DROUGHT MONITORING AND PREDICTION FOR DISASTER PREPAREDNESS

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ABSTRACT

The overall theme of the forum is to address the roles of science and technology in natural disaster reduction. This review will be devoted to drought early warning and preparedness. The review will highlight, among others, what we must know in order to reduce the impacts of droughts; the current state, achievements and limitations of science and technology; and a way forward into the next century. The first part addresses the various definitions that have been used for the term drought. The devastating socio-economic impacts of droughts are highlighted in the second section, with special reference to Africa where drought has been associated with many socio-economic miseries. Section 2 also highlights the potential use of drought monitoring and prediction products in early warning and reduction of the negative drought impacts.

Recent drought monitoring and prediction efforts are addressed in section three, with special reference to the use of El Niño and the Southern Oscillation (ENSO). Section 3 further highlights the need to take full advantage of any existing information regarding the climatology of past droughts. This requires policies that will ensure optimum utilization of any positive water stress including the availability of adequate water resources during the normal and wet rainfall years in planning for the drought years.

Specific success stories regarding the use of ENSO indicators in drought monitoring and prediction over some parts of the tropics are also presented in section 3, with special reference to the recent worldwide regional climate outlook fora. The last part of this review is, however, devoted to the limitations of current drought monitoring and prediction science and technology. Enhanced sectoral demands and challenges of drought monitoring/prediction science and technology in drought early warning and disaster preparedness during the next century are also addressed in the last part of the review.

1. DROUGHT DEFINITIONS

Drought is quite different from many other natural disasters, as unlike many others that have immediate impacts such as flash floods, drought creeps very slowly and the impacts are cumulative. Yet the impacts are sometimes more devastating (Table 1). It is, moreover, sometimes very difficult to accurately detect the onset of droughts, and some relief efforts often wait for the first victims before initiating relief emergencies. In general terms, drought may be considered as the situation where water demand for any particular system use significantly exceeds water supply from the traditional water sources for the system. Due to significant differences in the levels of water requirements by the different water use systems, various definitions have been presented for the term drought. These definitions range across hydrological, agricultural, meteorological and many other sectoral water uses (Ogallo, 1993). Precipitation is the major factor that often determines water availability from most natural sources of water, including water that may be available from underground aquifers, rivers, lakes, etc. Meteorological drought is, therefore, often presented simply as the situation when precipitation received at any location is significantly below the normal expectation for that specific location. Various measures of central tendency have been used to quantify the normal precipitation expectation at specific locations. These have included arithmetic mean, quartile / tercile / decile / percentile limits, among many other measures.

Too much and too little precipitation (floods and droughts) are often associated with various socio-economic disasters. Some of these impacts are highlighted in the second part of this review.

Table 1. Effects of the 1982-83 ENSO (NOAA, Published by the New York Times, 2 August 1983)

Location	*Phenomenon*	*Victims*	*Damage in US $*
United States			
Mountain and Pacific States	storms	45 dead	1.1 billion
Gulf States	flooding	50 dead	1.2 billion
Hawaii	hurricane	1 dead	230 million
Northeastern US	storms	6 dead	–
Cuba	flooding	15 dead	170 million
Mexico- Central America	drought	–	600 million
Ecuador-Northern Peru	flooding	600 dead	650 million
Southern Peru-Western Bolivia	drought	–	240 million
Southern Brazil- Northern Argentina, Eastern Paraguay	flooding	170 dead, 600 000 evacuated	3 billion
Bolivia	flooding	50 dead, 26 000 homeless	300 million
Tahiti	hurricane	1 dead	50 million
Australia	drought, fires	71 dead, 8 000 homeless	2.5 billion
Indonesia	drought	340 dead	500 million
Philippines	drought	–	450 million
South China	wet weather	600 dead	600 million
Southern India, Sri Lanka	drought	–	150 million
Middle East, chiefly Lebanon	cold, snow	65 dead	50 million
Southern Africa	drought	Disease, starvation	1 billion
Iberian Peninsula, Northern Africa	drought	–	200 million
Western Europe	flooding	25 dead	200 million

2. RECURRENCE OF DROUGHTS AND THE ASSOCIATED SOCIO-ECONOMIC IMPACTS OF DROUGHTS

Recurrences of extreme precipitation anomalies leading to the availability of too much or too little water are normal components of natural climate variability, as can be observed over many parts of the world. Year-to-year anomalies in regional precipitation have been associated with anomalies in the systems that control regional precipitation, including sea surface temperature [SST] anomalies, ENSO signals, etc. Some examples of the extreme anomalies which have been observed in past regional precipitation patterns will be reviewed in this section.

Past recurrences of too much or too little water have often been associated with far-reaching socio-economic and environmental implications. The adverse impacts of droughts and floods often include loss of life and property, mass migration of people and animals, environmental refugees, shortages of food, energy, water and many other basic needs of mankind. They have also been associated with environmental degradation, and a drop in gross value production for most precipitation dependent national domestic sectors, among many other environmental and socio-economic disasters. The degree of vulnerability to such natural disasters has, however, been highest in the developing countries, especially in Africa where droughts and floods have often been associated with severe socio-economic havoc in many countries.

In advanced countries, reduction in the degree of vulnerability of society to natural disasters like floods and droughts has been achieved not only through applications of advanced science and technology, but also through optimum use of available records in risk zoning over a given time and the development of realistic disaster preparedness policies, which include trying to give early warning of such natural disasters through monitoring and prediction efforts. The current state of science and technology cannot, however, adequately meet the unique demands of many users, among the questions asked are: how much rainfall will be received during the next season ? when will it start and end ? what will be the distribution of the dry and wet spells ?

3. DROUGHT MONITORING AND PREDICTION

Historical records are crucial in the zoning of drought risks and the general assessment of the vulnerability of any precipitation dependent socio-economic activity to various levels of drought stress. Such records are also needed in order to study the complex linkages between water stress and specific socio-economic activities. Furthermore, historical records can provide information about past droughts and how previous generations coped with them. Important lessons could be learnt from such coping strategies. It should also be noted that past data are fundamental in the development of sound disaster preparedness policies. Several databases are now available, these include re-analysis data, proxy climate data, data obtained from special research programmes (e.g., TOGA in 1985-94) and remote sensing data. The importance of real-time/ near real-time monitoring of the drought conditions will also be highlighted in this section, including initiatives by WWW, GCOS, GOOS, GTOS, etc.

Past records have shown that droughts are recurrent in all parts of the world The drought impacts, however, vary significantly in both space and time. In some years, new drought stress records have been set. The most unique drought has, however, been observed over Sahel Africa where a significant decrease in rainfall trends has been observed at many locations since the late 1960s. The region has strong SST and ENSO variability signals. Linkages between ENSO and droughts have been subjects of many recent studies. Many such studies have also examined the existence of any significant changes in the traditional space-time patterns of the extreme precipitation events like droughts and floods (IPCC, 1995).

As has been highlighted in the previous sections, drought creeps in slowly and the impacts are generally cumulative. Therefore, the best approach to drought disaster preparedness would be through monitoring and early warning of any impending drought conditions This would require timely availability of accurate and high-quality drought products. The last part of the review will address the current state of drought monitoring and prediction science and technology, with special reference to the recent use of ENSO and SST-related predictors over parts of global tropics. Some success stories regarding drought early warning will also be included in the review based on the recent worldwide climate outlook fora which have been organized by WMO/CLIPS, IRI, NOAA/OGP, national/regional climate centres, together with many other partners.

4. SECTORAL DEMANDS AND CHALLENGES OF DROUGHT MONITORING/ PREDICTION SCIENCE AND TECHNOLOGY IN THE NEXT CENTURY

With the economic challenges of the next century, including globalization, together with the rapid growth in global population levels, increased number of human settlements and expensive investments and structures would be expected in areas that are more vulnerable to natural disasters. The level of environmental degradation is also expected to increase, together with the demands for basic needs like food, water, settlement, energy, etc. This will require enhanced and integrated applications of climate information and prediction services. Key challenges to drought early warning in the next century will be highlighted in the final part of this review, including the required levels operational of seasonal climate prediction science and technology. Such challenges include data related problems, the capacity of the developing countries (hardware, software, and skilled multidisciplinary human resources) to monitor, process data/information and timely predict/early warning of the impending disasters, research to understand the complex linkages between water stress and various precipitation dependent socio-economic sectors, transfer of appropriate technology, enhanced seasonal prediction capacity including the ability to downscale prediction products to sectoral application levels, the education of the public and sectoral users about early warning information and products, networking and timely exchange of information/products, closer interface between producers of climate prediction products and the specific sectoral users, realistic and integrated disaster preparedness policies, availability of resources, etc.

REFERENCES

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