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MANAGEMENT AND MITIGATION OF ADVERSE EFFECTS OF DROUGHT PHENOMENON

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Abstract *Drought is a complex and poorly understood natural hazard. Its impacts are far-reaching and may linger for months or even years beyond the termination of the event. The impact of drought results from complex interactions between physical and social systems. An understanding of the characteristics of drought and an appreciation of the magnitude of economic, social, and environmental impact must precede the establishment of a viable assessment and response strategy that will ultimately reduce our vulnerability to droughts.*

INTRODUCTION

Among the various hazards of nature, drought is one of the most disastrous because it brings innumerable miseries to mankind. Few areas of the world can boast of not having faced this calamity at one time or the other in their history.

Drought has also been blamed for prompting mass migrations, environmental degradation (often referred to as desensitisation), and internal unrest. While drought may have been an important factor in each of these processes, it often proves to have been but one of many intervening factors. While drought by itself may not appear to be a major cause of societal dislocation, it can combine with underlying societal problems to initiate new changes that are already under-way. Often the impacts of drought lingers long after a drought has ended, thereby dissociating the drought itself from many of its impacts. In the present paper an attempt has been made to ascertain haw application of weather and climate can effectively minimise the disastrous effect of drought.

DEFINING DROUGHT AND ITS ANALYSIS

The drought problem can be considered basically as problem of the management and use of limited water resources. It is essentially a 'supply' and 'demand' problem. Various interests have advanced their own definition of drought according to their specific requirements. Any definition which does not include a reference to water 'need' vis-à-vis 'demand' must be regarded as inadequate. An extensive survey of the definition of drought has been made by Hounam et al.(1975).

Meteorological drought over an area is defined as a situation when seasonal rainfall over the area is less than 75% of its long term normal. It is further classified as moderate drought, if the rainfall deficit is between 26% and 50% and 'severe drought' when it exceeds 50%.

Drought and famines have occurred in India during the past centuries and have even been mentioned in folk lores. No precise data of the same for those periods are, however, available. Since the establishment of Indian Meteorological Department in 1875 and the data availability, it has been possible to demarcate areas affected by droughts in each year.

Some typical cases of significant drought has been depicted in Fig. 1. The year 1918 appears to be the worst drought the country has even witnessed by way of area affected and rainfall departures (Chowdhury et al. 1989; Bhalme et al. 1987; Das, 1995). In terms of area affected this is followed by 1899, 1877, 1987 and 1972 in that order. The average rainfall over plains of India is 105 cm, while Mooley and Parthasarathy (1982) and Thapliyal (1990) considered it to be 85.3 and 87.2 cm, respectively.

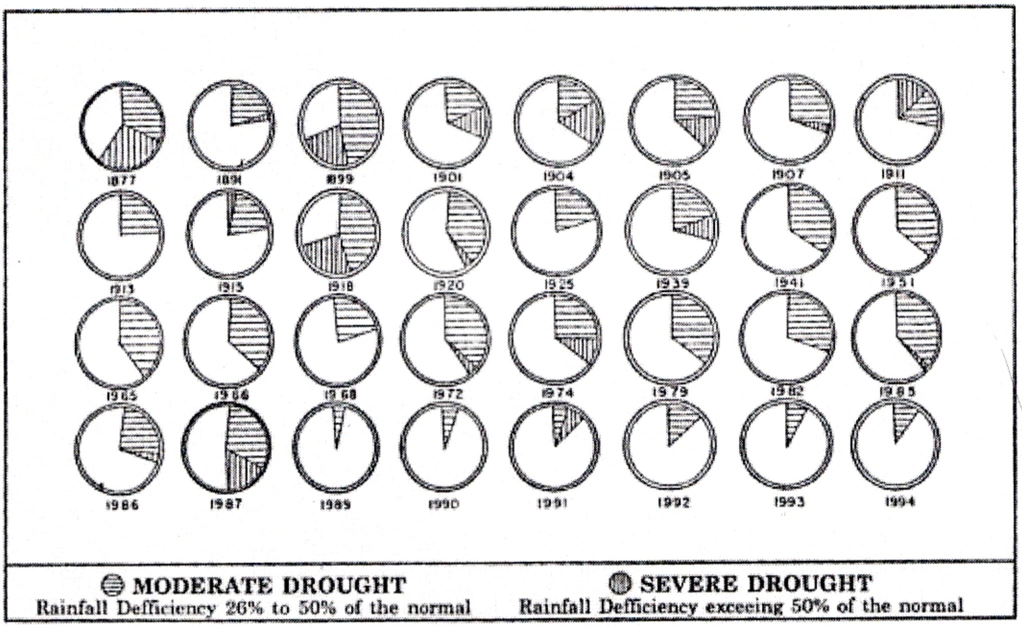

Fig. 1 Drought years in India with percentage of the area affected since 1875.

From analysis of rainfall departures during monsoon season, it was possible to demarcate areas of different degrees of drought. Moderate drought is defined as areas having seasonal rainfall deficiency between 26% to 50% of the normal and severe drought when the deficiency exceeds 50%. Percentage frequencies of occasions in each class were analysed and these are shown in Fig. 2(a) and 2(b).

An analysis has also been made classifying 'drought areas' as those which receive annual rainfall deficiency of 25% or more on 20% occasions. The areas which receive rainfall deficiency of 25% or more on more than 40% occasions represent 'chronically drought affected areas'. These are shown in Figs. 3(a) and 3(b).

MANAGEMENT OF DROUGHT

It is important to note that drought does not descend all of a sudden. It results from a set of weather sequences that require extended period to develop. Thus it takes a good period of time for a drought situation to begin, expand and decay. This allows us some time to adopt contingent plans to reduce the adverse effects of drought. Associated human misery underscore our vulnerability to this natural hazard and make it imperative to improve our knowledge of nature and causes of drought and to innovate strategies for reducing its

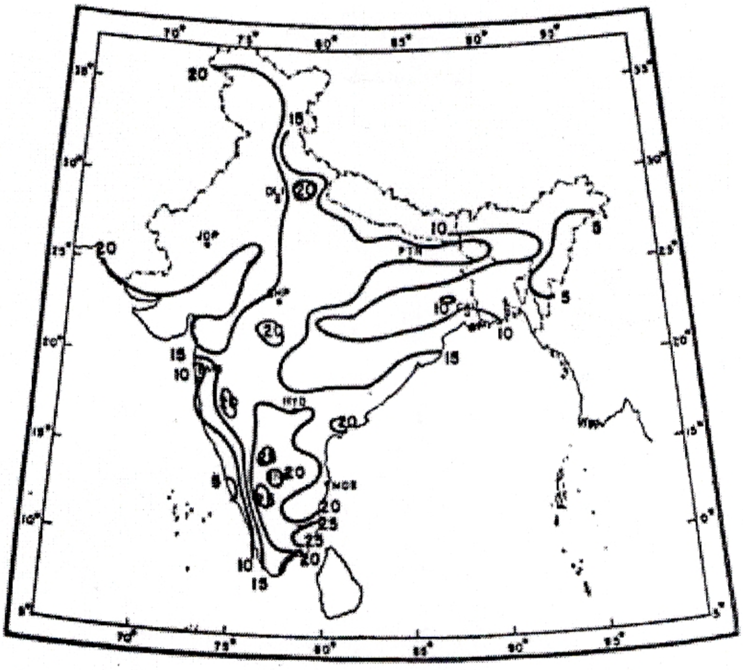

Fig. 2(a) Moderate drought indicated by monsoon rainfall departure (between -26% and -50%) on 20% occasions (isopleths - % occasions).

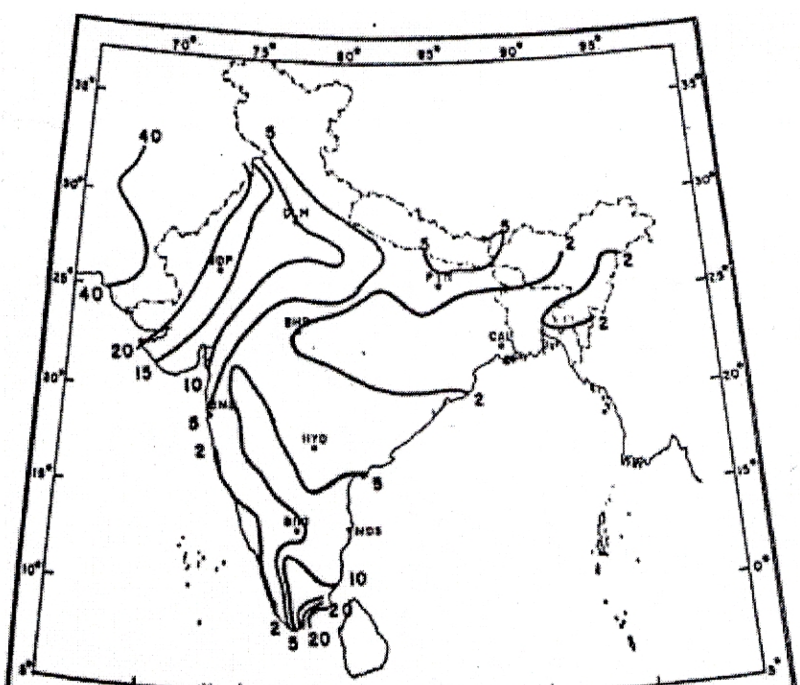

Fig. 2(b) Severe drought (departure > 50%) on 20% occasions.

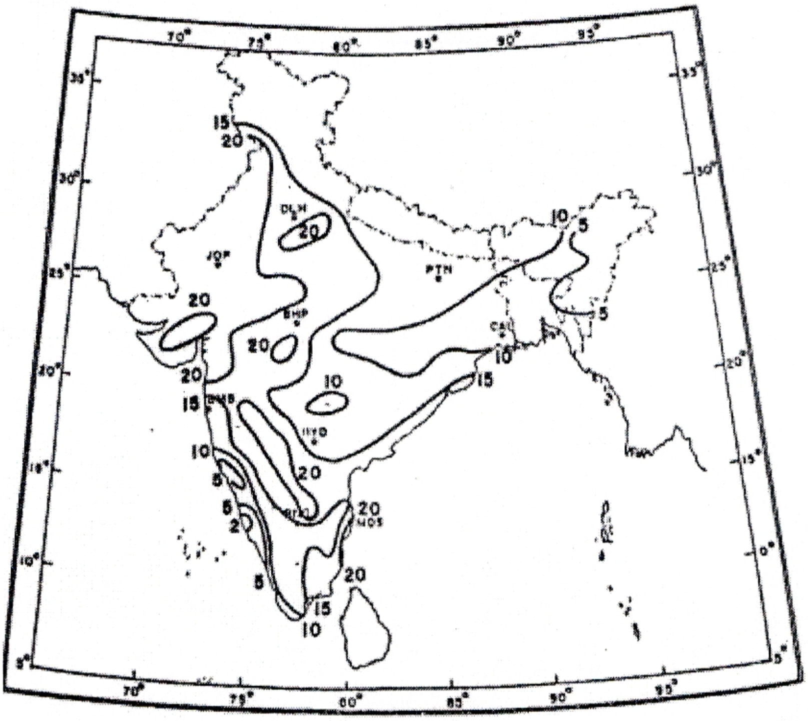

Fig. 3(a) Drought areas (departure > 25%) on 20% occasions.

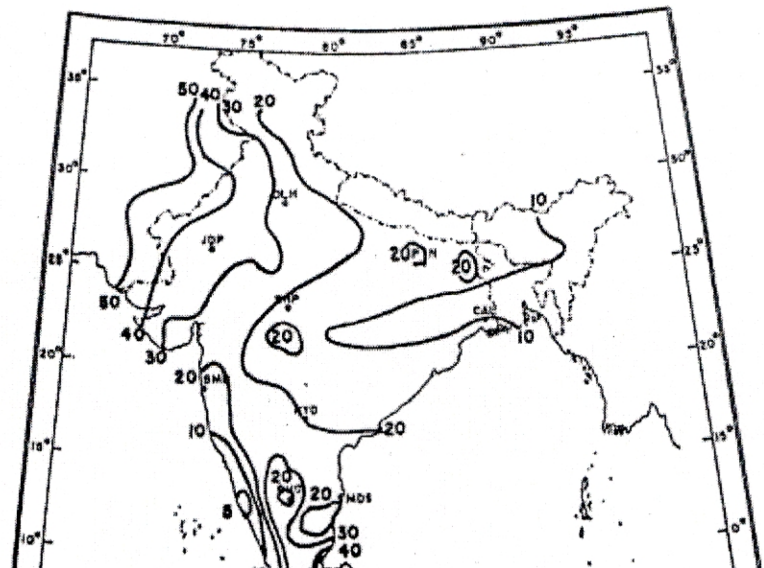

Fig. 3(b) Chronically drought affected areas (departure > 25%) on 40% occasions.

adverse impacts. There are two distinct phases in which the application of the knowledge of weather and climate can reduce the impact of drought on the communities. The first is the long term planning in which strategies can be devised, and precautions taken to reduce impact. The second phase is the action which is taken during the onset of the event to reduce adverse effects.

In arid, semi-arid and marginal areas with a probability of drought incidence of say, at least once in ten years, it is important for those responsible for planning of land use, including agricultural programmes, to seek expert climatological advice regarding rainfall expectations. Drought is the result of the interaction of human pattern of land use and the rainfall regimes. There is thus urgent need for a detailed examination of rainfall records of these regions. In this regard, the development of methods of predicting many weeks/months in advance the occurrence of rainfall deserves high priority.

Since the technological inputs quickly reach to an optimum level, more emphasis should be placed on the drought management policies i.e., land and water management to minimise the flood grain loss. This is specially important in dry-land farming areas. The agricultural planning and practices need to be worked out with consideration of the overall water requirement within the individual agroclimatic zones. Crops which need shorter duration to get matured and require less water need to be encouraged in the drought prone areas. Irrigation through canals and ground water resources need to be monitored with optimum utilization avoiding soil salinity and excessive evaporation loss. Food reserve to meet the emergency of maximum up to two consecutive droughts and about 2 to 3 drought per decade must be planned. A variety of policy decisions on farming, human migration, population dynamics, livestock survival, ecology, etc. must be formulated. Detailed investigations need to be carried out to evaluate the impact of adaptation and adjustment mechanisms on the economic benefits and employment opportunities and to identify priorities for development.

Statistical models are required relating food grains productions in different sub-divisions with the corresponding monsoon rainfall. In a recent study by Chowdhury and Das (1993), the correlation between all India summer monsoon rainfall data and annual food grain production is found to be 0.74 which is significant at 0.1% level. A common assumption is that higher levels of economic growth will automatically result in lower rates of growth of population. However, the population problem is important enough to warrant more direct policies, particularly recent scientific advances in methods of birth control. Better education about family planning and general improvement in the status of women throughout the world are required to ensure success.

There is also a need to have a Drought Watch System at district and state levels which would comprise experts in meteorology, agriculture, irrigation, public health, food supplies, etc. The prerequisite for the operation of such a drought watch system are:

- A network of rainfall stations, with reliable records of good quality, are homogeneous and extend over a period of at least 20 years and preferably more than 50 years;
- Weekly / monthly rainfall records are in computer compatible fore;
- Weekly /monthly rainfall totals are available at the drought watch centres within two or three days at the end of the week/month;
- The drought watch centres have the capability of issuing weekly/monthly drought watch statements whenever rainfall situation demands.

Drought planners should also take steps to plan for the possibility of climatic change. They must plan for the change, since they are already considering changes in population and technology that well affect the demand. To address climatic uncertainty, drought planners should assess the sensitivity of water resource systems to climatic change. One could conduct a simple analysis by examining for example how a 2oC or 4oC increase in temperature and a 10% increase or decrease in rainfall affects a system's vulnerability to drought. Alternatively, one could use more sophisticated scenario based on climate models. The sensitivity of the system to these kinds of changes could be compared to the impacts of other factors such as population growth and technological change. Drought planners in sensitive regions can take steps to improve the ability of water resource systems to recover from drought. Some important steps that can be taken are described below.

Water Conservation Promotion

Water conservation can be encouraged by reducing or eliminating wastages. Agriculture is the greatest user of water in the country and has the greatest potential of conservation.

System Optimisation

Better use of existing infrastructure would reduce vulnerability to regional droughts. Water resource managers should explore ways to transfer water between neighbouring systems during droughts.

Water Quality Protection

Water pollution, control and abatement programs can increase the amount of water available for consumption during droughts. States and river basins should have comprehensive drought contingency plans that will reduce the impacts of drought quickly. Such as automatic short-term water rationing. All of these measures would have benefits even if climate does or does not change.

MITIGATION OF DROUGHT

Drought is recurring phenomena and its occurrence cannot be avoided. However, its impact can be minimised through application of science and technology in developing suitable drought management plans. Generally, there are always some may be reeling under drought. Therefore, there is a need to develop infrastructure for mitigation of drought.

People of India form ancient times, have been concerned about the occurrence of this calamity. The governments from the historical past to the present, have tried methods to combat the drought situation of the people and reduce losses to the country's economy. These measures were restricted to the reduction/waiver of the land revenue, distribution of free food from the government stock/granaries, provision of employment to the poor, marginal agriculturists and landless labour force to provide purchasing power, migration of labour from the part of the country under drought to another part where rains are not too bad and food and employment are available, digging of water reservoirs in the form of tanks, wells and canals to provide irrigation facilities to avoid/reduce drought impact in future events, etc. The government has also initiated the policy of maintaining adequate food reserves. Grain storage facility has been improved and enhanced and a network of fair-price shops have been established in different parts of the country under public distribution system. This has helped to instil confidence in the people and avoid panic purchase by the affluent section of the society. Agricultural research and other inputs like, the use of fertilizers, provision of power for tapping underground resources for irrigation and additional irrigation resources have also contributed to the 'green revolution' in the country. Different types of 'food for work' programmes have been initiated by the central and state governments to augment purchasing power to the poor. Loans granted under the Land Improvements Act have stimulated the consturction of wells and other minor irrigation works.

Attempts to reduce drought resistance by various pre-sowing hardening treatments of seeds such as pre-sowing exposure to radiation, are being made. Attempts have also been made to evolve drought resistant cultivars and shorter duration crop varieties. Agronomic practices are developed so that the active growth of the crop when water demand is more does not coincide with rainless period. The meteorological community has also been contributing its experience in the following manner:

(a) Provision of improved long-range forecast of the seasonal rainfall before the beginning of the season. This provides time to the planners to adopt different strategies;
(b) Close monitoring of the rainfall over different parts of the country on daily, weekly and monthly scales within the rainy season;
(c) Delineation of different agro-climatological zones which helps in specific measures for agricultural planning on climatological basis;
(d) Continued research efforts to enhance our capabilities of forecasting monsoon rain over local, regional and all India basis on different temporal scales.

What we need today is change over from traditional farming methods of more modern dynamic, flexible practices, making greater use of modern technology. This is necessary if farmers are to respond rapidly to changing demand to agricultural produce, replacing and adjusting varieties, crops and technologies to cope with new situations. What is needed is that the farmer is actually able to apply the new technologies. This calls for intensive training for all those connected with agricultural production and planning. An efficient agrometorological training service consisting of professional scientists of high calibre is needed. This entails advanced level of training both in theory and practice.

Intensive training courses in practical observations on meteorological crop characteristics must be imparted. Training in rural areas is however, fraught with problems when compared with urban centres. The biggest problem is the geographical dispersion of the Indian population which impedes information on technological developments from getting through. The India Meteorological Department conducts a number of courses for the benefit of agricultural scientists in agrometeorology on a regular basis. A number of agricultural universities in India have syllabi of agricultural meteorological in which all aspects of agriculture, including drought are covered.

DROUGHT AND HUMAN HEALTH

In order to minimise the deleterious effects on human population due to drought, disaster preparedness and mitigation measures should be pre-planned integrating the nutrition and undertaken adequately and energetically. Such measures are listed below.

(a) Dietary survey and nutritional surveillance studies of the vulnerable population in the drought prone data. This will give base line and comparative data for future use.
(b) The above mentioned nutrition programmes should function in the states with nutrition officer of the state health services as their Technical Adviser.
(c) The Health and Nutrition officers should actively associate themselves with 'Crop Weather Watch Group' or 'Drought Monitoring Watch Group'.
(d) Training should be imparted in

- Diet and nutrition survey techniques.
- Organising, maintaining and supervising supplementary feeding centres.
- Supply of safe and portable drinking water, environment sanitation and personal hygiene.

When an area is declared as drought-stricken, the following mitigation measures should be undertaken immediately:

(a) Dietary survey should be carried out with special reference to consumption of food grains.
(b) Nutritional status survey should again be undertaken using the base line data for comparison, with a view to identifying cases of protein deficiency, energy malnutrition and Vitamin A and B Complex deficiency.
(c) Issue of pulses in 'special food for work programme' in the drought affected areas.
(d) Disinfection of existing drinking water sources susceptible to infections, particularly water-borne diseases such as gastroenteritis, dysentery, cholera, etc. should be done regularly through bleaching powder or Cl_2 tables.
(e) Safe and potable water is a precious commodity especially in drought affected areas and it should be transported to the remote villages and tribal areas by railways to the nearest rail heads and subsequently by tankers to the affected areas.
(f) Active community participation in the nutrition programmes should be encouraged.

RESEARCH

The Indian monsoon rainfall is stable on long term basis and drought occurs rather randomly. Thus although occurrence of a minor or major drought is a characteristics inherent feature of monsoon rainfall, there is no definite pattern for the increased frequency on the long term basis.

Though much work has been done in understanding genesis of droughts in India, research is needed in operation of the drought monitoring and mitigation system such programmes should be directed to locally relevant problems in addition to those of academic and general nature. The following could be some of the programmes that would be relevant to the regions:

- Studies on wet and dry spells using appropriate threshold values for determining suitable cropping pattern.
- Water balance studies.
- Agroclimatic zoning using various agrelimatic factors and indices.
- Developments of locations specific models for various crop physiological phases and environmental conditions.
- Micrometeorological features of various cropping systems.
- Medium range weather forecasting for smaller areas.
- Long range forecast for advance planning and for evolution of policies.

Pervasive societal ramification associated with drought often gets aggravated by human actions. Much work remains to be done on the economical consequences of drought on the society. Econometrics models of crop production should be developed and linked explicitly on the physical resources as well as to economic variables such as prices. New methods are needed to understand dynamic adjustment processes in economics. This is necessary to understand how climate affects agricultural production. The process by which agriculture contributes to net emissions of greenhouse gases and thereby hastens the global climatic change health effects are also required for evaluating the benefits of differential policies that affect climate change.

CONCLUSIONS

Drought is a complex and poorly understood natural hazard. Its impacts are far-reaching and may linger for months or even years beyond the termination of the event. The impacts of drought result from complex interactions between physical and social systems. An understanding of the characteristics of drought and an appreciation of the magnitude of economic, social, and environmental impact must precede the establishment of a viable assessment and response strategy that will ultimately reduce the vulnerability to droughts.

Extensive research efforts on rainwater management over the last 25 years have emphasized a number of soil and water conservation techniques. The choice of the most appropriate practice depends mostly upon the regional rainfall characteristics (volume and distribution behaviour), soil properties (water intake and retention characteristics) and slope of the land. The key consideration, however, remains with 'to utilize maximum proportion of precipitation for the benefit of the area of its incidence and simultaneously encouraging the highest protection against erosion'.

Over the last several years it has been the central objective of the government to ensure stable crop yields through agricultural research and development programmes. Monsoon prediction on all time and space scales and early warning of the calamity like drought occurrence provide important inputs for making policy decisions or choices to combat drought situations. Early predictions can be used to prevent or lessen the effect of adverse weather conditions.

A variety of policy decisions such as farming decisions, water management decisions, human migration decisions, population dynamics decisions, livestock survival decisions, ecological change decisions etc. are to be formulated.

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