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TEMPORAL RAINFALL DISTRIBUTION CHARACTERISTICS AT MAYURBHANJ, ODISHA, INDIA

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Abstract

Rainfall is one of the most important factor, which determines the sowing time and other agricultural activities especially for rainfed farming. Every attempt is therefore made to study and analyse rainfall data in order to understand its distribution, pattern and characteristics. The analysis of 19 years (1997-2015) daily rainfall data of Mayurbhanj district coming under North Central Plateau agro-climatic zone of Odisha has been done for determining the characteristics of rainfall and probability of occurrence of normal weekly rainfall. Seasonal and yearly analysis of the rainfall was also done for the Mayurbhanj station, whose annual average rainfall is 1808.2 mm, with 100 numbers of rainy days. Monsoon rainfall contributes more than 75% of the average annual rainfall. The weekly rainfall was more than 20 mm from 18th to 41st SMW, however the percentage contribution is almost zero for 1st to 14th and 45th to 52nd Standard Meteorological Week.

Key words : Normal rainfall, daily rainfall, standard meteorological week, probability analysis, rainfed agriculture, Mayurbhanj.

Introduction

The availability of rainfall is not well assured at all the place and time. There is a large variation of rainfall distribution observed from year to year in India (Dhar *et al*., 1979). Rainfall is one of the most important and governing factor in the planning and operation strategies of any agricultural programme for any area. Indian Agriculture mainly depends on monsoon rain. Out of the total cultivated are of our country, nearly 70% of area is rainfed, which depends on characteristic of monsoon. Despite of the progress, marginal and small farmers constituting 80% of agriculture income groups still depends on rainfed farming (Das and Subhash, 2004). In rainfed agriculture, the total amount of rainfall as well as its distribution affects the plant growth (Sharma *et al*., 1979; Sharda and Bhushan, 1985; Suresh *et al*., 1992). According to Mulat *et al*. (2004), the quantum of rainfall during crop growing season and temporal distribution of rainfall is a crucial factor deciding interannual fluctuations in national crop security. Crop planning is normally done basing on assured rainfall quantity, which is based on probabilistic measures (Ray *et al*., 2011a and Ray *et al*., 2011b).

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An attempt has been made in this paper to analyse the rainfall standard, week wise, as well as monthly rainfall distribution at different probability levels for Mayurbhanj, Odisha by using suitable techniques. Analysis of annual, seasonal and monthly rainfall of a region is useful to design water harvesting structure. Similarly, weekly rainfall analysis gives more useful information in crop planning (Sharma *et al*., 1979). Rainfall analysis is of great importance for developing and modifying the crop management practices for sustainable production system. Analysis of rainfall would not only enhance the management of water resources applications, but also the effective utilization of water resources thereby preventing floods and droughts (Chin-Yu Lee, 2005). Karate and Sena (2004) studied the application of rainfall analysis for planning soil and water conservation structures in semi arid Gujarat. Detailed knowledge of rainfall pattern helps in planning the cultivation of crops, their varieties, adoption of cultural operations, designing of different storage structures (Ray *et al*., 1987) and harvesting of excess rain water of any region (Sinhababu 1977; Budhar *et al*., 1987 and Kar, 2002) to meet out irrigation requirement during drought period. The criteria set by Raman (1979) for rainfall of 1 mm for defining a

rainy day is not suitable for agriculture purpose. However, Ashokraj (1979) used the criteria fixed by IMD for defining the rainy day *i.e.* the day with at least 2.5 mm rain is called a rainy day. Probability analysis is the most reliable method to predict occurrence of rainfall events based on past behaviour of rainfall (Kumar and Kumar, 1989). The weekly distribution of rainfall and its probability is helpful in crop planning by identifying the period of drought, normal and excess rainfall (Ray *et al*., 1980). When probability of occurrence of dry spell different length in a week bounded by wet weeks is know; adequate steps may be taken by shifting the sowing time or arranging minimal irrigation to get optimum yield.

Materials and Methods

The study place, Mayurbhanj has an area of 10,418 km² and is located at 22.0087° N latitude and 86.4187° E longitude with an altitude of 559 m above mean sea level. The amount of rainfall and number of rainy days in a week at Mayurbhanj, Odisha from historic daily rainfall records (1997-2015) collected from India Meteorological Department (IMD), Pune are calculated using probabilistic approach. Probability analysis is carried out to estimate the expected amount of rainfall at various probability levels of (25 - 90%) at Mayurbhanj station using Weibull's plotting position method (Murthy, 1998).

The weekly rainfall data have been analysed at different levels of probability by using Weibull's method. In this method, the weekly rainfall was arranged in descending order of magnitude. The highest one assigned rank 1; next magnitude was given rank 2 and so on. The probability 'P' of the week having rainfall exceeding or equalling normal value was calculated by using Weibull's formula (equation 1).

$$P = \frac{m}{n+1} \quad (1)$$

Where,

P = probability of occurrence

m = rank number

n = number of years of data used

The extreme event of monthly rainfall was calculated from the point rainfall data used for analysis. The extreme value of rainfall and rainy days were calculated from the 19 years of recorded data. Both minimum and maximum value of the rainfall and rainy days was used for necessary analysis.

Results and Discussion

Nineteen (1997-2015) of daily point rainfall data was analysed and the average annual rainfall of Mayurbhanj

Table 1 : Weekly rainfall at Mayurbhanj station at different probability levels in a year.

Standard Met Week (SMW)	Rainfall at different probability level				
	25%	50%	70%	80%	90%
1	1.8	0	0	0	0
2	3.4	0	0	0	0
3	0.1	0	0	0	0
4	4.1	0	0	0	0
5	1.7	0	0	0	0
6	8.4	1	0	0	0
7	3.7	0	0	0	0
8	2.6	0.1	0	0	0
9	0.3	0	0	0	0
10	4.8	0	0	0	0
11	6.2	0.3	0	0	0
12	7.5	1.8	0.2	0	0
13	12.9	1.8	0.3	0.1	0
14	12.7	1.1	0	0	0
15	28.2	6.2	5.1	0.4	0
16	20.3	5.7	1.5	0	0
17	31.2	3.2	1.3	0.3	0
18	33	23.4	16.1	3.9	0.3
19	30.1	13.4	9.6	3.6	2
20	46.7	30.3	20.3	12.4	4.5
21	90.7	41.6	33.9	32.2	19.9
22	90.7	48.3	33.6	14.2	7.5
23	114.2	64.4	52.1	29.2	17
24	94.8	56.5	39.2	26.4	20.9
25	87	61.3	49.9	29.3	11.9
26	104.5	72.5	45.3	32.7	17.5
27	138.2	79.6	38.6	24.5	11.3
28	162.2	106.6	89.8	68.3	32.3
29	117.4	101.8	92.1	82.4	26.1
30	129.1	106.4	68.8	56.3	35.2
31	101.8	70.9	59.5	44	26
32	129.2	72.8	60.3	33	9.4
33	137.9	77.6	58.5	55.7	46.7
34	93.4	67.9	35.1	17.3	92.6
35	109.3	59.6	34.8	27.8	7.4
36	111.9	74	45.8	39.2	32
37	79.2	56.7	33.4	24.8	0.6
38	135.8	72.1	61.6	29.4	4.8
39	75.7	26.3	4.7	0.9	0
40	51.6	39.4	19.5	10.6	2.5
41	36.3	5.9	2.4	0.2	0
42	31.4	4	0	0	0
43	21.7	0.4	0	0	0
44	5.1	0	0	0	0
45	1.5	0	0	0	0
46	3.1	0	0	0	0
47	0	0	0	0	0

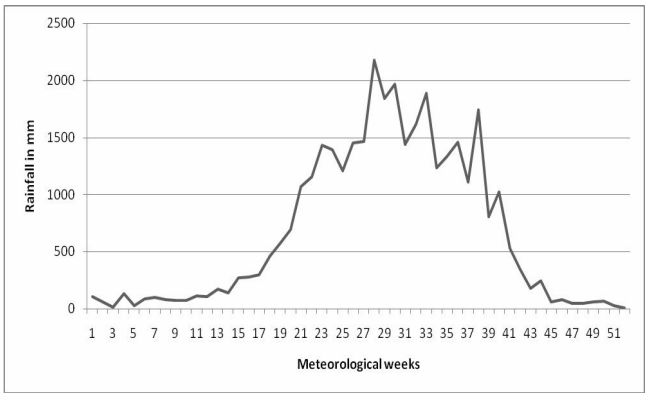

Fig. 1 : Depth of rainfall (mm) on standard week basis.

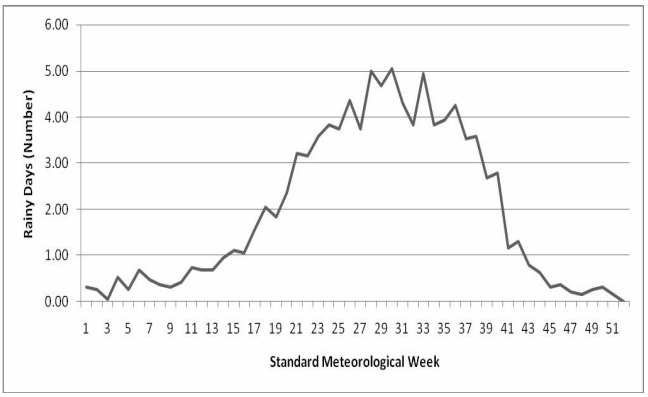

Fig. 2 : Number of rainy days in a standard week at Mayurbhanj.

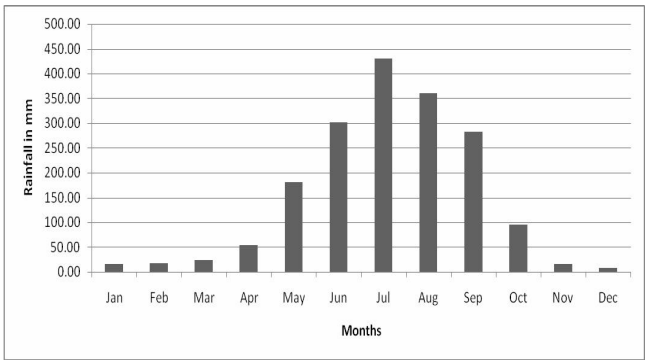

Fig. 3 : Monthly distribution of rainfall (mm) at Mayurbhanj station.

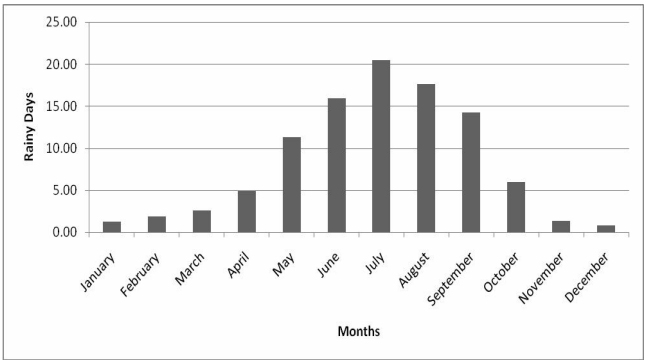

Fig. 4 : Average number of rainy days in a month.

is worked out to be 1808.2 mm, with 100 numbers of rainy days. The maximum rainfall of 2174.4 mm occurred in the year 1999 and the minimum quantum 1498 mm of rainfall was received during the year 2010 (fig. 7). The average monthly rainfall of the place for the months of March, April, May, June, July, August, September and October is 24.03, 53.56, 181.55, 302.04, 429.93, 360.07, 283.28 and 95.65mm, respectively. The maximum average rainfall is received during the month of July to a tune of 429.93 mm and the minimum average rainfall is received during the month of December to a tune of 7.95 mm (fig. 3). The average number of rainy days and amount of rainfall in a standard week at Mayurbhanj is presented in figs. 1 and 2, respectively. It is found that the average number of rainy day is equal to or more than three (3) from 21st to 40th week in a year (fig. 2). Annual rainy day is almost more than 90 for the analysed period (fig. 8). Average weekly rainfall exceeds 60 mm for standard week 22nd to 38th standard meteorological week (SMW) (table 2). Probability level prediction from 25 per cent to 90 per cent was done to find out the approximate amount of rainfall in a standard week at Mayurbhanj is shown in table 1. Generally, 50 per cent and above probability value of rainfall is taken as assured quantity of rainfall (Ray *et al*., 2011a; Ray *et al*., 2011b; Ray, 2012c). Weekly rainfall at Mayurbhanj shows that at 90 per cent probability the quantum of rainfall is nil from 1st to 17th and 41st to 52nd SMW (table 1). Therefore, assured sources of irrigation must be provided for winter crop cultivation. Heavy rainfall was observed on 38th SMW (282.9 mm). In this week, the normal value is 91.57 mm. The maximum value of rainfall was more than 80 mm from 18th to 44th SMW except in 43 SMW (35.5 mm). The percentage contribution of SMW is almost zero for 1st to 14th and 45th to 52nd (table 2). The weekly observed minimum, maximum and normal rainfall and the probability of the weekly normal rainfall equalling or exceeding the normal in a year is presented in table 2. The weekly quantum of rainfall is more than 40 mm from 21st to 38th SMW of the year for probability of 50 per cent. The monthly distribution of rainy days and amount of rainfall is presented in fig. 4 and 5, respectively. It is found that 1375.32mm of rainfall is confined to four months of the year (*i.e*. June to September). During these four months the total number of rainy days is more than sixty five (table 3). Normally at the first week of October the monsoon recedes. The seasonal rainfall analysis for rainy days and amount of rainfall is presented in figs. 5 and 6, respectively. The average value of monthly rainfall and number of rainy days, extreme event values, its standard deviation,

Table 2 : Weekly rainfall at Mayurbhanj station at different probability levels in a year.

Standard Met Week (SMW)	Extreme Value		Normal (mm)	Standard deviation (mm)	Coefficient of variation (%)	Percentage of contribution (%)
	Minimum (mm)	Maximum (mm)				
1	0	35	5.31	11.43	215.1601	0.3
2	0	35	2.88	8.04	279.149	0.2
3	0	7.5	0.57	1.76	307.3938	0.0
4	0	42.8	6.66	13.73	206.226	0.4
5	0	9.9	1.24	2.34	188.7579	0.1
6	0	21.3	4.52	6.78	150.1992	0.3
7	0	57.6	5.07	13.24	261.1907	0.3
8	0	27.4	4.05	8.36	206.4796	0.2
9	0	34.4	3.83	9.46	247.199	0.2
10	0	19.2	3.56	5.96	167.2354	0.2
11	0	39.5	5.67	10.39	183.0762	0.3
12	0	21.1	5.29	7.62	143.8428	0.3
13	0	46.8	8.81	13.42	152.4172	0.5
14	0	37.7	7.12	10.74	150.9286	0.4
15	0	72.2	14.12	18.61	131.7972	0.8
16	0	78.9	14.34	20.14	140.4589	0.8
17	0	68	15.57	22.04	141.5828	0.9
18	0.2	84.7	24.24	22.62	93.31047	1.3
19	1.7	121.7	30.09	36.54	121.4505	1.7
20	0	120.8	36.46	29.95	82.12814	2.0
21	1.3	129.4	59.18	37.49	63.34656	3.3
22	0.9	171.5	60.58	52.08	85.96995	3.4
23	5.8	168.5	75.39	45.98	60.9951	4.2
24	5.8	252.3	73.02	60.37	82.67937	4.0
25	0	144	63.45	37.69	59.39764	3.5
26	9.7	181.5	76.21	49.97	65.56909	4.2
27	5.4	195.9	77.09	58.50	75.88156	4.3
28	26.4	214.7	114.47	55.16	48.18986	6.3
29	18.3	182.2	96.91	40.37	41.65668	5.4
30	0.7	232.5	103.52	54.96	53.08919	5.7
31	14.2	149	75.52	38.48	50.95045	4.2
32	5.4	205.5	84.89	55.62	65.51982	4.7
33	40.3	183.1	99.33	49.50	49.82871	5.5
34	0	117.9	64.87	39.22	60.45971	3.6
35	6.4	178.5	70.05	51.80	73.9514	3.9
36	6.3	151	76.75	41.32	53.84328	4.3
37	0	124	58.28	32.37	55.53843	3.2
38	4.1	282.9	91.57	73.67	80.45454	5.1
39	0	118.8	42.32	40.81	96.43719	2.3
40	0	238.1	53.83	62.95	116.9454	3.0
41	0	183.9	27.67	47.20	170.5756	1.5
42	0	96.3	18.00	28.72	159.5496	1.0
43	0	35.5	9.35	11.76	125.8636	0.5
44	0	129.7	12.62	31.20	247.2443	0.7
45	0	20.9	2.84	6.10	215.0285	0.2

Table 2 continued...

Table 2 continued...

46	0	25.5	4.11	8.24	200.6516	0.2
47	0	31.1	2.34	7.29	311.3776	0.1
48	0	40	2.38	9.17	385.6035	0.1
49	0	27.6	2.92	8.51	291.8372	0.2
50	0	29.1	3.21	7.55	235.1471	0.2
51	0	15.9	1.11	3.70	335.2028	0.1
52	0	2	0.20	0.52	261.9372	0.0

Table 3 : Monthly normal and extreme rainfall (number of rainy days) along with SD, CV and percentage contribution at Mayurbhanj.

Month	Normal (mm)	Extreme Value		Std deviation (mm)	Coefficient of variation (%)	Percentage contribution (%)
		Maximum (mm)	Minimum (mm)			
January	15.89 (1.26)	66.8 (4)	0 (0)	19.91 (1.33)	125.27 (105.03)	0.89 (1.29)
February	17.27 (1.84)	76.1 (6)	0 (0)	18.95 (1.74)	109.71 (94.48)	0.97 (1.88)
March	24.03 (2.58)	88.5 (6)	3.2 (1)	20.73 (1.46)	86.27 (56.81)	1.35 (2.63)
April	53.56 (4.89)	116.6 (13)	0 (0)	35.24 (3.30)	65.80 (67.38)	3.00 (4.99)
May	181.55 (11.26)	305.1 (16)	76.3 (5)	70.24 (3.02)	38.69 (26.77)	10.16 (11.47)
June	302.04 (15.95)	598 (22)	127.4 (8)	116.62 (4.24)	38.61 (26.56)	16.91 (16.25)
July	429.93 (20.42)	629.4 (26)	259.3 (12)	100.70 (3.79)	23.42 (18.56)	24.07 (20.80)
August	360.07 (17.58)	514.2 (23)	267.4 (13)	68.45 (4.96)	19.01 (28.21)	20.16 (17.91)
September	283.28 (14.26)	446.4 (20)	186.3 (8)	80.68 (4.83)	28.48 (33.85)	15.86 (14.53)
October	95.65 (6.00)	328.3 (16)	19.7 (2)	80.00 (4.38)	83.64 (73.07)	5.35 (6.11)
November	15.13 (1.32)	60.7 (6)	0 (0)	18.55 (1.57)	122.61 (118.97)	0.85 (1.34)
December	7.95 (0.79)	48.9 (4)	0 (0)	13.94 (1.47)	175.29 (186.83)	0.45 (0.80)

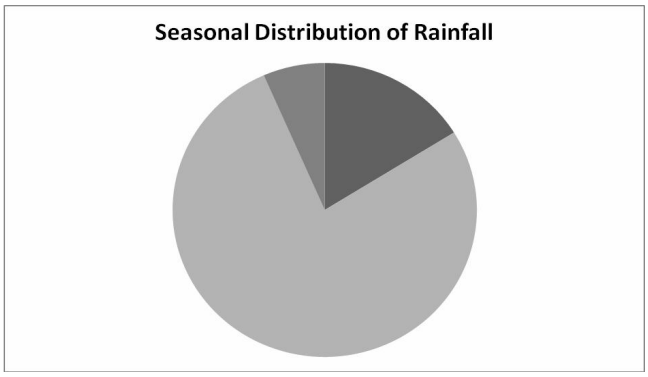

Fig. 5 : Seasonal distribution of rainfall at Mayurbhanj station.

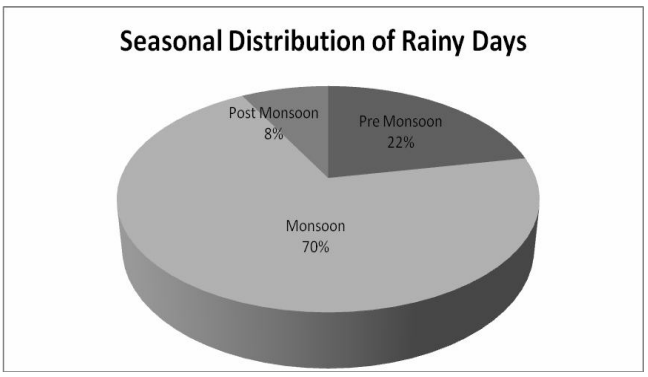

Fig. 6 : Seasonal distribution of rainy days at Mayurbhanj station.

coefficient of variations and percentage contribution is presented in table 3. Monsoon rainfall accounts for 77 per cent of the whole rainfall, with pre-monsoon and post-monsoon shower of 16 per cent and 7 per cent, respectively (fig. 4). The monsoon rainy days accounts to 70 per cent of the total rainy days in a year. The yearly distribution of rainy days and amount of rainfall is presented in figs. 7 and 8, respectively.

Conclusion

Knowledge of the onset of monsoon, amount of rainfall and its distribution are prerequisite to adopt any cropping system model at a particular region especially for rainfed crops. The present study reveals that Mayurbhanj station receives an average annual rainfall of 1808.2 mm, with 100 number of rainy days. More than 80 per cent rainfall occurs during 22rd to 44th week.

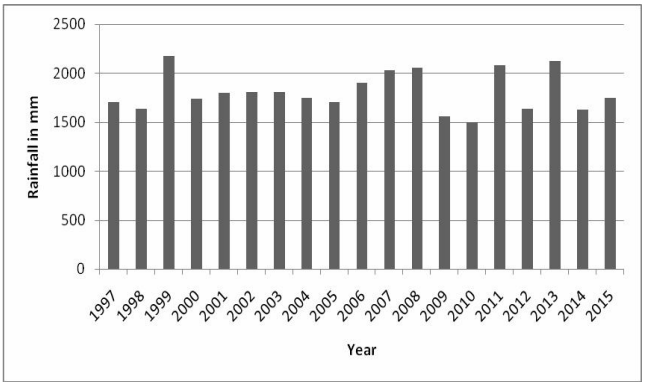

Fig. 7 : Year wise distribution of rainfall at Mayurbhanj station.

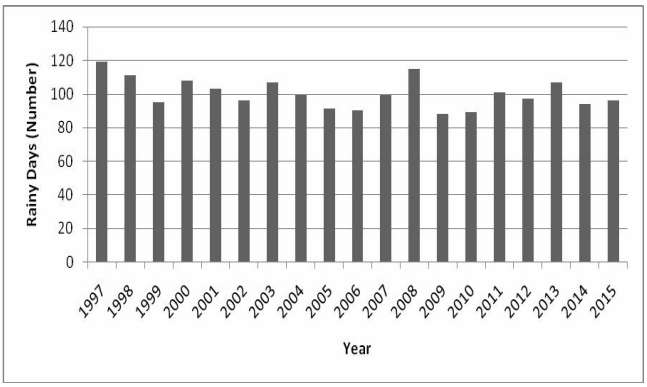

Fig. 8 : Year wise distribution of rainy days at Mayurbhanj station.

Rice nursery bed preparation can be started by 22nd SMW and harvesting operation can be completed by 38th-42nd week by selecting medium to long duration varieties. The amount of rainfall (about 200 mm) in the months of April and May, is considered as pre-monsoon showers, helps in seed bed preparation. Hence the length of monsoon is about 135 days which helps in growing paddy and other cereal crops. Since winter season gets about 7 per cent of total rainfall, rabi (toria/vegetables) crops can be planned after 44th week with assured irrigation. Water harvesting systems can be constructed, to store excess water during rainy season, which will be utilized as life saving irrigation for crops during winter season.

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