

Precipitation characteristics over Paradeep

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सार—वर्ष 1976 से रखे गए पारादीप की दैनिक वर्षा के रिकार्डों और 1982 में एस आर आर जी की स्थापना के बाद के रिकार्डों का इसमें विश्लेषण किया गया है तथा वर्षा जलवायु विज्ञान के बारे में विस्तार से जानकारी प्रस्तुत की गयी है। 4 जून 1982 को इस स्थान पर रिकार्ड की गई 264 मि. मी. वर्षा 24 घंटे में हुई सबसे भारी वर्षा है। वार्षिक औसत वर्षा 1475 मि. मी. है। जनवरी और दिसम्बर के महीनों में लगभग न के बराबर वर्षा हुई जबकि अगस्त के महीने में सबसे अधिक लगभग 339 मि. मी. तक वर्षा हुई। यहां पर वार्षिक वर्षा में भिन्नता 20 प्रतिशत है। मानसून से पहले की अवधि में 50 प्रतिशत अवसरों पर और मानसून की अवधि में लगभग 63 प्रतिशत अवसरों पर हुई हल्की वर्षा कुल मिलाकर 10 मि. मी. या उससे कम हुई। मानसून ऋतु से पहले 10 प्रतिशत अवसरों पर और मानसून ऋतु के दौरान लगभग 6 प्रतिशत अवसरों पर हुई अधिक वर्षा 4 घंटों से अधिक समय तक हुई। जबकि प्रातःकालीन (भा.मा. समय के अनुसार 04-08 बजे तक) वर्षा मानसून ऋतु से पहले और मानसून ऋतु दोनों अवधियों में हुई और मानसून ऋतु से पहले के महीनों में सांयकालीन वर्षा बहुत अधिक मात्रा में हुई।

ABSTRACT. The daily rainfall records since 1976 and the SRRG records after its installation in 1982 at Paradeep have been analysed and rainfall climatology has been worked out. The heaviest 24-hour rainfall recorded at the station is 264 mm on 4 June 1982. The mean annual rainfall is 1475 mm. January and December are near dry months while August is the wettest month getting about 339 mm rainfall. The variability of annual rainfall here is 20%. Light rainspells giving a total rain of 10 mm or less form about 50% occasions in premonsoon period and 63% of occasions in monsoon period. The extended rainspells lasting for more than 4 hours form about 10% of occasions in premonsoon season and 6% occasions in monsoon season. While morning (04-08 hr IST) period gets the rainfall in both premonsoon and monsoon months, early night gets the peak rainfall activity during the premonsoon months.

Key words — Rainfall, Premonsoon, Monsoon, Rain spells.

1. Introduction

Rain is the dominant form of precipitation in the tropical region. Rainfall, which forms the primary data in agriculture, forestry and water management studies, is an important parameter in both meteorology and hydrology. Since rain is a vital exchange parameter within the hydrological cycle, rainfall studies have their own scientific significance. Rainfall varies both in space and time. Hence a rigorous study of rainfall over a location (station) is required for various applications. Such point rainfall studies are available for a few Indian stations (Krishnaswamy 1951, Ramakrishnan 1952, Kalita 1985, Sridharan and Sivaramakrishnan 1987, Sivaramakrishnan and Prakasam 1992). Paradeep (20.3° N/86.7°E) is one of the premier cargo handling ports in the east coast of India handling ores and chemicals. A chemical manure plant, namely Paradeep Phosphates Ltd., has also started functioning from the late eighties at Paradeep. Hence a critical study of rainfall and rain spells occurring over Paradeep has been taken up and the results are generated which may be of critical use to various users.

2. Data

Direct reading raingauge data recording once a day are available from Paradeep Observatory since 1976. A self recording raingauge was installed in 1982 at this place. The data collected upto December 1993 by these were analysed and rainfall climatology as well as rainspell characteristics have been derived.

3. Methodology

From the daily rainfall figures since 1976, the monthly total and hence the mean monthly rainfall have been computed. So also the annual rainfall is derived. The record rain registered within 24 hours for each month was also identified. An initial inspection from the data revealed that December and January are the driest months for this place, May to October is the dominant rainy period here. From the declared (actual) dates of onset of monsoon and the dates of withdrawal of monsoon since 1976 through 1993, it is found that 15 June to 15 October can be called the monsoon period over this station. The actual dates of onset and withdrawal of monsoon are shown in Table 1. Hence the rains during

TABLE 1
Monsoon onset and withdrawal dates

Year	Onset	Withdrawal	Year	Onset	Withdrawal
1976	26 Jun	9 Oct	1985	15 Jun	19 Oct
1977	17 Jun	11 Oct	1986	18 Jun	22 Oct
1978	18 Jun	12 Oct	1987	11 Jun	13 Oct
1979	23 Jun	8 Oct	1988	10 Jun	11 Oct
1980	16 Jun	4 Oct	1989	13 Jun	13 Oct
1981	20 Jun	6 Oct	1990	13 Jun	16 Oct
1982	15 Jun	6 Oct	1991	8 Jun	16 Oct
1983	25 Jun	17 Oct	1992	17 Jun	15 Oct
1984	12 Jun	29 Sep	1993	16 Jun	19 Oct

TABLE 2
Mean monthly rainfall and average number of days

Month	Mean monthly rainfall (mm)	Highest 24-hr rainfall (mm)	Date	Average No. of days	Maximum days occurred
January	12	—	—	0.7	3
February	28	—	—	1.8	6
March	23	—	—	1.4	9
April	26	74	28 April' 87	1.4	3
May	89	216	26 May' 89	3.8	8
June	215	264	04 Jun' 82	9.4	16
July	256	140	04 Jul' 77	13.8	22
August	339	235	05 Aug' 85	14.7	23
September	231	186	09 Sept' 82	11.0	17
October	167	218	29 Oct' 91	5.8	10
November	78	101	09 Nov' 86	2.2	7
December	11	—	—	0.5	2
TOTAL	1475			66.5	

April, May and first half of June are the pre-monsoon rains. If there is a rainfall amount 2.5 mm or more in 24 hours that is generally taken as a 'wet' day. Nil rainfall and rainfall amount less than 2.5 mm is of no practical significance and those days are 'dry' days. The mean wet and dry days, weekwise, during monsoon were also computed and discussed. The chance of getting the dry period of 3 or more days was also investigated.

The data during January 1982 to December 1993 from the self recording rain gauge (SRRG) charts was critically examined. The rainspells contributing to the rainfall were analysed as to their occurrence in various parts of the day and night, their intensity as well as the duration of monsoon and pre-monsoon period to identify the characteristics.

4. Results and discussion

4.1. Rainfall climatology

Table 2 presents the mean monthly rainfall worked out as well as the annual rainfall. The highest one day rainfall for all the months from April to November alongwith the dates of occurrence are also shown in the table. It can be easily seen that December and January are the driest months. The rainfall activity starts picking up in May with the

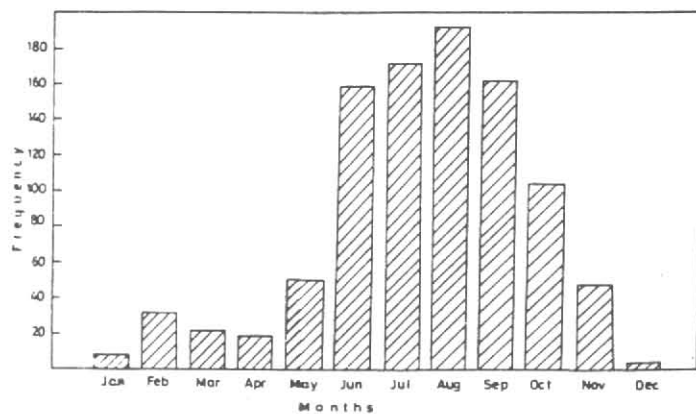


Fig.1. Monthly frequency of rainspells

pre-monsoon convective thundershowers. The passage of any cyclonic storm or system close to or over Paradeep gives some rainfall in November. Occasional rains due to extended trough from a western disturbance or a moving trough in the easterlies occurred during February and March.

TABLE 3

Mean dry and wet days during the weeks of monsoon period

Week	Mean days	
	Wetness	Dryness
15-21 Jun	2.6	4.4
22-28 Jun	3.1	3.9
29 Jun-5 Jul	2.9	4.1
06-12-Jul	2.9	4.1
13-19 Jul	3.2	3.8
20-26 Jul	3.4	3.6
27Jul-2Aug	3.3	3.7
3-9 Aug	4.0	3.0
10-16 Aug	2.8	4.2
17-23 Aug	3.5	3.5
24-30 Aug	2.7	4.3
31 Aug - 6 Sep	3.1	3.9
7-13 Sep	3.1	3.9
14-20 Sep	2.0	5.0
21-27 Sep	1.9	5.1
28 Sep - 4 Oct	2.5	4.5
5-11 Oct	1.8	5.2
12-18 Oct	1.3	5.7

One or two summer thundershowers occur in April giving some rain. August is the rainiest month with a mean rain of 34 cm. The monsoon months of July and September are almost having equal rainfall (24 ± 2 cm). Though by 15 June only southwest monsoon arrives at this place because of enhanced convective activity, June also gets a mean rainfall of 21 cm.

It can be seen that the heaviest 24-hour rainfall so far recorded over this place in 264 mm on 4 June 1982. During the period of study of 18 years, 15 heavy rainfall days (Rainfall >70 mm) have occurred in the month of August followed by 12 in July. The transition months to and from the monsoon period namely, June and October, have each 11 days of heavy rainfall during the 18 years' period. On an average about 4 heavy rainfall days occur in each year.

Table 2 also gives the average number of rainy days in each month. The maximum number of rainy days which occurred in a year during the period of study is also shown in this table to get an idea of maximum wet spell for the month. In a year, on an average there are about 67 rainy days. This total number of rainy days for an year seems to be stable as only in six out of 18 years. The total rainy days went beyond 67 ± 10 days.

4.2. Dry spells during monsoon

During the monsoon period the occurrence of 3 or more dry days in each week was investigated as this is a vital information for port operations. Table 3 presents the picture. It is interesting to note that in August, on two weeks, the dry days are more than the wet days.

4.3. Variability of rainfall

The variability of annual rainfall was scrutinised. The variability was 20% which can be expected in any coastal station. When the variability of monthly rainfall of June to September was scrutinised, both June and July have a high variability of 53%, while August and September were hav-

TABLE 4

Coefficient of variation of monthly rainfall

Month	Coeff. of Variation	Month	Coeff. of Variation
January	193.71	July	53.35
February	121.88	August	36.44
March	178.38	September	41.88
April	86.09	October	94.29
May	103.18	November	148.57
June	52.99	December	268.52

TABLE 5

Frequency distribution of rain spells based on duration

% Frequency	Duration				
	1 hr	1-2 hrs	2-3 hrs	3-4 hrs	> 4 hrs
Pre-monsoon	60	16	08	06	10
Monsoon	61	19	10	04	06

ing 36% & 42% variability respectively. As October is the period of withdrawal of southwest monsoon, depending on the early or late withdrawal, the variability figure is expected to be high and was also found to be 95%. The coefficient of variation for the monthly rainfall figures is shown in Table 4.

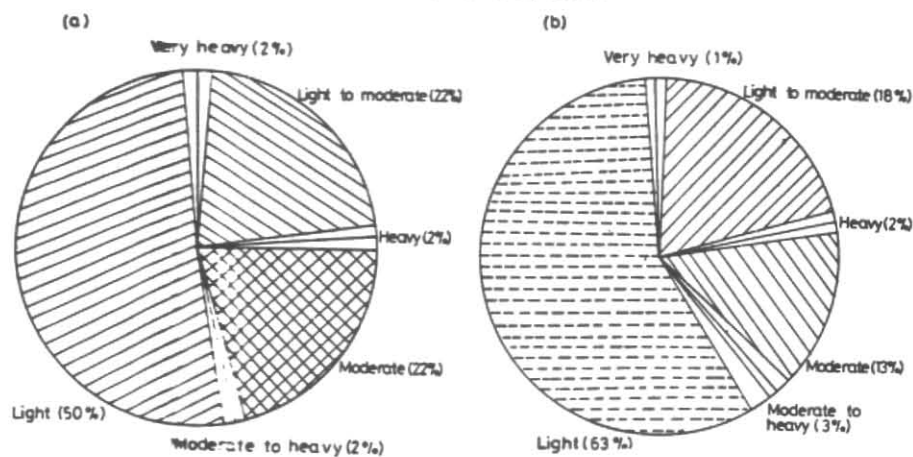
4.4. Details of rain spells

During 1982 to 1993, in all 964 rain spells occurred and these were studied in detail from the SRRG charts. The monthly frequency of the rain spells studied during these 12 years is shown in Fig. 1. Evidently, the monsoon months of June to October have got a large number of rain spells with August getting the peak number of rain spells. The rain spells were distributed based on the rain amounts. The spells during 1 April to 14 June were grouped together as pre-monsoon spells and the spells realised during 15 June to 15 October were grouped as monsoon rain spells. Figs. 2(a&b) present the percentage frequency distribution of rain spells based on the rain amount during pre-monsoon and monsoon months. It is found that light rain spells (spells giving a total rain of 1 cm or less) form about 63% of the population during the monsoon and just 50% during the pre-monsoon months.

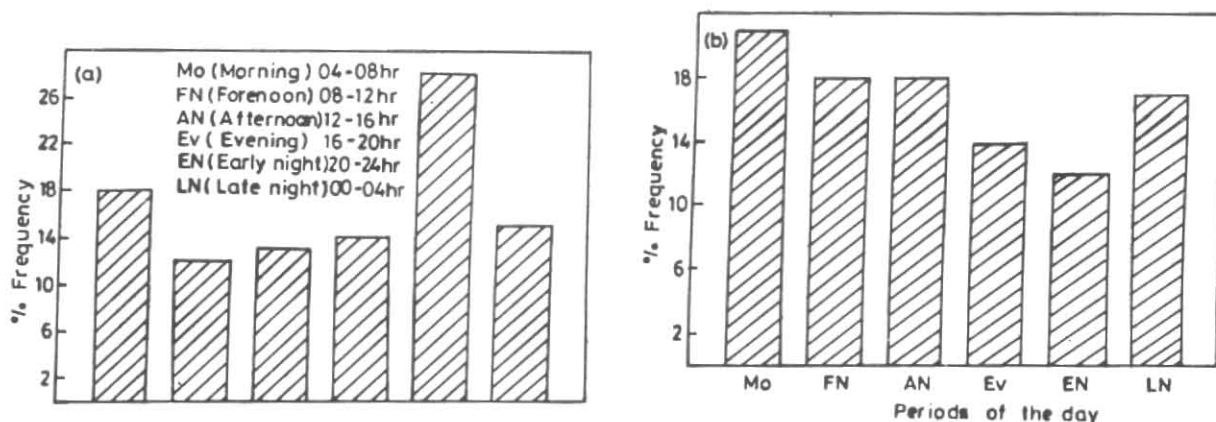
The frequency distribution for the two seasons, based on the duration of the spells (shown in Table 5) showed that the spells of smaller duration lasting 1 hour or less form 60% of occasions both during pre-monsoon and monsoon months. If we consider the rain spells of duration 2 hours or less, 3/4th of the total spells are covered under this category (pre-monsoon) while 80% in the monsoon months. Spells of extended duration of more than 4 hours form just 6% of occasions in monsoon months.

4.5. Diurnal variation of occurrence of rain spells

The diurnal variation of occurrence of rain spells is shown in Figs. 3(a&b) for the pre-monsoon and monsoon



Figs.2 (a&b). Spell frequency based on rain amount during (a) pre-monsoon and (b) monsoon



Figs.3 (a&b). Diurnal distribution of spell during (a) pre-monsoon and (b) monsoon

months. While morning (4-8 hr IST) is the preferred period both in pre-monsoon and monsoon months getting above 20% of total spells, peak rainfall activity during pre-monsoon months is in the early night (2000-2400 hr IST). Both forenoon and afternoon of the monsoon months get good amount of spells (a little less than 20% of spells). While there is a decrease in rainfall activity from early night to late night in premonsoon months, there is an increase in rainfall activity from early night to late night in the monsoon months. Thus, there are a few contrasting features in the diurnal trend of rain spell occurrence over this place.

5. Conclusion

The annual rainfall for Paradeep is 1475 mm. While June to October is the prominent wet period, December and January are practically dry months. August gets the maximum monthly mean rainfall of 339 mm. While there are

similarities in the rainfall characteristics of pre-monsoon and monsoon periods, there are certain contrasting features also between the two rains which have been explained.

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