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Analysis of rainfall variability in western Rajasthan, India

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Abstract

An attempt has been made to study the rainfall variability analysis of western districts of Rajasthan. Study was performed on data sets of annual rainfall for the period of 1986-2016 (31 year) for western districts of Rajasthan. The coefficient of variation and standard deviation for weekly, monthly and annual rainfall were also computed for selected 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 to be the least at Churu followed by Bikaner, Ganganagar and Barmer it was the highest.

Keywords: Rainfall variability estimation western rainfall variability analysis of western districts

Introduction

Western Rajasthan comes in arid western plain and Thar Desert. The soils of this zone are predominantly Sand soil, desert soil, aridisol and andisol group. These are generally Sand loam texture. The mean annual rainfall is 350 mm. The mean daily maximum temperature at Western Rajasthan form 24.5°C in January to 45.5°C in May. Similarly the mean daily minimum temperature ranges from 8.6°C in January to 29.7°C in May. The principal crops of the zone are pear millet, cluster bean, moth bean, chick pea, wheat and fruit crop ber, aonla, pomogranate, dateplam. Rainfall is one of the most important natural resource input to crop production in the Western region.

Rainfall characteristics

Rainfall variability of twelve districts (Sikar, Pali, Nagaur, Jodhpur, Jhunjhunu, Jalore, Jaisalmer, Ganganagar, Churu, Bikaner, Barmer and Hanumangarh) of arid western Rajasthan during the period 1986-2016 (31 year) was computed from available daily rainfall data recorded at rain-gauge stations of the district. The data were downloaded from the web site (www.waterresources.rajasthan.gov.in) for further scrutinized and checked for their use in the present study.

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 in known as annual rainfall. The mean of the annual rainfall was calculated by given formula

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

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

Decadal Rainfall analysis

From the Table 1, indicated that decadal rainfall for 31 years (1986 to 2016). The analysis of rainfall were performed on decade basis, Decade I from 1986 to 1995, Decade -II from 1996 to 2005) and Decade III from 2006 to 2016. The calculated mean rainfall data for different district was reported in table 1, The maximum mean rainfall was observed in Jalore (469.00mm) district for the decade I (1986-1995) followed by district Sikar (499.40 mm) for Decade-II (1996-2005) and 557.73mm for Sikar district for the Decade-III. The lowest CV was observed for district Bikaner for Decade I and III and district Churu for Decade II. The least rainfall observed in district Jaisalmer, Similar study trends were observed by other author (Yadav and Nath, 2018; Rajbanshi, J. 2015) [13, 8]

Table 1: Mean rainfall variability for the period of 1986-2016 (3 decades) in western districts of Rajasthan

District	1986-1995	1996-2005	2006-2016	1986-1995	1996-2005	2006-2016
	Decade-I	Decade-II	Decade-III	Decade-I	Decade-II	Decade-III
	Mean rainfall	Mean rainfall	Mean rainfall	Coefficient of variation	Coefficient of variation	Coefficient of variation
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

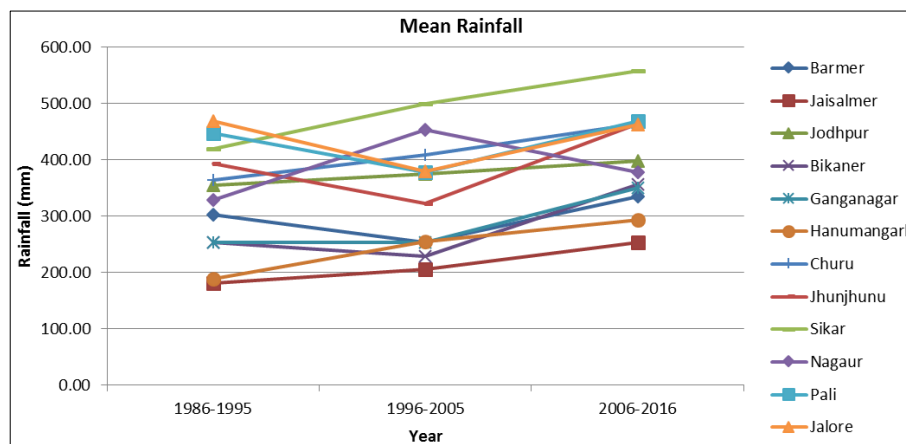


Fig 1: Mean rainfall for the period of 1986-2016 in western Rajasthan

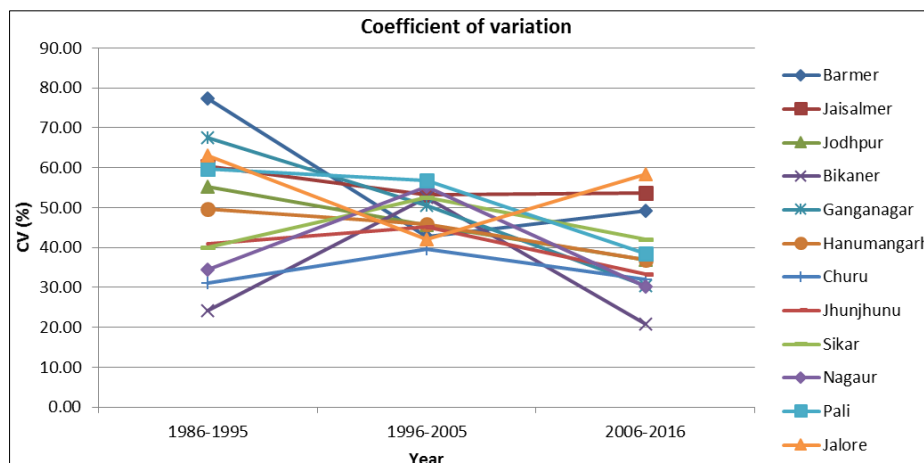


Fig 2: Coefficient of variation for the period of 1986-2016 in western Rajasthan

Monthly variation of rainfall, standard deviations and coefficient of variation for the period of 1986-2016 (31years).

The observed mean rainfall, coefficient of variation and standard deviation for a period of 1986 to 2016 (31years) for western districts of Rajasthan. The observed mean rainfall reported in the Table no. 2. It was found that the annual rainfall is higher at Sikar (494.06mm) district followed by Jalor (437.38mm) and Pali (431.81mm). The mean annual rainfall is lowest at Jaisalmer (214.02mm). The observed monthly rainfall highest at Jalor (166.2mm) followed by Pali (161.02mm) in the month of July. The higher rainfall always observed in the month of July and August due to the monsoon season. From observation of Table 3 data showed that the calculated coefficient of variation. The monthly values of CV during monsoon months were lower when compared to other

months. However the lowest values of CV were in the month of July and August the variation of coefficient value due to the cyclonic activity perform in the regions. When the CV for the annual rainfall was examined, it was found be the least at Churu (34.88) followed by Bikaner (36.43), Ganganager (38.02) and highest in Barmer (58.24). The calculated standard deviation reported in the Table no. 4. It was found that the annual standard deviation is higher at Jalor (244.90) district followed by Sikar (225.54) and Pali (217.74). The annual standard deviation is lowest at Bikaner (102.77) (Similar study on variability and trend analysis of rainfall data for Rajasthan by (Singh, B., 2016, Yadav and Nath, 2018) [4, 13], other authors worked on rainfall analysis (Asim and Nath, 2015; Singh, B. and Sharma, M.K., 2003, Parthasarathy, B and Dhar, O.N., 1975; Roy, 2015) [11, 6, 1].

Table 2: Monthly variation of mean rainfall for the of period (1986-2016) in western Rajasthan

Mean Rainfall (mm)												
Months	BARMER	JAISALMER	JODHPUR	BIKANER	GANGANAGER	HANUMANGARH	CHURU	JHUNJHUNU	NAGAUR	SIKAR	PALI	JALOR
JAN	0.7	0.8	3.17	3.13	5.41	3.9	6.45	5.25	4.26	6.16	2.55	3.46
FEB	3.13	3.47	4.13	10.03	14.98	11.74	10.32	8.09	4.37	11.25	2.85	3.76
MAR	2.5	3.27	2.11	8.75	11.58	9.06	10.38	8.3	3.24	6.41	1.78	0.77
APR	5.62	4.66	6.52	6.68	8.13	5.93	8.16	6.7	6.74	6.03	4.31	2.05
MAY	11.21	12.29	11.82	19.67	14.37	15.29	26.32	19.03	15.2	23.83	10.47	5.95
JUN	31.02	26.77	44.66	42.83	53.62	40.72	47.19	50.58	58.79	71.25	35.09	52.01
JUL	87.56	57.72	114.25	80.48	77.96	64.77	128	117.29	127.73	135.88	161.02	166.2
AUG	99.12	73.84	128.14	61.55	96.95	47.12	114.54	127.65	117.46	158.93	154.82	132.74
SEP	43.73	24.81	51.23	33.15	50.04	39.96	46.38	40.87	38.9	52.56	45.95	55.57
OCT	8.83	3.74	8.32	14.37	2.85	5.48	12.32	7.06	7.8	18.09	9.3	11.13
NOV	3.32	0.7	0.83	0.48	0.29	1.32	1.09	3.31	0.7	1.64	2.35	2.54
DEC	1.16	1.9	0.87	0.96	0.98	1.45	2.41	1.01	0.45	1.96	1.27	1.14
Total	297.96	214.02	376.1	282.13	287.21	246.78	413.61	395.2	385.69	494.06	431.81	437.38

Table 3: Monthly Coefficient of variation for the of period (1986-2016) in western Rajasthan

Coefficient of Variation (%)												
Months	BARMER	JAISALMER	JODHPUR	BIKANER	GANGANAGER	HANUMANGARH	CHURU	JHUNJHUNU	NAGAUR	SIKAR	PALI	JALOR
JAN	191.43	206.25	243.85	148.24	182.07	165.64	126.29	174.48	188.03	140.26	207.84	210.12
FEB	213.1	220.75	188.38	251.35	129.04	150.77	166.67	162.18	218.31	186.67	247.72	330.59
MAR	327.6	240.06	256.87	198.29	183.85	184.22	155.78	181.2	216.36	137.29	289.33	290.91
APR	248.75	187.77	138.34	205.54	141.45	149.24	205.51	150.45	142.43	184.74	171.46	241.46
MAY	175.02	197.56	131.22	112.91	164.23	123.81	92.06	116.61	126.32	113.13	207.83	175.8
JUN	116.89	108.67	111.53	99.23	100.41	107.22	78.66	91.93	192.16	124.18	88.09	89.19
JUL	97.85	118.8	86.33	87.04	68.52	55.75	63.25	62.42	76.65	72.06	70.84	85.36
AUG	139.94	110.4	71.4	98.18	47.08	117.08	63.69	69.37	76	101.95	88.33	115.07
SEP	130.55	145.1	130.39	118.64	115.87	130.83	95.97	104.21	107.84	115.91	109.14	127.5
OCT	175.88	234.76	272.96	240.92	265.61	219.34	314.53	215.01	325.77	336.04	188.17	224.53
NOV	480.72	347.14	381.93	733.33	406.9	286.36	290.83	210.88	432.86	383.54	433.19	477.95
DEC	369.83	363.68	325.29	236.46	263.27	242.76	295.44	314.85	404.44	284.18	272.44	378.95
Annual	58.24	55.77	44.32	36.43	38.02	45.36	34.88	40.48	44.59	45.65	50.42	55.99

Table 4: Monthly standard deviation for the of period (1986-2016) in western Rajasthan

Standard Deviation												
Months	BARMER	JAISALMER	JODHPUR	BIKANER	GANGANAGER	HANUMANGARH	CHURU	JHUNJHUNDU	NAGPUR	SIKAR	PALI	JALOR
JAN	1.34	1.65	7.73	4.64	9.85	6.46	8.15	9.16	8.01	8.64	5.30	7.27
FEB	6.67	7.66	7.78	25.21	19.33	17.70	17.20	13.12	9.54	21.00	7.06	12.43
MAR	8.19	7.85	5.42	17.35	21.29	16.69	16.17	15.04	7.01	8.80	5.15	2.24
APR	13.98	8.75	9.02	13.73	11.50	8.85	16.77	10.08	9.60	11.14	7.39	4.95
MAY	19.62	24.28	15.51	22.21	23.6	18.93	24.23	22.19	19.20	26.96	21.76	10.46
JUN	36.26	29.09	49.81	42.50	53.84	43.66	37.12	46.50	112.97	88.48	30.91	46.39
JUL	85.68	68.57	98.63	70.05	53.42	36.11	80.96	73.21	97.90	97.92	114.07	141.87
AUG	138.71	81.52	91.49	60.43	45.64	55.17	72.95	88.55	89.27	162.03	136.76	152.74
SEP	57.09	36.00	66.80	39.33	57.98	52.28	44.51	42.59	41.95	60.92	50.15	70.85
OCT	15.53	8.78	22.71	34.62	7.57	12.02	38.75	15.18	25.41	60.79	17.50	24.99
NOV	15.96	2.43	3.17	3.52	1.18	3.78	3.17	6.98	3.03	6.29	10.18	12.14
DEC	4.29	6.91	2.83	2.27	2.58	3.52	7.12	3.18	1.82	5.57	3.46	4.32
Annual	173.53	119.36	166.68	102.77	109.20	111.94	144.26	159.98	171.97	225.54	217.74	244.90

Conclusions

The present study concluded that "Rainfall variability estimation for western Rajasthan, India" for the period (1986 - 2016) to evaluate basis on different precipitation data. It was found that the annual rainfall is higher at Sikar district followed by Jalor and Pali. The mean annual rainfall is lowest in Jaisalmer District. Coefficient of variation for the annual rainfall was examined, it was found be the least at Churu followed by Bikaner, Ganganager and highest in Barmer and Coefficient of variation in monsoon months were lower than other months. However the lowest values of CV were observed in the month of July and August due to cyclonic activity the maximum rainfall observed in the month of August.

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