

# THE DIURNAL DISTRIBUTION OF RAINFALL AT PORT VILA, NEW HEBRIDES

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## 1. INTRODUCTION

The New Hebrides are a group of islands in the southwest Pacific between latitudes  $13^{\circ}\text{S}$  and  $20\frac{1}{2}^{\circ}\text{S}$  and longitudes  $166^{\circ}\text{E}$  and  $171^{\circ}\text{E}$ ; they are orientated roughly NNW/SSE. Port Vila (latitude  $17^{\circ}45'\text{S}$ , longitude  $168^{\circ}19'\text{E}$ ) is on the island of Efate which has an area of approximately 345 sq. miles. The town is situated on the southwest corner of the island and the town, harbour, and meteorological station are to some extent sheltered from the prevailing ESE winds. Rainfall records have been kept at Vila since 1905, but it is only during the past four years that continuous records with a recording raingauge have been maintained. This short paper is concerned with the analysis of these records.

The gauge is well sited on level grass-covered ground. However, the surrounding area is fairly well wooded and trees to within a height of forty or fifty feet lie thirty to fifty yards away to between NW and SW. A ring of shrubs, about ten yards away and maintained to a height of five feet, give good shelter from turbulent winds. The height of the rain gauge above M.S.L. is 65 feet and although rainfall records have been kept in the Vila area since 1905, the present site was established in 1951.

## 2. MONTHLY AND ANNUAL RAINFALL

Tables 1 and 2 give the monthly averages for rainfall for the 15 year period 1951-1965 and the actual monthly rainfall for 1962-1965, which are the years under consideration.

Table 1. Mean Monthly Rainfall Port Vila, 1951 to 1965

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Mean	11.31	9.74	14.45	5.25	6.31	5.56	5.20	3.96	4.91	3.94	6.58	8.42	88.94
Max.	24.88	21.06	21.99	18.55	10.81	11.36	14.59	8.87	13.25	8.83	20.15	23.73	131.68
Min.	3.20	4.30	3.47	3.13	3.74	1.39	NIL	0.35	1.05	1.51	0.73	0.19	57.30

Table 2. Monthly Rainfall Port Vila, 1962 to 1965

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1962	16.31	12.42	16.03	18.55	4.45	4.69	5.53	2.31	2.33	2.53	4.77	10.75	99.51
1963	22.40	8.15	7.77	12.52	6.75	3.40	5.95	7.29	1.05	2.27	1.35	2.53	81.43
1964	3.20	4.35	22.90	7.52	5.78	7.50	NIL	3.42	4.10	6.80	11.15	5.35	82.07
1965	15.34	8.95	13.30	4.75	9.12	3.55	4.68	4.95	3.72	7.20	4.20	12.03	91.79

\* Mr. Elliott was till recently Senior Meteorological Officer at Port Vila.

Total rainfall shows no great variation from normal in any of the years under consideration. 1962 indicates that a little over 75 per cent of the rainfall for that year fell in the wet months January - April and November - December. 1963 has nearly 70 per cent of its rainfall in the wet months. The distribution of rainfall in 1964 was a little out of the ordinary but still rather over 65 per cent fell in the wet months; January and February were exceptionally dry; March and November exceptionally rainy; June and October in the dry months, had more rain than normal. 1965 had nearly 65 per cent of its rainfall in the wet months; May and October in the dry months had more rain than usual.

### 3. HOURLY RAINFALL

In Figs. 1 and 2 the diurnal rainfall is presented in three ways. (In the scale of hours, 1 is the period from midnight to 0100 hours local zone time, 2 is 0100 to 0200 hours, and so on.)

- (1) The total hourly rainfall during the period 1962-65 in inches (see Fig. 1).
- (2) The total hourly rainfall during the period 1962-65 expressed as a percentage of total for the period (see scales on right of Fig. 1). (For example, if the rainfall was evenly distributed over the 24 hours, then each hour's rainfall would be 4.17% of the total.)
- (3) The number of occasions during the period when the hourly rainfall was (a) 0.01 in. or more, (b) 0.10 in. or more and (c) 0.40 in. or more (see Fig. 2).

Figure 1 shows the total rainfall in inches hour by hour for the four year period, also separated as wet season (November-April) rainfall and dry season (May-October) rainfall. Considering first total hourly rainfall in Fig. 1, the curve shows a peak in the first hour of the day, i. e. shortly after midnight, and another between 0300 and 0400 hours. The main peak occurs in the middle of the afternoon.

Reference to the plot of wet season and dry season rainfall shows the diurnal variation to be much greater during the wet season than the dry season. During the wet season a relatively dry period occurs during the morning between 0500 and 1000 hours, then building up just before noon to above average values which are maintained for much of the afternoon.

During the dry season, however, there is slightly above average rainfall during the morning with no pronounced trough. A relatively dry period is shown during the late morning and early afternoon, and only a short-lived peak around mid-afternoon.

### 4. FREQUENCY OF SPECIFIED RAINFALLS

An analysis was also made of the number of "rain hours" when rainfall was 0.01 in. or more, the number of occasions when rainfall was 0.10 in. or more, and the number of occasions when rainfall was 0.40 in. or more in the hour. The results are shown in Tables 3 and 4, and plotted in Fig. 2.

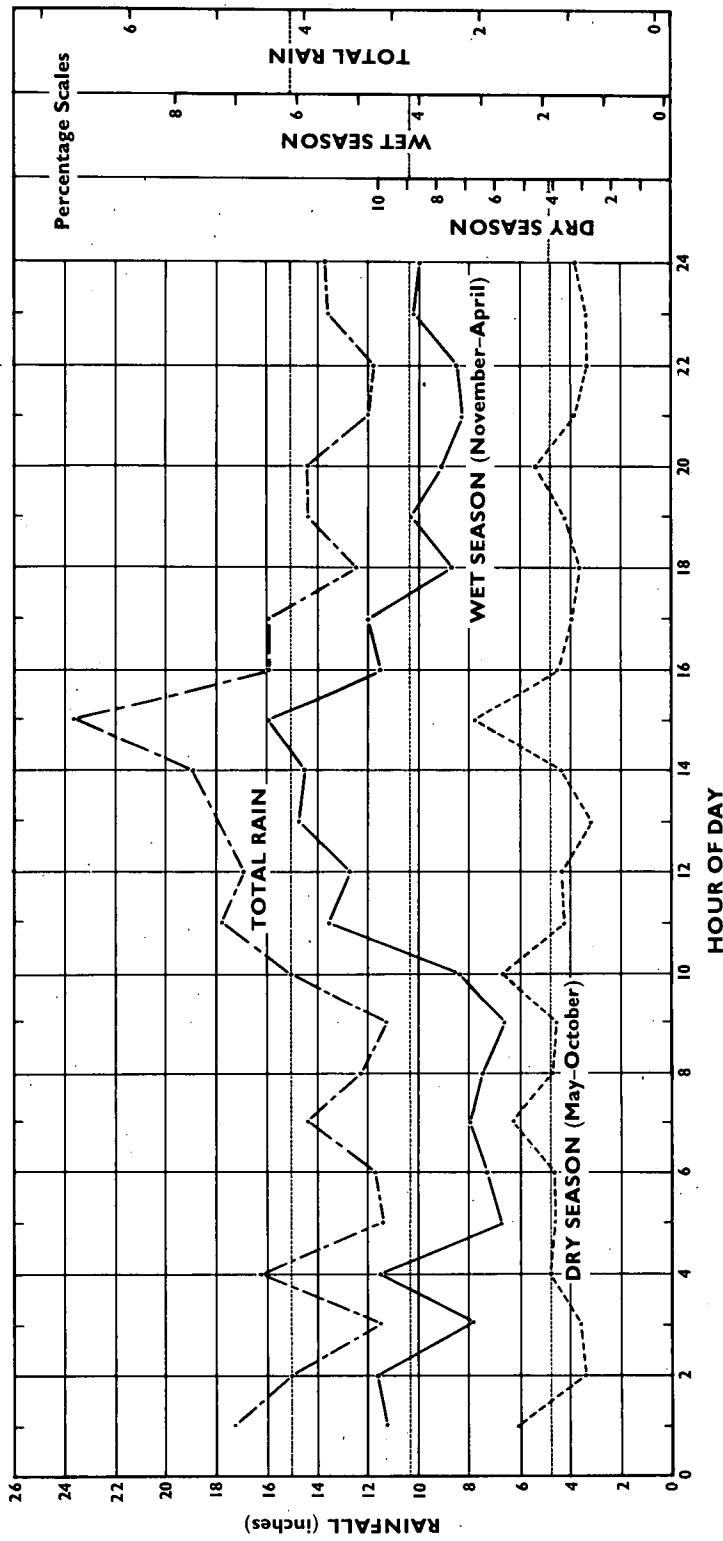


Fig. 1 Rainfall at Port Vila for four-year period 1962-1965

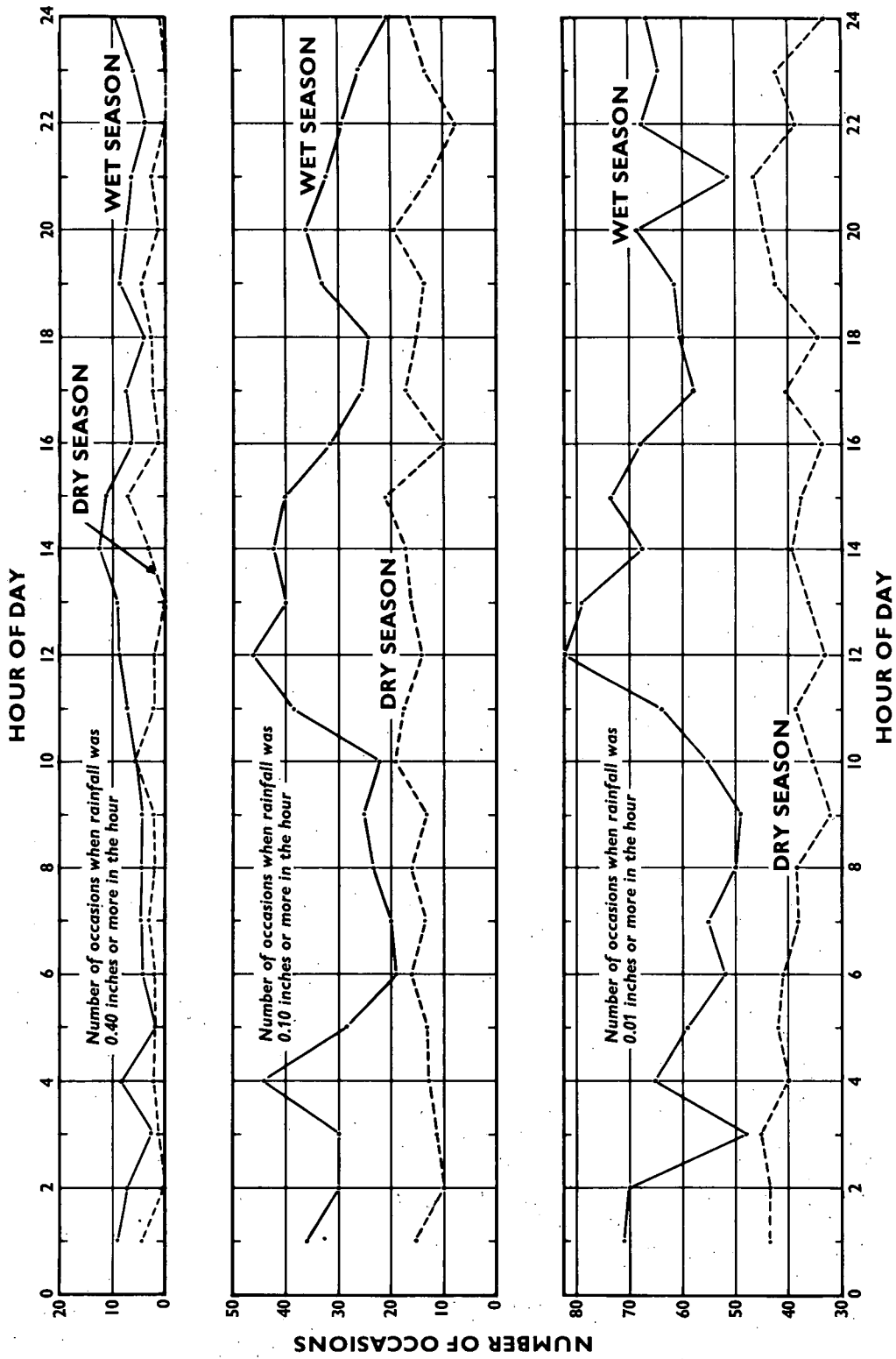


Fig. 2. Analysis of rainfall at Port Vila for 1962-1965

Table 3. Number of occurrences of specified amounts of rain in each hour for the Dry Season (May-October)

Hour of the Day →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Mean	S.E.
0.01 in. or More	43	43	45	40	42	41	38	38	32	35	38	33	36	39	37	33	40	34	42	44	46	38	42	33	37	4.5
0.10 in. or More	15	10	11	13	13	16	13	16	13	19	17	14	16	17	21	10	17	15	13	19	12	7	13	16	14	3.3
0.40 in. or More	4	0	1	2	1	2	3	2	2	5	2	2	0	5	7	1	2	2	4	1	2	0	0	1	2	1.8

Table 4. Number of occurrences of specified amounts of rain in each hour for the Wet Season (November-April)

Hour of the Day →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Mean	S.E.
0.01 in. or More	71	70	47	65	59	52	55	50	49	55	63	82	79	67	73	67	57	60	61	68	51	67	59	66	63	9.3
0.10 in. or More	36	30	30	44	28	19	20	23	25	22	38	46	40	42	40	32	25	24	33	36	32	29	26	20	31	8.0
0.40 in. or More	9	7	2	8	1	4	4	4	4	5	7	8	8	13	11	6	7	3	8	7	6	3	6	9	6	2.8

The dry season (May - October) shows no great variation in the diurnal frequency of rainfall and considering the smallness of the sample (4 years) it would probably not be correct to attempt any deductions of real significance from these figures. However, during the wet season a markedly different picture emerges. It is similar to the analysis of actual rainfall and percentage rainfall described earlier.

At the start of the day, in all categories, we have above average number of occasions of rainfall. It falls to below average between 0200 and 0300 hours and rises quickly to a peak by the fourth hour, which is generally just pre-dawn in the wet season. From 0500 to 1000 hours we have below average numbers of occasions in each of the three categories, and thereafter a quick rise to a peak around noon with only slow decay to below average again between 1600 and 1700 hours.

## 5. RAINFALL MECHANISM AND CONCLUSIONS

Rainfall in the New Hebrides is assumed to be associated with one or all of the following mechanisms.

- (1) Ordinary convection created by heating over land.
- (2) Convection over the sea caused by cooling aloft.
- (3) Convergence zones.
- (4) Upper troughs.
- (5) Vigorous tropical depressions.

The first matter for consideration is the size of the land mass of Efate and whether this is adequate to develop good day-time convection. Malkus (1964) has suggested that a land mass as large as Puerto Rico (100 by 25 miles) may be required to produce a midday peak. It would appear that during the dry season the temperature does not become high enough, the area of land mass is not big enough and the unstable ESE'ly air stream is not deep enough, to give any pronounced peak of convective rainfall during these months. With variation much smaller during the dry months, it is probable that a four year sample is insufficient to give a really satisfactory analysis.

The wet season, however, is much more tractable to analysis. With quicker and earlier rise to a high temperature, quickly developing cumulus cloud can give showers by mid-morning and a pronounced peak by mid-afternoon. Thus it can be said with reasonable confidence that a land mass the size of Efate (around 350 sq. miles) is adequate to give showers, provided the depth of instability is sufficient and moisture is available.

It is suggested that analysis of rainfall in Pacific Islands will lead to a truer appreciation of the development of convective cloud and a fuller understanding of weather patterns in this area.

#### REFERENCE

- Malkus, Joanne S.                      1964                      "Tropical Convection: Progress and Outlook",  
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