction was for conditions similar to those experienced in the past, and to instill a confidence that, through appropriate planning, the effects of the drought could be mitigated. With government guidance, farmers were able to plan seeds appropriately suited and timed for a short growing season.

Using a water-level monitoring system, FUNCEME advised that the level of consumption in the state’s capital, Fortaleza, could not be supported, and that, given the forecasted conditions, the city would be without drinking water by December 1992. A decision was made to restrict slightly water consumption and to renew operation of an old water system. Furthermore, recognizing the city’s vulnerability to a potential drought in the following year, the Governor decided to invest US$13M to construct a new dam in the Pacajús River.
The success of this planning was extraordinary. As shown in Table 1, although the precipitation in 1992 was 27% below the annual mean, grain production was maintained at 530,000 metric tons (82% of the annual mean). Comparing this to a similar event in 1987, for which no planning was taken in accordance to climate forecasts, and grain production dropped to a mere 15% of the mean, one quickly recognizes the remarkable success that was achieved. (Taken from notes of a personal conversation with Francisco Viana and Antonio Moura, 1992).

Table 1
Comparison of Three Drought Cases in NE Brazil

<table>
<thead>
<tr>
<th>Year</th>
<th>Precipitation (% of mean)</th>
<th>Grain Production (in metric tons)</th>
<th>Grain Production (% of mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>70%</td>
<td>100,000</td>
<td>15%</td>
</tr>
<tr>
<td>1992</td>
<td>73%</td>
<td>530,000</td>
<td>82%</td>
</tr>
<tr>
<td>1993</td>
<td>60%</td>
<td>400,000</td>
<td>62%</td>
</tr>
</tbody>
</table>

The 1993 figures tell another interesting story. In late 1992, when it became time to give a prediction for 1993, the scientific information was conflicting and did not provide a forecast with which the President of FUNCEME could feel confident. Although his research indicated that there would be a rainy season typical of the historical average, a consensus forecast made with Brazil’s Institute for Space Research (INPE) indicated that drought conditions may exist again in 1993. His response was to withhold the information and to ask for further outside assistance. Although the delay in issuing the forecast was somewhat unpopular, in MarchFUNCEME provided an accurate forecast of drought. As indicated in the chart above, the forecast was issued far enough in advance to allow for effective mitigation planning. When examining these projected figures for 1993, it is important to bear in mind that this was the second consecutive year of drought, and that environmental vulnerabilities had peaked by this exacerbated extended state of drought-related aridity. In this context, the results are even more impressive. (Taken from a personal conversation with Antonio Moura, October 1993).

International Research Institute for Climate Prediction (IRICP)

To take advantage of this increased predictability demonstrated in Northeast Brazil and in other experiences throughout the tropics, and to implement the application of this information to the benefit of society, NOAA led the multinational development of an International Research Institute which would focus on interannual climate prediction. The proposal for an IRI was developed by an International Task Group of scientists and science managers at the request of the Intergovernmental Board of the World Climate Research Program’s Tropical Ocean and Global Atmosphere (TOGA) Program. The concept envisioned an international network in which a central facility would develop and issue routine seasonal-to-interannual climate predictions based on fully coupled global ocean-atmosphere modeling of the ENSO phenomenon and its teleconnected implications. The forecast guidance products would be.
disseminated to Application Centers located throughout the world in those nations and regions that are particularly impacted by climate variability associated with the ENSO phenomenon. The Application Centers would then tailor their guidance to the specific conditions and needs of the localities which they serve in order to apply the information in support of the direct economic, social, and developmental needs of the region.

The strategy which has been followed in the development of this proposal has been to ensure that, at every level, the users play a role in defining the products. The information issued by the central facility would be tailored by the regional application centers, employing the advice and needs articulated by local decisionmakers, to provide "products" that would be effective, understandable, and useful in formulating policies, laws, strategies, and incentives that should take advantage of the forecast information.

Effective climate predictions, delivered at least a season in advance, would enable countries directly affected by natural climatic variability to prepare for both the positive as well as the adverse effects of anomalous conditions. Accurate predictions could save lives, livestock, agriculture, infrastructure and other capital investments, as well as fisheries, vulnerable ecosystems, and other resources depended upon for social and commercial purposes.

Many of the countries most affected by ENSO events happen to be developing countries. Their economies are dependent upon their agricultural sectors as a major source of food supply, employment, and foreign exchange. Drought predicted several months to a year in advance, coupled with response options effectively communicated to local farmers and resource managers, will assist affected populations in maintaining employment and securing supplies of food, water, and energy; allowing governments to save scarce financial resources and to mitigate the suffering of their populations. Those peoples and nations of the world who rely completely on anticipated seasonal climate conditions in precarious agricultural circumstances are cyclically victimized by variations of the average seasonal precipitation and temperature patterns. In providing these nations the opportunity to prepare for anomalous conditions before they occur, we are potentially breaking this cycle.

It is likely that all countries are directly or indirectly affected, to varying degrees, by regional climate variability associated with ENSO. As we continue our scientific examination of the statistical correlations between ENSO and anomalous regional temperature and precipitation patterns, we are increasing our understanding of global teleconnections of ENSO episodes that extend into the temperate latitudes. In addition, as evidenced in the example of Northeast Brazil, we are increasing our understanding of regional climate forcing factors, and of mesoscale interactions within the global climate.

It is also critical that we develop a more complete recognition of the full range of the direct and indirect effects of ENSO. As we advance our appreciation of the broadly defined implications of natural climate variability on societies, economies, cultures, and ecosystems, we need to work simultaneously to draw decision-making communities representative of these many diverse sectors into the process of developing the most effective way to apply predictive climate information. As the value of seasonal-to-interannual climate forecasting continues to be demonstrated through the successes of efforts such as those in Northeast Brazil, we need to be ambitious and proactive in generating awareness of the potential contributions of an IRI and its regional application centers to those who could benefit from such a worldwide, operational climate prediction and application program.
Through direct application of scientific results, the economically and technologically developed nations can join in full partnership with developing nations adversely affected by ENSO to progress towards sustainable development around the globe. A successful end-to-end-to-end program - from data gathering to process research and integrated computer modeling, to regional and local applications of forecasts, to inputs to decisionmakers and the ENSO research community - will depend heavily on effective multinational cooperation.

References


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Ethiopian Use of ENSO Information in Its Seasonal Forecasts

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Introduction

Ethiopia has an area of 1,112,000 square kilometers (as large as France and Spain combined), with a total population of 55 million. Of the total population, 90% of the people earn their living mainly from agricultural activity, as subsistence farmers working on 23% of the total arable land of the country.

The Ethiopian economy is mainly based on rain-fed agriculture. Regardless of the presence of surface and groundwater resources, the failure of seasonal rains seriously affects the country’s food production prospects and, in the past, has claimed millions of human and animal lives. An example of such an occurrence is the 1984 drought that resulted from the failure of the Belg (short season) rains and deficiencies in the Kiremt (main season) rainfall, aggravated by long dry spells and their untimely onset. This situation adversely affected the food intake of about 8 million people (RRC, 1985).

However, the severity and frequency of occurrence of drought (meteorological, hydrological, and agricultural) vary for different parts of the country. Rainfall is considered as the most important climatic element that influences Ethiopian agriculture. Because of this, the rainy seasons of different parts of the country are discussed in more detail.

The long-term mean monthly rainfall of 12 selected stations (4 from each region) is displayed in figures 2.2, 2.3, and 2.4. (The smooth curve which is overlaid over the line graphs is drawn using Harvard Graphics software.)

The central and most of the eastern half of the country have two rainy periods and one dry period. The two rainy periods are locally known as Kiremt (June to September) and Belg (February to May), which are the long and short rainy periods, respectively. The annual rainfall distribution over this region shows two peaks corresponding to the two rainy seasons, separated by a relatively short "dry" period (Figure 2.2). The dry period, which covers the rest of the year (i.e., October to January), is known as Bega.

The southern and the southeastern parts of Ethiopia (the regions identified by the letter C in Figure 2.1 have two distinct dry periods (December to February and September to November). The temporal distribution of rainfall over these regions shows two distinct peaks separated by a well-marked dry period (Figure 2.3).

The western part of Ethiopia, which is identified by the letter B in Figure 2.1, has one rainfall peak during the year (Figure 2.4). The length of the rainy period decreases, and the length of the dry period increases as one goes toward the north within this region, as a result of the meridional migration of the ITCZ (Inter-Tropical Convergence Zone).

In addition to the various atmospheric systems affecting Ethiopian rainfall, the temporal and spatial variations of rainfall discussed above could be the result of the topography and the geographical location
Fig. 2.1 The Rainfall Regimes of Ethiopia
Fig. 2.2 Monthly Distribution of Rainfall in Rainfall Regime A; (a) Mekele  (b) Kombolcha
(c) Addis Abeba (c) Diredawa
Fig. 2.3 Monthly Distribution of Rainfall (in mm) in Rainfall Regime C; (a) Gode (b) Filtu (c) Negele (d) Ìåbelo
Fig. 2.4 Monthly Distribution of Rainfall (in mm) in Rainfall Regime B; (a) Bahrdar (b) Nekemte (c) Gore (d) Jima
Fig 3.1 The location of Ethiopia in the Monsoon Region
of the country. The great East African Rift Valley (which runs northeast to southwest across Ethiopia), the mountains and highlands to the right and left of this Rift Valley, and the lowlands surrounding these mountains and highlands in every direction can be described as the country’s main topographical features.

**Planetary and Regional-Scale Atmospheric Systems Affecting Ethiopian Rainfall**

Ethiopia is located within the monsoon region, which is defined by surface-based observations and by consideration of atmospheric circulation patterns (Figure 3.1) (Henderson and Robinson, 1986). The main weather systems affecting Ethiopia are documented by different staff members of the National Meteorological Services Agency (NMSA).

During *Belg*, the main mechanism for Ethiopia’s weather patterns is the interaction between the extratropical and tropical weather systems. The Arabian ridge or anticyclone (when it is displaced to the North Arabian Sea), the penetration of deep, large-amplitude troughs in the westerlies into the lower latitudes, and the southward bend of the subtropical jet stream (STJ) at the upper levels are the major rain-producing mechanisms from February to May.

The tropical disturbances forming over the Arabian Sea and the southwest Indian Ocean also have direct and indirect influences on Ethiopian weather during *Belg* and *Kiremt*.

During the long rainy period (June to September), the ITCZ, the southwest Indian Ocean anticyclone (Mascarin High), the heat lows, the low-level jet (LLJ), and the South Atlantic anticyclone are the major low-level atmospheric features. The tropical easterly jet (TEJ) and the Tibetan anticyclone are the two important upper-level atmospheric features. The strength and position of these atmospheric systems vary from year to year and, so, also the rainfall activity. The ENSO episode is strongly linked with the various atmospheric systems and rainfall distribution over Ethiopia. This is briefly discussed in the next section.

**The Influence of ENSO on Rain-Bearing Atmospheric Systems and Rainfall**

Various research findings have revealed the relationship between ENSO and Ethiopian rainfall and atmospheric systems. During the 1982-83 ENSO event, the TEJ was weaker and concentrated over a narrow meridional band around 60E (CSM, 1983).

The principal cause of drought is asserted to be the fluctuation of the global atmospheric circulation, which is triggered by the SST anomalies occurring during ENSO events. These phenomena have significant impact on the displacement and weakening of the rain-producing mechanisms in Ethiopia (Haile, 1988).

A comparative study of a drought year (1972) and a normal rainfall year (1967) over the global tropics for the northern summer months revealed (1) a weaker TEJ, (2) a weaker Tibetan high, and (3) a southeastward shift over the major circulation patterns as well as of several dynamic parameters during 1972, a major El Niño year (Krishnamurti and Kanamitsu, 1981).

Similarly, the major rain-producing mechanism in Ethiopia and its vicinity - the ITCZ - was found to be weak, shallow, and shifted southeastward in drought years (Kruhova, 1981; Lamb, 1978). The findings of a case study of seasonal forecasts in Ethiopia are also consistent with the above-mentioned
results (Haile, 1987). These and other findings confirm that the fluctuations of atmospheric circulation, which are sometimes triggered by SST anomalies in the equatorial Pacific (ENSO) have significant impacts on the position, magnitude, and intensity of the rain-bearing systems in Ethiopia.

The above-mentioned changes of the rain-bearing systems frequently caused meteorological, agricultural, and hydrological drought. However, the 1982-83 El Niño, which was by far the most intense one, did not produce a very dry Kiremt (Ward and Yeshanew, 1990).

A preliminary investigation of the relationship between the equatorial eastern Pacific SSTs and Ethiopian Belg and Kiremt rains reveals that the timing and intensity of the Pacific SST anomaly must be considered while using ENSO information for forecasting purposes (Bekele, 1993).

The following conditions are used in identifying El Niño impacts on Ethiopia:

- For an El Niño event, the positive anomaly of equatorial Pacific sea surface temperatures should last at least 12 months with a maximum value greater than or equal to 1 deg C.
- The year with the maximum observed SST anomaly is referred as an El Niño year;
- If a year is preceded or followed by an El Niño year and the positive anomaly lasted for a period of more than six months, then it is regarded as a contiguous year to the El Niño year;
- When the sea surface temperature anomaly varies similar to an El Niño year, but the maximum is somewhat less than 1 deg C (say, 0.9 deg C), it is regarded as a weak event;

La Niña events are identified similarly by analyzing the negative sea surface temperature anomalies.

The classification of El Niño and La Niña events by their timing of occurrence was based on the timing of the significant SST increase (greater than or equal to 0.5 deg C). In the first group, the anomaly increases considerably in the period from January to June, in the second during July to December (Zang Hengfan and Wang Shaowu, 1989).

Based on this classification and a seasonal rainfall analysis of 223 rainfall stations for the period 1969 up to 1987, the following conclusions were made about the relationship between Belg and Kiremt seasonal rainfall and eastern equatorial Pacific sea surface temperature anomalies (SSTA):

- A negative SSTA is strong associated with rainfall deficiency in Belg;
- A positive SSTA is mostly associated with normal and above-normal rainfall amounts in Belg;
- The Group One type of El Niño is always associated with a severe and widespread meteorological drought in Ethiopia during Kiremt. The 1972 and the 1987 El Niño events can be taken as examples;
- The occurrence of Group Two types of El Niño events seems to have relatively less negative effect on Kiremt rains, both in its amount and its spatial distribution. The 1982-83 El Niño event can be taken as an example;
- ENSO events may not be the only cause of meteorological drought in Ethiopia.

The last statement above could be supported by the fact that the 1984 and 1985 failure of Kiremt in Ethiopia took place while there was a warm event over the tropical Atlantic. In 1984, a warm event of unusual amplitude affected the eastern tropical Atlantic during the relaxation phase of the 1982-83 Pacific ENSO. It is noteworthy that warm SST anomalies in the tropical Atlantic persisted during 1985 (CSM, 1986).

Another preliminary investigation shows that the formation of intense and frequent tropical disturbances over the southeast Indian Ocean occurs simultaneously with Belg and Kiremt rainfall deficiency in Ethiopia (Bekele, 1992).

Therefore, Ethiopian use of ENSO information, especially its seasonal forecasts, is based on existing knowledge and experience of the staff members of NMSA, as well as on the results of continuous studies and investigations. In addition to the available results of preliminary studies and research findings, ENSO information of the current year is very important for the preparation of seasonal outlooks in Ethiopia.

Sources of ENSO Information

ENSO stands for the coupling of El Niño (oceanic component) and the Southern Oscillation (atmospheric component). El Niño originally referred to the Northern Hemisphere wintertime (December, January, February) warming of the ocean waters off the coast of Peru. This warming in some years spread to or originated in the central or eastern equatorial Pacific Ocean. The Southern Oscillation is a seesaw-like motion of surface pressure, with centers of action around the Indonesia-North Australia region and the southeastern Pacific (WMO, 1987).

There are a number of bulletins used as sources of information for the purpose of preparing seasonal forecasts in Ethiopia. The two most widely used climate bulletins are:

- *Climate Diagnostic Bulletin*, produced by the Climate Prediction Center (formerly the Climate Analysis Center) of the US National Weather Service, Washington, DC;

- *Weekly Climate Bulletin*, also produced by the Climate Prediction Center of the US National Weather Service, Washington, DC.

In addition, the long-range forecast unit of the Ethiopian NMSA uses all available information from a variety of sources, including the following:

- The seasonal and monthly *Climate Monitoring Bulletin* for the Southern Hemisphere, Bureau of Meteorology, Melbourne, Australia;

- Monthly bulletin of the Drought Monitoring Center, Nairobi, Kenya;

- Seasonal and monthly bulletin of the South African Weather Bureau;

- *Rain Watch* and prediction for Africa, from the African Center of Meteorological Applications for Development (ACMAD).
Ethiopia’s Seasonal Forecasts and the Use of ENSO Information

The seasonal forecast is mainly about rainfall and its spatial and temporal distribution. The long-range forecast unit of the NMSA prepares and issues monthly and seasonal forecasts in Ethiopia. The methods of forecasting which are applied in preparing seasonal forecasts in the NMSA are based on the following: analogue, trend analysis, statistical assessments, and teleconnections.

Analogue method

This forecasting method is based on the assumption that a current synoptic situation will likely develop in the same way as similar past synoptic situations (WMO, 1992). Therefore, a proper selection of the analogue year is very important. ENSO information is used in this method to facilitate the selection of analogue years. After obtaining sufficient information about the status of the ENSO event of the current year, years which had the same ENSO status would be identified from past records. Then, the rainfall distribution and the synoptic features of the preseasonal months of the current year would be compared with the rainfall distribution and synoptic features of the preseasonal months of the analogue years.

The data set used to determine analogue years includes the SSTA of the equatorial Pacific Ocean, the Southern Oscillation Index (SOI), the surface charts, daily mean sea level pressure charts (ECMWF), 500 hpa chart, 200 hpa chart, tropical cyclone frequency over the southwestern Indian Ocean, and the preseasonal and seasonal rainfall.

Finally, an analogue year which closely resembles the current year would be chosen, based on the results of the above comparison and analysis. Then, the coming season would be anticipated to be under the categories of Above Normal, Normal, or Below Normal rainfall, based on the observed rainfall of the analogue year. Similarly, the onset and cessation of the rains will be projected.

Trend method

Using this method, the trends of the major synoptic systems are analyzed in the preseasonal period, and the result is compared with the ideal situation.

In some other cases, depending on the type of ENSO information available, the trend of SSTs over the central equatorial Pacific and the SOI are analyzed carefully to determine the status of an ENSO event.

A good example to show how ENSO information could be used (with the trend method) is the 1990 Kiremt seasonal forecast. It was stated as follows: "...From [Climate Diagnostics Bulletin and Climate Monitoring Bulletin], one can see that there has been a surface warming over the central equatorial Pacific Ocean since December 1989. If the warming continues, it will likely develop into an El Niño situation. Hence, previous years which have shown the same trend were selected" (NMSA, 1990).

In the above statement of the forecast, the information about the trend of the central equatorial Pacific SSTs is used to anticipate the trend of the major synoptic systems, assuming that the coming season will be affected by an El Niño event. This is one example of the application in Ethiopia of
applying ENSO information using this method.

On the other hand, once a forecast about the status of ENSO is at hand, it can be used in the trend analysis of the major synoptic systems to anticipate ahead of time (i.e., forecast) their intensity, magnitude, position, etc.

Statistical method

This is an objective method of forecasting, based on a statistical examination of the past behavior of the atmosphere using regression formulas, probabilities, and other statistical measures (WMO, 1992). The use of ENSO information under this method is based on the results of previous studies by different investigators on SOI and El Niño and their effects on Ethiopia's seasonal rainfall.

Teleconnections

Oceanic and atmospheric events at great distances from the central and eastern equatorial Pacific Ocean (i.e., the field of action), observed to occur in association with ENSO events, are considered subject to being forecast with some degree of reliability.

The effect of ENSO events on the global atmospheric circulation in general, and on the east-west overturning of the Walker Cell in particular, alters rain-bearing synoptic systems which influence the seasonal rainfall distribution of Ethiopia. Normally the ascending limb of the Walker Cell is over Africa. During the occurrence of ENSO, the descending limb replaces it (WMO, 1985).

Achievements, Problems, and Future Prospects of NMSA in Using ENSO Information in Its Seasonal Forecasts

As discussed earlier, the country's agricultural activity is highly dependent on seasonal rainfall performance. The deviation of the onset and cessation time of the rainy period, as well as the deviation of the seasonal rainfall amount from the long-term mean, affects agricultural output. To minimize the impacts of these events, the Ethiopian NMSA has been disseminating seasonal and monthly weather outlooks since 1987.

The seasonal forecast in Ethiopia is in an experimental stage. So far, no seasonal forecasting model has been developed. However, investigations about the effect of ENSO on Ethiopia's seasonal rainfall and its distribution are still in progress.

Nevertheless, the delay in transmission of sufficient ENSO information to the NMSA, the shortage of trained Ethiopian manpower specializing in long-range forecasting, and the lack of sufficient equipment are the major constraints on the development of a reliable seasonal weather or climate forecast in Ethiopia. NMSA is exerting great effort in order to solve these problems in cooperation with the WMO, UNDP, and other international organizations.

Before discussing the success rate of seasonal forecasts of the NMSA, it would be appropriate to know about its limitations. NMSA uses four categories to compare the seasonal rainfall amount with the long-term mean (SRA stands for Seasonal Rainfall Amount, LYM for Long-Range Mean):

- **Above Normal**: SRA/LYM * 100 > 125%
- Normal: SRA/LYM * 100 = 125% - 75%
- Below Normal: SRA/LYM * 100 = 75% - 50%
- Much Below Normal: SRA/LYM * 100 < 50%

A seasonal forecast and an assessment of rainfall and its distribution are made by making use of these four categories. Each verification of a seasonal forecast indicates a success rate of 75% or more. Among all of these forecasts, the success of the 1987 Kiremt (a Group One El Niño event) seasonal forecast is worthy of mention. This forecast provided a timely warning about the failure of the Kiremt rains. Making use of this forecast, the Ethiopian RRC (Relief and Rehabilitation Commission) managed to take necessary measures to avert the 1987-88 famine and was, in fact, awarded the Sasakawa-UNDRO prize for its efforts.

Currently, the seasonal weather outlooks of NMSA are distributed to higher governmental offices where they are used for planning and programming of the national economy, to other governmental organizations like the Ministry of Agriculture, and to international organizations like USAID and UNFAO.

ENSO is a potentially useful climate signal which may affect the atmospheric circulation in a reliably predictable way, and there are prediction schemes that show significant predictive skill. The findings of TOGA, a major ten-year research program to understand ENSO, are encouraging, and further progress is anticipated (WCRP, 1992). The future is bright. More sophisticated and effective ENSO prediction procedures are emerging rapidly. The coupled general circulation model being run by the US National Meteorological Center is one example (Cane, 1992).

Investigations are also under way at the NMSA to improve the understanding of the detailed effects of ENSO on Ethiopia’s seasonal rainfall. The combination of these two research activities will significantly upgrade Ethiopia’s seasonal forecast capabilities in the future.

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El Niño and Drought Early Warning in Ethiopia\(^1\)

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Introduction

El Niño (EN) is the increase in the surface temperatures (SST) in the central and eastern equatorial Pacific Ocean. EN results from changes in the pattern and direction of winds and ocean currents in the region, which have potentially catastrophic effects. There are also changes in atmospheric pressure across the Pacific Basin between Darwin, Australia, and Tahiti called the Southern Oscillation (SO). The SO is the seesaw "in atmospheric mass involving exchanges of air between eastern and western hemispheres... with centers of action located over Indonesia and the tropical Southern Pacific Ocean" (Trenberth 1991, 13-14). Thus, ENSO is a coupled air and ocean phenomenon with global weather implications. It is believed that ENSO is often associated with devastating droughts in Northeast Brazil, Australia, parts of Africa, the failure of the Indian monsoons, hurricanes along the east coast of North America, and so forth (Glantz 1993, 4).

Many researchers now believe that the occurrence of various droughts in Africa, especially in Southern Africa and the Horn, are caused by physical processes related to the occurrence of ENSO events thousands of miles away. If valid and reliable information about the linkages between these occurrences becomes available, it could help to forecast Sub-Saharan African droughts. Scientists believe that ENSO information can be useful for developing regional drought early warning systems. (Figure 1).

ENSO and Ethiopian Droughts

There have been notable droughts in Ethiopia throughout human history (Haile 1988; Degefu 1987; Pankhurst 1966; Nicholls 1993; Webb and Braun 1994). Previous droughts and the frequency of rainfall deviation from the average suggest that droughts occur every 3-5 and 6-8 years in northern Ethiopia and every 8-10 years for the whole country (Haile 1988, 90).

Haile (1988, 85) believes that Ethiopian drought is caused by ENSO, along with sea surface temperature (SST) anomalies in the Southern Atlantic and Indian Oceans combined with anthropogenic activities. ENSO events and SST anomalies affect rainfall distribution in Ethiopia by displacing and weakening the rain-producing air masses (1988, 92).

There is a remarkable correspondence between annual rainfall in Ethiopia and ENSO events (Haile 1988). A statistical analysis by Attia and Abulhoda (1992) shows that "ENSO episodes are negatively teleconnected with the floods of the Blue Nile and Atbara" rivers that originate in Ethiopia. Eltahir (1996) also concluded that ENSO events affect flows of the Nile River (indicating drought in highland Ethiopia, which is a source of 85 percent of Nile water) and that knowledge of these events could be used to improve the predictability of its annual flow. Empirical data indicate an association between
Figure 1. Climatic Zones of Ethiopia

Explanation on Legend

Bwh- Hot Arid Climate
Bsh- Hot Semi Arid Climate
Bsk- Cool Dry Climate
As- Tropical Climate (with dry summer)
Aw- Tropical Climate (with distinct dry winter)
Am- Tropical Monsoon Rainy Climate (with short dry season)
Aws- Tropical Climate
Cwb- Warm Temperature Rainy Climate (with dry winter)
Cfb- Warm Temperature Rainy Climate (without distinct dry season)
Cws- Warm Temperature Climate
H- Cool Highland Climate

ENSO events and droughts in Ethiopia. Thus, an ENSO-based early warning system, used effectively by policymakers, could help to reduce the societal impacts of drought in Ethiopia.

According to Nicholls (1993, 1), 1888 was a major ENSO year that damaged the economies of Brazil and Australia, as well as Ethiopia. Drought struck Ethiopia in 1888, leading to the historic deadly famine of 1888/89. About one-third of the population died because of famine, and ninety percent of the animals perished due to rinderpest infestation and the drought (Webb and Braun 1994, 20). In 1957/58 drought and locust invasion led to famine in Tigray. The 1972/73 drought led to the Wollo famine, during which about 200,000 people died. In all these cases, there was little early warning.

When past ENSO events are compared with drought and famine periods in Ethiopia, they show a remarkable association. Some drought years have coincided with EN events, while others have followed it.

Table 1. Chronology of El Niño and Drought/Famine\(^2\) in Ethiopia

<table>
<thead>
<tr>
<th>El Niño Years</th>
<th>Drought/Famine</th>
<th>Regions</th>
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<td>1539-41</td>
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<td>Hararghe</td>
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<tr>
<td>1618-19</td>
<td>1618</td>
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</tr>
<tr>
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<td>1828-29</td>
<td>Shewa</td>
</tr>
<tr>
<td>1864</td>
<td>1864-66</td>
<td>Tigray and Gondar</td>
</tr>
<tr>
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<td>1876-78</td>
<td>Tigray and Afar</td>
</tr>
<tr>
<td>1880</td>
<td>1880</td>
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<td>1887-89</td>
<td>1888-1892*</td>
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<td>1899-1900</td>
<td>1899-1900</td>
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</tr>
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<td>1953</td>
<td>Tigray and Wollo</td>
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<td>1965</td>
<td>1964-66</td>
<td>Tigray and Wollo</td>
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<td>1986-87**</td>
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<td>Tigray, Wollo, Addis</td>
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Sources: Quinn and Neal (1987, 14451); Degefu (1987, 30-31); Nicholls 1993; Webb and Braun; Ayalew 1996.

The 1982-83 ENSO "was the most extreme event in at least a century," with equatorial SSTs in the Pacific Ocean increased by an average of 2 degrees Celsius and exceeding 6 degrees \textit{Celsius} on the
coast of Peru (Cane 1993, 43). In Ethiopia, the 1983-84 drought took the lives of an estimated one million people, destroyed crops, contributed to the death of animals, and threatened the lives of millions of people with starvation. Famine was exacerbated, if not caused, by war and failed government policies, but drought was the main catalyst to crop failure. The famine prompted unprecedented (but delayed) humanitarian intervention, in spite of Ethiopia’s Marxist government of Mengistu Haile-Mariam.

The association between ENSO and droughts in Ethiopia is due to an atmospheric teleconnection or "the linkages over great distance of seemingly disconnected weather anomalies" (Glantz et al., 1991, 1). This means that the oceanic and atmospheric processes in another part of the world, such as the equatorial Pacific, could affect Ethiopian climate. Reliable ENSO information could be useful to forecast drought with longer lead time, enabling policy-makers to introduce early mitigating policies. Mark Cane (1993, 43) believes that "prediction is a possibility . . . especially when the patterns are forced by observable changes in surface conditions such as sea surface temperature (SST)."

A study by Cane et al. (1994, 204) found a correlation between Zimbabwean maize yield and ENSO that, according to the authors, enables prediction of maize production with a lead time of up to a year. These findings show that in the 1970s and 1980s, droughts and low maize yields vacillated nearly in step with El Niño. Thus, a warming of the central and eastern equatorial Pacific surface waters appears to provide a warning for policymakers to take actions in preparation for future drought in their region. Such findings could be used for drought early warning in Ethiopia as well.

Nicholls (1993, 170) believes that ENSO information could have provided an early warning to decisionmakers about Ethiopia’s severe 1888 drought, had such information existed then. The other Ethiopian droughts and famines in the 20th century appear to have followed ENSO events as well. I do not think that the correlation between droughts in the Horn of Africa and El Niño events is coincidental. The current state of knowledge also suggests that monitoring the Southern Oscillation Index (SOI) could predict drought with a longer lead time (ibid.).

**ENSO Information and Early Warning in Ethiopia**

An institutionalized famine early warning system in Ethiopia is a relatively recent phenomenon. In the past, accounts of famine were passed to the central government through rumors and informal reports by the local police and administrators. Previous Ethiopian governments were also sluggish in their responses to disasters due to lack of adequate information, resources, and political will. A formal famine early warning system was established following the 1973/74 famine that killed upwards of two hundred thousand Ethiopian peasants (Kaplan 1988, 24).

In 1976, the military government (which ruled from 1974 to 1991) established the Relief and Rehabilitation Commission or RRC (it was renamed as the Commission for Disaster Prevention and Preparedness or DPPC in 1995). Its task is to assess the food needs of the country and to mobilize resources. It advises the government and international donors about Ethiopia’s food balance, the number of people at risk, and identifies vulnerable regions. The DPPC receives information from the Ministry of Agriculture, the NMSA, the Ethiopian Nutrition Institute, and the Central Statistics Authority. Some NGOs operating in Ethiopia have their own early warning systems (Glantz, 1996a).

The Ethiopian NMSA collects and distributes agroclimatic information such as rainfall, temperature, water balance, and sunshine of the country. NMSA disseminates "flash reports" and
seasonal forecasts. It also releases crop situation reports and four annual seasonal output reports, two at the beginning and two at the end of the meher (main cropping season; begins in September) and belg seasons. One problem of the early warning system in Ethiopia is the lack of competence at the lower level of the government hierarchy (DPPC 1996).

I noted earlier the association between ENSO and drought in Ethiopia (Table 1). Recently, the NMSA has begun to use ENSO information to supplement its meteorological early warning system. According to the NMSA, a cool event (La Niña) leads to decreased rainfall in the belg season (February-May) and heavy rainfall during the main (kiremt) rainy season (June-September) (Bekele 1993). A warm event is associated with an above-normal rainfall during the belg season. According to previous droughts, a positive SST anomaly that lasts at least a year is always associated with severe kiremt (June/September) drought in Ethiopia (ibid.). Thus, during ENSO years, belg rains are heavy and the main summer (kiremt) rains are reduced. In normal seasons, belg rains are variable and the main rains are stable (Glantz 1996b). The abnormally heavy rainfall in the 1996 summer (meher) season in Ethiopia (when NMSA had issued an early warning) might have been linked to a La Niña (eg, cold event).

According to the National Drought Mitigation Center (1996), ENSO information helps for agricultural planning and for mitigating the societal impacts of droughts and floods. ENSO-based forecasts can help in determining land-use policies, and for conservation and humanitarian assistance. For example, when policymakers have advance information of low rainfall, they can prepare plans to assure an adequate food supply.

The following is an example of applying an ENSO-based forecast for drought policy in Ethiopia. Based on the 1986 El Niño information, "NMSA provided a seasonal forecast, and the DPPC (then the RRC) succeeded in averting the 1987 famine" (Ayalew 1996). In 1988 and 1989, the Ethiopian authorities and donors used ENSO data to recommend appropriate policies regarding the amount of land to be cultivated, input supplies (seeds, fertilizers), and conservation of food and water (NMSA, in Glantz 1996b, 79). Following the receipt of the 1992 ENSO information, the Transitional Government of Ethiopia (1991-95) set up the Disaster Prevention and Preparedness Committee in the Prime Minister's Office. The famine conditions of 1994 were averted due to the appropriate use of the 1993 information (Ayalew 1996). In 1996, the summer floods were predicted by the National Meorological Services Agency (Teshome 1997). The NMSA warned of possible flooding in its May 1996 forecast. In June 1996, the DPPC in turn distributed an early warning to its users.

The potential beneficiaries of ENSO information in Ethiopia are farmers, herders, and the government. The success of an ENSO early warning depends on the actions taken by its users. The information concerning the advent of an ENSO event could warn both cash and food crop producers. Based on such information, farmers could introduce adequate agronomic changes. With reliable drought early warning, farmers could buy fodder or sell their cattle before market prices collapse. At the national level, surplus food could be stored for the next season, and additional food could be imported in anticipation of shortfalls. Herders might also sell off part of their herds before the arrival of drought. ENSO information is useful, but it has some weaknesses when applied to specific local conditions.

Problems of Disseminating ENSO Information to Local Users

ENSO is a regional oceanic and atmospheric phenomena with global consequences. Its study and dissemination is of global importance. ENSO's effectiveness and limitations should be seen as based on
its relevance to the various hierarchies of users. The information is important for regional policymakers to plan agricultural trade within and between countries and for relief transfers at a global level. The key issue is how to use ENSO at the village level, where the subsistence farmers need specific local information.

Applying ENSO-based drought early warning to local conditions could reduce the impact of drought on society to its greatest extent. Farmers could be warned before the advent of drought as to when, what, and where to cultivate and when to sell their animals. Such actions require credible and reliable early warning and adequate information flow between government agencies and farmers. Such information helps the government to reorganize its resources before the impact of drought is felt. However, the effectiveness of ENSO information depends on its adequate dissemination to the local level and on the confidence of its users in the information.

Thus, how should ENSO information be treated by the various hierarchies of decisionmakers and users? ENSO’s effective level of prediction capability is global or, at best, regional. Its forecasting precision decreases when the spatial focus is narrowed from global, to regional, to national, to local levels. According to Farmer (1993), forecasting needs to be more spatially specific for the analysis to be useful. Farmer (ibid.) also raises the issue of the temporal and spatial distribution of ENSO effects on rainfall. This issue is relevant to Ethiopia, a country that has many local climates (Gonfa, 1996). For ENSO information to be credible at the local level, it has to respond to unique drought-related problems that arise due to diverse microclimates.

The diversity of climate in Ethiopia has given rise to the presence of several cereal species (English and Hess, 1974). Ethiopian peasants possess and cultivate diverse crops because of the diversity of microclimates. Not only do important crops such as wheat and barley have different planting and harvesting dates, but the multiple species of wheat, barley, and teff also exhibit varied maturation periods due to differences in soils, sunlight, temperature, and rainfall variations.

How does general ENSO information help the success of farmers with no access to irrigation? As noted, ENSO-based weather and climate prediction is general in nature and less effective in providing locally specific drought early warning. In Ethiopia, the NMSA, which is responsible for weather and climate forecasts, does not even have district branch offices.

Peasant farming in Ethiopia is complex. It is difficult to make generalized crop recommendations because farms a few kilometers apart have different natural endowments known only to local farmers. Those who advise farmers need to know the details of local weather, soil types, resources, and farming systems. Mengisteab Haile (1997), an agrometeorologist with the DPPC, stated that it is difficult to take samples of agrometeorological data from various districts. Topography tends to make local microclimates unique. As Farmer (1993) notes, broad statements about the weather, without stating how the information could be used, will make famine early warning ineffective. ENSO-based early warning should be more specific in time and space to be relevant to peasant farmers.

Conclusion

ENSO information could improve drought early warning by providing longer lead times to respond. This could enable farmers to identify suitable seeds and times for planting. This task is complicated, however, because Ethiopian farming is composed of numerous diverse microclimates. ENSO information would become more useful at the local level if it could be "tailored" to the needs of farmers.
by giving them specific information and recommendations.

Adequate early warning could enable farmers to sell their animals before they die of starvation. With such information, food could be imported and preparations for drought impact in other sectors of the economy could be made.

Despite the local limitations, ENSO information is useful for national and global policies that mitigate the adverse impacts of drought. National decisionmakers could use ENSO information to encourage farmers to produce, at least temporarily, food crops in place of cash crops, such as sugar cane, qat, and flowers. They could import food early and at lower cost and could reduce food exports. The information is also useful to solicit foreign resources before the full-blown impact of disaster becomes visible.

ENSO-based drought early warning could send a "wake-up call" to governments to prepare for national food shortages. With such information, policies that reduce the impact of drought could be introduced. An early warning with many months of lead time, such as could be provided by ENSO information, would eliminate the excuse of national governments who claim to be unaware of the advent of drought. When drought causes famine, and a reliable drought early warning was available, it becomes a man-made disaster.

Associated Photos (400kb)

End Notes

1. I am grateful to Dr. Michael Glantz of the National Center for Atmospheric Research for his encouragement, support, and critical comments while preparing this manuscript.

2. The chronology of Ethiopian drought and famine and their exact dating must be taken in the context of the problems associated with defining when a drought or famine commences and ends, as both are processes and not events.

3. The NMSA uses the analogue, trend analysis, statistical assessments, and teleconnections as a method of forecasting ENSO-based seasonal weather (Bekele 1993).

4. There was heavy rainfall in August 1996 in Ethiopia. The Awash River flood displaced many people and threatened the Metehara sugar plantation. The Aswan Dam in Egypt was full, leading to flood diversion. This was the result of the unusually heavy rainfall in Ethiopia's Blue Nile Basin.

References


DPPC (Disaster Preparedness and Prevention Commission), 1996: DPPC News. 6:3, April.


The problem of environmental deterioration is widespread in Ethiopia.
Photo by M.H. Glantz

Adequate early warning could reduce the problem of relief distribution.
Photo by M.H. Glantz
Diverse microclimates give rise to the diversity of food cultures. The author's father *Keshi Wolde-Georgis* eating *tihlo*, the traditional food of *Agame*, Tigray. Photo by Tsegay Wolde-Georgis.

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The SADC Regional Early Warning System: Experience Gained and Lessons Learnt from the 1991-92 Southern Africa Drought

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Introduction

The 1991-92 drought which affected southern Africa has been described repeatedly as the worst to affect the subcontinent in the 20th century. However, the sheer magnitude and scale of the crisis, in the context of other African droughts, is perhaps less well appreciated. In round figures, the 1991-92 southern Africa drought affected nearly 100 million people living in the 10 SADC States and South Africa, of which, 40 million were estimated to be directly at risk to hunger from the effects of the drought. The drought halved the region’s cereal harvest and required 10 million tonnes of grain to be imported, the bulk within a 12-month period. By any comparison, therefore, the 1991-92 southern Africa drought had all the makings of a major international catastrophe.

However, the southern African drought did not turn into the sort of human disaster that the world has come to associate with the failure of rains on the continent. Although food and water shortages were experienced by large numbers, especially in war-torn Angola and Mozambique, famine did not invade the lives of most people in the region. The fact that widespread hunger was averted is a significant, but largely unsung, success for the countries and donors concerned.

How this disaster was prevented has been the subject of several ex-post evaluations of the drought relief exercise. The conclusions of these various studies and workshops have been fairly consistent. Generally speaking, they all acknowledge that responsible government and sophisticated logistics enabled food imports to be ordered and delivered in record time and without significant congestion. These factors ensured a relatively rapid response to the crisis. But what about the alerts that triggered the response? Here, too, there seems to be a general consensus that the SADC Regional Early Warning System (REWS) performed its function by providing the necessary information in sufficient time to enable decisionmakers to implement food importation programs.

Within these overall positive assessments, however, a number of questions have been raised concerning the effectiveness of early warning. In particular;

- Could the Early Warning System have provided earlier warnings?
- Was the right type of early warning information provided to decisionmakers?
- Could decisionmakers have reacted more rapidly to the early warning alerts?
The Origins of the 1992 Food Crisis and the Role of Early Warning

The food crisis which hit southern Africa in 1992 was only partly the result of drought. Another important ingredient in the problem was the generally weak grain stock position of most SADC member states in the period leading into the drought.

As early as March 1991, the SADC REWS had predicted a substantial, region-wide grain shortfall (around 3 million tonnes) for the marketing year (1991-92) preceding the drought. Despite these warnings, import arrangements throughout that year remained inadequate and, by December 1991, when the first alarm bells of a region-wide drought were sounded, grain stocks were precariously low in almost all SADC countries. By the end of 1991 it was apparent that a number of countries, including Angola, Mozambique, Zambia, and Zimbabwe, were going to face acute maize shortages in the early part of 1992, irrespective of the prospects for the coming grain harvest in mid-1992. Meanwhile, there was early optimism regarding the 1991-92 growing season, as good rainfall was experienced in most parts of the sub-continent during October and November 1991.

By the end of December 1991, however, dry conditions had set in and had started to spread across southern Africa. The SADC Food Security Bulletin for December 1991 alerted governments and the donor community of this adverse change in growing conditions and issued tentative assessments of the likely impact on the forthcoming grain harvest in a number of countries.

During the next three months, dry conditions intensified and, by March 1992, the full impact of the drought on grain production had become apparent. The SADC REWS issued a detailed forecast of the size of the forthcoming maize harvest and the scale of import needs for the coming year in its March 1992 Food Security Bulletin.

The Response to the Alerts

Responses to initial warnings concerning the depletion of grain stocks over the 12-month period leading up to the drought were generally slow and late. It was not until such stocks had dropped to critical levels that reactions were initiated, by which time it was already too late to avoid the maize shortages which hit countries like Zambia and Zimbabwe during the early part of 1992.

Perhaps because of the critical stock position at the time, responses to the drought alert were much swifter. First indications of a concerted reaction came as early as January 1992, well before the full impact of the (still ongoing) drought could be assessed, when the SADC Food Security Sector Coordinator was directed by SADC Ministers to consult closely and urgently with member states, with a view to:

- assessing the extent of food shortages;
- evolving a common strategy to address the problem; and
- convening, if necessary, a donor's conference.

In the ensuing period up to the end of March, during which time the regional drought intensified, the REWS and its national components (NEWS) undertook a series of rapid assessments of anticipated food availability and of needs during the forthcoming marketing year. In March/April a joint FAO/WFP Crop
Assessment Mission was mounted in the region. Its findings verified the REWS findings.

On April 14, SADC convened a special meeting of Ministers of Agriculture and Transport to formalize regional institutional arrangements for drought relief. At about the same time, SADC entered into discussions with the UN Department of Humanitarian Affairs (DHA) in Geneva, Switzerland. These discussions culminated in the issuance of the worldwide Drought Emergency in Southern Africa (DESA) appeal on the 26th of May. This was followed up in early June by a jointly organized international Donor Pledging Conference.

In addition, it is important to recognize that, while all these activities were going on, individual countries - notably Zambia and Zimbabwe - had already begun to identify sources for their commercial maize imports. As it turned out, this was to have a significant bearing on the food security situation in these countries during the following months.

Earlier Warnings?

Many users of early warning information have the misconception that the REWS predicts weather conditions; they, therefore, ask why the 1991-92 drought could not have been foreseen. The function (or, more strictly speaking, one of the functions) of the REWS is somewhat less ambitious, being restricted to the assessment of the impact of weather conditions on crop production prospects and, hence, on the food supply situation. The REWS can say little, if anything, about harvest prospects until the growing season gets under way. The 1991-92 southern African drought was, in fact, a good example of the practical limitations of early warning systems under the present state of the art. As already discussed, the 1991-92 growing season started well in most parts of southern Africa. It was not until the end of 1991 that indications of a prolonged dry spell began to surface. Although by this stage it was already clear that, because of wilting and delayed plantings, the maize harvest was going to be reduced, there were still prospects for recovery if the rains returned in the following few weeks. In the event the rains did not return in January or February 1992, which are the critical rainfall months for the southern Africa maize crop. It is arguable, therefore, if the REWS could have provided any reliable indication of harvest prospects before February/March. What the REWS was able to do, however, during the period leading up to March 1992, was to raise awareness among decisionmakers of a deterioration in harvest prospects as the growing season developed, and to alert them that, should the worst happen, quick action would be needed if further food shortages were to be avoided.

In terms of being able to provide earlier, and at the same time reliable, crop forecasts, a major breakthrough in the application of climatological information for early warning is required. At present the types of advice issued on such phenomena as ENSO are not sufficiently reliable or dependable to be able to be used in crop harvest forecasts, partly because general global links are frequently overshadowed by localized climatic effects and partly because such advice is not yet sufficiently prognostic.

Experience in southern Africa has amply illustrated the fact that early warning systems need to establish credibility and respect before decisionmakers gain the confidence to utilize their information. Such credibility can only be built up gradually, as the systems prove themselves by providing useful and dependable services. If early climatological indicators are to be incorporated into such a system, they too need to be usable and dependable. In this respect, ENSO bulletins need to be more user-oriented (users, in an early warning context, are not always climatologists or meteorologists), providing assessments of the likely impact (e.g., risk analysis) on rainfall and other weather conditions in particular parts of the
world. Until such a stage has been reached, there seems little prospect of significantly improving the timeliness of drought early warnings.

How Much Is Enough Warning?

There are, as argued above, practical problems in being able to provide earlier and yet still reliable alerts of the impact of weather on food supplies. There is, of course, no point in providing earlier alerts, unless they are needed by decisionmakers. Since early warning costs money, and probably earlier warnings (which require sophisticated technologies) require more money, the question therefore begs itself as to how much early warning is really needed to safeguard food security. In particular, would having earlier warnings have helped SADC member states to better safeguard food security following the 1991-92 drought?

From the time that the first (albeit tentative) drought alarms were sounded (December 1991) to the main harvest time (May-June 1992), SADC member states should have had a five-month buffer (had they maintained reasonable stocks) in which to initiate actions to avert food shortages. While some major steps were indeed taken on the basis of these still tentative assessments, the main thrust of the response from both the affected countries and the donor community awaited more conclusive and detailed information which could only be released in March 1992.

If it had been practical to use climatological information in a risk analysis approach, it may have been possible to issue quantifiable assessments of harvest prospects somewhat earlier in the season. However, the conclusions from such an analysis would still have been, by their nature, fairly tentative. Confronted with results from a risk analysis exercise, decisionmakers, who tend to be a cautious breed, would probably have opted to wait out the drought until a more reliable assessment could be undertaken (that is, in February-March 1992).

The amount of early warning needed to ensure the implementation of effective actions to avert food insecurity is a function of the following:

- the level of grain stocks maintained;
- the time it takes to place orders for and take delivery of grain imports; and
- the degree of influence and persuasion of the early warning system.

Decisionmakers need to recognize that Early Warning Systems are only one line of defense in safeguarding food security and that, when they are used in isolation from other defense measures, they are rarely fully effective. In particular, the recent experience in southern Africa has shown the importance of integrating strategic grain reserves and early warning systems to provide an effective defense mechanism.

While early warning and strategic reserves are complementary food security measures, they also have an important element of substitution. That is to say, maintaining large strategic reserves provides a larger buffer to the impact of drought on national food supplies and, thus, reduces the dependency on early warning. On the other hand, low reserves mean little or no buffer stocks and increase the dependency on early warning to safeguard regional food security. This situation was amply illustrated during the recent southern Africa drought.
In the event of food shortages, normally the first remedial measure to be taken is to secure imports to offset the domestic shortfall. This process takes time. Exactly how much time depends on several factors, such as the following:

- the proximity of food import sources;
- the geographic location of the importing country (landlocked or coastal;)
- the efficiency of the transport network from source of imports to destination; and
- the type of import (aid or commercial).

Perhaps the last factor is the most critical. To take another practical example from the southern Africa drought, Zimbabwe, which went ahead and placed orders for commercial imports while the donor pledging exercise was still in its early stages, was able to take delivery of white maize sourced from South America within 2 months of placing the order. In contrast, food aid channeled through the bilateral and multilateral donors took between 4 and 6 months to reach the country.

The degree of influence that an Early Warning System is able to exert on decisionmakers also has an important bearing on the time needed to extract a response. Systems which are well-established and administratively well-located are usually able to invoke a more rapid response than fledgling systems, which perhaps find themselves lost at the bottom level of a government hierarchy.

Clearly, the amount of early warning time needed will vary from one country to another. In the southern Africa context, conditions differ considerably. At one extreme, small countries like Swaziland and Lesotho, which can normally rely on South Africa as a source for commercial imports, should be able to get away with just a few weeks of early warning. On the other hand, land-locked Malawi (with its severe foreign exchange problems and, therefore, a dependency on food aid) would require at least 4 months of early warning, depending on the level of grain stocks it maintains.

What Type of Early Warning Information Do Decisionmakers Need?

In the event of a food crisis two questions need answering, if food relief operations are to be effective:

- how much food is required; and
- by whom and where is the food needed?

The first question needs to be answered in order to ensure availability of food supplies. The second question needs to be answered to ensure accessibility to food supplies.

Logically, the issue of availability has to be addressed first. The most immediate concern is to ensure that there is enough food in the country to meet the needs of the population. This is the primary concern of the SADC REWS. But, it is equally important to be able to determine where food relief is needed and how many people require assistance.

Most operational Early Warning Systems seem to have a leaning or bias toward one or the other of
these questions. Few have so far been able to strike a balance between the two, perhaps because the approaches required to address the two issues are quite different.

Systems designed to give an answer to the availability question, such as the SADC REWS, are generally more supply-oriented and more global in their perspective. They forecast harvests and assess import needs for a country or region as a whole. Systems designed to give an answer to the accessibility question are more demand-oriented and localized in their perspective. They employ socioeconomic and nutritional information to locate and quantify at-risk populations.

The experience gained in southern Africa during the last drought suggested that SADC countries were fairly well-equipped to deal with the question of availability but were not so well-equipped to deal with the question of accessibility. Early Warning Systems need to be able to address both these issues. This is the way in which a number of Early Warning Systems, including the SADC REWS, are evolving.

**Will SADC Countries Be Better Prepared for the Next Drought?**

The drought of 1992 was not the first to disrupt food production in southern Africa, and it won’t be the last. There is even evidence to support claims that (because of population pressure, deforestation, and land degradation) future droughts could have a more damaging effect on food-crop production in the region (e.g., Vogel, 1994).

In the aftermath of the drought of the early 1990s there is, understandably, considerable attention within the affected countries and the donors on the role of early warning in alleviating food insecurity. The drought has been good for early warning. But, as the region enters, hopefully, a period of better rainfall, one wonders what will be the state of early warning systems after a few years of good harvests, during which time they will not appear in the limelight.

FAO’s assistance to the SADC REWS has been principally concerned with establishing a sustainable early warning system at both the national and regional levels. For this reason, the project places heavy emphasis on human power development (capacity building) and on the introduction of enduring methodologies and tools. The project also puts great importance on the provision of adequate institutional arrangements by the host governments. Hopefully, these efforts will continue to bear fruit, but, with many countries facing severe humanpower and fiscal constraints and with high rates of staff turnover, there will always be a question as to the capability of SADC countries to maintain effective and credible early warning systems well into the future.

Bearing in mind that early warning should, and does, serve the needs of both the host country as well as those of the donor community, perhaps some sort of longer-term partnership between these two sets of users would be the best way to ensure the continued existence of reliable food security information.

Finally, rather than waiting for the next drought to happen, countries in drought-prone areas of the world, such as southern Africa, need to give greater attention now to drought mitigation measures. Perhaps central to this is the need to move agricultural development strategies away from the objective of maximizing production in the short term toward ensuring sustainable production in the longer term. In addition, a more comprehensive approach to food security planning, which recognizes the multisectoral nature of effective food security strategies (which FAO has already initiated in a number of SADC
countries), is required, if the persistent threat of food shortages is to be eradicated once and for all from the African scene. [NB: for an evaluation of the responses to the 1991-92 drought in the SADC region and of the potential impact that an ENSO forecast (early in 1991) might have had on mitigating regional food shortages, see Glantz et al., 1997].

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Summary: ENSO/FEWS Discussions

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The participants at the workshop represent four areas of concern: ENSO forecasting, famine early warning systems, climate-related impact assessment, and food security. These are groups that do not necessarily interact with each other, despite the fact that each is concerned with coping with situations of extreme food shortages and the prevention of famine. Each of the participants was requested to prepare a response to a specific question related to his/her expertise. Discussion papers were to stimulate discussion about the prospects for the eradication of famine in sub-Saharan Africa.

In the following section, comments made during the session that followed the presentation of each discussion paper and in the final session of the workshop have been compiled in accordance with recurrent themes: definitional problems related to early warning, food security and famine, the value of early warning systems, surpluses and losses, indicators, creeping environmental phenomena, climate change, baseline vulnerability assessment, politics, conflict zones, combining early warning with response and development issues, capacity building, grassroots involvement, government and donor involvement in early warning systems, ENSO information, the media, IRI, and drought in the SADC region (1991-93).

This section does not constitute a summary of the key points of the meeting but is meant to supplement the discussion papers prepared by the participants for the workshop.

Early warning, food security, famine: more than strict definition

There is more to consider in food security than just food availability or access to food at the household level. One must also consider whether there are adequate health services available and, perhaps more specifically, whether children are properly cared for. It would be more cost-effective to deal with the seemingly mundane chronic problems like high rates of infant mortality, as opposed to the more "sensational" deaths associated with famines. Look, therefore, not only at the food production component of the food/hunger/famine/response equation but at other causes of malnutrition as well, especially in infants.

Definitions are important. Famine early warning systems (FEWS) are broader than their name implies (a focus solely on famine), and, as a result, they are burdened by their name. In reality, they are components of food security systems. They do more than just provide early warning, they monitor a variety of physical and societal processes. It is misleading to focus on famine early warning, when we really mean food security early warning. It changes the expectations about what the objectives of a FEWS might be. While recognizing that the purpose of such systems has evolved and that they are now mislabeled, participants suggested that the use of the term "famine" is useful because it evokes a deeper concern and a sense of urgency within the donor communities than does the notion of "food security." Use of the term "famine" is more helpful for generating moral and financial support to arrest the slide toward that state.
Few places in sub-Saharan Africa are so vulnerable to famine that absolutely nothing could be done to prevent its occurrence or to mitigate its impacts. Even in the worst of times in the Sudanese situation, for example, some relief food managed to filter into the country to the needy. To a skeptic, it would seem that governments prefer to cope with an occasional famine rather than to try to resolve chronic hunger. To eradicate hunger, governments would have to deal with its root causes, which lie in complex sociopolitical and economic controversies such as who owns the land, who has political power, etc. With respect to famine, governments only have to resort to an occasional emergency *modus operandi*. Although responding to famine emergencies is costly, it is relatively easier to do than eradicating chronic hunger, out of which famines emerge. This response of donor governments to food shortages gives the appearance of "muddling through" and responding only to crisis. However, it appears to be their preferred way to operate (but obviously not preferred by potential famine victims). Thus, one might ask, is the call for famine early warning systems just another example of a distraction?

**Value of EW systems**

Early warning systems are not going to bring about the salvation of sub-Saharan Africa. Although there is value to such systems, donor and recipient governments should not expect them to be a cure-all for resolving chronic hunger or for addressing the more basic issues of underdevelopment. Early warning systems are but one component in a more comprehensive food security system. Health care was cited as an analogy; constructing more hospitals will not necessarily improve the health of a population. A comprehensive health care system would be needed, of which hospitals would be but one element.

Earlier intervention in the "slide" from food shortage into famine is an objective of a famine early warning system. One solution to providing earlier intervention is to identify and monitor high-risk populations, following a stratification of the population to identify society’s truly vulnerable groups. How much effective targeting of such groups that a government can do will likely depend on its institutional capacity. As a result of the disparities between nations in their levels of infrastructure and institutional development, the effectiveness of early warning systems will vary from country to country. In addition, response measures appropriate in one country may not be the best responses elsewhere. Therefore, we must reconsider how valuable lessons from one famine situation might be to other situations elsewhere; and it may be that experiences in the same place but at different times may also be of questionable value as lessons. In any event, identifying weaknesses in previous responses to food shortages and famine processes can enhance the prospects of developing more effective coping strategies in future years. Famine early warning systems can improve a country’s capacity to respond, if they involve training people at the local level for *fews*.

Concern was raised about the focus of early warning systems on prompting a delivery of relief food aid, as the expected appropriate response to early warning. Food aid was challenged as a bad way to respond to famine, by creating dependency, not self-sufficiency, and as contributing little, if anything, to progress toward economic development. In general *fews* have not been involved in development issues, but they should be. Is this particular famine early warning technology being used to reinforce a bad response to adverse climatic variations? Governments and donors need to create ways to build up the income of the populace in order to improve food security. Ensure that people can produce some income, and they will be able to access food. Focus on income-producing mechanisms as a food security measure.

Funds are limited, early warning systems are costly, and the problems of food security for a large
portion of the African continent far outweigh the amount of resources available to address them. Information about a food shortage is not the only important input in policymaking; where to apply the existing funds is equally as important. Some agencies, like the OFDA (USAID Office for Foreign Disaster Assistance), move into a region only when a clear disaster strikes and impacts are highly visible. They would be unable to take action in cases where only one or two indicators suggest a severe drought might exist. Thus, with regard to policymaking, several participants challenged the view that more early warning information was the most burning issue for resolving food insecurity.

In the Sudan and Somalia, famine is real, visible, and evokes responses from the international community of donors, but what about countries where food shortages are severe but are not yet famine? Countries like Nigeria and Haiti are in dire need of food (situations of food insecurity but not famine). Little help has been available for them to develop early warning systems for food security; must these populations suffer from famine first, before the international community will respond to their food problems? Famines apparently serve as a wake-up call to the international donor community more than situations of severe food insecurity. The threat or occurrence of famine is likely to be the only way that governments and the international community would become mobilized to develop an early warning system for a country facing food shortages. Although a view was expressed that this process was acceptable because the system would then be set up to prevent the next famine -- in other words, suffer the first famine and then you'll get an early warning system -- most participants felt that the international donor community should be assisting all countries in Africa that are vulnerable to severe food shortages and potential famine and not just those in which famines have already emerged. Governments know which elements of their populations are at risk.

A particular problem faced by those who operate early warning systems is one of attribution. If a warning is issued and a famine does not occur, can the absence of famine be considered a success of the warning, or because there was no famine in the offing in the first place? This is an important issue to raise. Because of the creeping nature of the famine process, there would likely be differing views about which stage of food shortage exists at any given time. Thus, it would be difficult to evaluate the effectiveness of an early warning system based solely on whether a famine has not occurred.

**Surpluses and losses**

Early warning systems tend to focus on severe food shortages and relief needs. However, they could also be used in situations where there are agricultural surpluses, providing such information to ministries involved in marketing agricultural products. It would be useful to assess how marketing systems respond to the outputs (both projections of surpluses as well as warnings of shortages) of early warning systems (e.g., do they lead to hoarding or speculation). Problems of responding in a timely way to impending crises and in response to early warning are regional as well as international and national. For example, grain does not move easily within countries or within regions as the result of a variety of political, economic, and military constraints.

It was pointed out that FAO's early warning system (GIEWS) differed from USAID's FEWS in that the former was concerned with food production in good and bad years through its Food Information Systems (FIS). In good years, GIEWS plays a role, dealing with the marketing and movement of grains. However, the value of FIS was questioned for chronically food-short countries like Ethiopia. Such a system had been tried there in the late 1980s but had apparently not worked well.

**Indicators**
A judicious use of social as well as physical indicators can help to determine the level of resilience or vulnerability within a given community or group. Focusing solely on famine (in terms of starving masses) provides too little lead time for an adequate response by any organization. For example, when famine occurred in the Sudan in 1990-91, during the time of the Gulf War, the indicator that donors relied on was a "body count" (the number of famine-related deaths). Because the number of deaths per week was apparently not high enough (by some bureaucratic standard), action was delayed, among donor nations, and famine ran its course.

The earlier the indication of potential food shortages, the better. Lead time is important because, in general, it takes about four to six months for relief food to make its way from donors to the needy, although some procedures do exist that can expedite the process. FEWS tends to rely primarily on physical indicators because they are often available earlier than social ones. During the growing season, the importance (and weighting) of different indicators changes from one point in time to another. As the growing season gets closer to harvest time, FEWS analysts monitor grain prices in the marketplace. They rely on people going into the field, but when that is not possible, satellite imagery is used.

Some participants believed that the value of rainfall information as an early warning indicator was overrated in importance with regard to famine prevention. It is important to make decisionmakers understand the strengths and weaknesses of meteorological information and to show them how to use the information to mitigate potentially adverse impacts. Early warning systems must include more than just precipitation monitoring; they should include long-range forecasting and ENSO forecasts in order to build a system to intervene at different stages.

The poor quality of data can easily distort the true picture of a food situation. Data quality questions were raised with regard to malnutrition. Whereas nutritional data have been related to seasonality, they have not been adequately correlated with climatic data. If nutritional data are used to target at-risk areas, only a small percentage of the total population would become involved. First, people begin to reduce their food consumption with an early warning of an impending food crisis. However, this does not necessarily lead directly to health problems. In Nigeria, for example, during food stress periods there is also a change in the kind and quality of food eaten, and there is a reduction in hospitality. These, among other location-specific indicators, need to be looked at more closely as possible triggers to early intervention.

Another problem related to data quality is that well-trained people are needed to collect reliable data. If the deteriorating food situation is already advanced, however, few trained people are available during these situations.

The use of behavioral indicators presupposes a knowledge of the communities affected by food deficits. In Namibia, extended families assist members in need. For example, some of those who migrate to the cities send money back to their families; others do not. Coping responses that are resorted to during famine-like conditions need to be differentiated from "normal" coping strategies for "normal" fluctuations in interannual food availability. However, these, among other traditional mechanisms in various countries, have been breaking down.

The marketplace is a good location to monitor indicators, when searching for changes in food production and food access well in advance of the harvest. Activities in the market, including changing food prices and availability and livestock conditions and prices, are often leading indicators. Speculators could be a source of early warning information, because they have experience in areas where there have
been repeated food shortages.

In southern Africa, a considerable amount of nutritional data is collected, but it is not processed and analyzed. To many, nutritional data are considered a lagging indicator but they are, nevertheless, important in relief operations. For example, in Ethiopia the incidence of kwashiorkor has been used as an indicator, but by the time it becomes widespread, it is often very late in the famine process. However, an Oxfam study on the Sudan suggested that nutritional data were not lagging indicators. Reductions in food consumption seemed to come early in that food shortage situation, and it was surprising how fast malnutrition showed up in Sudanese children.

Baseline vulnerability assessment

Independent, objective baseline vulnerability assessments can be very important to the timely targeting of at-risk groups. They can be used to identify populations at risk to severe food shortage and famine. This may be more important than monitoring a few selected indicators perceived to be useful for early warning. Although baseline indicators can provide a needed glimpse of the state of a society, they do not provide sufficient information for responding to famines. Thus, the one activity should not be expected to perform the tasks of the other. Vulnerability assessments must be linked to famine early warning systems. Vulnerability assessments would be expensive to set up but much less costly to maintain, once the initial assessment had been completed. Because socioeconomic conditions tend to change over time within countries, there would be a need to update baseline assessments. Updating them would be cheaper and could be carried out with the assistance of households and grassroots organizations. A system of checks and balances must be set up to assure that assessments are objective and not used to achieve goals other than to enhance food security at the household level to national levels.

It was strongly argued that the primary focus of a vulnerability assessment must be on the household level for food security, since a national vulnerability assessment would not yield enough detail to enhance food security at the local level. It is necessary to rely on community-based management of drought impacts. Within a given community, people generally know who is at risk. Use, as informants, those who are in contact with the people at risk, such as schoolteachers and agricultural extension agents.

Creeping environmental phenomena

The consequences of low-grade, long-term, but cumulative environmental changes such as soil erosion, desertification, deforestation, and soil salinization must be built into an early warning system as part of a baseline vulnerability assessment. Creeping environmental phenomena need not be monitored as frequently as those identifying more immediate changes affecting food production, but they must be considered. A major problem with long-term changes in degradation (and with their indicators) is that humanitarian donor agencies (as well as the media) are not interested in them because they see their responsibility as requiring responses to highly visible, near-term crises.

Although occurring on time scales from months to a few years, the famine process is similar to creeping environmental changes that occur on the order of years to decades. Decisionmakers must decide when to intervene. In the absence of a sharp change in the process of degradation, how does one get policymakers to respond? While some decisionmakers are risk-takers, others are risk-averse. Is there a discernible threshold for action? In fact, there is a third group to consider: risk-makers. They create
risks for others but not necessarily for themselves. Risk-making should be factored into the accountability of policymakers for their decisions (or lack of decisions) in emerging food crises.

**Climate change**

There is considerable concern today about the possibility of a human-induced global warming of the atmosphere (e.g., the greenhouse effect). Global climate change is yet another creeping environmental phenomenon expected to occur on the order of decades. Those concerned about food security issues must take into account research findings related to the possible consequences for agricultural production and water resources of global warming.

For the present, "business as usual" is the most appropriate strategy for the agricultural sector. There are conflicting views about which areas will get wetter and which will get drier. Scientists do not yet know how, whether, or where production might rise or fall. Which of the several climate change scenarios for sub-Saharan Africa should one believe? At this time, the only climate change scenario that seems plausible is that average global temperature will increase, but we do not know with any reliability what will happen at the regional level. It was suggested that IPCC (Intergovernmental Panel on Climate Change) scenarios be used to get a first glimpse at possible rates of change and of potential adjustment processes. Nations must first learn to cope with climate variability and then cope with climate change. If the global climate changes, some areas will likely benefit, while others will be adversely affected. However, the national economy as a whole will likely not be devastated. We do not yet know what the ability of farmers in the tropics is to adjust to climate changes. Agrarian societies must think in terms of research needs and societal safety nets with regard to the regional, societal, and environmental consequences of potential global climate change.

**Politics**

Even with a highly successful baseline vulnerability assessment and a perfected early warning system, international and domestic politics can lower their utility and effectiveness. Political factors must be included with objectivity in vulnerability assessments, along with grain prices, and so forth, in order to provide a realistic assessment of vulnerability to famine. Consideration of political factors must also be incorporated into famine early warning systems. Even with an improved forecast mechanism, decisions about how, when, and to whom to respond are politically determined. Governments and NGOs (nongovernmental organizations) are often reluctant to deal with such issues as land ownership or the gap between rich and poor, or, more generally, with structural causes behind the lack of access to food of some groups within a country. In other words, politics is deemed too "political" a factor to include in such systems. Nevertheless, the politics of early warning and the politics of famine must be openly addressed in an operational sense as inputs into famine early warning. For example, even if experts know that planting dates should be shifted, the political situation might not allow for you to disseminate it to the farmers.

It was suggested that, after 15 years of experience in Ethiopia, leaving the decision about when to respond to a worsening food shortage up to decisionmakers does not work. Early warnings will not assure that a decisionmaker will take action, unless he/she is prepared to do so. Policymakers should be using early warning information and, if not, should be held accountable. Thus, early warning information must be linked to response, intervention and accountability. We must assess the political aspects for an early warning system (for example, who is to receive early warning information? Who must have it? What is the political setting into which one would put early warning (including ENSO)
forecasts?). Forecasts provide only one piece of information to policymakers. Forecasters will have to
compete with others to capture the attention of the policymakers.

Decisionmakers fear "hidden agendas" of sources of information out of their control. Often they
have their own hidden agendas in either calling for food relief or denying their need for food. Sometimes
governments have intervened in the early warning process because they did not want certain information
released for political reasons. This also happens in a regional context when some member states of a
regional organization hold back information from others in the organization. A regional early warning
system should be developed and supported, when practicable. Because regional organizations usually
cannot directly affect policies at the national level, a regional early warning system must form a good
working relationship with national ones which can, in turn, provide input into national economic
policies. Such was the situation in Botswana in the early 1990s.

A general feeling among participants was that decisionmakers are often reluctant to act and that the
problem was one of publicity, not probability. In the absence of reliable and credible forecasts of
anomalies, "business as usual" will likely prevail. Policymakers are constantly making decisions under
conditions of uncertainty. The more uncertain a forecast, the less responsibility the decisionmaker will
have to take for his action. Under such conditions, they can avoid being blamed for inaction. Personal
political safety is a higher goal for a decisionmaker if he/she can get away with ignoring such
information. Therefore, it is necessary to announce forecasts and early warnings publicly.

Conflict zones

It was suggested that there should be two early warning systems in war-torn countries, one for the
conflict zone and another for the nonconflict zone. Whereas a war zone is likely to be food-insecure, the
nonconflict zone would likely be food secure (and could even be in surplus). In addition, the
health-related needs of a population in a conflict zone differ from those in a nonconflict zone during
situations of severe food deprivation. In a war zone, the lack of medicines and vitamins or of feeding
centers exacerbates the adverse health situation of the victims of a famine process. Thus, early warning
systems would have different concerns in each of these zones. Providing only one system to encompass
these zones, as has been the case, labels the entire country as food insecure year after year, even though
the cause of that insecurity would be grounded in conflict, not climate anomalies, poor production
methods, etc. As an example, the "uncivil" war in Angola has led to widespread, severe food shortages.
This would greatly reduce the effectiveness of an early warning because, to be effective, it must evoke
an appropriate response. It would be difficult to get adequate relief supplies to them in a timely way. If a
conflict situation drags on for a long time (such as has been the case in the Sudan and Angola), donor
governments lose interest in dealing with their food shortages.

One participant cautioned that such two-part early warning system within a country would be
tantamount to institutionalizing a policy of triage, a situation in which famine victims in the conflict
zones would be forgotten because it would be difficult to gather reliable information on the food security
situation in the conflict zone.

Yet another kind of difficulty facing early warning systems and food security issues during military
conflicts is that different data would have to be collected in conflict and in nonconflict zones. When an
outbreak of hostilities occurs at the time of planting, planting efforts fail. Conflict zones are very
prevalent in many areas of sub-Saharan Africa today. The value of famine early warning and other types
of early warning systems becomes unclear in conflict situations.
Combine EW + response + development

The overriding purpose of combining vulnerability assessments, early warning systems, and effective response mechanisms is to eradicate famine on the African continent. These components must be linked in order to have an effective famine avoidance system. Combining warning and response mechanisms should reduce the time it takes for national and donor governments to respond to an impending food crisis, because it would forewarn governments about which populations to target for possible emergency assistance. In fact, a planned (institutionalized) response mechanism to famine early warning should reduce vulnerability to some degree. In the absence of a baseline vulnerability assessment, it would be necessary to return to the field, a time-consuming task, in order to identify the most needy. As things are done now, several months can pass from an early warning until the arrival of donor food supplies in response to that warning. That gap can be narrowed. The response time, however, also depends on the credibility given to the early warning system by donors and government agencies.

Many donors tend to separate development issues from food crisis issues, with different bureaucratic units dealing with either of the two issues. Yet, vulnerability assessments can be useful for development planning. Early warning systems, too, must be closely linked to those agencies dealing with economic development issues and removed from those organizations that deal only with short-term food crises. Responses to short-term crises could prove to be at cross purposes with long-term development objectives.

Some participants cautioned the donor community not to rush its responses to an early warning, because the affected countries and populations must first help themselves. In response to this view, it was noted that donors, governments, and individuals react differently depending on whether the warning is truly early or whether the disaster is already unfolding: some victims reduce consumption, some eat whatever is available (famine foods), some migrate, etc.

Some participants expressed concern about linking early warning and response systems, arguing that such a linkage would politicize early warning information. If an early warning system becomes embroiled in political issues, then its early warning bulletins may not be used in decisionmaking. SADC, for example, sees itself as an information system, e.g., a system with relatively narrow objectives. SADC's views are but one input that competes with the views of other agencies for the attention of policymakers within the region. SADC participants suggested that an early warning system should be focused on producing early warning information rather than triggering a response: It is the decisionmakers' responsibility to use early warning information to decide whether and when to respond. If the governments choose not to respond, the early warning system cannot be blamed. An early warning system can raise in stages, depending on the level of warning, the awareness of decisionmakers of an impending food crisis. With respect to the awareness process, FEWS has identified five stages of vulnerability (ending in famine). At each stage, decisionmakers are provided with suggestions about how they might respond early.

To get away from a disaster mentality, a preparedness system must be flexible and all-encompassing. If the poor are constantly on the edge of hunger, they would need help whether from drought, flood, or no access to income or food. Because long-term plans tend to become unchanging and rigid, contingency drought plans must be updated periodically as new information, technologies, and strategies become available. In addition, the belief that the government (or some organization) has a PLAN to avert food shortages can lead to a false sense of security.
Botswana, among some other countries, is a food-deficit country. It needs to import food. If Botswana can afford to buy food from outside its borders, it has food security. Concern was voiced that a focus on correcting food deficits by growing more food in countries like Botswana may be erroneous. As another example, one of Namibia's most important safety nets during drought has been its pensions for the elderly. The income from pensions helped them to get through such difficult times.

By maintaining adequate food reserves, the pressure to rely on a regional or national early warning system would be lessened. Large reserves could provide policymakers with lead time for action. Food reserves, however, are costly to maintain (about $7 million to store 1 million tonnes in southern Africa in the early 1990s). In addition, grain has a relatively short shelf life. It makes more sense to keep small grain reserves along with available funds to purchase grain when necessary, in order to make up for eventual food shortages.

Capacity building

Incorporating capacity building into the primary objectives of early warning systems. It must be undertaken so that national and regional organizations can eventually be operated by indigenous human resources. Capacity building would create a sense of ownership within these systems. Shared responsibility would put donors and users in closer communication with those who produce early warnings; suspicion and the perceived need for the cross-checking of information among them would no longer be necessary. Joint ownership of early warning information would reduce the duplication of effort that results from a lack of coordination. Joint ownership would benefit all involved. Regarding capacity building, an international institute, such as the proposed IRI, could be helpful. There must be an effort to build national capacity with regard to forecasting, including how to use ENSO information.

Grassroots involvement

Information related to food shortages is often collected from the local level and flows to the higher levels of government. Seldom, however, does the analyzed information flow back down to the grassroots level. Such information must be made available to local people or organizations so they can share in its ownership. They can use it, for example, for lobbying their governments to respond to emerging food and hunger problems. The information would be doubly useful by local (often informal) early warning systems. Local inhabitants should also be included in the planning of response activities to enhance their resilience in the face of changes in grassroots food security.

Involve governments and donors in EWS

Early warning practitioners must develop good rapport with government representatives. Involving government in the early warning system at each stage, from its creation to the issuing of early warnings, will give the system credibility to other government agencies and officials. In addition, different ministries and bureaucratic units within them must work more closely together. Bureaucratic constraints and poor decision-making processes tend to block attempts to provide effective intervention. For example, because droughts are often followed by floods, those making plans to cope with drought should also be prepared to work closely with those involved in developing contingency plans for coping with floods.

Governments must focus on the causes of food insecurity and famine and not just on their symptoms. Usually, with a focus on symptoms as opposed to its root causes, considerable funding is
diverted from development to emergency programs. Increased coordination is needed among donors so they can use their funds effectively and efficiently because, today, too many donors are going it alone. National authorities are often in a position to receive and transmit information received from donors. In some cases, national governments have provided misleading information about impending food shortages to provoke favorable responses from the donor community. Officially, national authorities decide whether a famine is occurring or not. Yet, donors have varying degrees of influence on a government’s decisions. The rural poor usually have little influence on resolving food issues, although they are the first and worst affected with declining food security.

Governments must devise ways to reduce their dependence on finite and highly variable natural resources. They should identify and create ways for their citizens to generate income. An early warning system’s function should be to generate in-house and in-country capacity, and not necessarily to generate food imports.

To what extent should those involved in an early warning system influence the way their early warning information is used? There are different views on how active their role should be: (a) just provide information to decisionmakers, or (b) actively pursue the use of early warning information, including ENSO-related information, by decisionmakers. There is a need to intervene in the marketplace before the food situation gets to the stage where humanitarian food relief is the only remaining viable option. Focus on protecting livelihoods as well as lives.

**ENSO**

The likely effects of ENSO on food production processes can be forecast with varying degrees of confidence, but in many countries food scarcity and sporadic food shortages are caused by a lack of access to food, as well as a lack of food availability in the marketplace. Many of the poor do not have the means to purchase it. Although a better ENSO forecast or a better use of existing ENSO-related information will not by itself resolve a nation’s food problems, it can be used to reduce vulnerability.

Those who produce ENSO information must educate people on how to use it effectively. In the past, such information was produced and presented to the public without much explanation. Training decisionmakers at various levels of society in its uses will enhance its value to society. Despite a reluctance of academic disciplines to interact with each other, the need to do so is clearly there. Excluding the Australian situation, in which ENSO information has been used in various sectors of society, there are few successes.

To improve food security decisions made by policymakers, the kind of relevant information collected and analyzed must be broadened beyond agroclimatic reliance on data. Policymakers need to be shown how to use the climate-related information that exists today so they will be better prepared (and ready) to use the increasing amounts of such information that will likely become available tomorrow, such as improved information about ENSO and its teleconnections.

The ENSO forecast community has not been producing information that meets the needs of *fews*. With regard to the use of climate (including ENSO) information, it is necessary to match the outputs of the forecasters with the needs of potential users. There are ways to improve this situation, however. ENSO forecast information may be useful and timely for some human activities but not for others.

The skill of an ENSO forecast falls off with time and with geographic specificity. The best time
range is 3 to 6 months, for which there is some skill for forecasting big and small events. Generally speaking, for major ENSO events, there is some forecasting skill for periods up to a year. With weaker ones, skill also declines. In addition, it is important to keep in mind that the natural system is more predictable at some times than at others.

Although there is insufficient, reliable, decadal-scale information about ENSO, this situation will likely improve in the future. The ENSO signals in Latin America are strong and reliable, and the intergovernmental political interests are, in general, favorable to the use of such forecasts. Thus, the strongest scientific interactions to date have been between forecasters of ENSO and researchers in Latin America. There is interest in strengthening the ENSO research and application community’s linkages to sub-Saharan Africa, where there are additional reliable and credible climatological connections yet to be identified and researched.

There are also now opportunities for researchers interested in focusing on the linkages between ENSO events and their African impacts. For example, one could use ENSO information to forecast total rainfall in the following November to May in southern Africa. Research could also focus on connections between sea surface temperatures in the south Atlantic and Indian Oceans and African rainfall anomalies. Although it makes sense that sea surface temperatures in these regions of the ocean would affect African rainfall, the focus until now has centered on the tropical Pacific. Also, sea surface temperatures in the Indian Ocean affect African weather, but their patterns are different from those related to ENSO. There is great potential for improved forecasts by improving our understanding of the Indian Ocean.

It appears that an ENSO forecaster needs to develop a track record in order to build up the credibility of and confidence in his/her ENSO forecasts. Mark Cane and Steven Zebiak successfully forecast the occurrences of the 1986-87 and the 1991-92 ENSO events and also predicted the non-occurrence of an ENSO event in 1990, despite the forecasts of others suggesting the emergence of ENSO.

There are several ways to view teleconnections: From the observations of geophysical mechanisms, statistical correlations, or from perceived, but unsubstantiated, linkages between ENSO events and anomalies in other parts of the globe. Sir Gilbert Walker identified many correlations eighty years ago, and researchers since then have upheld them. The Southern Oscillation Index (SOI) can be used to predict "teleconnected" climate anomalies occurring at various distances from the central Pacific Ocean. There are varying lengths of time lag between changes in the SOI, and such information, even if far from perfect, can be of great value to the management of numerous human activities. The reliability of the teleconnections, as we now know them, can be improved, along with improvements in the scientific community’s understanding of ENSO. Where reliable teleconnections to ENSO events exist, lead times could be given, for example, for forecasting droughts or floods. The forecast must be tailored to local needs and must create confidence in decisionmakers. Interpretations of such forecasts and other early warning information are required at the local level. Producers of ENSO information must seek to identify users’ needs. Equally as important, it is necessary for governments to make known to ENSO forecast producers what their country’s needs are for climate-related information.

The strongest correlations for teleconnections are, generally, in the tropics; the further away from the source region (the Pacific), the strength of the correlation attenuates and "noise" tends to dominate (e.g., regional climate forcing factors tend to override the ENSO signal). Parts of Africa provide good locations for investigating these linkages, because seasons are clear-cut, and changes in them are easier
to identify. Ultimately, the scientific community must put a real physical understanding behind these teleconnections in order to improve the reliance placed on them by policymakers.

The impact of the media on "spreading the word" to the public and policymakers about ENSO was great following the 1982-83 event. Popular North American magazines, such as Readers Digest, National Geographic, Time, and Newsweek, wrote feature stories about it and its impacts on ecosystems and people. ENSO (really, the term El Niño) has captured the attention of policymakers, the media, and the general public.

ENSO information can be used by "customers" to hedge decisions toward mitigative or adaptive measures in the face of possible drought. For example, if one identifies the possible occurrence of ENSO and drought in southern Africa, governments could start to hedge their policies to enhance various aspects of food security. However, governments should not rely on an ENSO forecast from only one source. They should determine what other forecasters say about the probability of its onset, magnitude, and intensity. Showing how useful ENSO forecasts and ENSO information are in a few key locations would be very instructive (e.g., northeast Brazil and Australia).

Australian wheat production was used as an example of ENSO's impacts on agricultural yields. Wheat was chosen as an example of linkages between ENSO events and yields because it is a high-value crop, although the correlation is higher for sorghum, an Australian crop of lower value. It was noted that the use of ENSO forecasts tended to flatten yield variations from year to year as a result of mitigative responses by farmers. Farmers, however, react to factors other than weather that affect price, such as insects or fertilizers. Questions were raised about how best to determine the effect of a forecast on a farmer's behavior.

ENSO information can also be used for managing Australian rangelands and livestock on an interannual basis. Such forecasts provided an opportunity for ranchers to hedge by destocking the rangelands. It was shown that environmental degradation in Australia was accelerated in those situations where there was a lack of appropriate responses to ENSO forecasts by ranchers.

The history of research on the physical understanding of ENSO is little more than a few decades old, catalyzed by the work of Bjerknes in the 1960s. Only now are scientific colleagues beginning to come around. Brazilians, for example, have become quite sophisticated in how they use forecasts related to ENSO. In Northeast Brazil, decisionmakers have used ENSO forecasts, and now people support that use. That awareness of the value of ENSO information has been lacking in sub-Saharan Africa. Africa, as was the case in Northeast Brazil, needs a "champion" to carry the banner in support of the use of ENSO information. There is a need for closer analysis of droughts and ENSO events in southern, eastern, and northeastern Africa.

As another example, there is a strong ENSO signal in the Caribbean, but apparently not much research has been done there to correlate ENSO events with Haitian rainfall. It is important to remember that the regional and local climatic settings can affect how an ENSO might affect Haiti. Haiti is a country plagued by chronic hunger and is potentially at risk to widespread famine. It could benefit greatly from an understanding and use of existing ENSO information in combination with a baseline vulnerability assessment and famine early warning system.

Within countries whose climates are affected by ENSO (as monitored by the SOI), ENSO forecasts lack the needed regional and local detail. Thus, the regional as well as seasonal detail for
"teleconnected" regions needs to be improved. Until recently, a major obstacle to the use of ENSO information has been the difficulty of convincing meteorologists that this can be usefully done. Many meteorologists have yet to be convinced by their colleagues of the value of such application of current ENSO information to the management of human activities.

Decisionmakers must be made aware of the cost of inaction when a reliable (but not perfect) forecast has been provided to them. This relates directly to getting decisionmakers to act under conditions of uncertainty. One way to do this is to make decisionmakers aware of each of the stages of the famine early warning process. This will enable them to hedge through incremental policy decisions. For example, ENSO forecasts are issued in the United States as an advisory, a warning, or a watch. These can be used to raise awareness incrementally of an impending adverse change in food production prospects. Incrementalism allows for early, low-cost action, such as the import of small amounts of food. Incrementalism provides additional "breathing space" for policymakers in the event a deteriorating food situation worsens.

ENSO information can be factored into early warning systems in two ways: Tactically and strategically. Tactically, once an ENSO event has been identified, discussion of possible response options can take place. Strategically, one can assist vulnerable populations in recognizing these options and taking appropriate steps to avoid famine. There is a degree of certainty that a disaster, such as drought, will recur. Governments know they are recurrent phenomena, but do not know exactly when. Disasters that are highly probable (and their impacts) should be linked to development issues for policymakers. For example, droughts can be forecast and the vulnerability of a society can be assessed. The intersection of these processes (one natural, one social) can be expressed in probabilistic terms about the likelihood of a famine. For example, it is possible to predict the likelihood of a disastrous flood in Bangladesh and a drought in Southern Africa within the next ten years. If one combines this with estimates of the baseline vulnerability of a population, estimates of the probability of occurrence of severe food shortages can be determined, and a very early strategic warning can be issued. A participant challenged this view, noting that, although it is possible to predict a drought within the next ten years, until it is possible to predict a drought in the next marketing year, early warning systems cannot be of much direct use to policymakers.

Interaction must be encouraged between the ENSO research community and those responsible for early warning systems. A great deal of information already exists within these two communities but has been underutilized because of poor interaction between them. The ENSO research community is composed primarily of physical scientists with varying levels of communication skills. The early warning community, which produces communiques to the user community, would benefit greatly by having a more formal liaison with ENSO researchers. This would facilitate collaboration between users and researchers. Identification of users is as important as producing the information itself. Government users are usually well-educated and are in the position to make use of early warning information. In reality, governments and the donor community who are the true users of early warning information in the Third World.

The media

Although the media provide late (or lagging) indicators of impending food security problems, they are often the catalyst to public awareness and outcry and, ultimately, to government action. Most lingering hunger stories, such as the combination of chronic warfare and chronic hunger in Angola or in the Sudan, are not attractive to the media. An environmental editor of a major international weekly
magazine said that a telling photograph was often more important than a story with no supporting photo, because a story can eventually be constructed to support a photo, but not vice versa.

Many obstacles confront photojournalists in their attempts to have their photographs appear in the press. Often the regions most at risk to food shortages are difficult to get to by photojournalists. They must depend on the good will of the government to let them visit such regions and on the assistance of NGOs that operate in the region to get them to the affected populations. Once photos have been taken and stories written, photojournalists must then convince their editors, who decide whether a story is newsworthy or whether the photos convey the message they want to send to their readers (they often ask how many have perished, for example).

Some participants expressed concern that reporters do not realize how powerful (and, therefore, dangerous) they are. The press is a transmitter of information. It has the power to create panic or, conversely, keep people (e.g., farmers) from taking appropriate action. Nevertheless, organizations concerned with famine and food security should not "use" the press to sensationalize a food shortage situation.

International Research Institute

An international center for climate prediction would help scientists and decisionmakers in different regions to understand processes that influence their regional climates. NOAA is now trying to gather support and funds for the establishment of such an international center. The IRI will have a much stronger focus toward application. Although ENSO research has an important role in famine early warning, application of that research must be treated as being as important as the research itself, in the funding arena as well as in verbal pronouncements.

If science and applications can be brought together, resources can be found to implement programs that can enhance the application and utility of scientific research related to ENSO. The IRI should not be just another supercomputing center, but should be a multidisciplinary one having a broad value to society as a whole. If anthropologists, for example, could become involved in the IRI, they, along with other social scientists, could act as translators between physical scientists and social scientists.

Drought in the SADC region, 1991-92

In the SADC famine early warning system, drought was initially viewed as a meteorological phenomenon. However, over time, it became evident that much more was involved in food security than just climate. It was realized that an early warning system could also be used to identify what to do in surplus years.

During the recent drought in southern Africa, SADC played a major role in averting severe regional food shortages. It provided a regional perspective and accelerated the gathering and dissemination of information related to deteriorating regional food security. Famine in the region was averted not just because of the region’s early warning system, but because there was a good logistical network, good government cooperation, and good relations with the donor community. In this regard, the food crises in southern Africa and in the Horn of Africa developed in different ways, reminding us that early warning systems are embedded in political systems and are directly affected by national and international politics. When evaluating their utility and effectiveness, they must be viewed in their political contexts.
Regional coordination within SADC was possible only after several years of developing an infrastructure capable of coping with food security issues. It has focused on regional agricultural and natural resource development. The larger countries in the region are trying to achieve self-sufficiency in agriculture. They look to agricultural policies that tend to diversify their economies away from a dependence on monocropping (e.g., maize). SADC, as a regional organization, however, does not dictate national economic policies to states in the region. It can, however, encourage the transboundary movement of agricultural products from surplus to deficit areas.

During the 1991-92 drought, it focused on dealing with improving responses to the severe impacts of drought as opposed to dealing with the way to make agricultural production more sustainable. SADC did not realize the importance of the role of media in changing public and government opinion. However, there was a slow change in media reporting about the drought, and eventually media reporting influenced opinion. The media, however, should not be manipulated by those concerned with food security to portray a situation as worse than it might be, because in the long run they would lose credibility with the public.

During the South African drought in 1991-92, problems did arise. For example, there was difficulty getting food to the at-risk populations, as food parcels were sent to townships and not to the Bantustans far from town. The people affected by severe food shortages are very poor. Only those who are really in need of food relief will come forward for it if able to do so. However, to get to lactating women, one must go through the clinics.

Yet another regional problem resulted from political pressures that exacerbated food shortages. For example, during the recent South African drought, the World Bank pressured the government to increase its foreign exchange by reducing its grain stocks through massive exports. When donors apply this kind of pressure without due consideration of indicators of drought and grain storage levels, they end up working at cross purposes to national government needs. With climate information having been available earlier (e.g., from ENSO forecasts), it might have been possible in South Africa to indicate to the government and the World Bank that stock levels should remain high, thereby discouraging the depletion of stock levels. This kind of information must be communicated in a user-friendly way.

A South African participant pointed out that all indicators in 1992 clearly suggested an ENSO event in the region, information that was known elsewhere as early as mid-1991. Given the strong correlation between ENSO events and rainfall in Southern Africa, why was that information not effectively communicated to planners in SADC? There is no lack of information being produced, but getting it to the right place at the right time is another matter. There is already considerable research being undertaken on the physical side of the equation. For example, there are at least three organizations in Australia concentrating on ENSO research; nevertheless, there is a major gap in application of research findings.