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RAINFALL CHARACTERISTICS AND METEOROLOGICAL DROUGHT CONDITION IN JHUNJHUNU DISTRICT OF WESTERN RAJASTHAN

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ABSTRACT

The rainfall characteristics, weekly water balance and meteorological drought conditions using six tehsil-wise rainfall data (1901-2005) in arid Jhunjhunu district were studied. The district experiences 399-556 mm of annual rainfall, 24-32 rainy days with a coefficient of variation of 37-44%. The seasonal rainfall (June-September) varied from 348-477 mm with 18-24 rainy days. The extreme rainfall events recorded in the Jhunjhunu district showed that 1-day highest was between 157.5 mm at Jhunjhunu to 281.4 mm at Khetri. 1-day highest rainfall was 91-117 mm once in 5-years to 167-226 mm once in 100 years. The long-term annual rainfall trends showed that there was a marginal increase at a rate by 12 mm/100 years at Jhunjhunu, 30 mm/100 years at Khetri, 56 mm/100 years at Chirawa and 100 mm/50 years at Udaipurwati. The meteorological droughts prevailed in 34 years out of 105 years (1901-2005). Thus, the frequency of occurrence of drought in the Jhunjhunu district varied from once in 3.6 years at Jhunjhunu to 3.0 years at Khetri. The other locations in the district experienced in 29 years at Chirawa. The drought frequency was highest during the decade 1981-90 with 6 out of 10 years recording moderate to severe drought and least frequency recording during 1941-50 with 2 out of 10 years as drought years.

Keywords: Rainfall characteristics, meteorological drought, Jhunjhunu district.

INTRODUCTION

Jhunjhunu district located in the arid western Rajasthan is highly vulnerable to extreme climatic conditions and drought compared to other arid regions of the country. It is charaterised by very hot summers and very cold winters with poor rainfall during south-west monsoon period. In May and June, the maximum temperature may sometimes goes up to 49^{o}c. The potential evapotranspiration rates are quite high, especially during May and June. The total annual potential evapotranspiration is 1502.6mm. Out of 6463.2 sq. Km. Of cropped area, only 2267.9 sq Km (35.1%) area has irrigation facility aggregating drought impact on crop production in the district. Agriculture activity is spread over both kharif and rabi cultivation. Kharif cultivation is rainfed and rabi cultivation is mostly based on ground water. The main kharif crops grown in the area are pearl millet (bajra), cluster bean (guar), cowpea, moong bean and moth bean whereas, principal rabi crops are wheat, gram and mustard etc. (CGWB, 2008). An attempt is made in this paper, to analyze the rainfall characteristics, weekly water balance for identifying the meteorological droughts.

MATERIALS AND METHOD

Jhunjhunu district is located in the extreme north eastern part (bordering Haryana state) of Rajasthan State (Fig. 1) and lies between 27°38′ & 28°31′ north latitudes and 75°02′ &76°06′ east longitudes is chosen for the present agrometeorological study by collection of six *tehsil*-wise rainfall stations data for the period 1901 to 2005. The frequencies of different categories of meteorological drought are made according to a classification given below by the India Meteorological Department (Koteswaram, 1976; Subrahmanyam, 1967, Rao *et al.*, 2007).

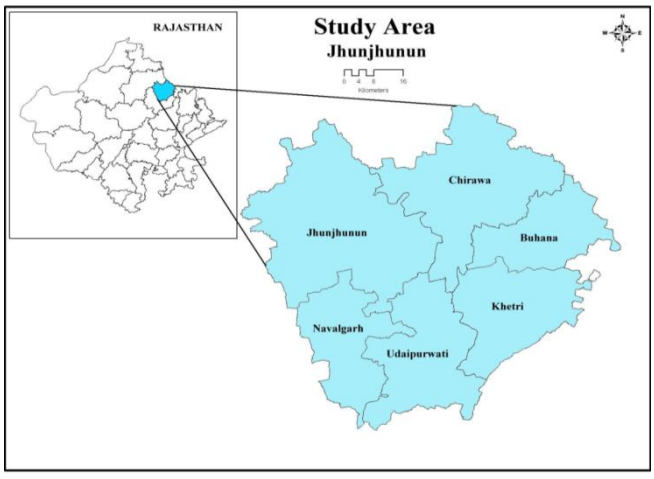

Fig.1: Tehsil wise map of Jhunjhunu district of arid Rajasthan

Table 1: Classification of meteorological drought

Drought category	Percentage departure from normal
Excess or flood	More than 51%
Above normal	+26% to +50%
Normal	+25 % to –25%
Below normal	-26% to –50%
Drought	Less than –51%

The 1-day maximum rainfall for different return periods were estimated using Weibull's formula (Chow, 1964, Rao *et al.,* 2007) based on daily rainfall events at these six locations of Jhunjhunu district. The following equation was used to estimate the probable maximum precipitation;

$$X_m = X_{mean} + \sigma K_m$$

Where,

X_m =estimate of PMP

X_{mean}=mean of rainfall

σ =standard deviation of rainfall

K_m= frequency factor

Where,

$K_m = X_L - X_{meanN-1}) / \sigma_{N-1}$

X_L is the largest value of the rainfall series

$X_{meanN-1}$ =Mean of the rainfall excluding X_L value

σ_{N-1} =Standard deviation of rainfall excluding X_L value

The annual rainfall trends were obtained by using linear regression technique based on the annual rainfall totals for each *tehsil.* The weekly water balance was computed using Thornthwaite and Mathur (1955) book-keeping procedure using weekly rainfall of different locations and weekly normal potential evapotranspiration values of Jhunjhunu.

RESULTS AND DISCUSSION

Climatic characteristics

Seasonal variation in air temperature:

During winter, mean minimum temperatures in Jhunjhunu district vary between 5.1 and 7.9^{0}C. Air temperatures sharply increase from April onwards and stand highest during May till pre-monsoon showers sets in the area. Summer air temperatures vary between 33.7^{0}C and 39.6^{0}C with peak values as high as 49^{0}C in summer and –3.5^{0}C during winter month. Temperatures fall during the monsoon period (June-September), but however, rise after recession of the monsoon by about 3 to 5^{0}C and again start falling from December onwards due to winter conditions.

Table 2: Tehsil-wise rainfall characteristics of Jhunjhunu district

Station	Annual rainfall (mm)	Annual rainy days	Coefficient of variation (%)	Seasonal rainfall (mm)	Seasonal rainy days	Highest rainfall (mm)	Lowest rainfall (mm)
Buhana	479	25	44	421	19	915(1996)	133(2002)
Chirawa	420	25	41	366	19	932(1908)	95(1938)
Jhunjhunu	399	26	37	348	20	778(1956)	93(1901)
Khetri	556	32	37	474	24	1252(1977)	89(1905)
Navalgarh	431	24	38	388	18	881(1917)	131(2002)
Udaipurwati	534	29	39	477	23	1191(1996)	211(2002)

Rainfall characteristics:

The normal annual rainfall of the district varied from 399 mm in 26 rainy days at Jhunjhunu to 556 mm in 32 rainy days at Khetri (Table 2). The southwest monsoon rainfall had contributed for 85-90% to the annual total, whereas the winter rains 4-5% and summer rains 6-7% to the total. The coefficient of variation in annual rainfall for these locations was between 37% at Jhunjhunu to 44% at Buhana. The annual rainfall in the district varied from a lowest of 93 mm in 1901 at Jhunjhunu to a highest of 1252.0 mm in 1977 at Khetri and 1191.0 mm in 1996 at Udaipurwati. The extreme rainfall events recorded in the Jhunjhunu district showed that 1-day highest was between 157.5 mm at Jhunjhunu during 21 July 1920 to 281.4 mm at Khetri during 06 September, 1908 (Table 3).

Table 3: Extreme rainfall events in Jhunjhunu district

Stations	Highest	Date	PMP (K=6)
Buhana	190	22 July, 1906	272.9
Chirawa	203.2	22 July, 1908	217.2
Jhunjhunu	157.5	21 July, 1920	164.6
Khetri	281.4	06 September, 1908	313.6
Navalgarh	182.0	23 July, 1996	244.4
Udaipurwati	279.0	09 July, 1968	352.8

The 1-day rainfall in Jhunjhunu district for different return periods of 5, 10, 25, 50 and 100 years are

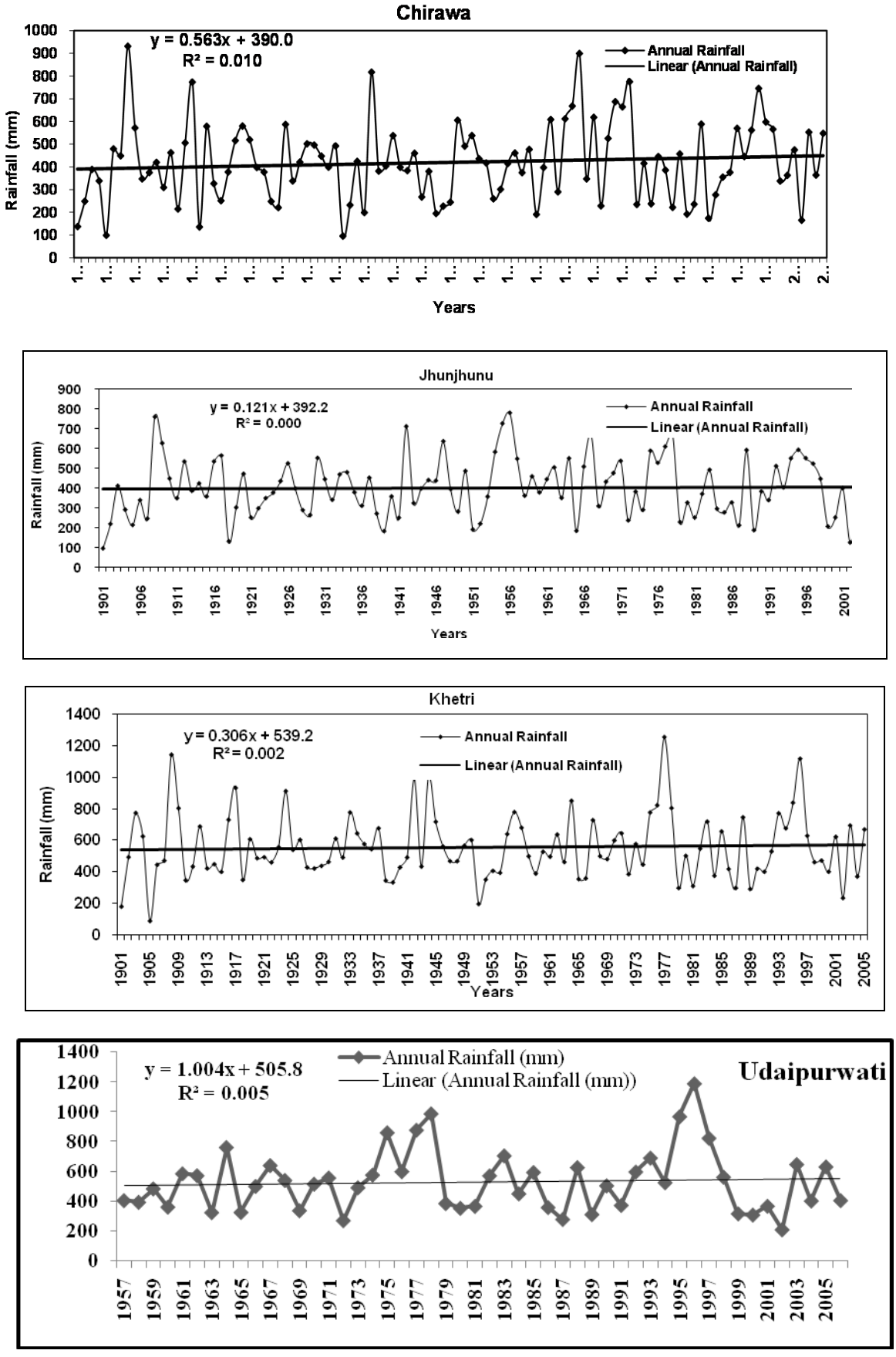

Fig. 2: Annual rainfall trend at different locations in Jhunjhunu district

presented in Table 4. The 1-day rainfall was lowest at Jhunjhunu and highest at Buhana for all return periods of 5, 10, 25, 50 and 100 years. The extreme rainfall records at these locations showed higher rainfall (Table 3) than that computed values for all return periods (Table 4).These return period rainfall values also showed that there is plenty of scope for water harvesting and reuse for cultivation of crops. The long-term trends in the annual rainfall of four tehsil locations of Jhunjhunu district (Fig.2) have showed either normal or marginal increase in rainfall in the district. The rainfall trends in Jhunjhunu district are presented in Fig.3. This figure showed that the highest meteorological drought intensity was thus 56 m in the decade 1981-1990.

Table 4: Return period of 1-day rainfall (mm) in Jhunjhunu district

Station	Return period (years)				
	5	10	25	50	100
Buhana	116.5	143.0	176.0	200.7	225.8
Chirawa	91.8	109.9	132.6	149.5	166.7
Jhunjhunu	82.8	98.1	117.2	131.5	146.0
Khetri	110.7	133.1	161.0	181.8	203.0
Navalgarh	112.7	138.2	169.9	193.6	217.8
Udaipurwati	113.0	137.3	167.6	190.3	213.3

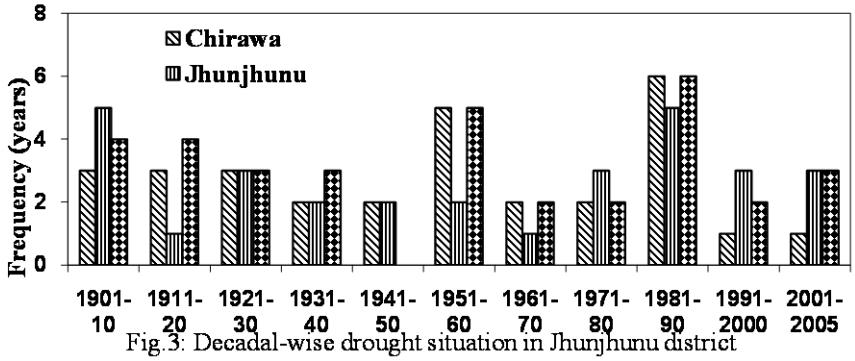

Fig.3: Decadal-wise drought situation in Jhunjhunu district

Meteorological droughts

The frequency of meteorological droughts occurred in Jhunjhunu district are given Table 5. Jhunjhunu location experienced highest number of normal to above normal rainfall years of 76 out of 105 years with minimum number of 29 years with below normal conditions. Khetri experienced highest number of years with below or severe drought conditions in 34 out of 105 years. Thus, the frequency of occurrence of drought in the Jhunjhunu district varied from once in 3.6 years at Jhunjhunu to 3.0 years at Khetri. The other locations in the district experienced in 29 years at Chirawa. The drought frequency was highest during the decade 1981-90 with 6 out of 10 years recording moderate to severe drought and least frequency recording during 1941-50 with 2 out of 10 years as drought years.

Table 5: Frequency of meteorological droughts occurred in Jhnujhunu district (1901-2005)

Category	Buhana (1996-2005)	Chirawa (1901-2005)	Jhunjhunu (1901-2005)	Khetri (1901-2005)	Malsisar (1996-2005)	Navalgarh (1915-2005)	Udaipurwati (1957-2005)
Excess	1	9	9	9	1	5	6
Above normal	1	19	19	19	0	6	6
Normal	5	48	48	43	7	28	18
Below normal	2	19	23	30	0	9	18
Severe	1	10	6	4	2	4	1
Total	10	105	105	105	10	52	49

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