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Identification of meteorological drought year for Varanasi district U.P.

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Abstract
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 is considered to be drought if it receives seasonal total rainfall less than 75% of its normal value. The rainfall records of 37 years for Varanasi 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 1972, 1979, 1992, 2004 as moderate drought years occurred in Varanasi district & there were no severe drought in this region. The chance of occurrence of drought in every 10 years varies from 1 to 2. It means that year after every 4 to 5 is a drought year.

Keywords: Meteorological Drought, Drought Frequency, Rainfall Departure

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 a normal feature of climate and its recurrence is inevitable. Rainfall is the primary indicator of drought and is the basis for most drought watch systems. The occurrences of droughts are generally linked to deficit precipitation, low soil moisture, deficit river flows or groundwater as compared to their corresponding normal values. The India meteorological Department (IMD) defined seasonal drought as the period with the seasonal rainfall deficiency more than 25% from its normal value. (Rao 1986). Drought is defined as the deficiency of available water that injuriously affects the usual crops, causes temporary scarcity of water for human/livestock consumption and influences the economic renewable resources. A simple approach to delineate good or bad monsoon years have been suggested by. They considered a year to be a bed monsoon year if in more than two-third number of meteorological stations the seasonal rainfall is deficient (Banerjee 1976). The conventional attitude to a drought as a phenomenon of arid and semi-arid areas is changing because even areas with high average rainfall often face acute water scarcity. Cheerapunji, the world's highest rainfall area, was facing severe drinking water shortages. Drought in the state of Orissa, with an average rainfall of 1100 mm, surprised many (Rahor 2005). A method for spatially representative depiction of vulnerability to drought using multiple indicators in Sonar basin. These indicators include topography characteristics, land-use types, soil types, relative availability of surface water and groundwater, water demand and utilization and the rainfall departures from corresponding mean values (Pandey *et al.* 2010). The unlike earthquakes, floods and cyclone, drought occurrence is a gradual process with long lasting effects. The droughts from 1980 to 2000 posed a threat to the food security and human mortality all round the world. On average 28% of the geographical area of India is vulnerable to droughts. Meteorologically ±19 % deviation of rainfall from the long-term mean is considered normal in India. He suggested that, rainfall deficiency in the range of 20 to 59% could be represented as "moderate" drought and more than 60%, as "severe" drought. From 1871 to 2002 (Samra 2004).

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 drought‖ if the rainfall deficit is between 26to 50% and severe drought‖ 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

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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 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 Varanasi district of U.P. Varanasi 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 Varanasi 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

Features of study area

The study area is located in the middle Ganga valley of north India, in the eastern part of the state of Utter Pradesh, along the left crescent shaped bank of the Ganga river. It has the headquarter of Varanasi district U.P. India. The area of Varanasi district is 1550.3 km^2, which is located within geographical co-ordinates of 25°14' and 25° 23' northern latitude and 82°03' and 83° 56' eastern longitudes (figure 1). Being located in the Indo-Gangatic Plains of North India, the land is very fertile because low level flood in the Ganges continually replenish the soil. Locally known, Varanasi is located on a higher ground between river Ganga and Varuna, at a mean sea elevation of 80.71 m.

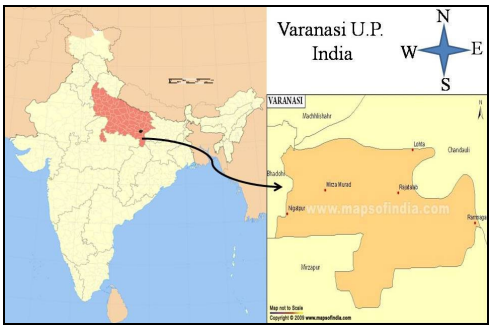

Fig1. Location of the study area

METHODOLOGY

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.

A drought year is one with less than average annual precipitation. A drought event is a series of one or more consecutive drought years. Drought frequency (*F*) pertains to the number of years that it would take a drought of a certain intensity to recur; for instance, once in 10 years. The reciprocal of the frequency is the return period or recurrence interval. In common usage, however, frequency and return period are often used interchangeably, for instance, a frequency of 10 years. Since dry periods are generally followed by corresponding wet periods, it follows that the recurrence interval of drought is always greater than the drought duration. Since the time unit is a year, the minimum duration of a meteorological drought is one year and the minimum drought return period may be two years.

In the present study, the annual rainfall series for 35 (1971-2007) years for the given station was analyzed using percentage annual rainfall departure from normal (PARD) to identify the drought years. Using the definition given by IMD, a meteorological drought year is marked as PARD ≤ -25% (Table 1). Plots of percentage annual rainfall departure from mean were prepared for identification of drought years and the drought events. The sample plots of PARD for Varanasi station in Uttar Pradesh are shown in Fig. 2.

Table 1. Intensity of Drought

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 Varanasi 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 2. From the analysis it is observed that in years 1972, 1979, 1992 & 2004 as moderate drought occurred in Varanasi district, the chance of occurrence of drought in every 10 years varies from 1 to 2. It means that year after every 1 to 2 year is a drought year. Table1: Frequency of drought years in Varanasi district for Annual rainfall departures, probability distribution and dry spell analysis etc.

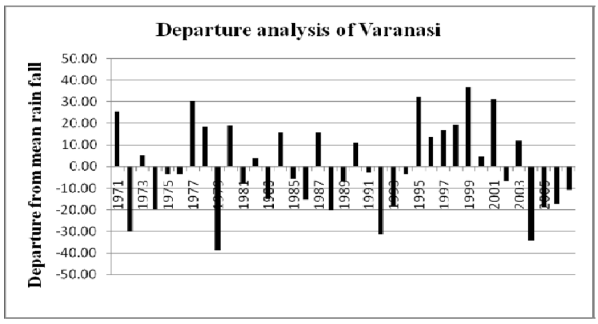

Fig 2.Percentage annual rainfall departure in Varanasi district.

Table 2. Frequency of drought years in Varanasi district

S. No.	Name of district	Data available (Year)	Mean annual rainfall In mm	Drought Years	Ave. Drought freque in10 yrs	Drought Years
1	Varanasi	37 (1971-2007)	1013.49	04	1.08	1.08

CONCLUSION

The occurrence of drought in India is not recent phenomenon. In order to find out whether the sufficient rainfall areas in Varanasi district are affected by the rainfall deficiency, the 31 years of rainfall data were analyzed to assess the yearly drought condition in the Varanasi district, U.P. The average frequency of drought recurrence in the area on the basis of annual departure is 1 to 2 years, these are moderately affected. The year 1972, 1979, 1992 & 2004 are found to be moderately drought affected year in the period of 37 years on the basis of annual analysis. Most important thing is that there was no severe drought in that Varanasi region.

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