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Drought Management in India

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Abstract

Droughts are one of the major constraints to crop production and food security worldwide. The situation has aggravated due to the drastic and rapid changes in global climate. Heat and drought are undoubtedly the two most important stresses having huge impact on growth and productivity of the crops. A wide range of plant responses to these stresses could be generalized into morphological, physiological, and biochemical responses. Interestingly, this review provides a detailed account of plant responses to heat and drought stresses with special focus on highlighting the commonalities and differences. Crop growth and yields are negatively affected by sub-optimal water supply and abnormal temperatures due to physical damages, physiological disruptions, and biochemical changes. A holistic approach taking into account the different management options to deal with heat and drought stress simultaneously could be a win-win approach in future.

Introduction

Drought is a subtle, insidious natural hazard that is a normal part of the climate of virtually all regions of the world. Its occurrence results in a myriad of economic, social, and environmental impacts in developed as well as developing nations, although the characteristics of its impacts differ considerably between the two settings. Drought is considered by many to be the most complex but least understood of all natural hazards, affecting more people than any other. It is a normal feature of climate and its recurrence is inevitable. However, there remains much confusion about its characteristics. It is precisely this confusion that explains, to some extent, the lack of emphasis on proactive drought management efforts in most parts of the world. Through an improved understanding of the inevitability and characteristics of drought, as well as its differences from other natural hazards, scientists, policymakers, and the public will be better equipped to establish much-needed policies and plans whereby future vulnerability to drought can be reduced. However the cost implication on drought management is not that easy to work out worldwide.

Drought as A Natural Hazard

Drought differs from other natural hazards in several ways. First, drought is a slow-onset, creeping natural hazard. Its effects often accumulate slowly over a considerable period of time and may linger for years after the termination of the drought event. Second, the absence of a precise and universally accepted definition of drought adds to the confusion whether a drought exists and, if it does, its degree of severity. Third, the impacts of drought during the Dust Bowl of the 1930's, nearly two-thirds of the U.S. land area experienced severe to extreme drought conditions. This ruined farm is buried under layers of dirt and sand blown

across the landscape. Droughts are non-structural and typically are spread over a larger geographical area than are damages resulting from other natural hazards. These characteristics of drought have hindered the development of accurate, reliable, and timely estimates of severity and impacts and, ultimately, the formulation of effective drought preparedness plans.

Types of Drought

Drought is normally grouped by type: meteorological, hydrological, agricultural, and socioeconomic. The impacts associated with drought usually take 3 months or more to develop, but this time period can vary considerably, depending on the timing of the initiation of the precipitation deficiency.

Meteorological Drought

Meteorological drought is expressed solely on the basis of the degree of dryness in comparison to some normal or average amount and the duration of the dry period. Thus, intensity and duration are the key characteristics of this type of drought.

Agricultural Drought

Agriculture is usually the first economic sector to be affected by drought because soil moisture content is often quickly depleted, especially if the period of moisture deficiency is associated with high temperatures and windy conditions. Agricultural drought links various characteristics of meteorological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, and soil water deficits. A thorough definition of agricultural drought should account for the variable susceptibility of crops at different stages of development.

Hydrological Drought

Hydrological droughts are associated with the effects of periods of precipitation shortfall on surface or subsurface water supply (for example, stream flow, reservoir and lake levels, and groundwater) rather than with precipitation shortfalls. Hydrological droughts usually lag the occurrence of meteorological and agricultural droughts because more time elapses before precipitation deficiencies are detected in reservoirs, groundwater, and other components of the hydrologic system. As a result, impacts of hydrological drought are out of phase with impacts of other drought types. Also, water in hydrological storage systems such as reservoirs, rivers, and groundwater often is used for multiple and competing purposes, further complicating the sequence and quantification of impacts. Water uses affected by drought can include purposes as varied as power generation, flood control, irrigation, drinking water, industry, and recreation.

Socio-Economic Drought

Socio-economic drought associates the supply and demand of some economic good or service with elements of meteorological, hydrological, and agricultural drought. In socioeconomic drought, deficiencies of precipitation are linked directly to the supply of some commodity or economic good (for example, water, hay, or hydroelectric power). Increases in population can alter substantially the demand for these economic goods over time. The incidence of socioeconomic drought can increase because of a change in the frequency of meteorological drought, a change in societal vulnerability to water shortages, or both. For example, poor land-use practices such as overgrazing can decrease animal carrying capacity and increase soil erosion, which exacerbates the impacts of, and vulnerability to, future droughts.

The Impacts of Drought

The impacts of drought are diverse and often ripple through the economy. Thus, impacts are often referred to as either direct or indirect. A loss of yield resulting from drought is a direct or first-order impact of drought. The climate trends and global crop production changes were reported by Lobell *et al.*, (2014). However, the consequences of that impact (for example, loss of income, farm foreclosures, and government relief programs) are secondary or even tertiary impacts. The impacts of drought appear to be increasing in both developing and developed countries, which in many cases reflects the persistence of no sustainable development and population growth. Lessening the impacts of future drought events will require nations to pursue development of drought policies that emphasize a wide range of risk management techniques, including improved monitoring and early warning systems, preparedness plans, and appropriate mitigation actions and programs. The impacts of drought that must be addressed can be classified into one of three principal types: economic, environmental, and social.

Economic Losses

Economic impacts ranges from direct losses in the broad agricultural and agriculturally related sectors (including forestry and fishing), to losses in recreation, transportation, banking, and energy sectors. Other economic impacts would include added unemployment and loss of revenue to local, state, and federal government.

Environmental Impacts

Environmental losses include damages to plant and animal species, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; and soil erosion. These losses are difficult to quantify, but growing public awareness and concern for environmental quality has forced public officials to focus greater attention

on them.

Impacts on Society

Social impacts mainly involve public safety, health, conflicts between water users, and inequities in the distribution of impacts and disaster relief programs. As with all natural hazards, the economic impacts of drought are highly variable within and between economic sectors and geographic regions, producing a complex assortment of winners and losers with the occurrence of each disaster.

Drought Preparedness and Mitigation

Drought is considered by many people to be strictly a natural or physical event. This view of drought provides little, if any, opportunity to alter the impact of drought through the application of appropriate drought management techniques. In reality, drought has both physical and social components, and it is essential that water managers and decision makers understand. It is critical that the people inhabiting each geographic region understand their exposure to the drought hazard: for example, the probability of drought occurrence at various severity levels. However, the risks associated with drought for any region are products of both the region's exposure to the event and the vulnerability of its society to a drought at that point in time.

Vulnerability, unlike the natural event, is determined by varied social factors. Examples include: Population changes, Population shifts (region to region and rural to urban), Demographic characteristics, Environmental awareness (or lack thereof), Level of technology, Wisdom and applicability of government policies, Land management practices; and Social behaviour. These factors change over time and thus vulnerability is likely to increase or decrease in response to these changes. Subsequent droughts in the same region will have different effects, even if they are identical in intensity, duration, and spatial characteristics, because societal characteristics will have changed. However, much can be done to lessen societal vulnerability to drought through the development of preparedness plans that emphasize risk management and the adoption of appropriate mitigation actions and programs and various mitigation strategies were developed by IPCC, 2014.

Management Alternatives during Drought

Many of the management alternatives available to water suppliers to prepare for and respond to drought events fall into two broad categories:

demand management and supply augmentation.

Drought Management

Public information and education campaigns, Emergency conservation programs, Water service restrictions, Restrictions on nonessential uses of water, Prohibition of selected commercial uses, Drought emergency pricing, Water rationing programs, Augmentation, Improvements in water systems (for example, leak detection, lining of transmission canals), Emergency sources of supply (for example, emergency interconnections, drilling new wells), Management of available water resources (for example, emergency water banks, over drafting of groundwater aquifers) and Search for new supplies of water. Recent research studies focussed on inducing drought tolerance in various plants worldwide reported by Ashraf (2010).

Conclusion

In summary, increased emphasis can and should be placed on drought mitigation and preparedness, as well as prediction and early warning capabilities, if society is to reduce the economic and environmental damages associated with drought and its personal hardships. This will require interdisciplinary cooperation and a collaborative effort with policy makers at all levels.

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