DROUGHT

INTRODUCTION

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 factors. The escalating impacts of droughts have increasingly drawn the attention of scientists, planners and society. The vulnerability to drought in relation to the increasing needs of the growing population has become a point of great concern, especially on the food front. In spite of the technological developments in providing improved crop varieties and better management practices, in India, agriculture has been considered a gamble as the agricultural productivity is strongly influenced by the vagaries of the monsoon.

Droughts are the resultant of acute water shortage due to lack of rains over extended periods of time affecting various human activities and lead to problems like widespread crop failure, unreplenished ground water resources, depletion in lakes/ reservoirs, shortage of drinking water and, reduced fodder availability etc. Often a region adopts itself to a certain level of water shortage based on the long-term climatic conditions experienced by it. Any negative departure from these levels creates conditions of drought, depending on the intensity and duration of this deficit. Thus drought conditions differ from region to region. Also the impact of drought over a region varies depending on which economic activity is impaired. Because drought affects many economic and social sectors, scores of definitions have been developed by a variety of disciplines and the approaches taken to define it also reflect regional and ideological variations.

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 fields of activity.

Droughts differ from other natural hazards in several important ways:

- slow-onset, creeping phenomenon that makes it difficult to determine the onset and end of the event;
- duration may range from months to years;
- no universal definition;
- no single indicator or index can identify precisely the onset and severity of the event;
- impacts are generally non-structural and difficult to quantify;
- spatial extent is usually much greater than for other natural hazards, making assessment and response actions difficult, since impacts are spread over larger geographical areas;
- because of their potentially long duration, the core area or epicenter will change over time, reinforcing the need for continuous monitoring of climate and water supply indicators
- impacts are cumulative and the effects magnify when events continue from one season or year to the next;

HISTORICAL DROUGHT EVENTS

The drought prone areas in the country classified on annual rainfall departures fall either in arid, semi-arid and dry sub-humid regions where droughts occur frequently. The probabilities of occurrence of droughts in different meteorological sub-divisions are given in the Table below:

Table: Probability of occurrence of drought in different meteorological sub-divisions:

Meteorological sub-division	**Frequency of deficient rainfall**
Assam	Very rare. Once in 15 years
West Bengal, Madhya Pradesh, Konkan, Bihar and Orissa	Once in 5 years
South Interior Karnataka, Eastern Uttar Pradesh and Vidarbha	Once in 4 years
Gujarat, east Rajasthan, western Uttar Pradesh	Once in 3 years
Tamil Nadu, Jammu & Kashmir and Telangana, West Rajasthan	Once in 2.5 years

As expected, the probabilities are high in the arid zone (Western India) compared with other sub-divisions. However, droughts occur at random and no periodicity has been noticed. The historical rainfall data of the country suggests that the monsoon rainfall recorded in the country during drought year 1918 was the lowest. The severe drought years that occurred over the past 200 years in the country as reported by are shown below:

Table: Reported drought events in India over the past 200 years:

Period	**Drought years**	**Period**	**Drought years**
1801-1825	1801,4,6,12,19,25	1901-1925	1901,4,5,7,11,18,20
1826-1850	1832, 33,37	1926-1950	1939,41
1851-1875	1853,60,62,66,68,73	1951-1975	1951,65,66,71,72,74
1876-1900	1877,83,91,97,99	1975-2000	1977,78,79,82,83,85,87,88,92

Administrative districts frequently affected by drought

States	**Districts**
Andhra Pradesh	Anantapur, Chittoor, Cuddapah, Hyderabad, Kurnool, Mehaboobnagar, Nalgonda, Prakasam
Bihar	Munger, Nawadah, Palamau, Rphtas, Bhojpur, Aurangabad, Gaya
Gujarat	Ahmedabad, Amrely,Banaskanta, Bhavanagar, Bharuch, Jamnagar, Kheda, Kutch, Meshana, Panchmahal, Rajkot, Surendranagar
Haryana	Bhiwani, Gurgao, Mahendragarh, Rohtak
Jammu & Kashmir	Doda, Udhampur

Karnataka	Bangalore, Belgaum, Bellary, Bijapur, Chitradurga, Chickmangalur, Dharwad, Gulbarga, Hassan, Kolar, Mandya, Mysore, Raichur, Tumkur
Madhya Pradesh	Betul, Datia, Dewas, Dhar, Jhabuva, Khandak, Khargaon, Shahdol, Shahjapur, Sidhi, Ujjain
Maharashtra	Ahmednagar, Aurangabad, Beed, Nanded, Nashik, Osmanabad, Pune, Parbhani, Sangli, Satara, Sholapur
Orissa	Phulbani, Kalakhandi, Bolangir, Kendrapada,

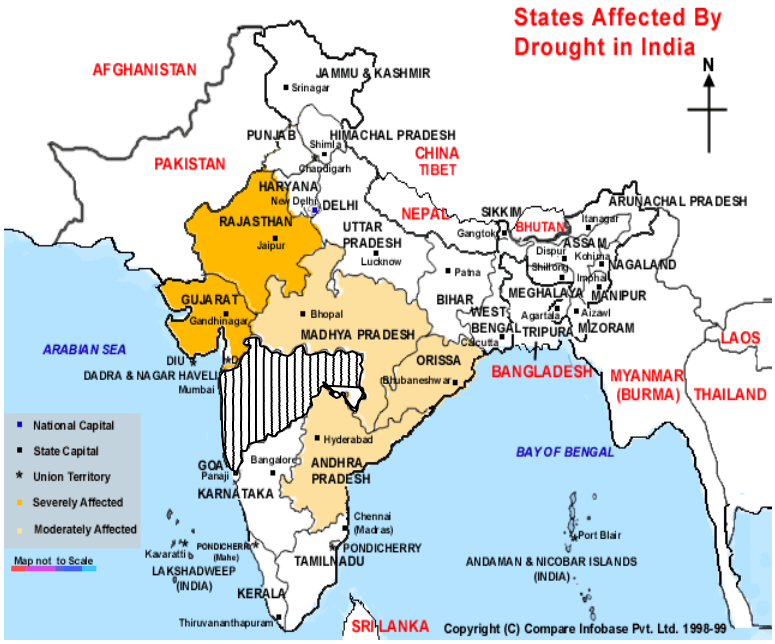


Fig. Map showing drought prone states in India.

TYPES OF DROUGHTS

Drought proceeds in sequential manner. Its impacts are spread across different domains as listed below.

Meteorological drought

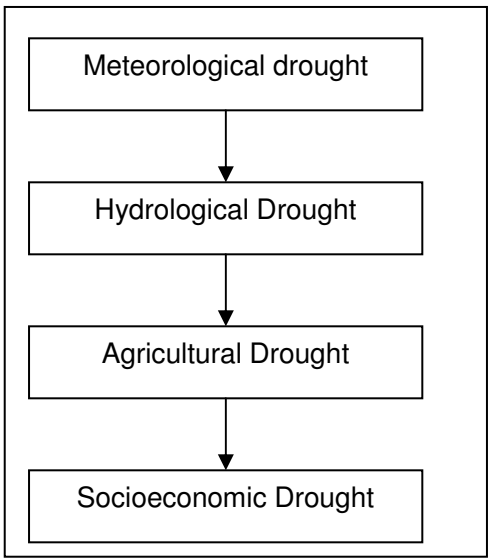
Meteorological drought is simple absence/deficit of rainfall from the normal. It is the least severe form of drought and is often identified by sunny days and hot weather.

Hydrological drought

Meteorological drought often leads to reduction of natural stream flows or groundwater levels, plus stored water supplies. Main impact is on water resource systems.

Agricultural drought

This form of drought occurs when moisture level in soils is insufficient to maintain average crop yields. Initial consequences are in the reduced seasonal



output of crops & other related production. An extreme agricultural drought can lead to a famine, which is a prolonged shortage of food in a restricted region causing widespread disease and death from starvation.

Socioeconomic drought

Socioeconomic drought correlates the supply and demand of goods and services with the three above-mentioned types of drought. When the supply of some goods or services such as water and electricity are weather dependant then drought may cause shortages in supply of these economic goods.

CAUSES OF DROUGHTS

Shortage of rainfall coupled with its erratic distribution during rainy season causes severe water deficit conditions resulting in various intensities of droughts. In India, the seasonal rainfall (monsoon rains) over the Indian sub-continent is a global phenomena associated with large-scale hemispherical movement of air masses. Therefore, identification of the major atmospheric phenomenon that influences the monsoons over Indian sub-continent is essential in drought management research. Two such relationships, viz., (i) sea-surface temperature anomaly around the Indian sub-continent in relation to atmospheric circulation, and (ii) large-scale pressure oscillation in atmosphere over southern Pacific Ocean are found to be useful in this context. The El Nino event is one such phenomenon, which has profound influence on the monsoon activity over Indian sub-continent. The Southern Oscillation Index (SOI) is one important parameter in the predictive sixteen parameters model used by IMD for long-range forecasting purposes. The study of the Indian summer monsoon over the country by India Meteorological Department showed that all the drought years are El Nino years whereas all the El Nino years are not drought years indicating thereby that various other factors also equally influence the monsoon over the sub-continent. In this context, the winter circulation over the sub-continent, extended period of occurrence of western disturbances (late in the season), strengthening of heat low over NW India in summer and shifts in zonal cells over India are some of the important parameters that influence monsoon system over the country.

Some of the researchers are of the opinion that the sea-surface temperature anomaly in the monsoon path is more important in predicting the monsoon rather than the pressure difference at far off places in the globe. Such studies have been initiated, but definite conclusions are yet to be arrived at. Therefore, successful prediction of monsoon over different parts of the country is still a problem and any progress in this direction will help in forewarning the occurrence of droughts.

Common causes for drought in India			
Meteorology	**Water Resources**	**Agriculture- Crop Yield**	**Population**
• Inadequate monsoon rainfall. • High temperature & evaporation,win	• Inadequate water availability, high water loss in storage & distribution,utilities.	• Shift in agricultural practices(low to moderate	• High greater rate of human & animals. • Location of high water

d speed. • Unseasoned rains & fog / snowfall.	• Over exploitation of surface & ground water.	water demand crops to high crops). • Crop damage due to rain & snow / pest.	consuming milestones at semi arid / arid regions.

IMPACT OF DROUGHTS

One of the sectors where the immediate impact of drought is felt is agriculture. With the increased intensity or extended duration of drought prevalence, a significant fall in food production is often noticed. Drought results in crop losses of different magnitude depending on their geographic incidence, intensity and duration. The droughts not only affect the food production at the farm level but also the national economy and the overall food security as well. Their impact is also felt due to:

- Deficit in ground water recharge.
- Non-availability of quality seeds.
- Reduced draught power for agricultural operations due to distress sale of cattle,
- Land degradation.
- Fall in investment capacity of farmers, rice in prices, reduced grain trade, and power supply.

ISSUES AND STRATEGIES FOR EFFICIENT MANAGEMENT OF DROUGHTS

The rainy period over greater part of the country is restricted to 3 to 4 months duration. Thus any small deviation in the occurrence of rainfall will adversely affect the normal activities in the biosphere. In a vast country like India with its varied climate, one or other part of the country experiences drought almost every year. However, its impacts can be minimized through development of better management techniques. Therefore, development of appropriate drought management strategy is of great importance and is currently addressed by the following mechanism and sectors:

Governmental

- Policy issues, national, regional and district level
- Rural development infrastructure
- Input supply, marketing and farm advisory services

Non-Governmental

- NGO's
- Rural institutions, local self-governments
- Private sector
- Philanthropic organizations
- Community codes (tribes, herders)

- International aid agencies
- Alternate land use systems

Research Development Institutions

- Best practices for rain water and soil management through linking on-station and on-farm research.
- Weather forecasts
- Contingency crop planning / mid-season corrections

Research and development initiatives especially in areas like understanding the monsoon behaviour, Agrometeorology, arid / dryland farming systems and hydrology have since been contributing substantially to the knowledge base on drought management. These advancements have contributed the development of useful technological options and also infused dynamism in agricultural production strategies and development of appropriate farming systems. Of late, the drought management approach has shifted significantly in the region from crisis response to risk management through early warning systems, advance planning for emergency response and better preparedness. This paradigm shift in R & D strategy has since made some impact, yet the sustainability in rainfed areas is yet to be achieved.

NEW APPROACHES AND METHODS

A fresh look needs to be taken for greater research and development efforts focused to new tools and approaches as well as the required paradigm shift in technology development with the involvement of the clients and stakeholders. The new approach may comprise of the following areas:

- Development of early warning and expert systems
- Mobilizing farmers: On-farm research and PTD in farming system research perspective
- Long-term strategy for development with emphasis on:
  - Prevention, mitigation and preparedness for drought
  - Integrated watershed management rainwater harvesting
  - Soil and crop management approaches
- Alternate land use systems
- R & D strategy
- Increased social security and better health

Drought Planning

Reducing the risks and therefore the impacts associated with drought in the future requires that much grater emphasis be placed on preparedness and mitigation. Preparedness leads to greater institutional capacity to cope with drought events through the creation of an organizational structure that improves information flow and coordination between and within levels of government. Drought preparedness, coupled with appropriate mitigation actions and programs, can reduce and, in some cases, eliminate many of the impacts associated with drought.

Drought planning process which has three components: monitoring and early warning; risk assessment; and mitigation and response, can be followed in the development of a drought preparedness plan. The monitoring and early warning

component of a drought plan is essentially provides the foundation on which timely decision can be made by decision makers at all levels (i.e., farmers to national policy makers). Given drought's slow onset or creeping characteristics, monitoring all components of the hydrological system is the only mechanism for detecting drought's early onset and its potential impacts on sectors, regions and populations groups. This information serves as the basis for management decision during both the developing and receding phases of drought, including the timing for the start-up and shut-down of mitigation and emergency response programs that are part of the drought preparedness plan.

Reducing Drought Impacts

The approach to drought in the past has been generally reactive and response oriented, i.e. through crisis management. Critical issues that could be addressed as integral parts for reducing the impact of drought should include:

- Supporting and strengthening the programmes for the systematic collection and processing of meteorological and hydrological observations,
- Building and strengthening scientific networks for the enhancement of scientific and technical capacities in meteorology, hydrology and other related fields,
- Developing an inventory of water resources indicators and indices,
- Development and dissemination of vulnerability/risk assessment tools
- Vulnerability assessment under different environmental conditions,
- Dissemination of drought planning methodologies that could be adopted by drought-prone countries in the preparation of plans,
- Transfer of appropriate technology to developing countries,
- Improved understanding of the drought climatology (frequency, intensity, and spatial extent) of drought patterns,
- Understanding the principal causes of drought at local regional and global levels,
- Development of standardized products / indicators for specific use, including hazards assessments,
- Development of decision support models for the dissemination of drought-related information to end users and appropriate methods for encourage feedback on climate and water supply assessment products,
- Improvement of the monitoring, modeling and prediction capacities and improved communication of how this information can be applied in decision support,
- Support all initiatives related to the promotion of Early Warning Systems,
- Development of national and regional drought and disaster management policies,
- Support development of regional networks for drought preparedness that would enhance regional capacity to share lessons learned in drought monitoring, prediction, preparedness, and policy development,
- Development of comprehensive drought reduction strategies that emphasize monitoring and early warning, risk assessment, mitigation, and response as an essential part of drought preparedness,
- Assessment of the availability of skilled human resources to be involved in drought preparedness planning,

- Education and awareness of policy makers and the public regarding the importance of improved drought preparedness as a part of integrated water resources management,
- Integration of local or indigenous coping mechanisms,
- Enhancement of regional/international collaboration.

Success stories/case studies: What mitigation can do?

Ralegan Siddhi

The people of Ralegan Siddhi in Maharashtra transformed the dire straits to prosperity. Twenty years ago the village showed all traits of abject poverty. It practically had no trees, the topsoil had blown off, there was no agriculture and people were jobless. Anna Hazare, one of the India's most noted social activists, started his movement concentrating on trapping every drop of rain, which is basically a drought mitigation practice.

Ralegan, before drought mitigation efforts

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Ralegan, after drought mitigation efforts

So the villagers built check dams and tanks. To conserve soil they planted trees. The result: from 80 acres of irrigated area two decades ago, Ralegan Siddhi has a massive area of 1300 acres under irrigation. The migration for jobs has stopped and the per capita income has increased ten times from Rs 225 to 2250 in this span of time. No World Bank funding, no-government grants - only people's enterprise.
Source: http://www.rainwaterharvesting.org/catchwater/feb2001/photogallery.htm

Tarun Bharat Sangh is transforming rural Rajasthan!

The work of Tarun Bharat Sangh, and it's founder Rajendra Singh in the districts of Rajasthan can easily be over-simplified as water-shed management whereas, it is in fact a revolution in regenerating life and society in denuded and deserted lands.

The villagers followed a simple two-step programme. First, revived vegetation on barren hill slopes and second, build small water catchments in the valleys and the plains. The first step was to identify water and fodder as the key to revival of rural life in the ravaged lands of Alwar. To make both available round the year, micro-structures to trap water had to be built and the denuded hills allowed regenerating, unimpeded by animal browsing. TBS discovered that only peoples' fullest cooperation can achieve these ends. The water harvesting structures called 'Johad' (water pond, see the picture on the side) were constructed with the consensus of villagers' Gram Sabha. Every member of the village contributed either in terms of labour or money towards this collective effort. A social fencing was farmed by the villagers' agreement to not let browsing by cows for 3 years, goats for 5 years and camel for 7 years to revive the denuded slopes in their village. People discussed on contentious issues for hours together and solved them in an amicable way. Fifteen years down the line, the villagers now sing the following song with joy and pride:

Denuded hills of Alwar

A Johad (water pond) constructed by the villagers

Restored slopes after five years!

"…. dead rivers begin to flow; …. agriculture becomes possible round the year; …. impoverished villagers, labouring in cities return, and families are re-united; …. wearying labour like fetching water, gives way to positive developmental work; …. with enough water and fodder, income from animal-husbandry begins to flow; …. nutrition levels rise and public health improves; …. wooded hills welcome back wildlife, that round off forests' whole-ness; …. people rid of insecurities, come together to address other issues of life, like education and local governance; …. awareness and confidence, enable micro-credit schemes that lower the cost of households and start small enterprises; …. people with leisure, turn to crafts, reviving folk practices like herbal medicine and community welfare…"

Well, it has happened in the space of 15 years in Rajasthan. Beginning from the small village of Bhikampura in Alwar district, the people-centred development model is spreading all over the state. Today you can see the river Arvari, dead for 40 years flow again. So too the rivers Ruparel, Jahjajwali and numerous other rivulets.

Resources

The following links will help you in advanced learning for understanding the drought risk management. You might want to suggest some of these sources to children as well!

- Are you prepared (www.areyouparepared.com)
- Center for Science and Environment (www.cseindia.org)
- Center for Water Efficient Landscaping, Utah (http://www.hort.usu.edu/cwel/)
- Central Arid Zone Research Institute (http://cazri.raj.nic.in)
- Central ground water authority (http://www.cgwaindia.com/)
- Central Research Institute for Dryland Agriculture (CRIDA) (http://dryland.ap.nic.in/)
- Crop Weather Outlook: http://www.cropweatheroutlook.org:8080/crida/
- Department of agriculture and cooperation (DOAC), Ministry of Agriculture (MOA): http://agricoop.nic.in/drought/drought22.htm
- DOAC, MOA, Weather Watch (http://agricoop.nic.in/weather.htm)
- Down to Earth, CSE (http://www.downtoearth.org.in/water.htm)
- Drought Monitoring Cell of Karnataka (http://dmc.kar.nic.in)
- Drought Watch of Agriculture and Agri-Food Canada (http://www.agr.gc.ca/pfra/drought/).
- Global vegetation health image map resources of NOAA (http://orbit-net.nesdis.noaa.gov/crad/sat/surf/vci/)
- IIT, Mumbai (http://www.csre.iitb.ac.in/rn/resume/drought/droughtindex.html)
- Indian Council of Agricultural Research Drought Monitoring and Advisory (http://www.icar.org.in/Drought/Drought00.htm)
- Indian Grassland and Fodder Research Institute (http://www.icar.org.in/igfri/index.html).
- International Center for Agricultural Research in the Dry Areas (ICARDA) (http://www.icarda.org/Theme3.htm)
- International Crops Research Institute for the Semi-Arid Tropics (http://www.icrisat.org/web/ASP/theme.asp?cid=2&ThemeId=3)
- International Water Management Institutes (IWMI, http://www.iwmi.cgiar.org)
- National Centre for Medium Range Weather Forecasting (http://www.ncmrwf.gov.in)
- National Climatic Data Center, NOAA (http://www.ncdc.noaa.gov/oa/ncdc.html)
- National Drought Mitigation Center (http://www.drought.unl.edu/)
- National Informatics Center's (NIC) Weather Resource System for India (http://www.weather.nic.in)
- National Oceanic and Atmospheric Administration's (NOAA) (http://www.drought.noaa.gov/)
- Rain water harvesting, CSE (http://www.rainwaterharvesting.org)
- Rainwater club (http://www.rainwaterclub.org/)
- Rainwater harvesting (http://www.aboutrainwaterharvesting.com/)
- Texas University (http://agnews.tamu.edu/drought/)
- United Stated Department of Agriculture (http://disaster.usda.gov/drought_jump.htm)
- Use it wisely (http://www.wateruseitwisely.com)
- Water harvesting (waterharvesting.org)
- Watershed management (www.watershedindia.net)