Regional Drought Monitoring Centres – The Case of Eastern and Southern Africa

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Abstract

Eastern Africa is prone to extreme climate events such as droughts and floods. In the past, these events have had severe negative impacts on key socioeconomic sectors of the economies of most countries in the subregion. In the late seventies and eighties, droughts caused widespread famine and economic hardships in many countries. For this reason and at the request of 24 countries in the eastern and southern Africa subregion, WMO established two drought monitoring centers (DMCs), in Nairobi, Kenya, and Harare, Zimbabwe, in 1989 with financial support from UNDP. The main objective of the centers was to contribute to early warning systems and mitigation of adverse impacts of extreme climatic events on agricultural production, the mainstay of economic activities in the subregion. Since their establishment in 1989, the centers have played an important and useful role in providing the subregion with weather and climate advisories and, more importantly, advance warnings on droughts, floods, and other extreme weather events, on the basis of which appropriate actions have been taken to mitigate the adverse impacts.

Because of the enhanced need for drought-related products, the two centers have split into the Drought Monitoring Centre, Nairobi (DMCN), and the Drought Monitoring Centre, Harare (DMCH). DMCN caters to countries in the Greater Horn of Africa region while DMCH is responsible for countries in southern Africa. Whereas DMCH has been integrated into the SADC, the DMCN is still a project and would need an institutional framework to ensure its long-term operation.

Introduction and Background

The frequent and widespread droughts of the 1980s and their attendant problems of famine and economic hardships provided a strong incentive for the establishment of monitoring capabilities within eastern and southern Africa. The establishment of the Nairobi and Harare operational drought monitoring centers under the UNDP/WMO project "Drought Monitoring for Eastern and Southern Africa" arose out of the realization that mitigating the effects of drought in this subregion could not be effectively tackled in isolation, but only through well-coordinated regional collaboration. The project had 24 participating countries: Angola, Botswana, Burundi, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Lesotho, Malagasy, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Seychelles, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe.

The two operational centers were charged with timely monitoring of drought, with respect to its intensity, geographical extent, duration, and impact on agricultural production; and giving early warning to enable the formulation of appropriate strategies to combat its adverse effects. This was to be achieved through improved application of meteorological and hydrological data and products.

Extreme climate events like drought, floods, cyclones, cold/hot spells, and severe storms are common in the subregion. Whenever they occur, they have devastating effects on agricultural activities and food security, water availability and quality, energy demand and supply, safety of transportation systems, human health, and many other socioeconomic activities. Many water-use activities in the eastern African countries heavily depend on rainfall. Because of the complex nature of rainfall patterns in the subregion, there is no year or season in which the whole region receives normal rainfall and is devoid of extreme climate anomalies. *The best strategy to minimize negative impacts associated with climatic extremes is timely availability of weather and climate information and prediction products, coupled with effective disaster preparedness policies.*

The extreme climate events have been associated with the El Niño/Southern Oscillation (ENSO) phenomenon, tropical cyclone activity, and anomalies in monsoon wind systems, among many other regional systems. Monitoring such anomalies is a core activity of the DMCs, global climate centers, and WMO.

ENSO events have a strong influence on the intertropical convergence zone (ITCZ), regional monsoon wind circulation, and patterns of rainfall anomalies over many parts of the subregion. The impacts, however, vary significantly from season to season and location to location. For example, El Niño episodes are often associated with above-normal rainfall conditions over the equatorial parts of eastern Africa during October to December and below-normal rainfall over much of the Horn of Africa during the June to September rainfall season. On the other hand, La Niña events often give rise to below-normal rainfall over much of the Greater Horn of Africa during October to December and March to May and above-normal rainfall during the June to September rainfall season.

Warm phase ENSO episodes have been more frequent in recent years than episodes of the cold phase (La Niña). This might have led to the recent recurrences of floods and droughts in regions with strong ENSO signals such as eastern Africa**.** *It should be noted that El Niño episodes at times change to La Niña. In such cases, many locations with strong ENSOs signal have observed severe floods that are followed by severe droughts, and vice versa.* These have had devastating socioeconomic impacts in such locations. For example, in equatorial eastern Africa, heavy rains associated with the 1997-98 El Niño event preceded the current dry conditions, which are the result of the 1998-1999-2000 La Niña conditions.

It should also be noted that ENSO is not the only cause of floods and droughts in the subregion. There is therefore a need for more regional research to understand other causes of climate anomalies in the region. ENSO can, however, account for more than 80% of the rainfall anomalies in some seasons and locations. This signifies the importance of ENSO, SSTs, and other general circulation information for purposes of early warning in the subregion. Another major factor that often affects regional circulation is the tropical cyclone activity over southern and northwestern Indian ocean regions. Cyclones are associated with intensive rainfall over the region of occurrence. However, they can cause drought in the regions outside the cyclone activity by dragging the normal winds to the cyclone region. This is one of the factors that caused the failure of the March-May 2000 rainfall season in the tropical eastern African region. The cyclone activity in the southwest Indian ocean region was associated with floods in Mozambique and other countries of southern Africa. Enhancement of regional/national meteorological and hydrological early warning systems is essential in order to enable them to take maximum advantage of new technology to produce useful climate and prediction information for decision making.

Overview of Drought Early Warning Systems in Eastern Africa

Drought is a natural component of the climatic system. Droughts have occurred in Africa throughout the historical period for which rainfall records are available (Ogallo and Nassib 1984; LeComte 1985; Winstanley 1985). Because of the varied nature of water use, drought assumes a variety of definitions, each of which is dependent on the water-use activity. However, it can be regarded as "*lack of sufficient water to meet essential needs*." It is a supply-and-demand phenomenon in which the demand exceeds the supply from all sources. In the eastern African region, many economic activities heavily depend on agricultural production. Rainfall fluctuations therefore play a significant role in determining the national economies.

Drought can be monitored through the application of various statistical techniques. This requires the availability of long-term series of historical data. The statistical techniques for monitoring drought range from highly sophisticated models like the Palmer Drought Index to simple procedures such as the use of percentiles, deciles, and quartiles.

Assessment of drought severity in the subregion is based on the quartile index as depicted in Table 1. Participating countries are charged with timely provision of near real time data to the operational centers. This computational assessment is supplemented by satellite remotely sensed data in the form of the NDVI and CCD.

Table 1. **Drought severity index based on the quartile range.**

Range	Comments
< Min	Driest on record
Q1-Min	Dry
Q1-Q3	Near normal
Q3- Max	Wet
>Max	Wettest on record

Q1: 1st quartile Q3: 3rd quartile

Cumulative rainfall information is also used to assess cumulative impacts of rainfall anomalies. The temporal evolutions of rainfall anomalies over the last several months for some selected stations over the Greater Horn of Africa are given in Figure 1. The cumulative curves indicate that some of the locations have recorded their worst drought since 1961.

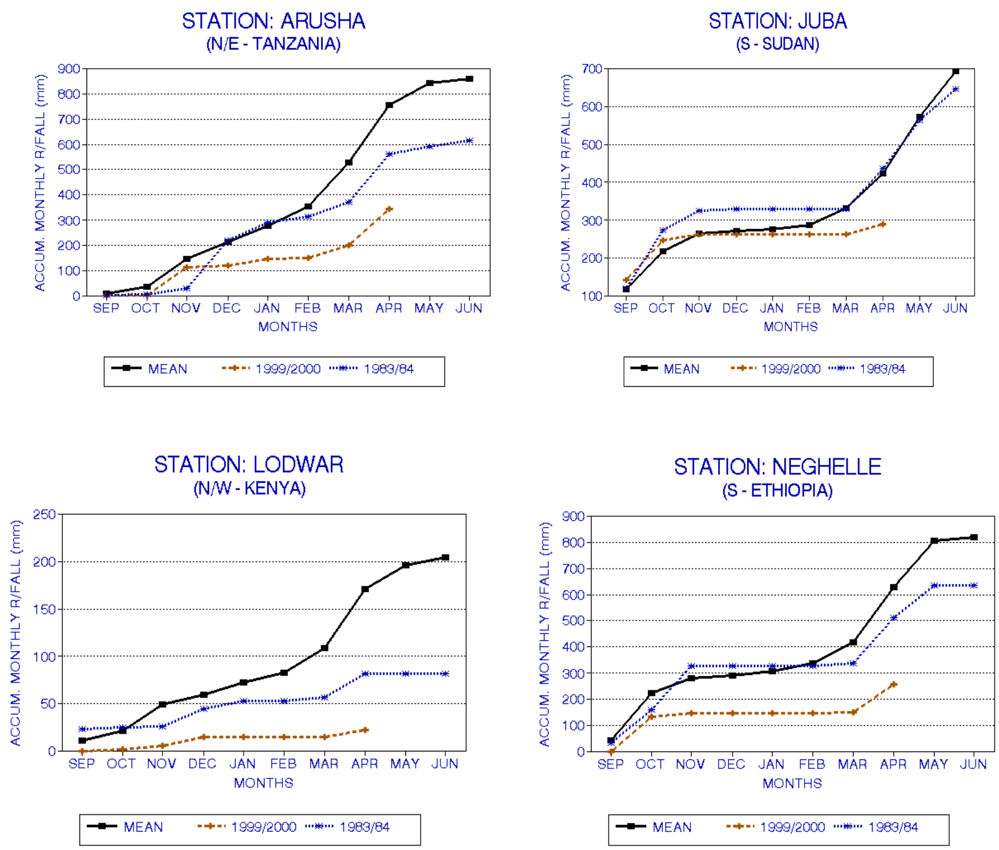

Figure 1. Time series plots of cumulative monthly rainfall for selected stations.

In recent years, new developments in early warning and climate prediction services have made it possible to predict ENSO with lead times of a few months. This has provided new prediction and early warning systems of ENSO-related extreme weather/climate events in many regions with strong ENSO signals, like eastern Africa. Formulation of seasonal (three months) weather outlooks is therefore based on ENSO conditions and sea surface temperature anomalies (SSTAs) as well as cyclone activity in the tropical oceans. On the basis of these indicators, the DMCs have been able to regularly forewarn the target groups of the possibilities of anomalous rainfall behavior in the subregion. Some of the countries in the affected sectors have used this timely information to institute strategies to minimize drought impacts.

Primary Data and Information Products

The DMCs prepare, publish, and disseminate to users the following products:

1. Ten-day weather advisories for the subregion, which include:

- decadal climatological summary (drought severity);
- decadal agrometerorological conditions and impacts; and

- decadal synoptic review and weather outlook.

2. Monthly Drought Monitoring Bulletin for the subregion, which includes:

- monthly and three-monthly climatological summaries (drought severity);
- dominant synoptic systems and three-month weather outlook;
- agrometeorological conditions and their impacts on agricultural activities and water resources; and
- monthly and three-monthly actual meteorological data.

In addition, special advisories are prepared and disseminated to users when the need arises.

The effectiveness of the products is evaluated through a feedback mechanism that has been established with the users. Climate outlook fora that take place before the beginning of the major rainfall seasons were initiated recently in the subregion. These bring together scientists from within and outside the subregion and users of climate information to participate in two activities. The first activity is a 2-day users' workshop that is meant to enhance the application of the climate information and products and to foster interactions between the producers and users of climate information. The second activity is normally a climate outlook forum at which a consensus climate outlook is developed and the potential impacts of the expected rainfall conditions are determined for the following rainfall season. The participation of users of DMC climate information in the climate outlook fora has facilitated the evaluation of the usefulness of the outlooks in diverse sectors of the economies. The users assess the past climate outlook products in terms of how closely the actual weather matched the forecasts. It has been noted that the past forecasts have been in broad agreement with observations made by users on the ground.

Identification of Primary Users

Because of the heavy dependence of many activities on water, users of the early warning information generated by the DMCs are quite diverse. They include policy makers, agriculturalists, water resources scientists, health officials, and environmentalists. Policy makers institute actions that can enable nations to absorb the shocks associated with climate extremes. A recent example is the timely appeal by a number of nations in the Greater Horn of Africa for donor intervention in the wake of the impending drought. Some countries waived duty on certain commodities to allow for sufficient importation.

The users also put in place actions that assist in reducing the impacts of extreme events. Workshops are organized at the grassroots level to educate the end users on strategies to adopt. An illustrative example is the case of Kenya Breweries, which made a profit of Kenya Shillings 130 million, or approximately US$2 million, on account of having judiciously used the forecast for July to September 1999.

Use of Triggers

The media is a very important avenue of disseminating information to the end users. It was on this basis that the 4th Climate Outlook Forum for the Greater Horn of Africa, held in September 1999, addressed the theme, "The role of the media in disseminating climate information." The users who attend such fora and subsequent national workshops determine potential impacts of the outlook for diverse socioeconomic sectors of the economy.

Status of Delivery Systems

The DMC products are disseminated through the following modes:

- high-frequency radio facsimile broadcasting,
- the meteorological data distribution (MDD) system,
- ordinary mail through the post office,
- ordinary fax, and
- the Internet on the DMC website.

After the inception of the climate outlook fora, additional approaches have been adopted to disseminate climate information to users. Immediately following the conclusion of the fora, the national meteorological services are given the task of organizing national workshops to disseminate the forecast information to the end users. It is in these workshops that details at the national level are included in the forecast information. The DMCN also posts the forecast information on its website immediately after the fora. The users who attend the fora normally formulate effective ways of disseminating the forecast information to the very grassroots level. In some cases, translation of the information into local languages has been adopted to ensure that it reaches as wide an audience as possible.

Major roles played by users include giving feedback to climate scientists during the users' capacity-building workshops. The feedback covers various issues aimed at increasing the quality of climate outlook products. Users emphasize what needs to be included in the climate outlook products to add value and make them more useful. They also emphasize the importance of providing climate outlooks in a simple and easily understandable language to enable end users to use it more effectively. For example, users have always stressed that expected rainfall amounts need to be included in the climate outlook products.

Constraints or Limitations of Current Systems

Data quality is not a major constraint as far as the current monitoring is concerned. The data used normally comes from synoptic stations, which are manned by well-trained meteorological personnel. However, before the data is used in any drought-related products, the spatial and temporal consistency of the data is ascertained. Any doubtful values are referred back to the source for verification. Station density is a problem, especially in the low potential rainfall areas, but the use of remotely sensed data supplements the data sparsity in such areas. Lack of a reliable and efficient communication system for data and products exchange was a major problem at the inception of the DMCs. However, this has greatly improved with the installation of Internet and e-mail services in most meteorological services of the subregion. In some countries, the interaction between the producers and users of climate information is still limited. This is a serious impediment to the dissemination and use of climate information, but the gap is being gradually closed through the users' workshops during the climate outlook fora.

Future Needs

- There is a need to increase the number of stations, especially in the marginal areas of the subregion. The use of remotely sensed data is being encouraged to supplement the conventional data.
- Users have proposed ways of packaging information for easier comprehension and dissemination. Some of these proposals have already been implemented. The interaction between the users and climate scientists, however, should be strengthened to facilitate effective implementation of some of these recommendations.
- There are initiatives to explore other modes of delivering climate information. The use of radio networks is being encouraged. The African Learning Channel is also another avenue of disseminating early warning information.
- Only a limited number of users have benefited from the users' capacity-building workshops that have been conducted so far. There is a need to train more users on the use of climate information. This will be achieved through national workshops that are planned within the current DMCN project. In addition, pilot application projects that are meant to demonstrate the value of using climate information are in the process of being implemented.

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