

SESSION-1 :

**DROUGHT ASSESSMENT,
MONITORING AND
MITIGATION**

IDENTIFICATION OF METEOROLOGICAL AND HYDROLOGICAL DROUGHTS IN CENTRAL INDIA

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ABSTRACT

Central part of India is facing the problems of recurrent droughts which are unpredictable phenomena both in their occurrence and duration; hence prevision and preparation against droughts are key elements for minimizing their impact. The present paper examines the meteorological, hydrological and agricultural aspects of drought in Chhindwara district of Madhya Pradesh located in central part of India. Assessment of meteorological and hydrological drought situation has been carried out through rainfall analysis and stream flow analysis using flow duration curve technique respectively. The study is further aimed at planning of life saving supplementary irrigation requirement for rain fed crops to reduce water stress during critical dry spells. In Chhindwara district approximately one out of every four to five year has been observed as a drought year and in some years deficiency in annual rainfall is observed up to 65%. The years 2000 and 2001 were severe meteorological drought years as most of the blocks of the district were under drought. Major part of the district has been found as a drought prone area where the probability of occurrence of rainfall equivalent to 75% of normal annual rainfall was less than 80%. The mean date of onset of effective monsoon (EMO) in Chhindwara district varies from 13th June to 21st June and the date of withdrawal of EMO varies from 19th September to 1st October. On an average two critical dry spells (CDS) were observed during the monsoon season with duration of 12 to 17 and 13 to 27 days. The maximum crop water requirement has been observed for rice and sugarcane during two CDS in the district. Low flow analysis has been carried out for the stream flow data of Hirankheri G/D site on Pench river. The maximum 75% dependable flow has been observed in August whereas the minimum 75% dependable flow has been observed in May. It is seen that the severity of low flow varies from 0.48 to 46.49 MCM and duration of low flow epoch ranges from 10 to 39 days. The year 1991 experienced maximum five events of low flows with total severity of 58.41 MCM and total duration of 102 days. The maximum severity with 46.49 MCM for 12 days duration has been observed in 1997. Therefore it can be concluded that 1991 and 1997 are years of deficit runoff volume indicating severe hydrological drought in the region.

ASSESSMENT OF DROUGHT SEVERITY USING METEOROLOGICAL AND BIO-PHYSICAL INDICATORS

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ABSTRACT

The drought occurrence is reported around the globe. Studies related to drought indicate its complex phenomenon. Dependency of rainfall (monsoon) for agriculture, drinking water etc., is very high on the Tropical wet/dry climatic zone spread out on the northern and southern hemispheres. Even though generations have adopted themselves to the local conditions for their survival, changes related to climate, pose a new serious problem in managing the resources and development. Central portion of the Indian peninsula receiving rain from winter (November-February) and summer (June-September) monsoon need to reevaluate their resources and development, while managing the drought severity.

An attempt has been made in assessing the drought severity index based on meteorological and bio-physical parameters in estimating the water stress on predominant crops of the region and drinking water supply system. Drought Severity Index (DSI) was classified as a day into dry or wet according to the amount of measured rainfall, length of the current dry spell as well as rainfall, evapotranspiration and water deficit during the dry spell. The distribution of dry spell length was truncated to 7-day length in order to suite the water week. The water deficit computed as the difference between cumulated rainfalls and ET_0 . Similarity and differences of DSI of previous years (2003-2009) with reference to ground level information and historical events were attempted, on a rain gauge station and spatial-temporal basis. Bio-physical parameters such as soil type, water holding capacity and plant phenology was used.

This exercise was carried out on Tel River basin, a tributary of Mahanadi River, covering an area of 2756 km² and lies between 19° 17' and 20° 00' N latitude and 82° 30' and 82° 59'E longitude in Kalahandi district of Odisha, Duration (length of the dry spells), intensity (amount of water deficit) and severity of drought in 5 meteorological stations were carried out. Spatial distribution of supplementary water availability was integrated using GIS in representing the sensitivity of crops and yield to monsoon vagaries. This information enables the water managers to formulate contingency plans and make decisions based on the future horizon to reduce the impacts of drought. Merits of this approach with the existing practices and possible modification are discussed.

DROUGHT ASSESSMENT OF ORISSA STATE BASED ON THE RECONNAISSANCE DROUGHT INDEX (RDI)

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ABSTRACT

Regional drought assessment is conventionally based on drought indices for identification of drought intensity, duration and areal extent. Among various drought indices, recently developed Reconnaissance Drought Index (RDI) has significant advantages over the other indices by including additional meteorological parameter i.e., potential evapotranspiration. In this study drought characteristics and rainfall trend of Orissa state are analyzed to in order to provide a guide for sustainable water resource management. For this purpose drought severity, areal extent is analyzed using RDI with grid rainfall and temperature data from 1973 to 2004. The annual RDI for each grid are estimated based on hydrological year i.e., starting from month of June and drought severity is classified. Further, minimum amount of rainfall required to avoid drought formation at different severity categories is also determined. It is observed that in the in two instances more than 25% of the area is drought affected and in the year 1974-75 the extreme drought and moderate drought affected area are 52.1% and 5.6% respectively. The minimum annual rainfall to avoid extreme drought vary from 450 mm to 1010 mm. Similarly to avoid moderate drought the threshold rainfall vary from 759 mm to 1360 mm. In general, it is observed that the rainfall amounts required for non-drought conditions decrease from the coastal planes toward the interior hilly regions of Orissa. Both parametric and non-parametric test showed a decreasing rainfall trend in South-West hilly regions of the state.

DROUGHT MONITORING IN SOUTHERN RAJASTHAN USING REMOTE SENSING DATA

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ABSTRACT

Drought is a normal, recurrent feature of climate and occurs in all climatic zones, although its characteristics vary significantly from one region to another. A number of studies have been carried out using remote-sensing techniques for identification and monitoring of the drought-affected areas on a regional, national and global scale. The present study has been carried out with the aim to integrate meteorological data analysis and satellite remote sensing data analysis for monitoring drought in southern part of the Rajasthan. Monthly rainfall of six stations has been used to derive Standardized Precipitation Index (SPI). The Advanced Very High Resolution Radiometer (AVHRR) onboard the National Oceanic and Atmospheric Administration (NOAA) series of satellite has been used for deriving brightness temperature (BT) and classification employing the Normalized Difference Vegetative Index (NDVI). The new index Water Supplying Vegetation Index (WSVI) detects drought information by combining vegetation with temperature retrieved from NOAA satellite data, Vegetation Condition Index (VCI) and Temperature Condition Index (TCI). Recently this technique has been improved by converting NDVI with radiation measured in of the thermal channels and converting brightness temperature into the VCI and TCI. These indexes are being used for monitoring drought.

On the basis of SPI analysis, it was observed that the year 2002 was drought year. The various satellite based indices were also computed for each year and found that in the year 2002 all the area was affected by drought with greater intensity, mostly by extreme and severe drought condition. Comparison of these both approach confirms that the drought year 2002 was worst affected by drought condition as compare to other year. On the basis of satellite based indices, the study area has been divided into various categories of drought. Finally, the areas under extreme, severe, moderate, slight drought and normal condition have been classified.

AGRICULTURAL DROUGHT MITIGATION AT WATERSHED SCALE

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ABSTRACT

Drought is a normal, recurrent climatic feature, which has caused distress and chaos since the known history of mankind. In India, droughts impose a serious threat to agricultural production in the affected region and as such, country's agriculture is described as a gamble with the monsoons. In recent years, concern has grown world-wide that droughts may be increasing in frequency due to climate change. Whether due to natural climate variability or climate change, the effective drought mitigation measures need to be planned and implemented for its reduced impacts on agriculture sector. In the past, the governmental strategy for drought relief and management generally included the components of early warning and drought monitoring, contingency crop planning for drought proofing, alternative land use systems, relief employment, cattle camps, fodder depots, animal healthcare, subsidized cattle feed for the milch cattle, drinking water arrangements, augmenting existing or creation of new water sources, medical and health arrangements. Though these measures are extremely important for helping people to cope with drought and reduce adverse impacts on their well being, these are mostly contingent measures. Considering the increase in frequency of droughts in different parts of the country, a shift is necessary in drought management policies from contingent drought relief to drought mitigation measures. The technologies at watershed scale which promote precipitation water use and enhance the water supplies at the local level should be seen as proactive approach for mitigation of agricultural drought. In a country like India where lot of water goes waste during monsoon season, the water management technologies that include various practices for in-situ moisture conservation, water harvesting and storage, and improved water saving techniques and farm practices, offer promise for effective drought mitigation at watershed level. The present paper discusses the potential of watershed approach and suggests various watershed-scale measures for improving the soil moisture regime, enhancing water supplies and ground water recharge for effective mitigation of agricultural drought.

NEED OF EFFICIENT WATER MANAGEMENT PRACTICES IN CANALS DEVELOPED FOR DROUGHT MITIGATION

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ABSTRACT

The State of Rajasthan is prone to famine and droughts, particularly over the western most and northern districts consisting of Thar Desert which often experiences a number of successive years of drought and scarcity. Most affected districts are Jaisalmer, Bikaner Churu Barmer, Ganganagar and Hanumangarh. The meteorological concept of drought involves consideration of deviation of actual rainfall from normal.

The total area of Rajasthan is 338410 sq km which is mostly arid to the west of Aravali range. Arid, semi arid and sub humid zones are 58%, 36%, and 6% of the total land area of the State. The annual potential evaporation is 147 cm and average annual rainfall is 32 cm, thus there is a water deficiency of 115 cm in western arid zone of Rajasthan. The percentage probability of scarcity varies from 36% in Ganganagar district to 74% in Jaisalmer district (Banerjee & Upadhyaya 1995). The desert has got maximum aridity index of 78% except Jammu & Kashmir with more than 80% aridity index, but certainly the problem of drought over Rajasthan is more acute than any other state in the country. Droughts are categorized mainly into three categories viz. meteorological, agricultural and hydrological droughts. These northern and western districts of Rajasthan come under arid zones and generally when meteorological droughts are there due to deficit rainfall in the area they are associated with agricultural and hydrological droughts.

Droughts typically result in shortage of food grains, unemployment, migration of population and shortage of fodder resulting in hunger deaths of livestock. To mitigate the menace of droughts, Himalayan waters were transformed to this Thar Desert by state rulers during pre independence and by Government of India after independence. Three canal systems were constructed viz. Gang canal (Bikaner canal) in 1927, Bhakra canal in 1954 and Indra Gandhi canal (Rajasthan canal) in year 1958 from river Sutluj. Culturable command area of these systems are Gang canal 305000 ha, Bhakra canals 372470 ha and Indra Gandhi canal 1869000 ha. The deserts of Rajasthan have been converted into a food bowl with the availability of water through these canal systems.

Due to lack of proper water management in these canal commands, water logging problems came up quite early particularly in Indra Gandhi canal command due to higher water allowance as compared to other canal systems. Designed water allowance was 2.54 cusecs/1000 acres in Gang canal, 2.56

cusecs/1000 acres in Bhakra canal and 5.23 cusecs/1000 acres in IGNP stage I, which was subsequently reduced to 3.0 cusecs /1000 acres in stage II. Due to poor water management this boon for drought prone districts changed into bane particularly in IGNP stage I by water lodging of rich agricultural lands. Modelling studies of waterlogged areas in IGNP stage I were conducted by Goyal & Arora (2005) and predicted that if suitable practices are introduced than the waterlogged area in IGNP stage I could be reduced to 4139.2 ha of by the year 2015 against 22000 ha in 1997-98. Arora & Goyal (2009) in a research study suggested some water management strategies in IGNP stage I for mitigating the menace of water logging. If proper management of water available in canals transported from Himalayan region is not done the fruits of scarce water available could not be shared. Optimizing the use of available water, adopting micro irrigation systems like sprinklers & drip irrigation, reclaiming waterlogged lands by surface drainage, conjunctive use of water are some of the ways to mitigate menace of these canal commands and make real use of available water in minimizing ill effects of droughts.

INCREASING THE WATER USE EFFICIENCY (WUE) TO MITIGATE THE DROUGHT SITUATION

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ABSTRACT

Drought is basically a phenomenon associated with the situation of below normal water availability to support the established or normal activities of an area of region. Stream flow drought normally called a hydrologic drought which normally affect man's activities and also many classes of water utilization such as water supply, water quality, hydroelectric over generation, water based are also responsible for bed aggradations due to reduced sediment carrying capacity of streams consequently inducing braiding in the streams and affecting stream morphology. The effects of drought generally is the limited access to an available water supply by surface or ground water right and reservoir operating rules. No matter how much study is got conducted on the theories of the Drought the practical and effective solution to fight the drought like situation is only the increase in Water Use Efficiency of the existing supplies. Water use efficiency (WUE) is the only effective tools for mitigating the impacts of the Drought. WUE is not simply a matter of using less water through restrictions. It is about careful management of water supply sources, use of water saving technologies, reduction of excessive demand and many other actions. The main options which exist to mitigate the drought are: (a) Reducing the Demand of the water and (b) Changes in the management of the water supply.

For irrigation, adopting appropriate cropping pattern is the best demand side management tool. The NCA (1976) has suggested crops with lesser water requirements in water paucity areas and the cropping pattern for various states. The water system operation policies may be tailored for benefits and demand reduction and supply enhancement measures. It is commented that the severity of atmosphere drought depends upon the distribution of rainfall and the phases of crop growth affected by dry periods and not on the total amount of rainfall alone therefore timed application of the water assumes great importance.

Increase in the water use efficiency increases the output per unit of water, reduce losses, reduce water degradation and reallocate water to the higher priority. It may be expensive and requires willingness, know-how and action at various levels of irrigation system managers and the system-dependent farmers. No irrigation method or technology in itself guarantees the attainment of high efficiency. How the system is operated is all important. With poor management even the most sophisticated system can result in water loss and inefficiency. Some 30 WUE studies were organized by CWC in different agro climatic zones of India and while analyzing the findings of WUE Studies some Common WUE improvement components of the water resources projects were identified which included structural and non structural measures. Water saved through Water Use efficiency needs to be suitable traded off in order of priorities even if it requires

greater conveyance. These developments in Israel provide valuable lessons to us for the development of our drought areas and in particular handling the droughts. The increase in water use efficiency is the most optimum drought preparedness technique where the surplus saved water may be utilized for the water stressed area.