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Temporal Rainfall Distribution Characteristics at Tura, Western Meghalaya

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ABSTRACT

Western Meghalaya is one of the major rainfed- rice grown areas of Meghalaya, India. Tura, the headquarter of West Garo Hills district of Meghalaya, is falling under mild extremely wet agro-climatic zone with an annual rainfall of 4,851.5 mm with 113 numbers of rainy days [average of 24 years (1984-2007) daily rainfall data]. Rainfall analysis with advanced statistical methods can be used for crop planning, land water management, water harvesting, aquaculture and floriculture planning etc. The analysis of 24 years (1984-2007) daily rainfall data of Tura, Meghalaya has been carried out. Monsoon rainfall contributes more than 70% of average annual rainfall. Weekly rainfall is more than 100 mm and 3 rainy days from 16th to 40th standard meteorological week, however, for 1st to 15th and 43rd to 52nd week the probability of getting rainfall is zero.

Key words: Crop planning, standard meteorological week, probability of occurrence, rainfed agriculture, rainfall analysis

INTRODUCTION

The knowledge on amount of rainfall, number of rainy days and its distribution over the cropping season are important for timely preparation of seed bed, selection of crop varieties, and choice of cropping pattern. In most part of India, rainfall is uneven and erratic. The amount of rainfall at a particular place is important; an equally important factor is its temporal distribution. The importance of this distribution is realised in agricultural and allied sectors. The knowledge of distribution of dry spells and amount of rainfall during wet spells is very much essential for successful irrigation water management of agriculture. The information of amount of rainfall during wet spell is useful for storage purpose based on the magnitude of dry spells. Also the crop development is severely affected if dry spells coincide with the sensitive phenological stage of the crop, and it is sometimes beneficial if it coincide with the ripening stage. The criterion 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 India Meteorological Department (IMD) for defining the rainy day i.e. the day with at least 2.5 mm rain is called rain day. A lot of work has been carried out in the past by various investigations on rainfall analysis, *viz*. i. Probability analysis of rainfall (Jakhar et al. 2011; Sharda and Bhushan 1985; Ray et al. 2011a), ii. rainfall characteristics analysis (Chakraborty et al. 2008; Mohanty et al. 2001; Satapathy et al. 1998; Ray et al. 2011b), iii. Dry spell analysis (Verma and Sharma 1989).

For Northeast India, Meghalaya in particular, rainfall analysis work have been done to find out the maximum probable rainfall, meteorological drought assessment, annual trend in rainfall etc. Williamnagar, Tura and Cherapunjee stations of Meghalaya shows an increasing trend in rainfall (Ray et al. 2012c). Meteorological drought assessment was done for Tura and Barapani stations of Meghalaya (Ray et al. 2013b; Ray et al. 2012b).

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Probable maximum amount of daily rainfall with its return period was analysed for Barapani and Nongstoin station of Meghalaya (Ray et al. 2012a; Ray et al. 2013a). When probability of occurrence of dry spell different length in a week bounded by wet weeks is known; adequate steps may be taken by shifting the sowing time or arranging minimal irrigation to get optimum yield. In this paper, the weekly and monthly rainfall pattern, extreme monthly rainfall event at Tura, Meghalaya has been analysed at different probability levels by using Weibull's plotting position method. The probability of occurrence of amount of normal weekly rainfall is also analysed. The distribution of weekly, monthly and seasonally rainfall is discussed in this paper.

MATERIALS AND METHODS

Tura, the head quarter of West Garo Hills district of Meghalaya is located at 25^0 20' to 26^0 N latitude, 89^0 40' to 90^0 30' E longitude at an elevation of less than 625 m above sea level. The amount of rainfall and number of rainy days in a standard meteorological week (SMW) at Tura was estimated from historic daily rainfall records (1984-2007) collected from IMD, Pune. Probability analysis is carried out to estimate the expected amount of rainfall at various probability levels of (50 - 90%) at Tura 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 equaling normal value was calculated by using Weibull's formula (Eq.1).

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

where,

P = probability of occurrence

m = rank number;

and 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 24 years of recorded data. Both minimum and maximum value of the rainfall and rainy days was used for necessary analysis.

RESULTS AND DISCUSSION

The average annual rainfall at Tura is 4,851.5 mm with 113 numbers of rainy days. The maximum annual rainfall recorded was 7,584.5 mm corresponding to the year 1984; and the minimum recorded was 3,757.8 mm corresponding to the year 1997. The number of rainy days and amount of rainfall in a standard week throughout a water year was calculated by simple average of the 24 years of daily rainfall. The average number of rainy days per week is more than three from 16th to 40th Standard Meteorological Week (SMW); these weeks also receive a rainfall of more than 100 mm. The weekly average number of rainy days and amount of rainfall is shown in Fig. 1 and Fig. 2, respectively. The probability weekly analysis was made for 50%, 60%, 70%, 80% and 90% probability levels for estimating the amount of rainfall. Generally rainfall at 70% probability can be safely taken as assured rainfall, while 50% chance can be considered as the maximum limit for taking any risk (Gupta et al. 1975; Dingre et al. 2006). The probability distribution of number of rainy days and amount of rainfall on SMW is presented in Figs. 3 and 4 respectively. Monthly analysis of point rainfall revealed that May, June, July and August were the wettest month contributing more than 60% of annual rainfall (Fig. 5). However, the annual rainy days are more than 10 in May to September months (Fig. 6). Seasonal rainfall analysed (Fig. 7 and Fig. 8) at the Tura station showed that monsoon season was contributing about 73% of total rainfall with more than 60% of rainy days. Weekly probability analysis of rainfall is presented in Table 1. It was found from Table 1 that there are 70% chances of getting rainfall more than 10 mm during 16th to 41st SMW. During 1st to 15th SMW and 43rd to 52nd SMW the amount of rainfall received was nil at all probability levels, hence it indicates that during winter and summer crop. The assured irrigation facilities need to be there, so that the cropping intensity may be enhanced. During 21st to 39th SMW even at 90% probability level there are every chances of getting

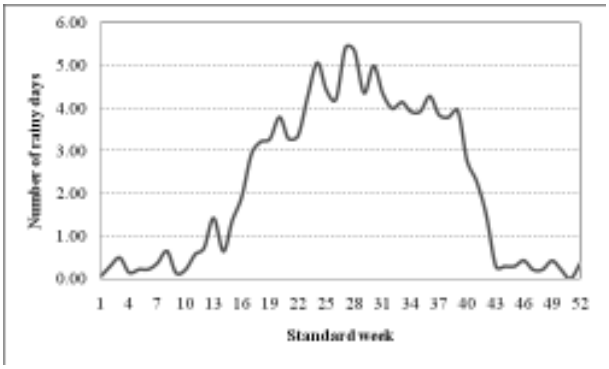

Fig. 1: Number of rainy days in a standard week at Tura

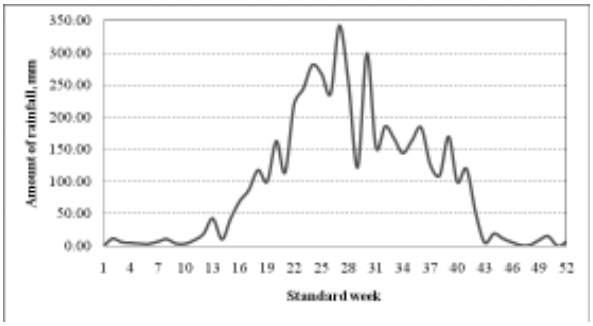

Fig. 2: Depth of rainfall in mm at Tura on standard week basis

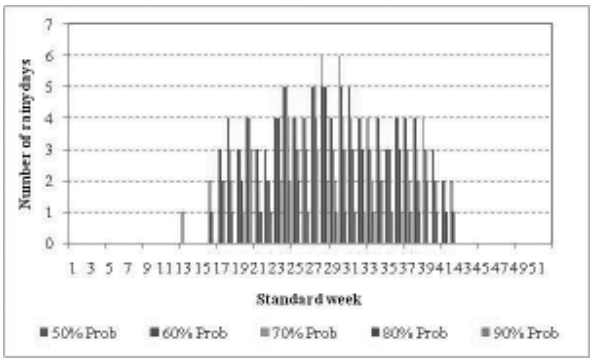

Fig. 3: Probability distribution of number of rainy days in a standard week at Tura

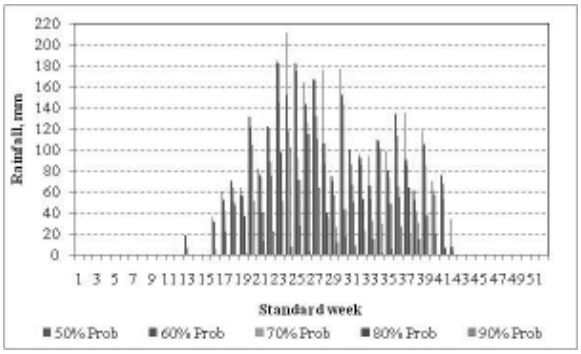

Fig. 4: Probability distribution of amount of rainfall in a standard week at Tura

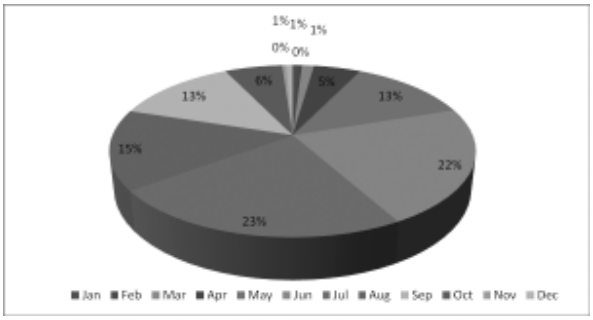

Fig. 5: Monthly distribution of rainfall at Tura station

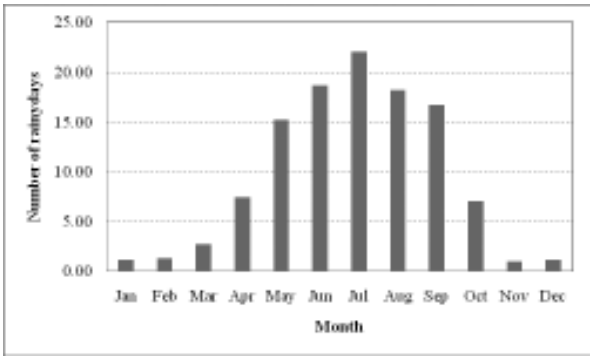

Fig. 6: Average number of rainy days in a month at Tura station

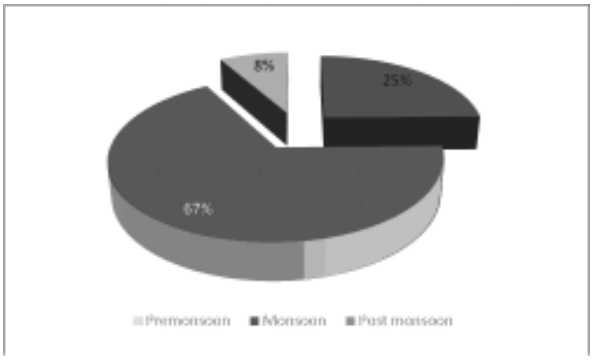

Fig. 7: Annual distribution of rainy days at Tura station

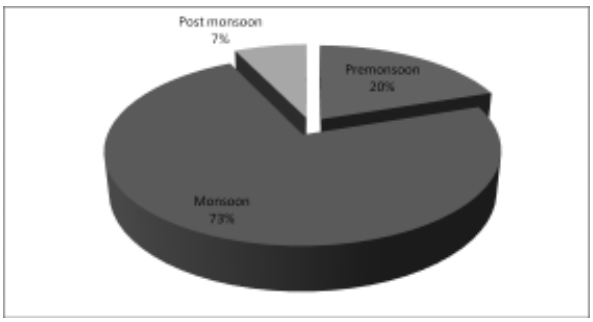

Fig. 8: Annual distributin of rainfall at Tura station

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

Standard Met Week (SMW)	Rainfall, mm at different probability level				
	50%	60%	70%	80%	90%
1.	0	0	0	0	0
2.	0	0	0	0	0
3.	0	0	0	0	0
4.	0	0	0	0	0
5.	0	0	0	0	0
6.	0	0	0	0	0
7.	0	0	0	0	0
8.	0	0	0	0	0
9.	0	0	0	0	0
10.	0	0	0	0	0
11.	0	0	0	0	0
12.	0	0	0	0	0
13.	19	7	0	0	0
14.	0	0	0	0	0
15.	0	0	0	0	0
16.	35.4	31	5.4	0	0
17.	59.6	52.2	42.2	22.6	0
18.	70.8	64.4	50	47	0
19.	64	56.4	55.2	37	2.6
20.	131	121	105.2	51.2	0
21.	82	76.2	73.7	40	13
22.	122.3	120.8	89	75.2	22
23.	184.6	182.6	145	97.5	51.6
24.	211.1	152.4	118	102.4	7.5
25.	182	175.2	92.2	71	28
26.	163.8	143.2	125.5	115	3
27.	167	166.9	132	110	64.2
28.	175.5	105.6	87	40.6	35.4
29.	75.4	70.5	57	26.7	12.5
30.	177	152.2	143.5	43	17.8
31.	100	86.2	66.8	50.4	8.6
32.	96.3	92.2	85.6	53.3	23
33.	93.8	66	53.1	32	15.2
34.	109.2	107.4	101.6	29.9	2.4
35.	99	80.8	72.8	48.7	6
36.	134.5	113.6	64.6	54.8	26.6
37.	135	90.4	85	63.8	20.8
38.	61.2	52	41.2	30.4	15.2
39.	117.5	105	85.4	37.6	0
40.	70	61.4	57	19.8	0
41.	76.2	67.4	53.4	6.8	0
42.	34.1	7.5	2.8	0	0
43.	0	0	0	0	0
44.	0	0	0	0	0
45.	0	0	0	0	0
46.	0	0	0	0	0
47.	0	0	0	0	0
48.	0	0	0	0	0
49.	0	0	0	0	0
50.	0	0	0	0	0
51.	0	0	0	0	0
52.	0	0	0	0	0

rainfall; hence high duration rice crop (more than 130 days) may be taken so that the harvesting time may not coincide with rainfall. In between 21st to 39th week, the chance of getting dry spell is almost zero. Table 2 shows the weekly extreme and normal rainfall, standard deviation (SD), coefficient of variation (CV) and percentage of contribution at Tura station. An extreme rainfall (maximum) of rainfall recorded for 30th SMW amounting to 1,119.9 mm; however the normal rainfall for this week is 299.83 mm. each SMW has got a contribution towards annual rainfall of this station but during 16th to 43rd SMW the percentage contribution is about 94%. Coefficient of variation of rainfall is less than 100% during 17th to 24th; 26th, 28th, 31st, 32nd and 34th to 39th SMW. Since the variation is less there are every chances of getting assured rainfall during 17th to 39th SMW. Monthly normal and extreme rainfall with number of rainy days along with SD, CV and percentage contribution at Tura is presented in Table 3. The CV values ranged from 72% to 31% during April to September month. It is found that about 86% of rainfall occur during five months (i.e. May to September) of the year. During these five months the number of rainy days exceeds more than 15. Normally at the first week of October, the monsoon recedes. Monthly analysis of point rainfall reveals that May, June, July and August are the wettest month cumulatively contributing more than 60% of annual rainfall (Fig. 5). However, the annual rainy days are more than 10 for May to September month (Fig. 6). The seasonal rainfall analysis for rainy days and amount of rainfall is presented in Fig. 7 and Fig. 8, respectively. Monsoon rainfall accounts for about 73% of the total rainfall, with pre-monsoon and post-monsoon shower of 20% and 7%, respectively. The monsoon rainy days limits to 67% of the total rainy day in a year.

CONCLUSIONS

The present study reveals that western Meghalaya receives quite a good quantum of rainfall. The Tura station, Meghalaya receives an average annual rainfall of 4,851.5 mm with 113 days of number of rainy days. During monsoon period there is less chances of any critical dry spell, hence rainfed agriculture can be done suitably. Since winter season gets only 7% of total rainfall, it is

Table 2: Weekly rainfall at Tura 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	5.8	0.41	1.55	374.17	0.01
2.	0	110.6	11.57	30.52	263.77	0.24
3.	0	40.2	5.86	11.24	191.92	0.12
4.	0	44.2	4.71	12.76	270.74	0.10
5.	0	31.2	4.24	10.80	254.57	0.09
6.	0	24.8	3.21	8.22	255.74	0.07
7.	0	62	6.54	16.72	255.81	0.13
8.	0	94.9	10.80	25.77	238.61	0.22
9.	0	45	3.83	12.07	315.25	0.08
10.	0	41.2	3.49	11.02	315.50	0.07
11.	0	54.4	8.76	17.07	194.98	0.18
12.	0	88.8	18.76	26.67	142.20	0.39
13.	0	174	42.69	51.94	121.69	0.88
14.	0	47	10.81	16.51	152.69	0.22
15.	0	223.2	42.25	67.13	158.88	0.87
16.	0	295.9	69.27	89.07	128.59	1.43
17.	0	206.4	86.82	65.77	75.75	1.79
18.	0	306.3	118.14	99.59	84.30	2.44
19.	2.6	270.8	100.29	77.59	77.36	2.07
20.	0	435.6	162.81	117.86	72.39	3.36
21.	13	307.4	114.03	82.16	72.05	2.35
22.	22	528.1	220.38	182.79	82.94	4.54
23.	51.6	829.6	244.76	193.39	79.01	5.04
24.	7.5	811.4	281.44	233.12	82.83	5.80
25.	28	990.4	267.29	276.48	103.44	5.51
26.	3	915	237.40	223.01	93.94	4.89
27.	64.2	1323	342.26	351.50	102.70	7.05
28.	35.4	612.6	253.88	210.80	83.03	5.23
29.	12.5	606.2	122.41	150.85	123.23	2.52
30.	17.8	1119.9	299.83	313.81	104.66	6.18
31.	8.6	394.5	153.35	121.31	79.10	3.16
32.	23	634.6	185.95	178.24	95.85	3.83
33.	15.2	620	165.96	182.45	109.94	3.42
34.	2.4	362.6	144.17	108.74	75.42	2.97
35.	6	473	164.19	144.92	88.27	3.38
36.	26.6	627.6	184.12	161.12	87.51	3.80
37.	20.8	224	126.21	65.71	52.06	2.60
38.	15.2	317.8	109.63	88.06	80.33	2.26
39.	0	554.8	169.96	158.13	93.04	3.50
40.	0	398.1	99.86	103.58	103.72	2.06
41.	0	469.4	120.29	126.81	105.42	2.48
42.	0	208.7	51.54	61.84	120.00	1.06
43.	0	28.8	5.31	10.51	197.84	0.11
44.	0	254.4	19.39	67.76	349.53	0.40
45.	0	74.4	11.81	24.23	205.06	0.24
46.	0	46	5.59	12.25	219.09	0.12
47.	0	7.5	1.21	2.57	212.83	0.02
48.	0	16	1.87	4.53	241.81	0.04
49.	0	133.4	9.53	35.65	374.17	0.20
50.	0	158.4	15.23	43.72	287.08	0.31
51.	0	0	0.00	0.00	0.00	0.00
52.	0	88.5	7.37	23.59	320.07	0.15

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

Month	Normal (mm)	Extreme Value		Standard deviation (mm)	Coefficient of variation (%)	Percentage contribution (%)
		Minimum (mm)	Maximum (mm)			
January	24.43(1.14)	0(0)	124.8(4)	42.78(1.41)	175.12(123.06)	0.50(1.01)
February	23.54(1.36)	0(0)	99.9(4)	33.05(1.45)	140.42(106.61)	0.49(1.20)
March	62.05(2.71)	0(0)	152.1(8)	57.47(2.40)	92.61(88.41)	1.28(2.40)
April	240.45(7.50)	0(0)	623.4(16)	175.17(4.27)	72.85(56.99)	4.96(6.64)
May	611.44(15.21)	0(10)	1183.6(23)	283.58(3.79)	46.38(24.89)	12.60(13.47)
June	1068.47(18.71)	0(14)	2701.7(23)	562.18(2.49)	52.62(13.33)	22.02(16.57)
July	1116.58(22.07)	0(16)	1959.8(28)	489.23(3.97)	43.82(17.99)	23.02(19.54)
August	729.12(18.21)	0(13)	1552.0(25)	370.67(3.58)	50.84(19.64)	15.03(16.13)
September	626.41(16.71)	0(11)	1045.9(22)	197.00(3.41)	31.45(20.38)	12.91(14.80)
October	295.31(7.07)	0(3)	664.8(11)	171.09(2.30)	57.94(32.56)	6.09(6.26)
November	19.91(1.00)	0(0)	85.8(3)	29.30(1.11)	147.14(110.94)	0.41(0.89)
December	33.77(1.21)	0(0)	291.8(7)	79.06(2.12)	234.10(174.48)	0.70(1.08)

necessary to construct water harvesting structures, to store excess water during rainy season, and vegetables and other cash crops during winter season which will be utilized as life saving irrigation for fruit crops. A good amount of rainfall during monsoon season helps the farmer to go for fish cum paddy culture and pisciculture in the water harvesting ponds.

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