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Drought Hazards and Mitigation Measures

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1. INTRODUCTION

Droughts are manifestations of significant shortages in all domains of the water cycle. They have adverse impacts on the environment, water availability and water quality, water supply system, hydropower generation, navigation, groundwater balances, vegetation cover, agricultural production, etc. of the affected region. Drought is a regular part of natural cycles and single-most weather related natural disaster affecting livelihoods, developmental activities, natural resources (water, soil, and biodiversity) and economy of a country (http://en.wikipedia.org/wiki/Drought). Although droughts may persist for several years, even a short, intense drought can cause significant damage and severely affect local economy. This global phenomenon has a widespread impact on agriculture. Indeed drought is one of the most serious problems arising from climate variability for human societies and ecosystems (Yurekli and Kurune, 2006). The occurrence of droughts is not limited to a particular region. It has been observed that their impact has been completely different in developed and developing nations because of several socio-economic and political factors influencing both behavioral and management patterns. Even within the developing countries, the effects of droughts can vary significantly, but the fact remains that the economically weaker countries or groups in a country are most severely affected by the droughts.

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007), many parts of the developing world are very likely to warm during this century. South Asia is likely to experience extreme climatic events associated with climate change, such as increasing severity and frequency of floods and droughts, and the length of growing season and yield potential of crops is expected to decrease in areas suitable for agriculture, particularly along the margins of semi-arid and arid areas which are already drought prone. India may experience a rise of temperature of 1°C by the year 2050 (IPCC, 2007; Sivakumar, 2008). By the end of the century, there will be a change in precipitation by 5-25% over India with more reductions in the winter rainfall than the summer leading to droughts during summer months (Lal et al., 2001; Prabhakar and Shaw, 2008).

Drought has been a recurring feature of Indian agriculture. Major parts of India having the probability of three to four-year drought in a ten-year period in which, there is again a probability of getting one or two years moderate and half year to one year severe drought. Due to the variability of climate in recent past, more intense and longer droughts have been observed in wider areas since 1970, particularly in the tropics and subtropics. The rainfed regions encompassing arid, semi-arid and dry sub-humid regions (covering regions having rainfall less than 1150 to 1200 mm) are more prone to climatic variability and drought (Ramakrishna et al., 2007). Rainfed agriculture is practiced in 90 Mha accounting 60% of cultivated area and contributes 44% foodgrain production contributing 91, 91, 80, and 60% of coarse

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cereals, pulses, oilseeds and cotton, respectively. Besides this, 66% of livestock population is also dependent on rainfed areas. Even with the completion of envisaged river linkage project covering various parts of India, it is estimated that 50% would still remain rainfed (Vittal et al., 2006). On the top of it, the projected changes in temperature and precipitation due to climatic variability will further aggravate the water scarcity problem in already suffering rainfed regions (Lal et al., 2001; Prabhakar and Shaw, 2008). These issues call for concerted efforts in addressing the drought as an opportunity, rather than as a national calamity. A general belief about natural disasters like drought is that they are inevitable, unavoidable and unmanageable. A change in this attitude following a scientific approach would help in mitigating the effects of drought.

This chapter presents, besides the basics of droughts, the impacts of drought and the management of agricultural drought in various agricultural drought regions of India with an emphasis on drought coping practices in season and drought amelioration on a permanent basis. It also addresses issues concerning meteorological and hydrological droughts, for example, efficient rainwater management, conservation of soil moisture, crop and contingency planning, etc. Along with the existing policies and support systems, new approaches or programs to combat droughts in the drought-prone regions are also discussed.

2. DEFINITION OF DROUGHT AND DROUGHT TYPES

Drought is a climatic anomaly, characterized by deficient supply of moisture resulting either from sub-normal rainfall, erratic rainfall distribution, higher water need or a combination of all the three factors. In general, drought means different things to different people. To a meteorologist it is the absence of rain, while to the agriculturist it is the deficiency of soil moisture in the crop root zone to support crop growth and productivity. To the hydrologist, it is the lowering of water levels in lakes, reservoirs, etc., while for the city management it may mean the shortage of drinking water availability. Thus, it is unrealistic to expect a universal definition of drought for all the fields (saarc-sdmc.nic.in).

There are several definitions of drought given by various experts (Thronthwaite, 1948; Ramdas, 1960; Van Bavel, 1953; Palmer, 1965). However there is no universally accepted definition of the term. Drought is a multifaceted concept, which defies attempts at precise and objective domain. Most drought definitions are based on meteorological observations, agricultural problems, hydrological conditions and socio-economic considerations (Sharma et al., 2006). Schneider (1996) defined drought as an extended period—a season, a year or several years of deficient rainfall relative to the statistical multiplayer mean for a region. Dracup et al. (1980) considered four variables to define drought appropriately: (i) nature of the water deficit, precipitation, soil moisture or stream flow; (ii) basic time unit of the data, e.g., month, season or year; (iii) truncation which distinguishes low flows from normal/high flows, e.g., mean, median, mode or other derived threshold value; and (iv) regionalization and/or standardization. Thronthwaite (1948) described four types of droughts as *permanent*, *seasonal*, *contingent* and *invisible*. In India, the definition given for meteorological drought by the India Meteorological Department (IMD) is most widely used by Central and State Governments.

It is worth mentioning that drought is different from *famine* and *desertification* in respect of occurrence, duration, types/kinds and extent and impact. According to the Encyclopedia Britannica, "famine is severe and prolonged hunger in a substantial proportion of the population of a region or country, resulting in widespread and acute malnutrition and death by starvation and disease". Famines usually last for a limited time, ranging from a few months to a few years. They cannot continue indefinitely, if for no other reason than that the affected population would eventually be decimated. On the other hand, "desertification is land degradation in the arid, semi-arid and dry sub-humid regions resulting from various factors, including climatic variations and human activities" (UNCCD, 1995). One of the most important reasons