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Analysis of rainfall data for drought investigation at Agra U.P.

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Abstract
This study presents analysis of droughts at Agra district of Uttar Pradesh India. Drought conditions were assessed for yearly time steps using rainfall data for thirty one years (1970 to 2000) at Agra station. According to the India Meteorological department (IMD) an area/region is considered to be drought if it receives seasonal total rainfall less than 75% of its normal value. The rainfall records of 31 years for Agra were obtained from the India Meteorological Department (IMD). Rainfall data has been subjected to various kind of analysis including seasonal & annual rainfall departures, probability distribution and dry spell analysis etc. For identification of drought years and the extent of deficit of annual rainfall, the annual rainfall departure analysis has been carried out. A year is considered as drought year if the total amount of annual rainfall over an area is deficient by more than 25% of its normal value. From the analysis it is observed that in years 1970,1986,1987,1990 and 2000 as moderate drought & years 1972 & 1979 as a severe drought occurred in Agra district, the chance of occurrence of drought in every 10 years varies from 2 to 2.5. It means that year after every 3 to 4 year is a drought year.

Keywords: Rainfall data, Drought investigation, Agra district

INTRODUCTION

Drought is considered by many to be the most complex but least understood of all natural hazards, affecting more people than any other hazard (G.Hagman 1984). It is broadly defined as severe water shortage. Low rainfall and fall in agricultural production has mainly caused droughts. A droughts impact constitutes losses of life, human suffering and damage to economy and environment. Droughts have been a recurring feature of the Indian climate therefore study of Historical droughts may help in the delineation of major areas facing drought risk and thereby management plans can be formulated by the government authorities to cope with the disastrous effects of this hazard. However, there remains much confusion within the scientific and policy communities about its characteristics. It is precisely this confusion that explains, to some extent, the lack of progress in drought preparedness in most parts of the world. Drought is a slow-onset, creeping natural hazard that is a normal part of climate for virtually all regions of the world; it results in serious economic, social, and environmental impacts. Drought onset and end are often difficult to determine, as is its severity. The impacts of drought are largely nonstructural and spread over a larger geographical area than are damages from other natural hazards. The non-structural characteristic of drought impacts has certainly hindered the development of accurate, reliable, and timely estimates of severity and, ultimately, the formulation of drought preparedness plans by most governments. The impacts of drought, like those of other hazards, can be reduced through mitigation and preparedness. Drought preparedness planning should be considered an essential component of integrated water resources management. Increasing society‘s capacity to cope more effectively with the extremes of climate and water resources variability (i.e., floods and droughts) is a critical aspect of integrated water resources management. Shakir Ali (2003) has reviewed the drought indices in India and concluded that there is a need to test the most important drought indices in different agroecological regions of country and to select only those indices, which are appropriate for a particular agroecological region. Dracup et al. (1980) emphasized that the droughts are inherently regional in nature, and thus their aerial extent is an important characteristics to be considered. Recently a method was developed by Tiwari et al. (2007) to characterize the meteorological drought indices using the data of Hazaribagh. On comparison, they found that the developed method is more rational than existing methods of drought characterization. Drought is generally defined as water shortage caused by the imbalance between water supply and demand. Drought is generally viewed as a sustained and regionally extensive occurrence of appreciably below average natural water availability, either in the form of precipitation, surface water runoff or ground water Gbeckor-Kove, (1995). Drought has different meanings to different disciplines. What is drought for an agriculturist need not to be so to a hydrologist or meteorologist. There is no universal definition applicable to all disciplines. It is temporary feature caused by climatic fluctuations and is an extremely complicated phenomenon. The formation and intensity of drought are gradual and cumulative process, which occur so slowly that they are not easily discerned. Factors, which may induce drought, are very complex. In addition to many factors in natural environmental conditions like precipitation, evaporation temperature, wind, humidity, etc. the hydrological conditions such as surface water and ground water etc.; the agricultural condition such as soil behavior, cropping pattern, crop varieties and growing period etc.; and the geographic condition like topography etc. also contribute to drought. The recurrence of drought over many parts of the country in recent years caused unprecedented economic losses and great suffering to the affected

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areas. They not only reduced the agricultural production but also threatened country with famine. Drought causes innumerable problems immediately or with the time lag as the economy gradually experiences the adverse shock of the phenomenon. The occurrence of drought leads to reduction in stream-flow, and consequent reduction in reservoir and tank levels and depletion of soil moisture and groundwater. This on a continuous basis leads to reduce availability of fodder, decline in agricultural production and livestock wealth, besides causing misery to people inhabiting these areas. The drought characteristics and associated problems vary from area to area, depending upon the amount of variability of available water supplies and the demand of water for specified users.

Classification of drought

Generally the drought could be clustered into meteorological drought, agricultural drought, hydrological drought, and societal /economic drought (Wilhite and Glantz , 1987). Meteorological drought is characterized by the water storage induced by the imbalance between precipitation and evaporation, in particular, water shortage based solely on precipitation e.g. rainless situation. Meteorological drought over an area is defined as a situation when seasonal rainfall over the area is less than 75% of its long term normal. It is further classified as moderate droughtǁ if the rainfall deficit is between 26to 50% and severe droughtǁ when it exceeds 50%.A list of some of the definitions is given in WMO (1975). Agricultural drought refers to the water storage caused by the imbalance between soil available water and the water requirement of crops. It is related to physiological drought determined from conditions of crops, natural vegetation, livestock pasture and other agricultural systems. The agricultural drought occurs when water deficit severely affects the agricultural system as a whole. Some agriculturists have measured the effect of water deficit in terms of economical losses induced by the deficit. The economical loss can include factor like drop in crop production, livestock deaths industrial losses, plants not planted, changes in land use, emergency relief expenses etc. Hydrological drought is represented by the water shortage formed by the imbalance budget of surface water and underground water. It is mainly affected by various hydrological factors such as surface run off, shallow and deep underground water etc. The water resources in the form of precipitation, infiltration, river systems and other surface /ground water, inflow/outflow system may be included in the hydrological water balance equation as fallow:

W=G – L

Where,
W=available water for the system use.
G=total incoming water of the system (precipitation, infiltration, storage, etc)
L=total water loss (evaporation, run off etc.)

Hydrological drought occurs when the water demand by the hydrological system greatly exceed the water available from the system use (W)from the water balance equation it is clear that precipitation is the most common natural factor which may induce hydrological drought. Finally socio-economic drought is associated with the supply and demand of some economic goods. It occurs as an interaction between agricultural activity (i.e. demand) and natural events (i.e. supply) which results in a water volume or quality inadequate for plants and / or animals needs.

Assessment of Drought

Years Drought can be defined as a temporary harmful and widespread lack of available water with respect to specific need. It implies a deficiency of rainfall of sufficient magnitude over a prolonged duration so as to interfere with some phases of regional economic activities. According to the India Meteorological department (IMD) an area / region is considered to be drought if it receives seasonal total rainfall less than 75% of its normal value. In the present study attempt has been made to assess the drought situation in Agra district of U.P. Agra is an important district in northern region of U.P., where the occurrence of recumbent drought have badly affected the agricultural production and economy of the area. The rainfall records for the Agra district were obtained from the India Meteorological department (IMD). Rainfall data has been subjected to various kind of analysis including seasonal & annual rainfall departures, probability distribution and dry spell analysis etc.

MATERIAL AND METHODS

The daily rainfall data of thirty four years (1970 to 2000), the rainfall records for Agra district were obtained from the India Meteorological department (IMD). The Agra district is located on the bank of river Yamuna in the northern region of Uttar Pradesh and lies between north latitude 27º11' to 27º19' and east longitude 78º01' to 78º02' and elevation of above 63.4 m above mean sea level. The main occupation of the district is agriculture and pearl millet, sorghum and potato are the chief grown crops. The average annual rain fall in Agra is 663.8 mm. the rainfall in this track is received from south western monsoon. According to the India Meteorological department (IMD) an area / region is considered to be drought if it receives seasonal total rainfall less than 75% of its normal value. Rainfall data has been subjected to various kind of analysis including seasonal & annual rainfall departures, probability distribution and dry spell analysis etc.

Calculation of departure

Step-1 - Take the annual discharge data (mm) of any district.
Step-2 - Firstly we will calculate the mean of annual rainfall data.
Step-3 - Now we calculate the standard deviations, skewness, maximum, minimum and median of the rainfall data.
Step-4 - For calculating the departure we will substrate the annual rainfall data of a year from the mean rainfall of the year.
Step-5 - Now we will find out the 75% of mean rainfall.
Step-6 -Then we calculate the drought year .for calculating the drought year we will to compare the annual rainfall .if the value of annual rainfall of year with 75%of mean rainfall, then it is called drought year but if the value of annual rainfall of year is greater than the 75% of mean rainfall then it is called the no drought year.
Step-7 - After calculating the drought year, we calculate the departure from mean rainfall. It is calculated with help of below given formula.

Departure from mean rainfall
= (annual rainfall of year - mean rainfall) / Mean rainfall*100

Step-8 - Finally we will calculate the class of severity of the particular

block. If the value of departure from mean rainfall is less than -25% then no drought condition, but if the value of departure from mean rainfall is coming between the -25 to -50%then it is called the moderate drought condition. If the value is generate then -50% then the condition of drought is severe for the particular area or block.

Percentage departure of rainfall from normal	Intensity of drought
0.0 to -25.0	No drought condition
-26.0 to -50.0	Moderate drought condition
More than -50.0	Severe drought condition

RESULTS AND DISCUSSION

Annual Rainfall Departure For identification of drought years and the extent of deficit of annual rainfall, the annual rainfall departure analysis has been carried out. A year is considered as drought year if the total amount of annual rainfall over an area is deficient by more than 25% of its normal value. The percentage annual rainfall departures in all blocks of Agra district are given in Figure. From the annual rainfall departure analysis, the drought years have been identified and its average frequency of drought is presented in Table. From the analysis it is observed that in years 1970,1986,1987,1990 and 2000 as moderate drought & years 1972 & 1979 as a severe drought occurred in Agra district, the chance of occurrence of drought in every 10 years varies from 2 to 2.5. It means that year after every 3 to 4 year is a drought year. The Agra district experiences severe drought in the year of 1979 it is -56.94.

Table1. Frequency of drought years in Agra district for Annual rainfall

S. No.	Name of district	Data available (Year)	Mean annual rainfall In mm	Drought frequency		Ave. Drought frequency In 10 yrs period	Drought Years	
				No.	In Yr		Severe	moderate
1	Agra	1970-2000	666.44	07	31	2.25	1972, 1979	1970,1986,1987, 1990 & 2000

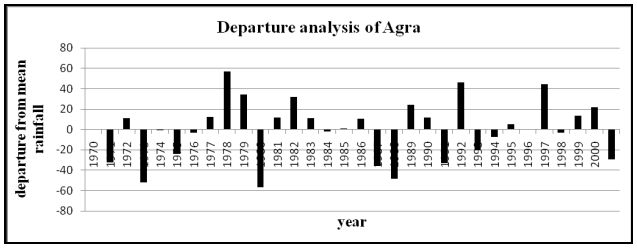

Fig (a-c). Percentage annual rainfall departure in different blocks of Agra district.

CONCLUSION

The occurrence of drought in India is not recent phenomenon. In order to find out whether the sufficient rainfall areas in Agra district are affected by the rainfall deficiency, the 31 years of rainfall data were analyzed to assess the seasonal and yearly drought condition in the Agra district, U.P.

1. The average frequency of drought recurrence in the area on the basis of annual departure is 3 to 4 years, some blocks are severely affected by drought & some are moderately affected.
2. The year 1970, 1986, 1987, 1990 & 2000 are found to be moderately drought affected year in the period of 31 years on the basis of annual analysis.
3. The year 1972 & 1979 are found to be severely drought affected year in the period of 31 years on the basis of annual analysis.
4. The trend in the rainfall showed that the rainfall is decreasing in the area.

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