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Analysis of variability and different trends of daily rainfall events over cropping pattern over Giridih district of Jharkhand, India

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Abstract
In this study, analysis of the variability and trends in the daily gridded rainfall events of ≥5 mm or [daily rainfall events] during the southwest monsoon of four seasons (Monsoon, Post-monsoon, winter and summer) season over geographical regions of Giridih district of Jharkhand, India. The results of this study underscore the complex processes and variability of rainfall data that is associated with 13 blocks of Giridih, district, India, over 20 years (2000-2019) were analyzed. The average annual rainfall of Giridih district of Jharkhand, India was observed about 1058.4 mm. Dumari recorded the highest rainfall of 1362.2 mm while the lowest was 737.6 mm in Gawan block. No significant variations in total rainfall were observed. The result showed that the rainfall distribution among four seasons (Monsoon, Post-monsoon, winter and summer) which clearly indicated that 85.1 to 89.4 percent rainfall mainly concentrates during monsoon months and rest 10.6 to 14.9 percent within the rest three seasons under such circumstances possibility of second crop is only for less water requiring crops with minimum, reduced tillage or under paira cropping. The huge difference in rainfall was observed in the month of June that was lies between 91.8 mm and 243.3 mm among the allocated blocks of Jharkhand, while less fluctuation in rainfall was observed in September among the rest blocks of Jharkhand, India. in this research the September rainfall virtually helps the maturity of crops and planning the succeeding Rabi crops. Under such situation if rain seizes, a supplemental irrigation is essentially required and harvested water may support the crops to greater extent. Variations in trend of rainfall have been observed in time and space. Trend analysis on total as well as monsoonal rain has been showed variable trend within the blocks. Most of blocks (Giridih, Bengabad, Gandey, Jamua, Dhanwar, Deori, Tisari, Gawan, Pirtand, Dumari, Bagodar, Suriya) recorded a decreasing trend of rainfall between -4.0 to -42.3 mm/yr whereas increasing trend of rain was observed in Birni as 14.5 mm/yr.

Keywords: Variability, trends, daily rainfall, cropping pattern

Introduction
Giridih district of Jharkhand comes under Central and Lower Plateau Zone and Hill Region and Agro-climatic sub zone IV having total geographical area of 4962 sq. km is more or less rainfed. Giridih is dominated by hills, valleys and plateau with a considerable area (32.12%) under forest. The soils occurring in different land situations have been characterised during soil resource mapping of the state on 1:250,000 scale (Haldar *et al*,. 1996) [1] and three soil orders namely Alfisols, Inceptisols and Entisols were observed in Giridih district. Alfisols were the dominant soils covering 63.6 percent of TGA followed by Inceptisols (18.4%) and Entisols (16.9%).Major cereal crops in the district are Paddy, Maize, pulses (black Gram, Arhar, Pea, Moong, Urad) and vegetable crops (Tomato, Brinjal, Potato, Onion, Radish, Ridged Gourd, Cabbage, Bottle Gourd, Bitter Gourd, Okra, Cauliflowers etc). It can be managed by close monitoring of seasonal conditions, suggesting contingent crops on real time basis, adopting different farm level options like change in sowing dates, adopting suitable crops/varieties and supplemental irrigation using micro irrigation coupled with advance weather information. These measures have shown to reduce the adverse impacts of drought. Present study has been formulated with a view to identify more accurate crop plans for different climatic situations especially drought based on characterization of rainfall, soil, irrigation facility, land features and existing cropping situations of Giridih district at block level.

Rainfall is one of the most important factor for rainfed agriculture in India. About 61% of farmers in India rely on rainfed agriculture (NRAA, 2019). Around 58% of cultivated area is under rainfed condition which contributes to 40% of food productions in country (Prasad *et al.*, 2015) [5].

Due to dependency on monsoon, the productivity of the rainfed area is very low.

Rainfall and temperature are vital climatic parameters, which have been frequently used to identify the alterations in global climatic conditions (Mayowa *et al*. 2015; Sa'adi *et al*. 2019) [11, 12]. The seasonal and annual rainfall received and its variability directly influences the success or failure of crops through its beneficial or adverse effect on growth and yield (Halikatti *et al.*, 2010) [2]. Therefore the analysis of annual and seasonal distribution of rainfall is essential for selection of suitable crops and varieties for better production. The variability analysis of rainfall found to be useful in taking cropping pattern decisions (Prabhakar *et al*., 2017) [4]. Drought is caused by a deviation in the precipitation pattern from normal precipitation, which is a natural hazard that is insufficient to meet the demands of human activity and the environment (CWC, 1982) [6]. Drought is estimated using the time series of discharge and rainfall (Fleig *et al*., 2006; Van Loon, 2013) [13, 7].

Material and Method

The study was conducted in 13 blocks (Giridih, Bengabad, Gandey, Jamua, Birni, Dhanwar, Deori, Tisari, Gawan, Pirtand, Dumari, Bagodar and Suriya) of Giridih district of Jharkhand. Giridih is located under latitude from 23^0 52′ 59"to 24^0 46′47" N and longitude from 85^0 40′30" to 86^0 34′18" E and its altitude ranges from 289 m to 600 m above MSL. Giridih falls under sub-zone IV (North eastern plateau zone) among three agro-climatic subzones present in Jharkhand state. Long-term rainfall data for a period of 20 years (2000-2019) of all blocks of the district were collected from the office of District Agricultural Office of Giridih on a daily basis. The detail analysis of rainfall were done using a software (Weather cock V 1.0) developed by VUM Rao, AVMS Rao, GGSN Rao, T. Satyanarayana, N. Manikandan, B. Venkateswarlu of All India Coordinated Research Project on Agrometeorology, Central Research Institute for Dryland Agriculture Hyderabad, India. The criteria used under the software for individual parameters are as under.

Agricultural drought

As laid down by National Commission on Agriculture, 1976

Kharif – At least four consecutive weeks receiving rainfall less than half of the normal (>5mm)

Rabi: Six such consecutive weeks

Input: Weekly rainfall data

Output: Agricultural drought weeks during kharif and rabi season each year.

Meteorological drought

As prescribed by India Meteorological Department three types of drought based on rainfall deficit from normal are-

a. Mild drought: < 25%

b. Moderate drought: 26-50%

c. Severe drought: >50%

Input: Daily rainfall data

Output

a. Annual wise rainfall amount

b. Occurence of drought type each year

c. Probability of occurence of each drought type over the years

Result and Discussion

Rainfall characterization and Seasonal distribution

Rainfall data available from 13 blocks of Giridih over 20 years (2000-2019) were analysed and an average annual rainfall of 1058.4 mm was observed. Dumari recorded the highest rainfall of 1362.2 mm while the lowest was 737.6 mm in Gawan block. No significant variations in total rainfall were observed. Data from table no 5 showed rainfall distribution among four seasons (Monsoon, Post-monsoon, winter and summer) which clearly indicated that 85.1 to 89.4 percent rainfall mainly concentrates during monsoon months and rest 10.6 to 14.9 percent within the rest three seasons Under such circumstances possibility of second crop is only for less water requiring crops with minimum, reduced tillage or under paira cropping.

Table 1: Rainfall distribution in blocks of Giridih district

Block	Annual rain (mm)	Monsoon rain (mm)	Post monsoon rain (mm)	Winter rain (mm)	Summer rain (mm)
Giridih	1360.0	1115.0(82.0)	80.0(5.9)	27.9(2.1)	137.0(10.1)
Bengabad	1081.9	906.2(83.76)	91.5(8.5)	14.4(1.3)	69.8(6.5)
Gandey	1033.3	874.6(84.6)	69.6(6.7)	15.3(1.5)	73.9(7.1)
Jamua	1149.2	994.0(86.5)	81.0(7.0)	9.3(0.8)	64.9(5.7)
Birni	916.8	794.2(86.6)	77.4(8.4)	8.6(0.9)	36.7(4.0)
Dhanwar	949.4	832.3(87.7)	64.0(6.7)	7.9(0.8)	45.1(4.8)
Deori	888.2	739.9(83.3)	75.0(8.4)	3.6(0.4)	69.8(7.9)
Tisari	909.3	783.9(86.2)	77.3(8.5)	8.1(0.9)	40.1(4.4)
Gawan	737.6	650.1(88.1)	44.0(6.0)	11.4(1.5)	32.1(4.3)
Pirtand	1246.1	1040.6(83.5)	112.6(9.0)	16.2(1.3)	76.7(6.2)
Dumari	1362.2	1137.9(83.5)	99.2(7.3)	24.5(1.8)	100.6(7.4)
Bagodar	1072.3	865.4(80.7)	97.5(9.1)	7.7(0.7)	101.7(9.5)
Suriya	1052.7	874.8(83.1)	90.8(8.6)	3.6(0.3)	83.5(7.9)
District Avg.	1058.4	893.0 (84.6)	81.5 (7.7)	12.2 (1.1)	71.7 (6.6)

Figure in parenthesis is represent percent value

Distribution in rainfall with time and space has been observed in many parts of India and abroad as reported by Singh *et al*. (2003) [8] in Hisar, Bhiwani and Sirsa area, Karthikeyan *et al.* (2008) [9]; Kumar (2013) [10] in Palamu and Horo (2015) in West Singhbhum.

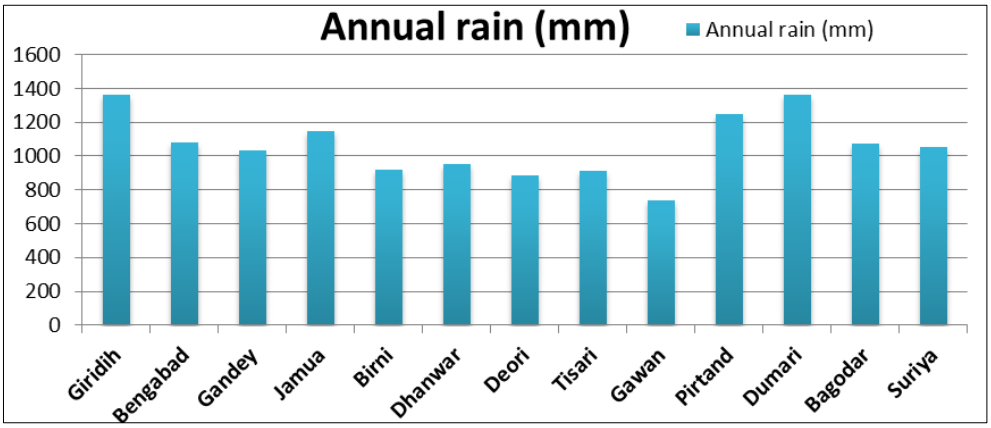

Fig 1: Annual Rainfall distribution in blocks wise of Giridih district

Annual Rainfall distribution in blocks wise of Giridih district.

Monthly distribution

The monthly rainfall distribution has ranged from 162.9 to 362.0 mm during the past 20 years. Huge difference in rainfall was observed in the month of June i.e. between 91.8 mm and 243.3 mm among the blocks while less fluctuation in rainfall was observed in September among the blocks. In all the blocks, average rainfall fluctuated between 166.6 mm and 281.8 mm during September which can be seen from Table 6. Similar distribution of rainfall among the monsoonal months have been observed, reported by Mukherjee and Banerjee (2009) [3] in West Bengal.

September rainfall virtually helps the maturity of crops and planning the succeeding rabi crops. Under such situation if rain seizes, a supplemental irrigation is essentially required and harvested water may support the crops to greater extent.

Table 2: Block wise monthly distribution of rainfall of Giridih Distict

Blocks	Monthly distribution of rainfall (mm).													Average
	Giridih	Bengabad	Gandey	Jamua	Birni	Dhanwar	Deori	Tisari	Gawan	Pirtand	Dumari	Bagodar	Suriya	
Jan	9.0	4.6	7.3	2.4	3.0	2.7	0.8	0.3	5.0	5.7	9.6	1.9	1.0	3.7
Feb	16.5	8.9	7.6	5.9	5.1	4.6	2.0	6.1	5.9	9.8	14.4	5.1	1.9	6.2
Mar	12.3	6.4	4.0	6.8	1.7	2.1	7.2	4.5	1.7	6.1	12.2	5.1	5.0	5.1
Apr	28.9	5.8	9.5	4.2	2.6	7.9	4.4	5.2	5.6	15.1	12.2	17.6	15.1	9.1
May	95.8	57.6	60.3	54.0	32.4	35.1	58.2	30.4	24.7	55.6	76.2	79.0	63.4	51.7
Jun	240.9	155.1	151.1	172.0	116.0	119.0	137.3	100.0	91.8	198.8	243.3	155.9	150.6	149.8
Jul	362.0	303.6	300.6	285.1	218.4	280.3	200.0	257.2	228.8	301.1	344.8	252.2	250.7	269.7
Aug	276.0	228.1	238.4	255.1	225.3	217.7	209.6	226.5	162.9	262.1	296.3	253.9	257.9	236.4
Sep	236.1	219.4	184.4	281.8	234.5	215.2	192.9	200.2	166.6	278.6	253.5	203.4	215.6	220.3
Oct	76.1	89.4	69.1	77.6	72.4	61.0	66.7	71.5	42.7	108.4	97.5	97.0	90.3	78.6
Nov	4.0	2.1	0.5	3.4	4.9	3.0	8.3	5.8	1.3	4.2	1.7	0.5	0.5	3.1
Dec	2.5	0.8	0.4	1.0	0.5	0.7	0.9	1.7	0.6	0.7	0.6	0.7	0.7	0.8

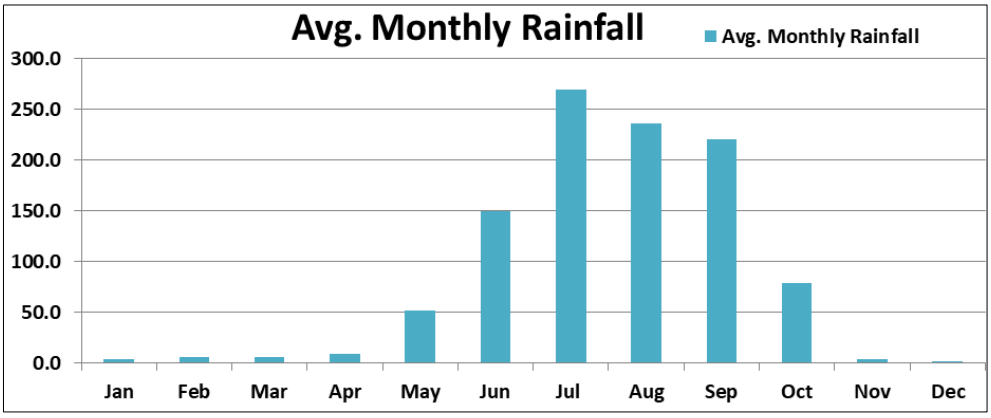

Fig 2: Avg. Monthly wise rainfall of Giridih Distict

Avg. Monthly wise rainfall of Giridih District

Rainfall trend

Slightly decrease in rainfall trend was observed in all blocks of Giridih both for annual and seasonal rain except Birni block. Variations in trend of rainfall have been observed in time and space. Trend analysis on total as well as monsoonal rain has been shown through Table 7. Trend line equation developed from 20 years rainfall data showed variable trend within the blocks. Most of blocks (Giridih, Bengabad, Gandey, Jamua, Dhanwar, Deori, Tisari, Gawan, Pirtand, Dumari, Bagodar, Suriya) recorded a decreasing trend of rainfall between -4.0 to -42.3 mm/yr whereas increasing trend

of rain was observed in Birni as 14.5 mm/yr. Table no 7 showed similar results were also observed for monsoonal rain as that of annual rainfall through all the block.

Table 3: Rainfall trend in blocks of Giridih district

Block	Annual rain equation	Monsoonal rain equation
Giridih	y = -42.35x + 1804	y = -30.55x + 1435
Bengabad	y = -19.04x + 1281	y = -13.89x + 1052
Gandey	y = -4.033x + 1075	y = 0.394x + 870.4
Jamua	y = -7.331x + 1226	y = -8.610x + 1084
Birni	y = 14.54x + 753.9	y = 13.15x + 656.1
Dhanwar	y = -4.641x + 998	y = -5.341x + 888.3
Deori	y = -24.08x + 1141	y = -21.78x + 968.6
Tisari	y = -6.671x + 979.3	y = -4.959x + 835.9
Gawan	y = -13.63x + 880.8	y = -13.18x + 788.6
Pirtand	y = -6.494x + 1314	y = -5.505x + 1098
Dumari	y = -27.44x + 1650	y = -21.00x + 1358
Bagodar	y = -10.51x + 1182	y = -12.82x + 1000
Suriya	y = -12.41x + 1183	y = -9.443x + 974

Seasonal variability

Seasonal (kharif and rabi) variability of rainfall in terms of standard deviation (SD) and coefficient of variations (CV)% analysed for all 13 blocks of Giridih district showed less variability in Kharif (CV: 44.7 – 92.4%) than rabi (CV: 136.8 to 317.8%). It is evident from the values of CV that rainfall during Kharif was rather more consistent and reliable than that of Rabi which can be seen from Table 8. Values of standard deviation were observed more in kharif as compared to rabi season due to more amount of rainfall during the kharif season. Standard deviation also followed the same results as of CV% among the blocks of Giridih.

Table 4: Seasonal rainfall variability of Giridih district

Blocks	Season	Av. Rain (mm)	% of total rain	SD	CV%
Giridih	Kharif	1191.1	87.6	87.1	44.7
	Rabi	73.1	5.4	13.6	136.8
Bengabad	Kharif	995.7	92.0	98.2	53.7
	Rabi	28.6	2.6	11.0	255.4
Gandey	Kharif	943.7	91.3	130.5	77.5
	Rabi	29.4	2.8	10.5	272.7
Jamua	Kharif	1071.5	93.2	123.6	65.3
	Rabi	23.7	2.1	10.7	277.9
Birni	Kharif	866.6	94.5	98.7	65.1
	Rabi	17.8	1.9	7.9	257.9
Dhanwar	Kharif	893.3	94.1	105.6	69.8
	Rabi	21.0	2.2	9.1	279.0
Deori	Kharif	806.5	90.8	106.8	75.5
	Rabi	23.5	2.6	12.1	285.7
Tisari	Kharif	855.4	94.1	111.1	75.0
	Rabi	23.6	2.6	11.8	317.8
Gawan	Kharif	692.8	93.9	115.9	92.4
	Rabi	20.1	2.7	7.3	257.9
Pirtand	Kharif	1148.9	92.2	110.4	53.0
	Rabi	41.5	3.3	14.4	235.3
Dumari	Kharif	1235.4	90.7	141.9	66.7
	Rabi	50.6	3.7	15.1	237.2
Bagodar	Kharif	962.3	89.7	91.5	54.3
	Rabi	30.9	2.9	10.2	248.9
Suriya	Kharif	965.1	91.7	89.2	54.2
	Rabi	24.1	2.3	7.7	248.7

Conclusion

It is evident from the findings the value of coefficient of variation (CV%) about daily rainfall during Kharif was more consistent and reliable than that of Rabi season. The values of standard deviation were observed more in Kharif as compared to Rabi season due to more amount of rainfall during the Kharif season. Standard deviation also followed the same results as of CV% among the blocks of Giridih, India, Jharkhand. The September rainfall virtually helps the maturity of crops and planning the succeeding Rabi crops. Under such situation if rain seizes, a supplemental irrigation is essentially required and harvested water may support the crops to greater extent to promote corps yield and their productivity.

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