Detailed Abstracts

Drought situations over India

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Abstract

In beginning of 21st century, India suffered first all India drought in 2002 due to poor rains in southwest monsoon season(SWM) during June to September. Thereafter, SWM rains have been normal keeping the India safe from droughts. But major parts of northwest India have been facing drought like situations frequently. There have been negative departures of about 20% or more than those of normal values over these areas. These regions got normal SWM rains broadly in three years viz. 2001, 2003 and 2005 during the decade. Observations from year 2002 to 2008 by Gravity Recovery and Climate Experiment (GRACE) satellites have shown depletion of ground water by an average rate of 4 cm (+/-1cm) / Year over Rajasthan, Punjab, Haryana and Delhi (Matthew Rodell, Nature August 2009). Analyses of long term observations have shown, number of events with less than four days continuous rain spell have increased and prolong dry epochs also have increased over India (Dash et al, NCMRWF-IMD Intl. Conf. 2008). Frequent subdued rains during SWM have been most probable cause of reduction of ground water over major parts of plains NW of India. There have gross loss to the country due to droughts. The country has suffered a financial loss of about 14,98,722 US$ and 350 million people got affected badly due to drought in past ten years (Santosh Kumar, Yojna, June2009). India is facing bad situation in SWM 2009 similar to the poor rains during SWM 2002. This year SWM arrived in Kerala about one week ahead of its normal date, progressed northward and reached Delhi on the normal climatological date. But, the all India SWM rain received was 92.6mm (-46%) on 1July2009. By the time this abstract is communicated, it rained 463.4 mm (-26% of normal) as of 19August and total 648.6 mm (-21%) as of 16September2009. As per prevailing conditions shown by the numerical weather prediction(NWP) models at National center for medium range weather forecasting(NCMRWF) and IMD synoptic analyses, the rainfall stock seems to remain similar i.e. approximately –25% of normal in the ongoing week ending on 26August2009. This deficiency is worse than that of SWM rain of season –21% on 28August2002. Subdued rains caused about 50% loss of paddy crop coverage in India. Since 65% agriculture is still rain fed. Electric power can be used for watering the crops in crucial phases. But, more than 10% loss occurred in hydro-electric power generation in July alone this year. Severity of problem and government's efforts towards minimizing the related losses and troubles was part of Honorbale Prime Minister's independence speech. Despite governments efforts, speculation of significant economic loss is there for this year due to loss in Kharif crop(Prof. Swaminthan). It requires analyzing the observed facts of rains in more details and study the associated atmospheric conditions responsible for such scenarios using latest and NWP capabilities.

In the present study an insight is given on inter-annual and intra-seasonal variability of SWM rain over sensitive parts of India in recent past ten years. Simulations of atmospheric conditions by NWP models at NCMRWF have thrown some light on situations of prolong weak conditions of SWM or droughts over India in past decade.

Linking future climate change with drought in development planning for preparedness and mitigation

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India faced several drought years in last six decades. It is also a matter of concern with increased frequency as well as intensity, partly may be due to factors related to changing climate in recent years. In India livelihoods of the more than 75% of the population are directly or indirectly dependent on agriculture sectors. The strong and recurrent link between climate change and drought effects has highlighted the importance to initiate a new way of analyzing the way communities can cope with drought. An individual farmer, local and national government is concerned to reduce the destructive effect in terms of agricultural output and livelihoods of the agrarian society of the rural India. Drought planning is generally accepted tool to apply to reduce the future risks for governments at all levels. At present drought plans are of more generic that can be applied to any drought prone areas, and we must agree that a good number state drought plans are fundamentally response oriented. Country has done well in terms of drought assessment and drought response in past as part of agricultural drought planning, however, it lag behind in providing critical inputs in terms of monitoring and early warning system as a part of agricultural drought and livelihoods preparedness plan. In development context agricultural drought, compare to meteorological drought, concerns are centered largely on issues of food security, availability of non-skilled and semi-skilled wages in rural areas, migration etc.

An effective livelihoods warning system in drought that embedded scientific knowledge on soil health and soil moisture dynamics, crop, household food availability, wage availability can help individuals as well as societies to deal with potential impacts of drought-disasters and support the process of sustainable agricultural development. In the context of increasing climate variability and climate change, there is increasing recognition for an effective and efficient drought warning systems that must 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 both governmental and non-governmental, to trigger mitigation and emergency response programs at grassroots level. The purpose of this paper is to discuss the current status of drought planning in India and illustrate the key role that drought early warning systems play in drought plans.

Drought Assessment, Prediction and Weather based Agromet-advisory in India

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Abstract

India is one of the agricultural economy based country. Despite, the share of agriculture sector to GDP of the country is only about 24%, 70% of Indians are dependent on farm incomes, and about 60% of farm cultivation depends on rains. In India, delayed and deficient monsoon seasons severely affect the farmers. The crops and cropping area vary with the rainfall pattern during monsoon and ultimately affect the agricultural production. In past few years there has been increase in extreme weather events such as drought, flood, heat and cold waves, strong wind etc.

India suffered of drought in 2002 with seasonal (June-September) all India rainfall 19% below normal after all India drought occurred during June-September, 1987. However one part or other parts of the county suffer from drought invariably every year. In 2009, around half of the districts have been declared drought affected. Lessons from developed and developing countries demonstrate that drought results in significant impacts, regardless of level of developments although the character of these impacts will differ profoundly. Droughts have severe economic, environmental and social impacts. Timely determination of the current level of drought and its prediction may aid the decision making process in reducing the impacts of drought. Following features will be discussed in the paper.

India Meteorological Department monitors occurrence of drought through the variation of rainfall on different spatial scale (district, met subdivision, state and country) and temporal scale (daily, weekly and seasonal). Other effective indices used are aridity anomaly every fortnight. Though its assessment and monitoring system is well established, prediction remains a challenging task. Viewing the importance, IMD generates the district level weather forecast for rainfall, temperature, wind and humidity using multi-model super ensemble technique. IMD in collaboration with different stakeholders is providing district level Agromet Advisory Service (AAS) for the benefit of farmers. These advisories are issued twice a week on Tuesday and Friday through a network of 130 AMFUs established at ACZ scale and contain information on current weather, forecast and specific advice on intercultural operation a farmer needs to act upon. Information on drought assessment and prediction is highlighted in the advisory and contingency planning, if required, is also suggested. NWP models in their predictions were able to give clear signatures of changes according to movement of rain bearing systems. Areas devoid or having poor rain could be detected in advance. It is possible to reduce agricultural losses by advanced prediction of poor or no rain situations, timely dissemination of weather based agro-advisories to farmers and planners.

Drought management strategies in Agriculture in Andhra Pradesh

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Andhra Pradesh has historically been one of the drought affected states in India. Out of the 23 districts in Andhra Pradesh, four districts of Rayalaseema (Anantapur, Chittoor, Kadapa and Kurnool), four districts of Telangana (Ranga Reddy, Mahaboobnagar Nalgonda and Medak) and one district of Coastal Andhra (Prakasam) are drought prone districts. Rainfed crops like jowar, maize, groundnut, greengram,blackgram and sunflower and one water-intensive crop like rice are mainly affected owing to drought in these districts. The drought conditions occur due to failure of South West Monsoon, delay in arrival of SW monsoon, break monsoon conditions or early cessation of SW monsoon. Rainfed agriculture in India depends on onset of monsoon and the rainfall distribution during crop growth season. The amount of rainfall and the time of onset of monsoon decides the type of the crop to be grown. The timely onset and well distribution of monsoon rain in the month of June and July decides the area coverage of rainfed crops. Any deviation in onset of monsoon rain results in significant change in area covered by different crops. Drought during crop season will have significant influence on growth and development of crops which leads to reduction in yield. Drought can be managed by closely monitoring seasonal conditions, suggesting contingent crops on near real time basis, adopting different farm level options like changing the sowing dates, adopting different crop varieties and supplemental irrigation using micro irrigation and advance weather information on occurrence of drought through extended range forecast/seasonal climate forecast and disseminating agromet advisories issued based on medium range forecast for mid-season corrections. These measures have shown to reduce the adverse impacts of drought .

Monsoon 2009 – A comparison with recent deficient years

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Abstract

The rainfall departute during the southwest monsoon season from 1st June to 26th August is -25% of long period average (LPA). Thus, by end of the sesson (till end of September), the seasonal rainfall from June to September is likely to remain as deficient with a minimum negative rainfall departure of -10% for the country as a whole. During 2009 the deficiency of rainfall in June turned out to be identical with that of departure of June rainfall during 1926 with a departure of -48%. Similarly the August 2009 was also a deficient month with negetaive departure of about -27%.

The earlier major drought in 2002 was unique in respect of its climate anomalies and impact on the society, particularly in respect of the farm production. Indian summer monsoon rainfall was 19% short of the LPA. The deficiency of rainfall in July turned out to be the severest in recorded history since 1877 at -49%; the earlier record was -48% in 1918. This caused a loss to farm production estimated at a staggering figure of three hundred billion Indian rupees.

One of the feature that is directly responsible for deficit June during 2009 is that the southwest monsoon although arrived over southern tip of India few days early, there was complete stagnation in progress of monsoon northward from the south Peninsula (around the latitude 15^0N) during the period from **8th June to 20th June.** This stagnation was associated with cold circulation anomalies in the middle and upper troposphere**.** The monsoon only started slowly progressing northward after 21st. Thus, for 13 days the features must be very adverse for the monsoon progress. Thus departure of June 2009 was associated with a stagnation in monsoon progress from 8-20 June, 2009.

The forecast from different numerical models on real time basis for the monsoon season of 2009 are discussed in details in this study.

Rectification of the Standardized Precipitation Index Classification for Drought Evaluation in Fars Province

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Abstract

With the climate conditions in Iran, drought is always expectable and to cope with its damages it is important to know its features. For defining drought features, description of past drought and case studies, the phenomenon should be turned from qualitative and descriptive to numeric and quantitative. So drought indices are used. Basically a drought index is a function consisted of different drought-based environmental factors, resulted as a number at the end. Standardized Precipitation Index is one of the most important indices upon which drought evaluation is achieved with the range of precipitation. Upon this index, drought severity is determined regarding the related classification. Studies have shown that for drought monitoring, some researchers use different classifications with the understudy climate conditions. As fine drought severity classification in each area, may have a big role in predicting and crisis management when drought happens, thus we examine the results from important classifications in Fars Province. In this study, there are three classifications have been compared differ in mild drought and precipitation. McKee et al. (1993) presented the first classification. Other classification is used by Hayes et al. (1999). There is another classification presented and used by Giddings et al. (2005). Thus a classification is determined with 30-year results compatible with the understudy climate conditions at every aspect. Upon this, the classification presented by Giddings et al. (2005) (Modified Classification) is determined and recommended as the optimal classification for localization of drought evaluation in Fars Province.

Key **words: Drought, Standardized Precipitation Index, Fars Province.**

Drought monitoring using Remote Sensing and meteorological data in Iran

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Drought is one of the major environmental disasters in many parts of the worid. There are several possibilities of drought monitoring based on ground measurements, hydrological and climatological data. Drought indices that derived by meteorological data have coarse spatial and temporal resolution and also to **obtain** a near real-lime drought condition over a big area is difficult. Because of the spatial and temporal variability and multiple impacts of droughts, we need to improve the tools and data available for mapping and monitoring this phenomenon on all scales. Using remote sensing data provides an excellent strategic **monitoring** tool to assess the level of drought stress and **to** signify the need to take action at a regional scale. In this study, we used Advanced Very High Resolution Radiometer (AVHRR) images. The study covered 1997-2005 (March-July) time period. Raw AVHRR images were processed and geometric registration and radiomctric calibration were performed. Therefore data obtained from the (AVHRR) sensor on board the NOAA polar-orbiting satellites have been studied as a tool for drought monitoring. Ten-day maximum Normalized Difference Vegetation Index (NDVI) maps were produced and vegetation condition index (VCI) was calculated using the maximum and minimum NDVI values for the same time period. Also vegetation health index **(VHI),** Temperature Condition Index (TCI) were used in this study. Precipitation statistics from synoptic meteorological stations were collected and with this data Standardised Precipitation Index (SPI) has been calculated.

Analysis and interpretation of these maps reveal that good agreement was not found between **the spatial** extent of the satellite-derived drought-indices and the meteorological-based SPI. Elased on the statistical analysis, higher correlations were found among the remote sensing indices. Also the meteorological data cannot provide sufficient information for validation of satellite derived drought indices,

Keywords: Drought monitoring, "NOAA-AVHRR, Iran, **NDVI,VCI,TCI,SPJ**

Evaluation of vegetation indices and drought monitoring using NDVI in Iran

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Abstract

Drought is one of the major environmental disasters in many parts of the world. There are several possibilities of drought monitoring based on ground measurements, hydrological and ciimatoiogical data. Drought indices that derived by meteorological data have coarse spatial and temporal resolution and also to obtain a near real-time drought condition over a big area is difficult. Because of the spatial and temporal variability and multiple impacts of drought, we need to improve the tools and data available for mapping and monitoring this phenomenon on all scales. Remote sensing data provides an excellent strategic monitoring tool to assess the level of draught stress and to signify the need **to take** action at a regional scale.

Vegetation growth is trie most direct and important indicator of drought events and, therefore, an understanding of vegetation indices is critical to the drought estimation. In this paper we evaluate some **of** vegetation indices such as Normalized Difference Vegetation Index (NDVI), soil-adjusted vegetation index (SAVI), Enhanced Vegetation Index (FVI) and so on.

!n this study, we used AVHRR images to evaluate the capability ofNOAA-AVHRR data for drought monitoring in Iran. The study covered 1997-2007 (March-July) time period. Raw AVHRR images were processed and geometric registration and radiometric calibration were performed. **Then,** ader evaluation of vegetation indices, NDVI was selected as the most similar spacebornc vegetation index to the actual vegetation cover on the ground. Accordingly, series often-day NiWI maps were produced using a11 available data. By evaluating the nine-year time series of NDVI, the possibility of monitoring drought using a rather simple approach is presented. The results obtained have been able to evaluate in an objective way the impact caused by the drought in different regions during the period **of 1997-2005** {March-July}, revealing how useful the spatial remote sensing can be in this kind of application.

Keywords: remote sensing, vegetation indices, drought monitoring, NDVI, Iran

STUDY OF DROUGHTS: SPECIFIC TO ORISSA

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ABSTRACT

Indian Summer Monsoon Rainfall season (ISMR) is known to play a very important role in occurrence of droughts, which in turn is responsible for regulating the crop yield, well-being of the society, and employment generation. AH this is related to the economy of the country. There is growing evidence that the climate change has implications for drought vulnerable districts of the state Orissa; with studies projecting future possible changes in the frequency and intensity of droughts. The study focuses on meteorological droughts across the state. The rainfall data for the scientific analysis was obtained from Climatic Research Unit, U.K., and Indian Meteorological Department, India, for time period of 1901-2002 and 1901-1950 respectively. Univariate analysis of the two data sets revealed that the months of June-September (ISMR) contributes 79% of the annual rainfall in the state, with maximum rainfall in the month of August. The analysis also revealed that Cuttack district was the least vulnerable district, while Gajapati was the most vulnerable district. It was also seen that Rayagada was the most drought prone district. Mapping of the drought prone districts was done using ArcView GIS 3,2 Software. 'No-regret' adaptation strategies were suggested after studying the on-going adaptation strategies and Government polices/programmes being implemented to cope with the consequences of extreme rainfall events.

Keywords: Orissa, Droughts, Indian summer monsoon rainfall, Adaptation strategies

Drought Risk Assessment and Mitigation Analysis for Bundelkhand Region: A Case Study

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ABSTRACT

Water is increasingly becoming scarce resource in many parts of the world. Drought is slowly and steadily gripping over India. Certain regions are now chronically drought prone due to erratic precipitation, dropping water levels and consecutive monsoon failure. The Bundelkhand comprises of 13 districts and is distributed over southern Uttar Pradesh and northern Madhya Pradesh. It is recognized as one of the poorest regions of India with certain districts termed as 'Bimaru' means 'Ailing[1]. Bundelkhand is experiencing drought and drought like situation since last decade. But people were earlier able to manage this disaster using their traditional knowledge. Intensity of drought is increasing year after year and for past six years Bundelkhand is facing worst drought in its history. In this region main sources of economy are agriculture based. Most of the water reservoirs, tanks, and ponds were being used for irrigation purpose. Most of these structures are now in dilapidated condition, and whatever left they are in very poor state due to land-use anomalies. Water level has gone down to 100 to 200 feet which was earlier available at 20 to 30 feet from ground level. Severe water scarcity has serious impact on economy, society and environment of Bundelkhand. This has led to accelerated land degradation, soil erosion and desertification. Due to water shortage, declining agriculture productivity, livestock, poverty and indebtedness, hunger and malnutrition, food and job insecurity have pushed villagers to migrate. Both central and state governments have released a lot of funds and initiated various rural development schemes to combat drought. But this is not enough; there are many gaps in the implementation and the delivery of outcomes. There is a need of tuning between central and state government. Money pours in, but calamity relief is not reaching to the poorer section of the society. It is important to prepare an action plan as early as possible to be based on reducing the sufferings related to water scarcity and food shortage There is a need to change some of the existing policies relating to water management, mining, agriculture, rural credit, forestry and industry with reference to regional specificities. The present paper analyses the above aspects for the Bundelkhand region of M.P and U.P, with a detailed study of Banda district.

Key words: Drought, scarcity, water management, mitigation, environment, attitude.

Impact of Drought and Flood on Indian Food Grain Production

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Abstract

Indian agriculture is highly dependent on spatial and temporal distribution of rainfall. Agriculture provides livelihood to almost three fourth of population of India. Climate extremes such as drought and flood affect agriculture severely. An account of impact of climate extremes viz. drought and flood, on Indian food grain production has been presented in this paper. There are temporal fluctuations in food grain production and area under the food grain. In secular terms, both of them increased upto mid-eighties. After mid-eighties there is decline in the area of food grain while maintaining an increase in production of food grain suggesting the improvement in agricultural technology and policy. There is more temporal fluctuation in the production of food grain than the area under food grain. The analysis reveals that impact of drought on Indian agriculture is more than that of flood. Rabi food grain production depicts better adaptability to drought than kharif food grain production mostly due to better access to irrigation infrastructure. Among the various food crops analysed all except jowar can effectively face flood events. Wheat and jowar perform relatively better during drought events. Rice is most sensitive crop to the extreme climate events. Since rice is staple food in the sub-continent, management of rice productions against climate extremes needs special attention for food security and sustainability.

Monitoring of Drought in Andhra Pradesh during Southwest monsoon 2002

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ABSTRACT

Using Thronthwaite's technique weekly water balance has been computed for all the districts in Andhra Pradesh for the monsoon season of the drought year 2002, beginning from June to the end of September utilizing the Potential Evapotranspiration values obtained by Penman's method. Normal value of weekly Aridity Index has been taken as the agricultural drought index to demarcate the drought affected areas. Results showed that all the regions of the state had continuously been under the grip of severe drought conditions during the period from 27-06-02 to 17-07-02. It affected kharif crops like rice, maize etc. Severe drought situation prevailed over Rayalaseema region during the period from 22-08-02 to 02-10-02. It had affected crops during the flowering to grain filling stages most.

Key words: Weekly Rainfall, PET, Aridity Index and GIS (Arc View)

Bundelkhand: Drought, drought and drought

Sanjay Vijayvargiya

Drought may be rare occurrence for large part of the country but people of Bundelkhand region are facing continuous drought since more than a decade. Some times Government declares droughts and some times people faced but government denied.

Bundelkhand is known for its unique undulating topography, ravines, large artificial water reservoirs and drinking water crisis for 2-5 months despite average annual rainfall of 800-1000 mm.

Early drought has been declared in 167 districts of the country including 5 out of 7 districts of Bundelkhand region of Uttar Pradesh. Declaration of drought is normally an issue of revenue and drought means deficit food grain production without considering humanitarian aspects of drought. CWWG normally take lead to develop alternative crop plan in situation like present or in case of early drought. But Alternative crop plan may be suitable only in irrigated areas and it has nothing to do with rain fed agriculture.

Drought declaration criteria of the country are based on the rainfall received in a particular area and at prima-facie it is more useful for irrigated areas.

Bundelkhand region is largely rain fed and erratic rainfall normally destroys the overall crops. In preset situation un-irrigated Kharif crop is either completely lost or it may used as fodder for few days and if there is no rains in the end of September and beginning of October, more than 50-60 percent of the Rabi crops will not be sown.

Survival of small marginal farmers and land less agriculture labourer is at stake in Bundelkhand due to continuous drought.

This is only first half of the August and 4 suicides in different parts of the region are already reported, it is assessed that food and fodder may be available for next few weeks and water may be available for next few months.

Drought in Bundelkhand is not a rare occurrence rather it is a continuous situation and drought situation assessment need to be reconsidered from the community perspective and approach of eventual response need to be change.

The potential of peer learning between Africa and Asia on Drought as a development issue

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Context:
Globally, and especially in developing countries, drought is one of the significant natural disasters in terms of spatial extent, duration of exposure, mortality and long-term socio-economic and environmental implications, posing a serious impediment to the achievement of Millennium Development Goals (MDGs). Over the past decade, a number of initiatives have pioneered partnerships among like-minded countries in Africa to strengthen their capacity for drought prevention, preparedness and recovery systematically. For example, the African Drought Risk and Development Network (ADDN), co-sponsored by UNDP and UN International Strategy for Disaster Reduction (ISDR), defines drought as a development issue rather than simply as a natural hazard. The Network aims to enhance applied exchange on key issues linking drought risk and development by providing a platform for sharing, analysis, documentation and dissemination of innovation, best practices and lessons learnt in Africa and beyond; as well as acting as a forum for the elaboration of policy relevant critical strategies.

Despite the considerable achievements seen through ADDN and other initiatives thus far, challenges still lie ahead. Among the gaps identified is also the limited opportunities for networking and technical exchange of best practices between African and non-African experts and practitioners. A wealth of knowledge - based resources already exists in Asia for drought coping and resilience building, both at policy and practice levels, many of which are deemed relevant in the African context, and vice versa. Indeed, the asset eroding impacts of recurrent drought are a major impediment to the attainment of the MDGs in both regions. Drought is the greatest natural hazard in Africa in terms of economic impact and loss of life, while Asia has the greatest number of people who are regularly exposed to drought.

Potential of Africa – Asia networking:
Yet much of this potential remains unrealized, in part because the mechanism to stimulate innovation system across the regions is not fully in place, leading to repetition of work between them. In order to help bridge gaps between knowledge producers and users, the call has been made for more institutionalized South-South cooperation and more formalized inter-regional communication strategies between Africa and Asia. Furthermore, experts and practitioners from Asia (e.g. China, India, Sri Lanka) have interacted at various levels with Drought Forums in Africa to share their experiences and lessons in drought risk management, as well as to be exposed to the innovative practices undertaken in Africa.

Africa – Asia Drought Risk Management Peer Assistance:
Given the good previous basis of cooperation and exchange this paper analyses the potential and challenges in institutionalizing the inter-regional knowledge exchange and

peer-learning process between Africa and Asia in the field of drought preparedness, adaptation and impacts mitigations. It will also devolve deeper into the opportunities and gaps currently existing to enhance the dissemination and use of best practices in drought risk reduction for development in the two regions. The paper will provide the decision-makers and practitioners engaged in drought risk management in Asia and Africa with critical insights on how the good practices and lesson learnt could be better communicated and up-scaled to help strengthen capacities at multiple scales in drought-prone areas in the two regions.

Coping droughts to enhance agriculture productivity from rainfed regions

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Abstract

Drought which is broadly defined as deficient supply of rainwater to meet the water needs of various forms of life in the ecosystem such as water drinking and other uses for both human and animal population, plants and agricultural crops water needs and decomposition organic matter in the soil etc. These would influence food and nutritional security of the human population. Drought conditions are the manifestation of the aberrations in the large scale weather phenomena at global level such as variability in monsoon rainfall both spatially and temporally which affect significantly the countries economy. Therefore, there is a need to understand the nature and extent of the damage caused by different intensities of drought in various regions of the country and evolve suitable strategies to cope up droughts in enhancing agricultural productivity. Based on the long term monthly rainfall data collected for various stations spread across country, the frequencies and the probabilities of the meteorological droughts of moderate and severe intensity have been computed and spatial maps have been prepared. As agricultural crops are likely to be affected immediately due to different intensities of water stress conditions, viable rainfed technologies developed over the period at CRIDA and its coordinating projects to manage drought conditions during the crop growing period have been reviewed. Use of ITK in management of water resources in drought prone regions and improving rural livelihood through adaptation of technologies have been critically evaluated. Similarly, contingent crop planning options for the different agroclimate regions of the country under different climate scenarios is discussed.

Approaches for minimizing the damages due to droughts using Information and Communication Technology (ICT) and Decision Support Systems (DSS), for managing drought conditions and their effective utilization with the different stake holders have been discussed. Importance of weather insurance as part of climate risk management in rainfed regions has been highlighted. Need for re look in to the delineation of existing drought prone areas in the country for proper distribution and utilization of relief funds

by government organizations, a separate drought code using NDVI, irrigation and probabilities of meteorological drought has been developed and attempts to reclassify the regions using the above criteria was carried out.

Watershed approach utilizing NREGA/S for Bundelkhand Drought
AND

Creating Village Based Trained Key Resource Persons for sustainable Drought Management

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The outcome of droughts had severe impact on the lives and livelihoods of the inhabitants of Bundelkhand region. The ecological and social settings throughout are so diverse that for generations droughts have ravaged the lives of the inhabitants of this area with unrelenting regularity every alternate year and sometimes for subsequent years, with an astonishing fact that every third house of rural region is devoid of water for drinking, agriculture land hungry for being moisturized and most importantly that villagers with their families are unable to earn their two time meal.

National Rural Employment Guarantee Act with its component aims to enact by addressing the key problem areas related to droughts and their impact. NREGA ensures to save life and dignity of most vulnerable by filling voids through substance i.e. economical stability. The need of today is to capacitate the community/villagers/institutions for water conservation techniques and pop out a sustainable plan community in context of water conservation under NREGA.
The project objectives were to develop a TOT manual for water conservation and Reference Manual for PRIs & Pradhan about water conservation & its methods under NREGA. Participatory Farmers Planning (PFP), is site specific and the farmer-friendly planning, is the approach followed by PGVS and its patterns in the NREGA.

Creating Village Based Trained Key Resource Persons for sustainable Drought Management

- Making trained human resources available around the issue of water conservation & its methods at the local level through capacity building of trainers in each block of Bundelkhand.

- Training of all Pradhans in one block of Lalitpur distt. for developing Panchayat level water conservation plan.

Impact of Natural Disaster on Environment and Economy: A Case Study of Drought in Rajasthan State, India

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Abstract

Rajasthan with an area of 342,000 km^2 (10.4% of the country total) and population of 56.5 million (5% of the country total) has 76.6% of its area under rural category. Though the state covers about 10 % of the country's area but has only 1% of India's water resources. The average rainfall of Rajasthan is 574 mm but it varies significantly across different regions. Every year some parts of Rajasthan are affected by drought. But the State has failed so far to diagnose the drought phenomenon and to come up with a long term solution. Declaration of drought is a sensitive issue and the Rajasthan Government has declared 26 districts in the State as drought-hit in 2009. Based on the crop assessment, the district administrator found that over 50 per cent of the kharif crop wilted due to insufficient monsoon rains. The impact of drought on the overall economy of the state as well as the country is evident at macro and micro–levels. The impacts could be direct or indirect and may vary in nature and intensity. The extent and intensity of drought impacts is determined by prevailing economic conditions, the structure of the agricultural sector, management of water resources, cereal reserves, internal and external conflicts, etc. There is a need for consistent collection of data on livestock mortality, human migration, coping strategies, depletion of groundwater table, etc.

The study is based on secondary data published by various line departments of state and central Government, review of published research papers and books on the subject and personal interactions of the authors with people in rural and urban areas. The attempt has been made to assess the impact of drought on environment, economy livestock, etc. There is a need to involve the state of art technology such as Remote Sensing, GIS and GPS etc for the advance prediction of drought as well as drought monitoring and management.

Keywords: rainfall, natural disaster, drought monitoring, Remote Sensing, and GIS, environment and water resource

Climatic changes and forewarning of agricultural drought over Western Rajasthan

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ABSTRACT

Daily rainfall data of arid Western Rajasthan for long period (1901-2007) have been utilized to form an annual rainfall time series. The time series are subjected to linear trend analysis with respect to all the 12 district headquarters of the region. To study the climatic shift in the region, mean moisture index (I_m), intensity and frequency of drought have been worked out over Western Rajasthan. Study has showed that in general, there is an apparent increase in annual rainfall at a linear rate of 21 mm century^{-1} with respect to entire regions. However, this change in rainfall is not uniform at all the places. Out of 12 districts, nine district headquarters viz.; Nagaur, Jalore, Sri Ganganagar, Sikar, Jodhpur, Churu, Jaisalmer, Pali and Barmer indicated increasing trend whereas, at remaining three places of Hanumangarh, Bikaner and Jhunjhunu have decreasing trend. The shifts in the moisture index line of -80.0 does not show any continuous increase or decrease of desertification conditions in the arid zone of Western Rajasthan. Whatever shifts have been noticed with respect to space and time were only temporary causing mild spurts of aridity and desertification. Frequency of drought revealed that over different places its frequency varied between 4 and 8 per decade in the past. Besides minimum three mild droughts, each decade also experienced at least either one severe or two moderate natures of droughts. The probability of occurrence of severe droughts, however, indicate highest percentage of 21 at Jaisalmer and 20 at Barmer which shows that these extreme western parts of the region experience droughts of severe nature at least once in every five year period.

Monitoring of cumulative weekly rainfall during different kharif crop growing seasons is very simple but can be successfully used as an indicator for early warning of agricultural drought for different crops in the Western Rajasthan. Data recorded over CAZRI, Jodhpur in the recent past revealed that if enough sowing rain is not received latest by 27th meteorological week (before middle of July), there is a likely chance of occurrence of terminal drought for pearl millet at reproductive phase of the crop as observed during drought years 2000 and 2004. Similarly, if adequate sowing rains do not occur by the end of July, there is no possibility left to grow even short duration kharif pulses successfully. In 2002, when adequate sowing rain did not occur by middle of August, the entire region was wiped out under severe drought and there was even acute shortage of natural grasses, fodder, feed and drinking water for animals in the region.

Mapping of Drought severity for a Semi-Arid District of Karnataka State

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Droughts, one of the major natural hazards and would impact the amount of water available to crops grown for domestic and commercial usage and therefore a detailed monitoring of droughts on spatial and temporal scales is essential for the social and economical growth of the region. The present study is on the evaluation and mapping of drought severity for the Bijapur district in the Northern Interior Karnataka which is prone to severe water shortages most of the year. Placed in the Deccan plateau, the district is characterized by hot and dry weather with an annual rainfall of about 400mm. Because of erratic rainfall and lesser humidity, the region experiences severe drought conditions throughout the year with a gross annual water deficit of about 1500-1600mm and therefore the crop growth is restricted to about 90 days per annum. In order to evaluate the drought severity and extent, we use the SPI model and the Geographic Information System. Daily precipitation data available for 50 stations for the period 1950-2005 are used to estimate the intensity, duration and extent of drought using the methodology described by Ponce et al (2000). The SPI model is based on the probability of precipitation and is designed to quantify the precipitation deficits for multiple time scales. Drought conditions are interpreted for each of these location and maps are prepared in Arc View GIS platform. The results confirmed the area under severe droughts for a period of 10% of the total events with an intensity of more than 1.25.

DROUGHT MANAGEMENT: A CASE STUDY OF INDIA

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The paper deals with the phenomenon of drought and disaster management system in India. In common parlance, drought denotes scarcity of water. In this situation, crop failure due to lack of rains is the most common form of drought. It results in reduced income of farmers and agricultural labourers. It reverses the development process, creates health problems, encourages unsocial behaviour, demoralises the people; and leads to migration thus exporting conflict and resentment to the neighbourhood regions. Vulnerability to drought, from economic angle reduces the demand within the economy generally, increases defaults on loans in rural sector, and reduces the Government revenues. The drought affects national budget as it costs heavily to the Government for organising relief measures. However, at the state or national level, the drought impacts a creeping long-term set back to the socio-economic development.

The major objectives of study are to explore the causes and impacts of drought; analyse the existing drought management system in India; and suggest necessary measures to mitigate the disaster.

Given the large size of the country and the very high time and space variability of the southwest monsoon rainfall, it is not surprising that no part of India can be regarded as free from the likelihood of occurrence of drought. That is why there are parts of the country suffering from drought even in the best of the monsoon years. (e.g., Madhya Pradesh in 1988 or sometimes drought occurring in the usually very rainy north eastern States of the country (e.g., in 2005). The Government has launched various programmes for drought management like Desert Development Programme, Drought Prone Area Programme, and Food for Work Programme. Now, there is an urgent need to focus attention on all aspects of drought management, including relief measures**.** As the disaster preparedness is a very cost-effective component of disaster management, therefore the study seeks to emphasise on preparing the community for meeting the challenges. **In this direction, joint efforts of citizens, political leaders and administrators to converge the National Rural Employment Guarantee Act (NREGA) and other agricultural and rural schemes to minimise the impact of drought will be boon for inclusive growth.**

Drought in Rajasthan

M.K.Khanna

Rajasthan is one of the largest states of India having area of 34239 Sqr. Km with a population of 5,64,73122 as per 2001 census. 77% of the population lives in villages. The animal population of Rajasthan is 543 lacs as per 1997 census and its account for 25% of India's Animal population. The average rainfall of Rajasthan is 531mm in comparison to India's average rainfall of 883 mm. Rajasthan is geographically divided by Aravali Hills and divides Rajasthan in Western and Eastern Rajasthan. Western Rajasthan comprises of desert as it goes with the name of Rajasthan as a Desert state, where Aravali Hills became a Barrier to spread desert from Western Rajasthan to Easter Rajasthan.. The average rainfall in Western Rajasthan is 279 mm.

The present policy of the Government on drought relief has been evolved over a period from the various measures adopted for amelioration of the distress caused by famines and scarcities from time to time .To appreciate the dimensions of the policy it will be worthwhile to recount some of the important milestones in its evolution.

The famine policy of the erstwhile rulers in India was evolved through a process dictated by conditions prevailing from time to time and as per the resources of the state. This paper tries to review the measures and policies evolved over the years.

Analyzing the effects of intermittent droughts on monsoon cereal crops

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Climate change associated increase in climatic variability poses major risk to the crop production. In India, agriculture is monsoon dependent and increased occurrence of seasonal or intermittent droughts cause a large impact on crop production and form the major source of variation in productivity. In order to quantify the impact of intermittent droughts on phenological growth, dry matter and yield, a pot study was conducted with three cereal crops viz., maize, sorghum and pearl millet. These crops were exposed to drought condition at different periods of crop growth viz. D_1 (15 days from 28 - 43 days after sowing; DAS), D_2 (one week from 44 – 50 DAS), D_3 (seven days from 51 – 57 DAS) and D_4 (one week from 58 - 64 DAS). Apart from these, a control set was maintained under natural conditions. Observations were taken on phenology, dry matter accumulation and yield. Results indicated that intermittent droughts during pre-flowering stage has prolonged the crop duration in maize and pearl millet. On the other hand, in sorghum, the crop duration decreased when exposed to drought from 44 DAS onwards till pre-flowering. Even though intermittent drought condition reduced the plant height and dry matter accumulation in all three crops, the reduction was more when crop was exposed to drought (D_1) in early stage. Analysis indicated that maize suffers higher yield loss in the event of intermittent drought coinciding with early (28-43 DAS) and flowering phases, while least yield loss was noted in pre-flowering drought stress. Similar trends were observed in sorghum. On the other hand, pearl millet yields improved when drought coincides with panicle emergence. The results indicate crop specific response to intermittent drought.

Stratospheric Winds (QBO) and Extreme Weather Events (Flood/Drought) of Indian Summer Monsoon: A Reappraisal

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Abstract

The relation between stratospheric winds (QBO) during different phases and extreme weather events like flood/drought/normal years of Indian summer monsoon has been examined. It has been found that the concurrent correlations are highly enhanced during the easterly phase of QBO. All recent major El Nino events, which were associated with droughts in India, *viz.* 1965, 1972, 1982 and 1987, the QBO phase was easterly during the monsoon season. Interestingly, whether one of the severest drought years 1979 is accepted as an El Nino event or not, the QBO phase was easterly during the monsoon season. During 1991, the standardized monsoon rainfall anomaly was about to exceed the threshold of −1, and the QBO phase was easterly. However, for the El Nino year 1963, although the QBO phase was easterly, the monsoon rainfall was normal. While El Nino events, which were associated with normal monsoon rainfall *viz.* 1953, 1957, 1969 and 1976, the QBO phase was westerly during the monsoon season. During the 1951 El Nino, QBO data are not available. Interestingly, the phase of QBO remained easterly for 1 year from May 1996 to April 1997, but changed over to the westerly phase from May 1997 commencing 1 month before the onset of the Indian monsoon. This may be the reason, as supported by our analysis, why India had a good monsoon during 1997 despite a strong El Nino event. This study also explained the failure of this year (2009) monsoon. The results explained that the El Niño-Southern Oscillation (ENSO) events continuing during the monsoon season and are associated with easterly phase of QBO are likely to cause drought, while events which are associated with westerly phase of QBO are likely to result in a normal monsoon over India.

AGRICULTURAL DROUGHT ASSESSMENT AND MANAGEMENT IN ORISSA

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Abstract

The State of Orissa is frequently affected by drought, despite its high annual rainfall (1450 mm). Although deficit of monsoon rainfall over time and space is the cause of the agricultural drought, amount of rainfall is not much useful to assess and declare the occurrence of drought for various land situations during the ongoing season. Accordingly, crop criteria were formulated to assess the drought situation for three periods of kharif season. Monsoon rainfall characteristics were used to fix time limit for declaring early season, mid season and late season drought as July 15, August 31 and October 15. A set of farm operations and crop conditions were proposed as the indicators of drought occurrence. Real time crop criteria were suggested to decide whether or not drought has occurred. Critical limit of crop damage was considered as 50%. Due to spatial variation of rainfall and land type, Gram Panchayat was considered as the geographical unit for assessment. Amounts of rainfall over a period required for various operations of rice crop were suggested for different land situations so as to monitor the crop condition during the season. A set of preventive and curative management practices were suggested as mitigate the drought impact.