

Original Research Article

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Rainfall Variability Estimation for Western Rajasthan, India

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ABSTRACT

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The present research investigation was undertaken to work out the rainfall variability analysis of western districts of Rajasthan. The coefficient of variation and standard deviation for weekly, monthly and annual rainfall were computed for all the districts. The normal onset of monsoon over different western districts of Rajasthan is between June to October. It was found that the annual rainfall is higher at Sikar district followed by Jalor and Pali. The mean annual rainfall is lowest at Jaisalmer. When the CV for the annual rainfall was examined, it was found that the least CV was at Churu followed by Bikaner, Ganganager and highest in Barmer district.

Introduction

The distribution pattern of rainfall for India is very uneven and varies considerably from year to year and region to region. In western Rajasthan district there is high dependency on rainfall. It is one of the important source of ground water recharge.

The contribution of winter, summer and Post-Monsoon season's rainfall amounts to about 2%, 3% and 4% respectively of the annual total rainfall (Upadhyaya, 2014). The long term climatic changes related to rainfall and temperature is most likely to affect the agriculture and hydrology of whole India and definitely the Rajasthan region. Different studies have been conducted to know the inter-annual and inter-seasonal variability in

rainfall. Krishnamurty and Shukla (2005) studied the inter-seasonal and seasonally persisting patterns of Indian monsoon rainfall. While the other fellow such as Gill *et al.*, 2010 processed on the variability in climate temperature and rainfall in these different agro climatic regions of Punjab. Thus this research focuses on the variability of rainfall in western Rajasthan.

Materials and Methods

The rainfall data for the 12 districts of western Rajasthan was taken from water resources department (water.rajasthan.gov.in) for period 1986-2016. The 31 years data was future used for the rainfall variability analysis. Time series analysis such as standard deviation, coefficient of variation and mean rainfall.

Methodology

Mean rainfall

The amount of rainfall collected by a given rain gauge in 24 hrs is known as daily rainfall (mm or cm) and the amount collected in one year is known as annual rainfall. The mean of the annual rainfall over of 35 years (in India) is known as mean annual rainfall (average annual rainfall or normal annual rainfall).

$$\text{Mean Annual Rainfall} = \frac{\text{Total Rainfall}}{\text{Number of Yeras}}$$

Standard Deviation (SD)

It is defined as the square root of the mean of the squares of deviations of the rainfall value from the arithmetic mean of all such rainfall. It is a measure of variability or the scatter or the dispersion about the mean value. It is given by the following formula.

$$SD (\sigma) = \sqrt{\frac{\sum(X - \bar{X})^2}{n - 1}}$$

X = Rainfall

\bar{X} = Mean rainfall

n = Number of year

Coefficient of variation

Assessment of rainfall variability through Coefficient of variation (CV %) appears to be simple. CV is defined as the Standard deviation divided by the mean value of rainfall. It shows the variability of rainfall in percentage.

$$CV \% = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

The greater the CV, the lesser the dependability of receiving rainfall.

Considering the annual CV, the IMD is using the following criteria for assessing the rainfall in a particular area.

Normal = - 19 to 19 % of annual normal rainfall.

Deficit = - 20 to - 59 % of annual normal rainfall.

Scarce = - 60 % and above of annual normal rainfall

Results and Discussion

The results of this study have been presented in different subheadings as following:

Decadal Rainfall analysis

For this the 31years (starting from 1986 to 2016) rainfall data has been divided into 3 decades viz 1986-1995, 1996-2005 and 2006-2016 respectively district wise. In table 1 the mean and coefficient of variation of these different decades has been presented.

The lowest CV was found for the Bikaner district for the first and last decade, while for the 2nd decade (1996-2005) the CV was least in case of Churu. For all the decades the least rainfall was observed in Jaislmer, while there is variation in maximum amount of rainfall in three decades.

The result of the study shows that the coefficient of variation during the south west monsoon was highest in Pali (68.47%) and Jalor (56%) district, while the lowest CV was found in the Hanumangarh district (23.99%). Overall the range of CV for the 12 districts of western Rajasthan varied from 23.99% to 68.47% (Table 2). From the Table 2 it may be concluded that the there is high variation in the amount of rainfall in different districts of the western Rajasthan.

Table.1 Decadal Rainfall Variability in Western Districts of Rajasthan

DISTRICT	1986-1995	1996-2005	2006-2016	1986-1995	1996-2005	2006-2016
	Mean Rainfall	Mean Rainfall	Mean Rainfall	CV	CV	CV
Barmer	301.90	253.40	334.91	77.43	42.71	49.17
Jaisalmer	180.26	205.48	252.49	60.47	53.30	53.74
Jodhpur	354.18	374.27	397.70	55.29	45.54	37.03
Bikaner	253.48	229.00	356.50	24.22	52.52	20.89
Ganganagar	252.37	252.80	350.18	67.57	50.62	30.45
Hanumangarh	188.64	254.40	292.73	49.61	45.91	36.91
Churu	364.40	408.50	463.00	31.21	39.68	32.05
Jhunjhunu	392.92	322.00	463.85	40.94	45.28	33.27
Sikar	418.70	499.40	557.73	40.05	52.54	42.11
Nagaur	328.13	452.35	377.44	34.53	55.29	30.25
Pali	446.61	377.52	467.72	59.74	56.72	38.44
Jalore	469.00	378.49	462.19	63.11	42.14	58.48

Table.2 Variability of SW monsoon of Western Rajasthan

Months	Barmer	Jaisalmer	Jodhpur	Bikaner	Ganganagar	Hanumangarh	Churu	Jhunjhunu	Nagaur	Sikar	Pali	Jalor
June	31.0	26.8	44.7	42.8	53.6	40.7	47.2	50.6	58.8	71.3	35.1	52.0
July	87.6	57.7	114.3	80.5	78.0	64.8	128.0	117.3	127.7	135.9	161.0	166.2
August	99.1	73.8	128.1	61.6	97.0	47.1	114.5	127.7	117.5	158.9	154.8	132.7
September	43.7	24.8	51.2	33.2	50.0	40.0	46.4	40.9	38.9	52.6	46.0	55.6
Total	261.4	183.1	338.3	218.0	278.6	192.6	336.1	336.4	342.9	418.6	396.9	406.5
SD	33.07	23.99	42.74	20.95	22.07	11.55	43.33	44.69	43.54	50.79	67.94	56.91
CV	50.60	52.41	50.54	38.43	31.69	23.99	51.57	53.13	50.79	48.52	68.47	56.00

Table.3 Variability of NE monsoon of Western Rajasthan

Months	Barmer	Jaisalmer	Jodhpur	Bikaner	Ganganagar	Hanumangarh	Churu	Jhunjhunu	Nagaur	Sikar	Pali	Jalor
October	8.8	3.7	8.3	14.4	2.9	5.5	12.3	7.1	7.8	18.1	9.3	11.1
November	3.3	0.7	0.8	0.5	0.3	1.3	1.1	3.3	0.7	1.6	2.4	2.5
December	1.2	1.9	0.9	1	1	1.5	2.4	1	0.5	2	1.3	1.1
Total	13.3	6.3	10	15.9	4.2	8.3	15.8	11.4	9	21.7	13	14.7
SD	3.92	4.56	4.3	7.88	1.34	2.36	6.12	3.08	4.15	9.41	4.33	5.41
CV	88.49	217.14	129.13	148.68	95.71	85.51	116.35	81.05	138.33	130.15	100.00	110.41

During SW monsoon the Sikar district received the highest amount of rainfall (418.6mm) and Jaisalmer received only 183mm of rainfall. Similar kind of study had been conducted by Upadhyaya, H., (2014), Which conducted that the state receives 91% of its annual rainfall due to the South-West monsoon, which is its principal rainy season.

The contribution of winter, summer and Post-Monsoon season's rainfall amounts to about 2%, 3% and 4% respectively of the annual total rainfall. Study suggested an increase of 30% or more in precipitation over north-western India by 2050 and an increase in probability of extreme rainfall events. The state of Rajasthan is also likely to get affected by this scenario of climate change as well, making it essential to study the variations in rainfall in the state.

The result of the study shows that the coefficient of variation during the north east monsoon was highest in Jaisalmer (217.14%) and Bikaner (148.68%) district, while the lowest CV was found in the Jhunjhunu district (81.05%). Overall the range of CV for the 12 districts of western Rajasthan varied from 81.05% to 217.14% (Table 3). From the Table 3 it may be concluded that there is high variation in the amount of rainfall in different districts of the western Rajasthan. During NE monsoon the Sikar district received the highest amount of rainfall (21.7mm) and Ganganagar received only 4.2mm of rainfall. Similar kind of study had been conducted by Gill *et al.*, (2010), Which conducted that the rainfall over three agro-climate region of Punjab and found that in last 40 years the Ludhiana received below normal rainfall for 24 years being highest during 1988 (1334mm) and the lowest during 1974 (379.6mm). The rainfall variability showed a SD of 210.45, 227.07 and 312.30 mm and CV of 33.70, 30.14 and 30.46 % for Bathinda, Ludhiana and Ballowal Saunkhri, respectively.

Form this study it may be conducted that there is high variation in rainfall pattern of western Rajasthan. The study of rainfall variability is important for planning and operational strategies of any agriculture crop. From the annual analysis of rainfall it was conducted that lowest rainfall was at Jaisalmer and highest at Sikar district.

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