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RAINFALL ANALYSIS OF DIFFERENT DISTRICTS AND TEHSIL OF CHHATTISGARH STATE

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Abstract

One of the most interesting aspects of weather is rainfall and its variance from one place to another. The amount of rainfall received over an area is an important factor in assessing the amount of water available to meet the various demands of agriculture, industry, irrigation, hydroelectric power generation and other human activities. For this study, long term daily rainfall data of 57 stations to represent 27 districts and 56 tehsils of Chhattisgarh state has been collected from the Department of Agrometeorology, IGKV Raipur. Weekly, Monthly and Annual rainfall data were analysed from daily rainfall data. Result revealed that the mean annual rainfall and rainy days of different districts were showed **t**he highest mean annual rainfall of 1432 mm was recorded in Dantewada followed by Narayanpur (1385 mm) and Bastar districts (1363 mm), respectively. The lowest mean annual rainfall of 989 mm was recorded in Kawardha district followed by Balodabazar and Mungeli districts with 1032 mm & 1048 mm, respectively. The CV for the annual rainfall was found be the least at Bastar (14.3%) with 195.7 mm SD followed by Bilaspur (17 %) with 203.6 mm SD, while highest CV was found at Dantewada 40.8 % with 585.3 mm SD followed by Dhamtari district 30.2% with 318.8 mm SD. The highest mean annual rainy days of 86 days were recorded in Jashpur District with 18.7 % CV & 16.1 days SD followed by Bilaspur district where the mean annual rainy days of 84 days with 22.6 % CV & 19.1 days SD. Bemetara had lowest mean annual rainy days of 49 days, 13.9 days SD with 28.4 % CV.

***Keywords*:** Rainfall analysis, Standard deviation, coefficient variation, Chhattisgarh

Introduction

One of the most interesting aspects of weather is rainfall and its variance from one place to another. The amount of rainfall received over an area is an important factor in assessing the amount of water available to meet the various demands of agriculture, industry, irrigation, hydroelectric power generation and other human activities. Therefore, distribution of rainfall in time and space is an important factor in determining the economical status of a region or a state or a nation. Indian agriculture is mostly rainfed (around 60 % of arable land) and monsoon plays a major role not only in agriculture but also in allied day to day activities. India, 75 % (870 mm) of the annual rainfall (1150 mm) is received during South-West Monsoon period (June to September). C.G. state, situated in eastern India, is located between 170 41' N and 240 45' N latitudes and 790 30' E and 840 15' E longitudes. Most of the rainfall occurs in the state from June to September, and December and January witness some rainy cyclones. Distribution of rainfall is important for crop planning especially for rainfed agriculture (Reddi and Reddy, 2004). Rainfall analysis is important in view of crop planning for any region. Rainfall studies, particularly its variability and trend analysis can give more information for rainfed region crop planning. The knowledge of total rainfall and its distribution throughout the year is extremely useful and important for better planning of cropping pattern, developing irrigation and drainage plans for an area. Success of rainfed agriculture largely depends on the onset and the withdrawal of monsoon. Crop failure and yield loss may be occurred due to late onset of monsoon and early withdrawal of rains (Manikandan *et al.* 2017). In most part of our country, rainfall is uneven, uncertain and erratic.

Materials and Method

Study Area

Chhattisgarh, situated in eastern India, is located between 17˚ 46′ N and 24˚ 5′ N latitudes and 80˚ 15′ E and 84˚ 24′ E longitudes. The state has three agro climatic zones viz., Chhattisgarh plains, Bastar plateau and Northern hills region and 27 districts *viz* Raipur, Mahasamund, Rajnandgaon, Durg, Dhamtari, Kawardha, Bilaspur, Jangir, Korba, Jashpur, Raigarh, Ambikapur, Koria, Kanker, Jagdalpur, Dandewada, Narayanpur, Bijapur, Mungeli, Gariabandh, Balod, Balodabazar, Bemetara, Surajpur, Sukma, Kondagaon and Balrampur spreading over a geographical area of 137.90 lakhs hectares.

Rainfall Data

Daily rainfall data of 57 stations to represent 27 districts and 56 tehsils of Chhattisgarh state has been collected from the Department of Agrometeorology, IGKV Raipur. Selected stations along their latitude longitude and data availability period were presented in Table No.1.

Rainfall Analysis

(i) Weekly, Monthly and Annual rainfall analysis

Weekly, Monthly, Annual, Decadal and Seasonal rainfall data were analysed from daily rainfall data. Following parameters were calculated by using different softwares available in department of Agrometeorology, IGKV, Raipur.

(ii) 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 over 30 years (in India) is

known as mean annual rainfall (average annual rainfall or normal annual rainfall).

$$\text{Mean annual Rainfall} = \frac{\text{Total rainfall}}{\text{Number of Years}}$$

(iii) 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.

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

Where,

- X = Rainfall frequency
- X = Mean rainfall
- n = Number of years

(iv) 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, lesser the dependability of receiving rainfall. The coefficient of variation indicates the amount of fluctuation in rainfall recorded over a long period of time from the mean values. The coefficient of variation of annual precipitation is an index of climatic risk.

Results and Discussion

District-wise annual rainfall and rainy days

The mean annual rainfall and rainy days of different districts are presented in (Table 2). The highest mean annual rainfall of 1432 mm was recorded in Dantewada followed by Narayanpur (1385 mm) and Bastar districts (1363 mm), respectively. The lowest mean annual rainfall of 989 mm was recorded in Kawardha district followed by Balodabazar and Mungeli districts with 1032 mm & 1048 mm, respectively. The CV for the annual rainfall was found be the least at Bastar (14.3%) with 195.7 mm SD followed by Bilaspur (17%) with 203.6 mm SD, while highest CV was found at Dantewada 40.8 % with 585.3 mm SD followed by Dhamtari district 30.2% with 318.8 mm SD.

The highest mean annual rainy days of 86 days were recorded in Jashpur District with 18.7 % CV & 16.1 days SD followed by Bilaspur district where the mean annual rainy days are of 84 days with 22.6 % CV & 19.1 days SD. Bemetara had lowest mean annual rainy days of 49 days, 13.9 days SD with 28.4 % CV.

Station wise annual rainfall and annual rainy days

The highest mean annual rainfall of 1432 mm was recorded in Dantewada station followed by Jashpur nagar (1397 mm) and Narayanpur station (1385 mm), respectively while lowest mean annual rainfall was observed at Balodabazar (973 mm) followed by Neora (974 mm) and Kawardha (984 mm), respectively. The CV for the annual rainfall was examined; it was found be the lowest at Pendra (14 %) followed by Bagbahara (16 %).

Highest number of rainy days of 96 days was observed at Jashpur nagar, followed by Pendra (72 days) and Pendra road (69 days), respectively (Table 2). Lowest CV value for rainy days was found at Kota (12.9%) followed by Pendra road (13.2%) and Jashpur nagar (14.8%), while Dhamtari showed highest CV value 38.1 % followed by Charama (30.8%) and Deobhog (30.1 %), respectively.

Manikandan *et al.* (2017) also reported the mean annual rainfall at Bhavanisagar was 677.9 mm and it varied from 362.7 (lowest in 1990) to 1169.36 mm (highest in 1987) with standard deviation (SD) of 192.5 mm. The average annual rainy days was 42 which were between 24 days (1982) and 64 days (2008). Similarly, Kingra *et al.* (2013) reported that the annual rainfall ranged from 617 (2009) to 2041 mm (1988) with an average value of 1062 mm for Ballowal Saunkari and a standard deviation (SD) of 303 mm, indicating a highly erratic nature of rainfall.

Conclusion

High rainfall variability indicates chances of instability in the crop productivity. Low CV value indicated that the rainfall was stable in the months of July and August but again the CV increased in the month of September which creates water stress condition during reproductive and maturity stages of crops due to intermittent dry spells. About approximate 80 per cent of the total average annual rainfall concentrated in the south-west monsoon and received during a short span between June to September. Kharif food grain production is adversely affected due to monsoon break or failure. If there is well distributed rainfall in sufficient quantity then this stored water can be utilized to grow second crop in *rabi* season. This rainfall variability studies can help to plan conservation of excess water and its utilization during their peak requirement.

Table 1: Geographical locations of 57 stations under study and rainfall data availability period

S.No.	District	Station	Latitude	Longitude	Data base	No. of years
1	Balod	Balod	20^0 73	81^0 20	1964-2015	51
2	Balod	Dondi	20^0 40	81^0 09	1993-2015	22
3	Balod	Dondilohara	21^0 81	81^0 11	1993-2015	22
4	Balod	Gundardehi	20^0 94	81^0 29	1993-2015	22
5	Balod	Gurur	20^0 68	81^0 40	1993-2015	22
6	Balodabazar	Balodabazar	21^0 23	81^0 67	1960-2015	55
7	Balodabazar	Simga	21^0 62	81^0 70	1981-2015	34
8	Balrampur	Wadrafnagar	26^0 05	74^0 02	2003-2015	12
9	Bastar	Jagdalpur	19^0 05	82^0 04	1980-2015	35

10	Bemetara	Bemetara	21^0 71	81^0 52	1962-2015	53
11	Bilaspur	Bilaspur	22^0 5	82^0 13	1972-2015	43
12	Bijapur	Bijapur	19^0 82	81^0 03	1978-2015	37
13	Bilaspur	Pendra	22^0 75	81^0 89	1981-2015	34
14	Bilaspur	Kota	22^0 29	82^0 02	1981-2015	34
15	Bilaspur	Pendra road	22^0 77	81^0 96	1999-2015	16
16	Dantewada	Dantewada	18^0 84	81^0 34	1973-2015	42
17	Dhamtari	Dhamtari	20^0 42	81^0 34	1960-2015	55
18	Dhamtari	Gangrel	20^0 78	81^0 54	1979-2015	36
19	Durg	Dhamdha	21^0 32	81^0 33	1993-2015	22
20	Durg	Patan	21^0 04	81^0 53	1993-2015	22
21	Gariaband	Deobhog	20^0 00	82^0 40	1981-2015	34
22	Gariaband	Gariaband	20^0 63	82^0 06	1972-2015	43
23	Gariaband	Rajim	20^0 59	81^0 55	1981-2015	34
24	Janjgir	Janjgir	22^0 10	82^0 92	1960-2015	55
25	Janjgir-Champa	Champa	22^0 02	82^0 43	1960-2015	55
26	Janjgir-Champa	Akaltara	22^0 02	82^0 43	1997-2015	18
27	Jashpur	Pathalgaon	22^0 55	83^0 46	1960-2015	55
28	Jashpur	Jashpur Nagar	22^0 53	84^0 12	1972-2015	43
29	Jashpur	Bagicha	23^0 03	83^0 64	1974-2015	41
30	Kanker	Kanker	20^0 15	81^0 32	1981-2015	34
31	Kanker	Charama	20^0 49	81^0 37	1981-2015	34
32	Kawardha	Kawardha	22^0 00	81^0 17	1963-2015	52
33	Kondagaon	Konda	19^0 6	81^0 67	1999-2015	16
34	Korba	Kanki	22^0 22	82^0 65	1960-2015	55
35	Koria	Manendragarh	23^0 21	82^0 21	1974-2015	41
36	Mahasamund	Mahasamund	21^0 10	82^0 10	1973-2015	42
37	Mahasamund	Saraipali	21^0 33	82^0 99	1981-2015	34
38	Mahasamund	Basana	21^0 28	82^0 82	1990-2015	25
39	Mahasamund	Bagbahara	21^0 03	82^0 38	1997-2015	18
40	Mungeli	Mungeli	22^0 05	81^0 68	1972-2015	43
41	Narayanpur	Narayanpur	19^0 72	81^0 24	1974-2015	41
42	Raigarh	Sarangarh	21^0 85	83^0 07	1960-2015	55
43	Raigarh	Gharghoda	22^0 18	83^0 83	1972-2015	43
44	Raigarh	Dharamjaigarh	22^0 28	83^0 15	1975-2015	40
45	Raigarh	Lailunga	22^0 39	83^0 56	1999-2015	16
46	Raipur	Raipur	21^0 15	81^0 41	1960-2015	55
47	Raipur	Neora	21^0 56	81^0 80	1981-2015	34
48	Raipur	Arang	21^0 19	81^0 96	1982-2015	33
49	Rajnandgaon	Rajnandgaon	21^0 05	81^0 05	1962-2015	53
50	Rajnandgaon	Gandai	21^0 66	81^0 10	1962-2015	53
51	Rajnandgaon	Khairagarh	21^0 26	81^0 02	1962-2015	53
52	Rajnandgaon	Mohala	20^0 57	80^0 75	1975-2015	40
53	Rajnandgaon	Amba Chowki	20^0 77	80^0 74	1975-2015	40
54	Rajnandgaon	Chhuria	20^0 63	80^0 73	1998-2015	17
55	Sukma	Sukma	18^0 34	81^0 65	1972-2015	43
56	Surajpur	Pratappur	19^0 59	80^0 5	1973-2015	42
57	Surguja	Ambikapur	23^0 10	83^0 15	1981-2015	34

Table 2: District wise annual rainfall and annual rainy days with Standard Deviation (SD) and Coefficient of Variance (CV)

S.No.	Districts Name	Annual rainfall (mm)	SD (mm)	CV (%)	Rainy days	SD (mm)	CV (%)
01	Balod	1127	208.4	18.5	62	15.1	24.4
02	Balodabazar	1032	251.6	24.3	59	13.3	22.4
03	Balrampur	1141	310.3	27.2	53	12.4	23.6
04	Bastar	1363	195.7	14.3	72	8.9	12.3
05	Bemetara	1091	311.8	28.5	49	13.9	28.4
06	Bijapur	1247	225.6	18.0	62	11.1	17.7
07	Bilaspur	1195	203.6	17.0	84	19.1	22.6
08	Dantewada	1432	585.3	40.8	61	10.3	17.0
09	Dhamtari	1054	318.8	30.2	62	23.8	38.1
10	Durg	1123	219.8	19.5	57	11.9	20.8

11	Gariaband	1179	253.0	21.4	70	15.3	21.9
12	Janjgir-Champa	1190	245.7	20.6	71	14.8	21.0
13	Jashpur	1316	234.8	17.8	86	16.1	18.7
14	Kanker	1145	260.4	22.7	61	18.7	30.6
15	Kawardha	989	176.4	17.8	56	10.6	19.0
16	Kondagaon	1116	208.9	18.7	65	13.1	20.3
17	Korba	1171	251.5	21.4	56	14.8	26.4
18	Koria	1241	306.7	24.7	54	10.3	19.0
19	Mahasamund	1159	193.2	16.6	79	16.0	21.2
20	Mungeli	1048	191.4	18.2	61	17.8	28.9
21	Narayanpur	1385	294.5	21.2	65	9.7	14.9
22	Raigarh	1183	208.7	17.6	80	17.6	22.1
23	Raipur	1105	294.9	26.6	68	19.2	28.2
24	Rajnandgaon	1133	191.8	16.9	78	15.3	19.8
25	Sukma	1359	283.2	20.8	63	12.3	19.5
26	Surajpur	1229	269.2	21.9	57	9.4	16.3
27	Surguja	1345	325.5	24.1	68	10.1	14.7

Table 3: Station-wise annual rainfall and annual rainy days with Standard Deviation (SD) and Coefficient of Variance (CV)

S.No.	Station Name	Annual rainfall (mm)	SD	CV (%)	Rainy days	SD	CV (%)
1	Akaltara	1339	295.9	22.1	56	9.2	16.6
2	Amba Chowki	1189	254.4	21.3	53	10.3	19.5
3	Ambikapur	1360	355.2	26.1	68	10.3	15.2
4	Arang	1157	269.5	23.3	50	9.1	18.2
5	Bagbahara	1030	164.8	16.0	55	7.2	13.0
6	Bagicha	1261	313.9	24.9	67	14.9	22.1
7	Balod	1119	232.2	20.7	55	15.6	28.4
8	Balodabazar	973	303.6	31.1	50	10.0	20.0
9	Basana	1173	312.2	26.6	56	8.4	15.0
10	Bemetara	1092	311.8	28.5	49	13.9	28.4
11	Bijapur	1267	216.8	17.1	63	12.9	20.5
12	Bilaspur	1171	246.2	21.0	59	12.8	21.5
13	Champa	1153	401.3	34.7	55	16.0	29.1
14	Charama	1158	274.8	23.7	53	16.3	30.8
15	Chhuikhadan	1093	254.1	23.2	52	13.4	25.6
16	Chhuria	1009	167.9	16.6	43	8.9	20.7
17	Dantewada	1432	585.3	40.8	61	10.3	17.0
18	Deobhog	1068	264.6	24.7	51	15.5	30.1
19	Dhamdha	1075	320.8	29.8	47	13.6	28.9
20	Dhamtari	1054	318.8	30.2	62	23.8	38.1
21	Dharamjaigarh	1282	294.0	22.9	61	11.7	19.3
22	Dondi	1073	249.8	23.2	44	9.4	21.4
23	Dondilohara	1070	273.9	25.5	46	9.6	20.8
24	Gariaband	1256	341.8	27.2	52	11.2	21.5
25	Gharghoda	1229	200.0	16.2	62	11.2	18.1
26	Gundardehi	1061	187.8	17.7	48	11.1	23.1
27	Gurur	1239	224.9	18.1	50	7.5	15.1
28	Jagdalpur	1363	195.7	14.3	72	8.9	12.3
29	Janjgir	1174	219.6	18.7	53	8.0	15.0
30	Jashpur Nagar	1397	254.1	18.2	96	14.2	14.8
31	Kanker	1131	268.5	23.7	52	12.8	24.5
32	Kartala	1171	251.5	21.4	56	14.8	26.4
33	Kawardha	984	164.1	16.6	56	10.2	18.1
34	Khairagarh	1026	209.5	20.4	52	9.6	18.4
35	Kondagaon	1116	208.9	18.7	65	13.1	20.3
36	Kota	1132	238.1	21.0	61	7.9	12.9
37	Lailunga	1130	317.8	28.1	67	13.3	20.0
38	Mahasamund	1135	274.9	24.2	60	13.5	22.6
39	Manendragarh	1241	306.7	24.7	54	10.3	19.0

40	Mohala	1221	266.5	21.8	55	11.3	20.5
41	Mungeli	1048	191.4	18.2	61	17.8	28.9
42	Narayanpur	1385	294.5	21.2	65	9.7	14.9
43	Neora	974	300.9	30.8	50	17.7	35.5
44	Patan	1172	242.8	20.7	47	10.4	22.2
45	Pathalgaon	1281	262.2	20.4	67	14.3	21.6
46	Pendra	1274	187.0	14.6	72	17.0	23.5
47	Pendra road	1256	254.6	20.2	69	9.3	13.5
48	Pratappur	1215	347.5	28.6	56	10.4	18.6
49	Raipur	1153	325.4	28.2	58	14.3	24.6
50	Rajim	1175	226.2	19.2	57	16.1	28.1
51	Rajnandgaon	1191	284.0	23.8	56	14.0	24.9
52	Saraipali	1313	281.0	21.4	62	14.9	24.0
53	Sarangarh	1089	229.3	21.0	56	15	27.0
54	Simga	1091	207.8	19.0	50	11.1	22.1
55	Sukma	1359	283.2	20.8	63	12.3	19.5
56	Wadrafnagar	1141	310.3	27.2	53	12.4	23.6

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