Drought Conditions and Management Strategies in India

Brij Mohan Singh Rathore[1], Ridhima Sud[1], Vivek Saxena[1], Laxman Singh Rathore[2], Tilok Singh Rathore[3], Venkata Godavarth Subrahmanyam[1], Murari Mohan Roy [4]

Corresponding author: Mr B.M.S Rathore; e-mail:bms.rathore@nic.in
1 Ministry of Environment and Forests, New Delhi, INDIA
2 India Meteorological Department, New Delhi, INDIA
3 Arid Forest Rersearch Institute, Jodhpur, INDIA
4. Central Arid Zone Research Institute, Jodhpur, INDIA

Background

Drought affects all parts of our environment as well as our communities. Different types of droughts have varying economic, environmental and social impacts. Approximately 16 per cent of India's geographic area, mostly arid, semi-arid and sub-humid is drought-prone (GoI 2013a). Due to high temporal and spatial variability in rainfall and wide variations in physiographic and climatic conditions in the country, droughts are experienced in varying intensities (moderate or severe) almost every year irrespective of a good monsoon. Since 2001, the country has experienced three major droughts, in the years 2002, 2004 and 2009, severely affecting the various sectors and overall economic development of the country. The National Commission on Agriculture classifies droughts as meteorological, agricultural and hydrological based on the concept of its utilization. While it is difficult to demarcate the onset and end of drought, the impacts can be severe affecting the poorest and most deprived sections of the society (NRSC 2008). India is primarily an agrarian economy and while the sector's contribution to the national Gross Domestic Products (GDP) is gradually declining- from 51.9 per cent in 1950-51 to 13.7 per cent in 2012-13 at 2004-05 prices- it employs over 50% of the population. Adding to the vulnerability is the fact that approximately 56 per cent of the total cropped area is rain-fed (GoI 2013a). Although the country has experienced three major droughts between 2002 and 2012, the capacity to cope with the adverse impacts is steadily increasing due to improved technology and irrigation and partly due to diversification of rural economic activities away from pure farm activity (GoI 2013a). Several policy measures undertaken by the Government of India (GoI) help in building capacity for drought prevention, preparedness, mitigation and management. This has also led to a shift in perception of droughts from a 'crisis of an urgent nature' to a management issue (GoI 2012).

Drought monitoring and early warning systems

A wide network of observatories routinely monitor rainfall situation over different spatial and temporal scales in the country. Since 1992, the India Meteorological Department, Earth System Science Organisation (ESSO-IMD) monitors rainfall situation throughout the year in different spatial scales (districts/states/meteorological subdivisions and all India in daily, weekly/monthly/seasonal scales. Based on this data, ESSO- IMD prepares rainfall reports for the use of different state/central government agencies. Until 2012, ESSO-IMD was monitoring drought using two most important drought indices viz. percent deviation of rainfall from normal and Aridity Anomaly Index (AAI). The first one covers meteorological drought while the second one is used for agricultural drought by monitoring the incidence,

spread, intensification, and recession of drought. Since 2013, ESSO-IMD started using Standardized Precipitation Index (SPI) to monitor drought in the districts of India on a monthly scale. This is in accordance with the guidelines issued by the World Meteorological Organization which recommends SPI as the most useful drought monitoring index because of its versatility in covering all three forms of drought viz. meteorological, agricultural and hydrological. Besides, the standard monthly and cumulative SPI, four weekly district SPI maps are computed and prepared every week to monitor progress, starting or ending of agricultural drought. In addition to the SPI and AAI, the Normalized Difference Vegetation Index (NDVI) is also used in drought monitoring.The Central Water Commission, National Centre for Medium Range Weather Forecasting, National Remote Sensing Centre and National Rainfed Area Authority are other key agencies that provide early warning.

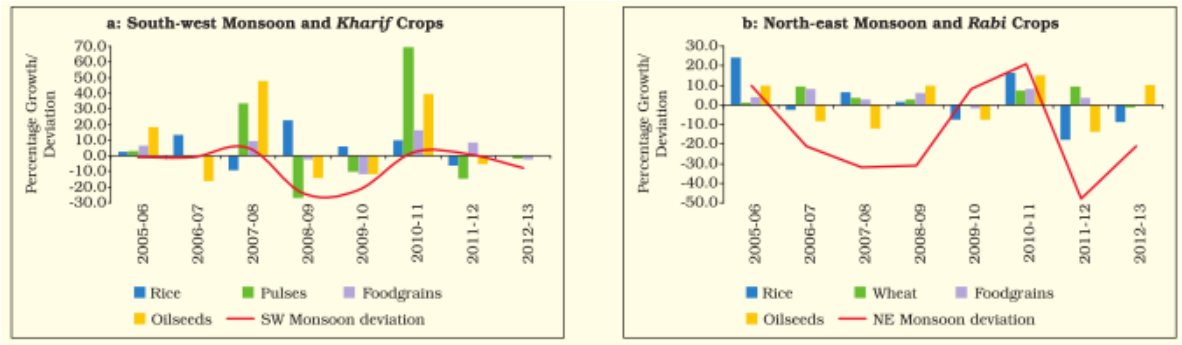
The Drought Research Unit was established in 1967 by the ESSO-IMD to conduct studies on various aspects of droughts in India. The ESSO-IMD in collaboration with ICAR has set up 130 Agro-Meteorological Field Units (AMFUs) and provide medium range weather forecast based agro-advisories at district level (GoI 2010). The Crop Weather Watch Group at the Central level, collects data from monitoring mechanisms of rainfall, water resources, crop growth etc. and assesses the status of these parameters on a weekly basis.

In order to overcome the limitations of drought monitoring, the National Agricultural Drought Assessment and Monitoring System (NADAMS) project provides near real-time information on prevalence, severity level and persistence of agricultural drought at state/district/sub-district level. The project currently covers 13 states of India which are predominantly agriculture based and prone to drought situation. The drought atlas for India is being developed by the National Atlas and Thematic Mapping Organisation (NATMO) which when integrated with the planning process would help identify and prioritize specific areas in risk management.

Vulnerability Assessment

Vulnerability assessment considers the potential impact of loss caused by a disaster as well as the vulnerability of the drought area. As far as India is concerned, it is vulnerable, in varying degrees, to a large number of disasters including drought. Droughts adversely impacts livelihood and economies of a large section of population in the rain-fed, arid and semi-arid regions.According to the National Remote Sensing Centre (2008), about two thirds of the geographic area of India receives low rainfall (less than 1000 mm), which is also characterized by uneven and erratic distributions. Out of net sown area of 140 million hectares, about 68% is reported to be vulnerable to drought conditions and about 50% of such vulnerable area is classified as 'severe', where frequency of drought is almost regular. Agriculture is the immediate victim of drought disaster – impacting crop area, crop production and farm employment. According to Murthy et al. (2010) the 1987 drought in India damaged 58.6 million hectares of cropped area affecting over 285 million people. The 2002 drought reduced the sown area to 112 million hectares from 124 million hectares and the food grain production to 174 million tons from 212 million tons, thus leading to a 3.2 per cent decline in agricultural GDP (Murthy et al. 2010).

Since only 45.0 per cent (2009-10) of the total cropped area is under irrigation, any shortfall in rainfall adversely impacts crop production (GoI 2013a). The dependency of the agricultural sector on the Indian summer monsoons, as shown in Figure 1, is evident from the fact that despite a record production of food-grains at 259.32 million tonnes in 2011-12, the delayed onset and deficient first half of South-West monsoon in 2012 had adverse impact on Kharif crop area coverage and yields (GoI 2013b).



Source: GoI 2013a

Figure 1: Trends in Rainfall Deficiency and Agricultural Production

Agricultural losses impact the income and purchasing power of farmers converting small and medium farmers into agricultural labourers resulting in an increase in unemployment. Consequently, farmers and farm workers tend to migrate to urban areas in search of employment opportunities. The 2002 drought, one of the severest in India, affected 56 per cent of its geographical area, the livelihoods of 300 million people and 150 million cattle in 18 states. The GoI had to provide relief amounting to about US$ 4500 million (Das et al 2007). Shortage of drinking water supplies and food insecurity are the other consequences that emerge. Fodder deficit drives away the animals to distress sales. Thus, while climate is the initial causative factor for drought, its implications are governed by the human interactions with the situation.

For demarcating drought prone districts, a combination of variables including climatic, area under irrigation and source of irrigation are used. Developing vulnerability profiles for regions and communities help provide critical information about the effected entity, the nature of risk and the reasons for such risk (GoI 2010). In the context of increasing climate variability and climate change, there is growing recognition of a need for effective and efficient drought warning systems that rely on accurate and timely assessments of soil crop, micro-climate (because of slow onset nature of drought) and its linkage with livelihoods support programme to trigger mitigation and emergency response programs at grassroots level (Bandyopadhyay 2009).

Emergency relief and drought response

While early warning indicators for drought have a considerably degree of ambiguity associated, as they may or may not culminate in a full-blown drought, the government has in place the requisite and institutional and policy framework to address the challenge.

Legal and Institutional Framework

While the central government plays the role of a facilitator, the primary responsibility of managing drought (or any other natural calamity) is that of the respective State government. With the enactment of the Disaster Management Act in 2005, the National Disaster Management Authority (NDMA) was set up as the apex body for Disaster Management in India, with the Prime Minister as its Chairman. Further, Disaster Management Authorities at the State and District Levels are headed by the Chief Ministers and Collectors/*Zilla Parishad* Chairmen respectively.

There is growing awareness about the benefits of an integrated approach to disaster risk management because of its greater economic efficiency (Kull et al 2013). For effective drought management, India has in place an institutional mechanism that ensures coordinated action across ministries. The Ministry of Home Affairs is a nodal authority for natural disaster management. The other coordinating agencies are ministry (s) of Agriculture, Rural Development, Drinking Water Supplies, Water Resources, Health, Science and Technology, Department of Space, Indian Meteorological Department, Relief Commission of state governments and non-governmental organizations(Gupta et al. 2011).The Department of Agriculture & Cooperation is mandated to coordinate relief measures necessitated by drought. The National Disaster Management Cell, at the Ministry of Agriculture monitors the drought situation in different states and the resources availability.

District-wise contingency plans are prepared by Central Research Institute for Dryland Agriculture (CRIDA), in collaboration with State Agricultural Universities (SAUs) / Indian Council of Agricultural Research (ICAR) Institutes / Krishi Vigyan Kendras (KVKs) (GoI 2012).Research institutions like the International Crops Research Institute for Semi-arid Tropics, Central Arid Zone Research Institute, Indian Grassland and Fodder Research Institute, Central Soil Salinity Research Institute, Indian Council of Forestry Research and Education and those under the Indian Council of Agriculture Research provide information on various aspects of drought management(Gupta et al. 2011).

Policies and Programmes

in 2009, India launched its National Policy on Disaster Management with a vision to build a safe and disaster resilient India. The policy aims to develop a holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response (GoI 2009). Some of the major government programmes help mitigate the adverse impacts of drought and build resilience of people by encouraging efficient water management practices, ensuring livelihoods, ensuring economic access to food and supplying fodder among other measures. A major programme of the GoI, significant from the drought relief and management perspective, is the Mahatma Gandhi National Rural Employment Guarantee Scheme. The scheme aims to provide minimum job guarantee for100 days in a year to the adult family members of rural households below poverty line. The days for wage employment can be increased in drought years to help stabilize incomes.

Finance

The National Disaster Response Fund (NDRF) and State Disaster Response Fund (SDRF), constituted under 2005 Disaster Management Act, provide immediate drought relief to the affected people. For combating the adverse financial impacts of drought, the National Agricultural Insurance Scheme (NAIS) was introduced in 1999 and Weather Based Crop Insurance Scheme in 2007. The GoI also set-up the Agriculture Insurance Company of India (AIC) in 2003to better serve the needs of farmersand facilitate a sustainable actuarial regime. Besides commercial, regional rural banks and the cooperative credit sector also makes financial credit available to the farmers on easy terms (GoI 2010).

Practices to alleviate drought impacts

Several of the programmes of the GoI help build resilience of communities against drought. Since 2005, there has been a paradigm shift from the erstwhile relief-centric response to a proactive prevention, mitigation and preparedness-driven approach for conserving developmental gains and also to minimise loss of life, livelihood and property (GoI 2010).The National Mission for Green India, one of the eight missions under India's National Action Plan on Climate Change, aims at improving the quality of forest cover in 5 mha and creating new forest cover in another 5mha over 10 year period with a project cost of about US$ 8 billion. Currently, there is an outlay of US$ 2.14 billion, for a period of 2012-17, to address 2.8 m ha of predominantly degraded lands and help restore multiple ecosystem services as well as enhance livelihoods of the households dependent on these lands. The Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), a flagship employment guarantee program with an annual outlay of appox. US$ 8.23 billion has a strong focus on land, water and afforestation activities. Similarly the Integrated Watershed Management Programme (IWMP) has targeted development of 75 million hectares of rainfed/degraded area in a phased manner during 2007-2027. For 2013-14, IWMP has an outlay of US$0.88 billion. India's draft National Water Policy (MoWR 2012) seeks address issues such as the scarcity of water, inequities in its distribution and the lack of a unified perspective in planning, management and use of water resources.Other key programmes of the GoI that help build resilience of drought affected people include the National Watershed Development Project for Rainfed Areas, National Food Security Mission, National Horticulture Mission and Rashtriya Krishi Vikas Yojana, National Mission on Micro Irrigation. The possibility of reorienting regular development programmes of the Central and State governments is also being explored.

There is tremendous potential for harnessing the Indigenous Technical Knowledge (ITK) for alleviating drought impacts. India is endowed with a rich repository of knowledge-relating to cloud formation, lightning, wind direction, rains and drought which has evolved over centuries to perceive and manage natural disasters and extreme weather events by disaster prediction, response, mitigation, and effects of weather on crops (Gupta & Singh 2011; Pareek & Trivedi 2011). This vast and time-tested ITK on natural resource management can be extrapolated to understand the modern concepts of disaster risk management in terms of early warning, preparedness, mitigation, response and relief (Gupta & Singh 2011).

The need for knowledge and skills on drought management

While India has strong drought assessment capabilities, there is need to enhance capacity for early warning and impact monitoring, particularly in the light of climate change impacts, which can further compound the challenge of drought monitoring for early warnings because of wide variability in rainfall pattern even at local levels. Lack of adequate drought monitoring systems and the capacity to respond via appropriate political, institutional, and technological frameworks, inhibit the development of integrated drought management plans or early warning systems. There is need of top-down approach to provide national real-time drought monitoring and seasonal forecasting, and a bottom-up approach that builds upon existing regional and local systems to provide national coverage.

Drought management capabilities can also be further strengthened and several studies suggest measures for this purpose. For example Prabhakar et al. (2007) highlights that although agromet advisories to help farmers adopt appropriate agricultural practices are issued on a weekly and bi-weekly by the local governments, there is a need to enhance medium and long range forecast capabilities. Effective and timely coordination among various Ministries/Departments/Organisations can enhance the drought management results (GoI 2010).The measures that can be undertaken at the national and regional level are as follows:

National Level

1. Further strengthening of the observational network for drought monitoring to bridge the gap between the existing and desired meteorological and hydrological monitoring network;
2. Improvement in information and communication technologies in an integrated manner for tacking the multifaceted challenge of drought at various spatial scales;
3. Capacity enhancement for medium and long range drought forecasting;
4. Better coordination among ministries and departments;
5. Developing mechanism for context specific and need based forecasting including local language for better understanding.

Regional Level

6. Enhancement of real time monitoring capabilities at a regional level through training and joint monitoring programmes;
7. Improvement in methodologies and analytical tools for drought analysis and vulnerability assessment at local and regional level;
8. Organization of joint training programmes to build human capacity in improved resilience towards drought;
9. Effective and collaborative implementation of drought relief programmes;
10. Strengthening effective water and commodities supply system.

References

Bandyopadhyay S.K 2009, 'Linking future climate change with drought in development planning for preparedness and mitigation'.*In: Abstract of Second India Disaster Management Congress, New Delhi.* National Institute of Disaster Management, New Delhi

Das, S.K, Gupta, R.K &Varma, H.K 2007. 'Flood and drought management through water resources development in India'.Bulletin-The Journal of World Meteorological Organization, Volume 56(3)

GoI 2013a, 'Reserve Bank of India Annual Report 2012-13', Government of India.

GoI2013b, 'State of Indian Agriculture, 2012-13'.Ministry of Agriculture, Government of India.

GoI 2012, 'Crisis Management Plan; Drought (National)'.Ministry of Agriculture, Government of India.

GoI 2010, 'National Disaster Management Guidelines; Management of Drought', National Disaster Management Authority, Government of India. http://www.ndma.gov.in/en/ndma-guidelines.html. *Last Accessed: 20th April 2014*

GoI 2009, 'National Policy on Disaster Management'. Ministry of Home Affairs. Government of India. http://nidm.gov.in/PDF/policies/ndm_policy2009.pdf. *Last Accessed: 20th April 2014*

Gupta, AK & Singh, A 2011, 'Traditional Intellect in Disaster Risk Mitigation: Indian Outlook-Rajasthan and Bundelkhand Icons', *Indian Journal of Traditional Knowledge*, vol. 10, no. 1, pp. 156-66.

Gupta, AK, Tyagi, P & Sehgal, VK 2011, 'Drought disaster challenges and mitigation in India: strategic appraisal', *Current Science*, vol. 100, no. 12, pp. 1795-806.

Kull, D, Mechler, R & Hochrainer-Stigler, S 2013, 'Probabilistic cost-benefit analysis of disaster risk management in a development context', *Disasters*, vol. 37, no. 3, pp. 374-400.

MoWR 2012, 'Draft National Water Policy (2012)', as recommended by National Water Board in its 14th meeting held on 7th June 2012. Ministry of Water Resources, Government of India. http://mowr.gov.in/writereaddata/linkimages/DraftNWP2012_English9353289094.pdf.*Last Accessed: 20th April 2014*

Murthy C.S. & Sesha Sai M.V.R. 2010,'Agricultural Drought Monitoring and Assesment'. In Roy P.S, Dwivedi R.S & Vijayan D. (Eds), *"Remote Sensing Applications"* (pp. 303-330). National Remote Sensing Centre, Indian Space Research Organization, Department of Space, Government of India.

NRSC 2008. 'Agricultural Drought'. National Remote Sensing Centre, Indian Space Research Organization, Department of Space, Government of India. Retrieved from http://www.dsc.nrsc.gov.in/DSC/Drought/index.jsp?include1=homelink2_b1.jsp&&include2=homelink2_b2.jsp. *Last Accessed: 24th April 2014*

Pareek, A & Trivedi, PC 2011, 'Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan, India', *Indian Journal of Traditional Knowledge*, vol. 10, no. 1, pp. 183-9.

Prabhakar, S.V.R.K&ShawR. 2007, 'Climate change adaptation implications for drought risk mitigation: a perspective for India', *Climatic Change* 88:113-130. http://sitemaker.umich.edu/aid_climate_change/16._drought_risk_management_in_india. *Last Accessed: 20th April 2014*