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Trend and variability of monsoonal rainfall in different blocks of Chhattisgarh

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Abstract

An attempt has been done for the trend analysis and to find out the variability of monsoonal rainfall of different (146) blocks of Chhattisgarh. For that Long-term rainfall data of 25 years (1996-2020) was collected from the department of Agrometeorology, CoA, IGKV, Raipur (C.G.). for the trend analysis linear trend method was used with the help of TREND software. And Coefficient of variation was utilized to quantify the monsoonal variability. Results revealed that In Chhattisgarh plain zone out of 89 blocks, 3 blocks (Rajim, Mahasamund, Arang) observed a significantly increasing trend, and only 1 block (Champa) reported significantly decreasing trend of monsoonal rainfall. In the Bastar plateau zone out of 25 blocks 11 blocks observed significantly increasing trend of monsoonal rainfall. In the Northern hill zone out of 32 blocks, only 1 block (Jaspur) observed a significantly increasing trend and 11 blocks observed significantly decreasing trend of monsoonal rainfall. In Chhattisgarh Plain Zone, Monsoonal variability ranged between 13% (Malkharoda block) to 31% (Deobhog block). In Bastar plateau zone, Monsoonal variability ranged between 16% (Kondagaon block) to 28% (Sukma block). In Northern Hill Zone Monsoonal variability ranged between 15% (Pharsabahal and Duldula block) to 27% (Surajpur block).

Keywords: Monsoonal rainfall, rainfall trend, monsoonal rainfall variability

Introduction

God loves us rain is the proof of that human beings have always been aware that weather affects their life and activities. (Varshneya and Pillai, 2003) ^[10]. India which is predominantly an agricultural country depends mainly on the monsoon rains for its agriculture. A major portion of the cultivated area still depends on the rainfall as the only source of water for raising crops.

The rains during the southwest monsoon contribute the major portion of the total rainfall during the year. The four wet months from June to September (monsoon season) account for more than 75% of the annual rainfall, in the country. (Anonymous, 2020) ^[1]. The rainfall during monsoon season controls many sectors from agriculture, food, energy, and water, to the management of disasters. (Gouda *et al.*, 2017) ^[4].

The variability of monsoon rainfall is highly unpredictable at multiple scales both in space and time. (Gouda *et al.*, 2017) ^[4]. Rainfall variation studies are important for planning purpose and supply of water to different sectors of economy (irrigation water, drinking water and industrial use). Coefficient of variation is used to assess the variability of the rainfall over India. (Varshneya and Pillai, 2003) ^[10]. On the basis of available database the mean annual rainfall of Chhattisgarh is 1188 mm with a coefficient of variation of 26% (Chaudhary *et al.* 2015). [3] small fluctuation in the seasonal rainfall can have devastating impacts on agricultural sector at regional level.

Materials and Methods

Database used (Rainfall data)

The long-term daily rainfall data was collected from (1996-2020) from the Department of Agrometeorology, IGKV, Raipur. For carrying out monsoonal rainfall trend and monsoonal variability in percentage.

Data quality analysis

After collecting the rainfall data, the quality of the data was checked using MS Excel which was a pre-requisite step before the analysis of the result. For that a column was selected whose quality was to be checked, then the filter tab was applied, Then all the values in that column

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were shown in ascending order from which the inappropriate data was picked out, which didn't seem right and replaced with the appropriate one. the missing values with normal values were also generated.

Method description

Trend analysis

Trend analysis is a method of collecting information and attempting to find out a pattern or trend from that information. This method is based on the time series data where information (data) in the sequence is plotted against time (significantly long period) to detect a general pattern of a relationship between time and information (factor).

Linear regression method of trend analysis

Linear regression analysis uses an equation to analyze the relationship between two or more quantitative variables in order to predict one from the other. Simple Linear Regression measures the relationship between two variables: x and y. x is the independent variable and y is the dependent variable. A particular observation of y depends on x and an additional random error. The linear regression line is derived using the following equation,

$$Y = a + bX$$

Where,

Y = Dependent variable

a = Intercept

b = Slope

X = Independent variable

Coefficient of variation

The coefficient of variation was used to assess the variability of monsoonal rainfall is defined as the Standard deviation

divided by the mean value of rainfall. The coefficient of variation is calculated by dividing the standard deviation by the mean value of rainfall. It depicts rainfall variability as a percentage. The coefficient of variation indicates the amount of fluctuation in rainfall recorded over a long period of time from the mean values.

$$CV \% = \frac{\text{standard deviation}}{\text{Mean}} \times 100$$

Results and Discussion

Trend and variability of monsoonal rainfall in different blocks of Chhattisgarh were worked out, and the outcomes are presented separately in different agroclimatic zone, which has different weather characteristics.

1. Chhattisgarh Plain Zone.
2. Bastar Plateau Zone
3. Northern Hill Zone.

Trend and variability of monsoonal rainfall in different blocks of Chhattisgarh Plain Zone

In Chhattisgarh Plain Zone out of 89 blocks a significantly increasing trend of monsoonal rainfall was noticed in 3 blocks (Rajim, Mahasamund Arang), while significantly decreasing trend was observed in 1 block (Champa) rest all the blocks indicated non-significant changes in monsoonal rainfall either increasing or decreasing and Monsoonal variability ranged between 13% in the Malkharoda block to 31% in the Deobhog block. Sinha *et al.* (2019) ^[9] also observed a similar trend results in Janjgir-Champa (significant) and other (Non-significant) in the different districts of Chhattisgarh. sahu *et al.* (2023) ^[8] also reported similar monsoonal variability in some blocks of Chhattisgarh. Nema *et al.* (2018) ^[7] observed similar results of monsoonal variability when compared with blocks of the respective districts.

Table 1: Trend and variability of monsoonal rainfall in different blocks of Chhattisgarh Plain Zone

S. No.	District	Block	Linear Trend	SD	Mean	CV (%)
1	Balod	Balod	NS INC	182.1	1018.3	18
2		Dondi	NS INC	218.8	1133.5	19
3		Dondi Lohara	NS INC	151.9	1057.6	14
4		Gunderdehi	NS INC	167.6	1007.0	17
5		Gurur	NS INC	171.9	1020.7	17
6	Balodabazar	Balodabazar	NS INC	178.6	966.0	18
7		Bhatapara	NS INC	191.5	908.8	21
8		Kasdol	NS INC	182.9	991.5	18
9		Palari	NS INC	198.3	918.1	22
10		Simga	NS INC	175.3	896.0	20
11	Bemetara	Bemetara	NS INC	166.8	995.4	17
12		Berla	NS INC	196.9	1043.0	19
13		Nawagarh	NS INC	151.8	950.4	16
14		Saja	NS INC	227.8	1137.7	20
15		Thankhamariya	NS INC	197.0	1086.3	18
16	Bilaspur	Belha	NS INC	167.3	1036.8	16
17		Kota	NS INC	183.0	1114.2	16
18		Masturi	NS INC	179.5	1077.0	17
19		Takhatpur	NS INC	181.0	1056.5	17
20	Dhamtari	Dhamtari	NS INC	177.5	1033.4	17
21		Kurud	NS DEC	184.3	1031.2	18
22		Magarlod	NS DEC	260.5	1086.5	24
23		Nagri	NS DEC	255.2	1083.3	24
24	Durg	Dhamdha	NS INC	201.7	1088.7	19
25		Durg	NS INC	206.9	1044.1	20
26		Patan	NS INC	210.0	999.5	21
27		Chura	NS INC	231.9	1110.4	21

28	Gariyaband	Deobhog	NS INC	355.9	1135.3	31
29		Gariyaband	NS INC	221.1	1100.2	20
30		Mainpur	NS INC	285.5	1038.4	27
31		Rajim	S*** INC	228.1	1115.9	20
32	Gaurella, Pendra, Marwahi	Pendra	NS INC	165.5	1113.1	15
33		Pendra road/Gaurella	NS INC	167.5	1091.8	15
34		Marwahi	NS INC	202.8	1092.1	19
35		Akaltara	NS DEC	189.6	1070.5	18
36	Janjgir Chapa	Baloda	NS DEC	184.0	1163.4	16
37		Champa	S*** DEC	179.3	1061.0	17
38		Janjgir	NS DEC	149.6	1081.9	14
39		Nawagarh	NS DEC	153.8	1028.7	15
40		Pamgarh	NS DEC	172.6	1038.4	17
41		Bodla	NS DEC	240.2	968.4	25
42	Kabeerdham	Kawardha	NS INC	158.7	968.0	16
43		Pandariya	NS INC	154.0	990.8	16
44		Sahaspur Lohara	NS INC	192.5	1024.0	19
45		Antagarh	NS INC	234.2	1199.3	20
46	Kanker	Bhanupratappur	NS INC	296.0	1190.7	25
47		Charama	NS INC	213.4	1053.7	20
48		Durgkondal	NS INC	341.6	1302.2	26
49		Kanker	NS INC	255.7	1099.3	23
50		Narharpur	NS DEC	220.6	1073.7	21
51		Pakhanjur	NS INC	289.6	1316.1	22
52		Chhuikhadan	NS DEC	213.5	880.7	24
53	Khairagarh Chhuikhadan Gandai	Khairagarh	NS DEC	195.5	954.3	20
54	Korba	Kartala	NS DEC	180.0	1141.3	16
55		Kartghora	NS DEC	181.7	1179.5	15
56		Korba	NS DEC	181.9	1163.0	16
57		Pali	NS DEC	192.4	1180.3	16
58		Pondi Uroda	NS DEC	172.0	1152.6	15
59	Mahasamund	Bagbahara	NS INC	261.9	1107.2	24
60		Basna	NS INC	201.0	1016.6	20
61		Mahasamund	S** INC	238.4	1083.2	22
62		Pithora	NS INC	199.2	1013.1	20
63		Saraipali	NS INC	264.9	1135.0	23
64	Mohla Manpur Ambagarh Chowki	Ambagarh chowki	NS DEC	174.4	1052.5	17
65		Manpur	NS INC	315.9	1294.6	24
66		Mohla	NS INC	246.9	1191.7	21
67	Mungeli	Lormi	NS INC	171.9	1061.3	16
68		Mungeli	NS INC	154.4	999.2	15
69		Pathariya	NS INC	168.9	1001.8	17
70	Raigarh	Gharghoda	NS DEC	233.6	1195.8	20
71		Kharsiya	NS INC	168.5	1185.0	14
72		Lailunga	NS DEC	210.3	1193.5	18
73		Pusour	NS INC	223.0	1274.6	17
74		Raigarh	NS INC	251.4	1285.2	20
75		Tamnar	NS DEC	213.7	1232.6	17
76		Udaipur/ Dharmjaigarh	NS DEC	208.3	1179.9	18
77	Raipur	Abhanpur	NS DEC	163.6	1037.7	16
78		Arang	S*** INC	251.9	1043.9	24
79		Raipur/Dharsiwa	NS INC	243.7	995.8	24
80		Tilda	NS INC	196.5	911.3	22
81	Rajnandgaon	Chhuriya	NS DEC	163.6	1037.7	16
82		Dongargarh	NS DEC	175.7	1023.4	17
83	Sakti	Dabhara	NS INC	182.5	1214.2	15
84		Jaiapur	NS DEC	149.6	1081.9	14
85		Malkharoda	NS INC	151.7	1150.0	13
86		Sakti	NS DEC	166.3	1127.1	15
87	Sarangarh, Bilaigarh	Baramkela	NS INC	251.4	1285.2	20
88		Bilaigarh	NS INC	170.2	1008.3	17
89		Sarangarh	NS INC	207.1	1160.3	18

Level of significance: * = 1%, ** = 5%, *** =10%

Trend and variability of monsoonal rainfall in different blocks of Bastar Plateau Zone

In Bastar Plateau Zone out of 25 blocks a significantly increasing trend of monsoonal rainfall was noticed in 11

blocks. rest all the blocks indicated non-significant changes in monsoonal rainfall either increasing or decreasing and Monsoonal variability ranged between 16% in the Kondagaon block to 28% in the Sukma block Kumar *et al.* (2022)/5]

reported similar results in this region when compared with blocks of the respective districts. Bhuarya *et al.* (2015) ^[2] also reported lowest monsoonal rainfall variability in Kondagaon. Sahu *et al.* (2023) ^[8] reported similar monsoonal variability in

some blocks of Chhattisgarh. Nema *et al.* (2018) ^[7] observed similar results of monsoonal variability when compared with blocks of the respective districts.

Table 2: Trend and variability of monsoonal rainfall in different blocks of Bastar Plateau Zone

S. No.	District	Block	Linear trend	SD	Mean	CV (%)
1	Bastar	Bakawand	NS INC	277.5	1300.7	21
2		Bastanar	S* INC	231.3	1259.7	18
3		Bastar	S** INC	249.7	1275.8	20
4		Darbha	S* INC	266.7	1330.9	20
5		Jagdalpur	S** INC	298.3	1327.1	22
6		Lohandiguda	S* INC	226.7	1235.7	18
7		Tokapal	S* INC	261.2	1285.1	20
8	Bijapur	Bhairamgarh	NS INC	251.2	1277.6	20
9		Bhopalpattanam	NS INC	312.8	1355.9	23
10		Bijapur	NS DEC	292.7	1358.8	22
11		Usur	NS INC	348.2	1394.9	25
12	Dantewada	Dantewada	NS INC	240.6	1293.7	19
13		Gidam	NS INC	225.2	1215.9	19
14		Katekalyan	S** INC	277.5	1354.0	20
15		Kuakonda	NS INC	303.2	1398.2	22
16	Kondagaon	Bade Rajpur	NS INC	199.1	1119.4	18
17		Keshkal	NS INC	190.3	1151.9	17
18		Kondagaon	NS INC	220.9	1129.9	20
19		Makdi	NS INC	191.4	1184.2	16
20		Pharasgaon	NS INC	233.8	1159.0	20
21	Narayanpur	Narayanpur	S** INC	205.7	1190.8	17
22		Orcha	NS INC	236.8	1262.7	19
22	Sukma	Chhindigarh	S** INC	327.4	1382.4	24
23		Konta	S*** INC	265.1	1295.7	20
24		Sukma	S** INC	129.4	465.2	28

Level of significance: * = 1%, ** = 5%, *** = 10%

Trend and variability of monsoonal rainfall in different blocks of Northern Hill Zone

In Northern Hill Zone out of 32 blocks a significantly increasing trend of monsoonal rainfall was observed in 1 block (Jaspur), while a significantly decreasing trend was reported in 11 blocks rest all the blocks indicated more or less stable status of monsoonal rainfall and Monsoonal variability ranged between 15% in Pharsabahal and Duldula block to

27% in Surajpur block. Kumar *et al.* (2022) ^[5] reported somewhat similar results in region when compared with blocks of the respective districts. This is in with the findings of Sahu *et al.* (2023) ^[8] and Nema *et al.* (2018) ^[7] who reported similar type of monsoonal rainfall variability in Northern Hill Zone of Chhattisgarh state. Mahilange and Das (2018) ^[6] also found the highest variability in Surajpur in Northern Hill Zone of Chhattisgarh.

Table 3: Trend and variability of monsoonal rainfall in different blocks of Northern Hill Zone

Sl. No.	District	Block	Linear trend	SD	Mean	CV (%)
1	Balrampur	Balrampur	NS DEC	223.7	986.2	23
2		Rajpur	S** DEC	238.0	1068.8	22
3		Ramanujganj	S** DEC	225.1	933.6	24
4		Samri	NS DEC	172.8	1039.1	17
5		Shankargarh	S** DEC	205.7	1080.3	19
6		Wadrafnagar	S** DEC	224.8	934.5	24
7	Jaspur	Bagicha	S*** DEC	220.0	1160.2	19
8		Duldula	NS INC	171.2	1175.4	15
9		Jaspur	S** INC	214.6	1155.8	19
10		Kansabel	NS DEC	204.1	1190.8	17
11		Kunkuri	NS DEC	194.6	1205.0	16
12		Manora	NS DEC	202.1	1153.4	18
13		Parsabahal	NS INC	178.8	1161.4	15
14		Pathalgaon	NS DEC	193.6	1205.1	16
15		Baikunthpur	NS DEC	272.7	1042.0	26
16	Koriya	Khadgawana	NS DEC	248.5	1075.4	23
17		Sonhat	NS DEC	243.3	1078.0	23
18	Manendragarh Chirmiri Bharatpur	Bharatpur	NS DEC	231.4	1088.9	21
19		Manendragarh	NS DEC	254.4	1086.3	23
20	Surajpur	Bhaiyathan	S*** DEC	298.7	1269.1	24
21		Oudgi	S*** DEC	249.1	1038.7	24

22		Pratappur	S** DEC	261.6	1023.9	26
23		Premnagar	NS DEC	230.2	1186.5	19
24		Ramanujnagar	NS DEC	325.3	1371.9	24
25		Surajpur	NS DEC	52.1	190.5	27
26	Surguja	Ambikapur	S*** DEC	230.7	1131.1	20
27		Batouli	S*** DEC	220.6	1147.9	19
28		Lakhanpur	NS DEC	217.1	1128.1	19
29		Lundra	S*** DEC	226.0	1114.1	20
30		Mainpat	NS DEC	208.4	1153.0	18
31		Sitapur	NS DEC	213.1	1174.7	18
32		Udaipur	NS DEC	200.8	1128.0	18

Level of significance: * = 1%, ** = 5%, *** = 10

Conclusion

In all 3 agroclimatic zones of Chhattisgarh out of 146 blocks 15 blocks observed a significant increasing trend and 12 blocks reported a significant decreasing trend of monsoonal rainfall and Monsoonal variability ranged between 13% (Malkharoda block) to 31% (Deobhog block).

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