GEOACTA, 24, 50-61, 1999

ON THE MEAN MONTHLY PRECIPITATION REGIME OF SELECTED REGIONS OF SABAH (EAST MALAYSIA)

Alejandro Livio Camerlengo
Faculty Of Applied Sciences And Technology - Universiti Putra Malaysia Terengganu
21030 Kuala Terengganu - MALAYSIA

ABSTRACT

In this paper the monthly rainfall distribution on Sabah is addressed. Eight types of rainfall distribution may be distinguished. The importance of the two inter-monsoon periods in the monthly rainfall distribution as well as the two (seasonal) monsoon winds at both coasts of Sabah is well established. In this regard, our results confirm previous findings for Peninsular Malaysia.

RESUMEN

En este trabajo se estudia la distribución de la precipitación media mensual pluvial de ciertas regiones de Sabah, situada en la parte norte de la isla de Borneo perteneciente a Malasia. Se han podido establecer ocho distintos régimenes pluviales en Sabah como asimismo, la importancia en la distribución media mensual pluvial de: (a) los periódos inter-monsónicos y (b) los vientos monsónicos en las dos costas este y oeste, respectivamente.

1. INTRODUCTION

Malaysia gained its independence in 1957. In itself, it may be considered a young country. A complete set of rainfall stations only became operational in the state of Sabah in 1982. As such, to carry out this investigation, I am restricted to start from this particular year.

The equatorward migration of the area of convergence ahead of the northeast (NE) monsoon season takes place in September/October. This area of convergence represents one of the inter-monsoon periods.

The NE monsoon season starts in early November and continues through March. Within this period larger amounts of rainfall, during the first two months of the NE monsoon season, are recorded at the eastern coast of Peninsular Malaysia. (The total amount of precipitation during these two months is roughly 50 % of the total annual rainfall). On the other hand, a dry season (where the average monthly rainfall is lesser than 100 mm) is noticed at this same coast from February to July.

The poleward migration of the area of convergence in advance of the southwest (SW) monsoon represents the other inter-monsoon period. Its passage in our area of interest occurs in April/May.

Larger amounts of rainfall are detected during the September/October inter-monsoon period as compared to the other one. Nieuwolt (1981) attributes this to a stronger convergence during the former inter-monsoon period.

The SW monsoon starts in late May and continues through early September in our area of interest. In particular, maximum rainfall is observed at the western coast of Peninsular Malaysia. Due to the discharge of humidity (of the air mass) at the windward side of the mountain range of Sumatra, during the boreal summer, the total amount of rainfall at the west coast of Peninsular Malaysia is considerable lower than the ones at similar coasts in northern Thailand and Burma (Nieuwolt, 1981).

The aim of this study is to better understand the role that the two predominant monsoons have on the monthly rainfall pattern of Sabah, in East Malaysia. Particular emphasis is given to both the east and the west coasts as well as to the stations located at both sides of the mountain range.

To the author's knowledge, no similar attempt to study the monthly rainfall distribution of selected areas of Sabah, with such a complete set of data, has been done before. Therefore, this study represents the first of such an attempt. Nevertheless, similar studies have been conducted for Peninsular Malaysia and Singapore (Nieuwolt, 1981; Dale, 1959; Watts, 1955; Ramage, 1964).

For the sake of completeness, and taking into consideration that Sabah is an integral part of Malaysia, I have chosen to compare our results with the ones of Peninsular Malaysia (figure 1).

2. DATA

Data from 21 stations has been obtained from the "Monthly Summary of Meteorological Observations" published by the Malaysian Meteorological Service (1982-96). The location as well as the name of the stations is shown in figure 2 and Table 1, respectively. Fifteen years of rainfall data has been arbitrarily selected. In doing so, all analyzed stations are affected by the same ENSO events.

3. RESULTS AND DISCUSSION

For the sake of clarification eight types of rainfall distribution may be defined. They are: (a) mountain region, (b) inter-mountain region, (c) eastern side of the mountain region, (d) western side of the mountain region, (e) northern west coast, (f) central west coast, (g) northern east coast, and (h) southern east coast, in accordance to the particular location of the meteorological stations.

3.1. Mountain region

January precipitation is largely affected by the Northeast (NE) monsoon winds where the air mass coming from the Sulu Sea discharges its humidity as it moves further inland.

It is interesting to observe that Ranau, Kambarangan and Kundasang have similar average rainfall during the first three months of the year (figure 3). It has been deduced that the belt of maximum rainfall in Sabah is roughly at 1.200 m high (Camerlengo *et al.*, 1999). In spite of this, the latter station register lesser rainfall than the other two

stations. This may largely be attributable to the fact that Kundasang is at the leeward side of the mountain range.

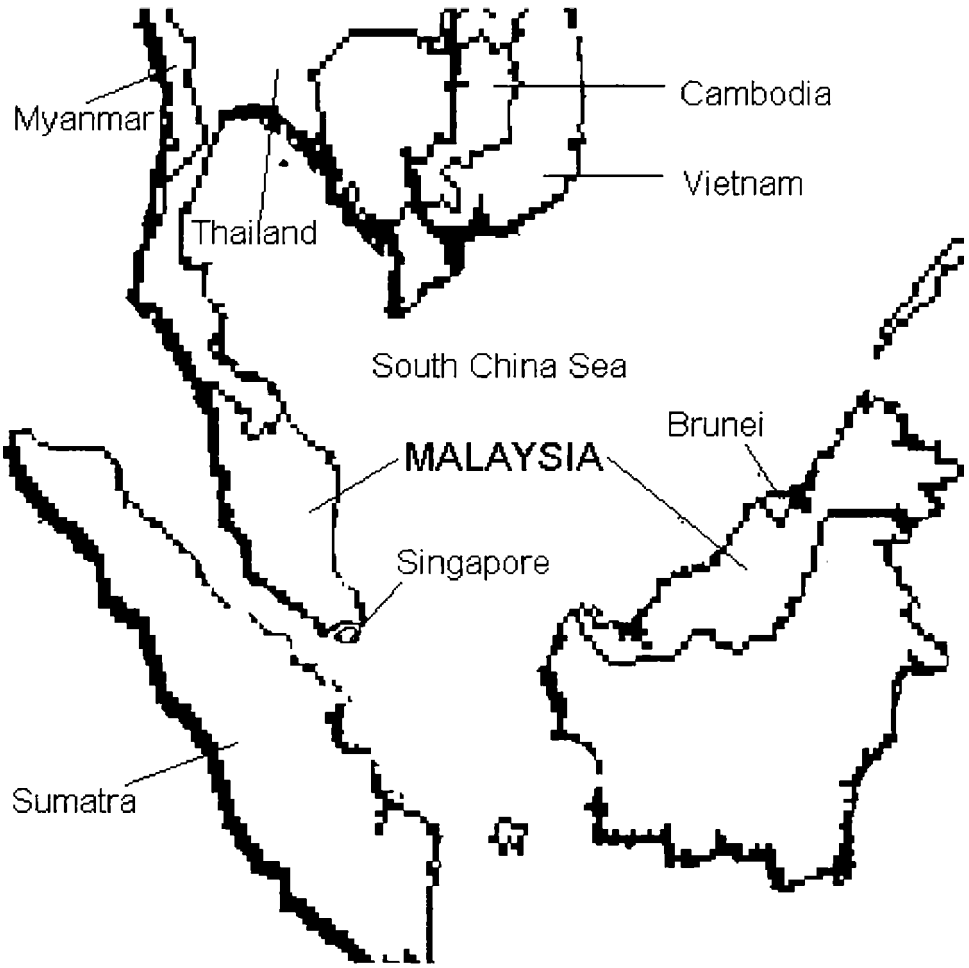

Figure 1: A particular area of South-East Asia where the location of Sabah is shown.

March represents the driest month in Sabah (Camerlengo *et al.*, 1999). Thus, a steady decrease of rainfall, starting in January, is observed in these three stations in the first quarter.

May represents one of the inter-monsoon periods where the poleward migration of the area of convergence ahead of the southwest monsoon (SW) enhances precipitation. Larger values of rainfall, recorded in these three stations, may be explained by this effect.

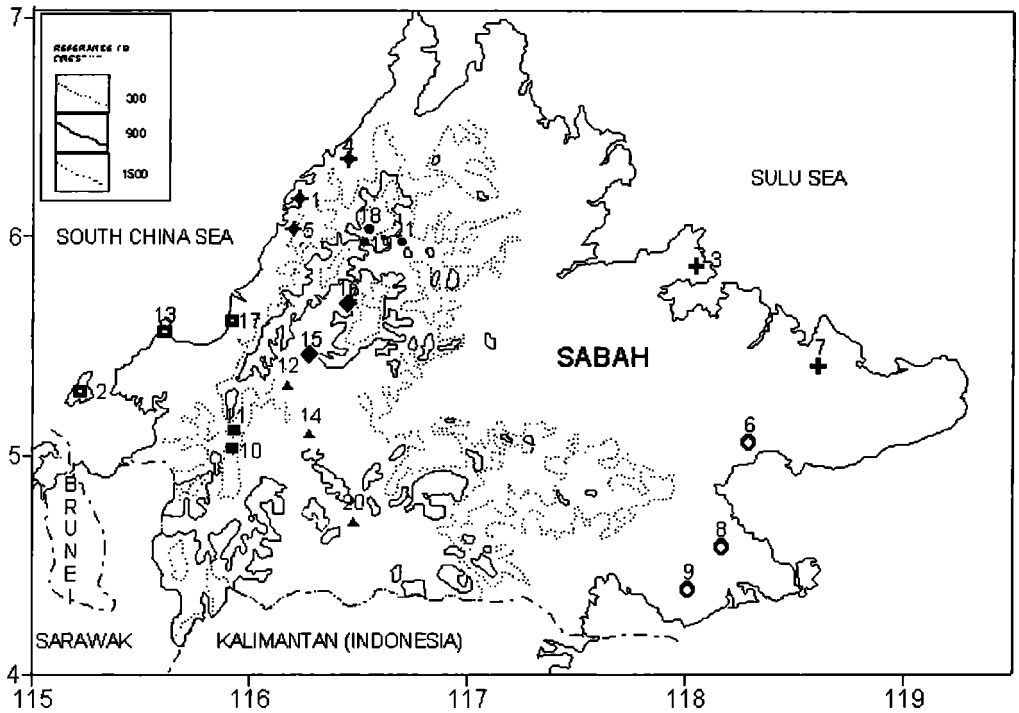

Figure 2: Location of the analyzed stations. The stations of the mountain region are denoted by Я, the ones of the inter-mountain region by ◆ , the ones of the eastern (western) side of the mountain range by ▲(▮), the ones of the northern (central) west coast region by ✦ (■), the ones of the northern (southern) east coast by ✚ (O), respectively.

The further increase of rainfall during the following months, both in Kundasang and in Kambarangan, may be explained by the combined effect of the two: (a) the SW monsoon winds, and (b) the topographic effect. This is due to the fact that these two stations are at the windward side of the mountain range during the boreal summer.
It is observed that Kambarangan has considerable larger monthly rainfall values than both Ranau and Kundasang.

October, represents the other inter-monsoon period, where due to the equatorward migration of the area of convergence formed by the retreat of the SW monsoon and the advancing NE monsoon, rainfall is enhanced (Nieuwolt, 1981). The maximum monthly value, observed in this particular month both in Kundasang and in Kambarangan, is thus explained.

Ranau, on the other hand, is at the leeward side of the mountain range during the boreal summer; i.e., during the SW monsoon season. Its lower monthly rainfall values (from June onwards) with respect to the other two stations may be explained by this effect. A slight rainfall increase observed in December should be attributable to the

fact that this particular station is at the windward side of the mountain range during the NE monsoon season.

TABLE 1: Name of the analyzed stations.

No	Longitude	Latitude	Name	Height (m)
1	115° 15'	5° 18'	TUARAN AGRICULTURAL STATION	6
2	116° 14'	6° 10'	LABUAN	29.3
3	118° 04'	5° 54'	SANDAKAN	10.3
4	116° 27'	6° 21'	KOTA BELUD	37
5	116° 12'	6° 02'	LAWA MANDAU	842
6	118° 18'	5° 05'	LAHAD DATU AGR. STATION	30
7	118° 37'	5° 26'	TOMANGGONG	0
8	118° 10'	4° 24'	KUNAK COCOA PROJECT	107
9	118° 01'	4° 24'	QUION COCOA STATE	210
10	115° 56'	5° 2'	SAPONG ESTATE	183
11	115° 56'	5° 7'	TENOM (LAGUD)	195
12	116° 10'	5° 21'	KENINGAU	305
13	115° 36'	5° 35'	KUALA PENYU	3
14	116° 17'	5° 07'	NABAWAN	0
15	116° 17'	5° 28'	APIN-APIN	457
16	116° 27'	5° 42'	BATU BAJAU	0
17	115° 55'	5° 37'	KIMANIS ESTATE	98
18	116° 33'	6° 02'	KAMBARANGAN	2146
19	116° 32'	5° 58'	KUNDASANG	1280
20	116° 29'	4° 43'	SEPULOT	0
21	116° 42'	5° 58'	RANAU	549

3.2. Inter-mountain region

Lower monthly rainfall, noticed in Batu Bajau and in Apin-Apin, should largely be attributed to the fact that these two particular stations are located at the leeward side of the mountain range during both monsoon seasons (figure 4). As a consequence of this, not a significant monthly rainfall difference is observed between these two stations. A moderate increase of rainfall (in these two stations) is recorded during the first inter-monsoon period. In short, due to their location, these two stations remain largely unaffected by the two monsoon winds, as neither of them experiences a monthly record superior than 180 mm.

3.3. Eastern side of the mountain range

Except for July, where it registers 150 mm of rainfall, Nabawan has consistently monthly rainfall values lower than 110 mm (figure 5). During the boreal summer, Nabawan is at the leeward side of the mountain range. The distance between Nabawan and the mountain range is approximately 30 km. Therefore, the air mass arriving at Nabawan is somewhat drier than the one arriving at Keningau (which is located at a

few km on the leeward side of the mountain range) during the boreal summer. Except for July, this explains the slightly larger rainfall values observed in the latter station.

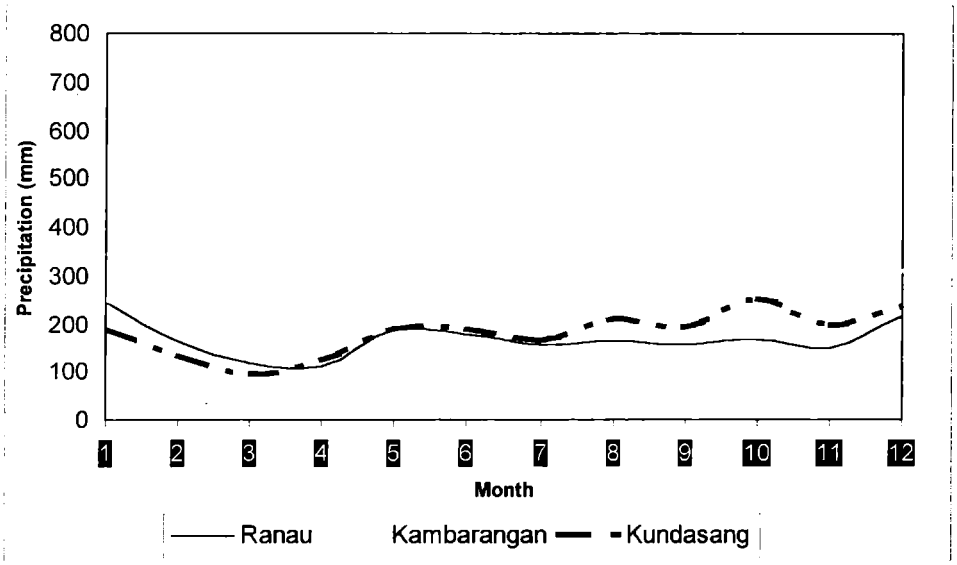

Figure 3: Monthly rainfall value of Ranau, Kambarangan and Kundasang.

It may be stated that the monthly rainfall distribution of the stations located in the inter-mountain region is similar to the ones of Keningau and Nabawan. This is due to the fact the stations of the former region are also located at the leeward side of the mountain range during the boreal summer. Therefore, in a similar fashion as with the latter two stations, the monthly rainfall distribution of the former stations are not affected by the two predominant monsoons, as both stations are also at a considerable distance from the east coast.

On the other hand, Sepuloh is located in a valley surrounded by higher mountains. Uplifting, due to solar radiation, begins in the early daylight hours at the mountain range facing the Sun. Rainfall starts at noon and continues throughout all the afternoon as uplifting (triggered by the other mountains that are facing the Sun after midday) continues. This may help to explain the fact that Sepuloh' s monthly rainfall values are considerable larger than the ones of Keningau and Nabawan, respectively.

Maximum rainfall values are usually observed during inter-monsoon periods. Due to the fact that Sepuloh is further to the south, it registers the passage of the area of convergence of the first inter-monsoon period in April. Thus, the maximum monthly rainfall value is recorded in this particular month.

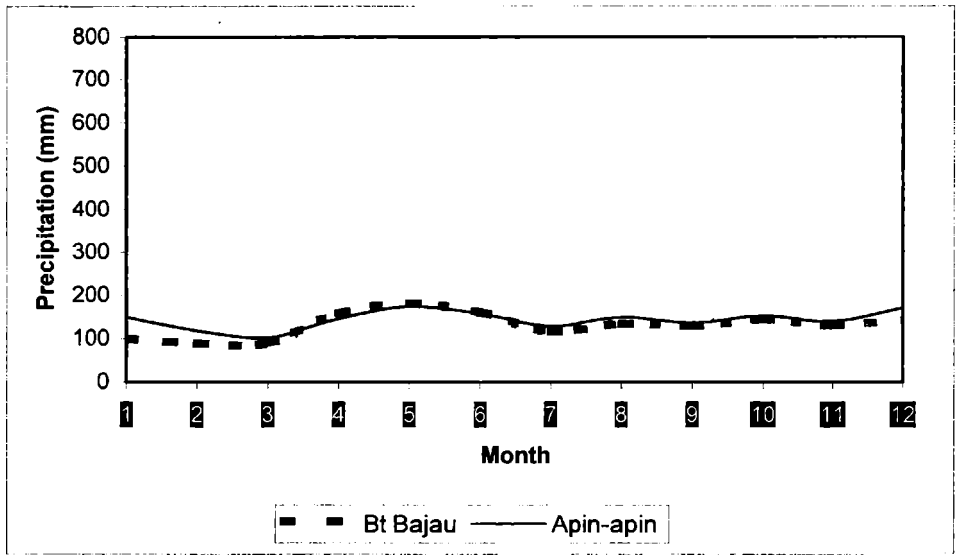

Figure 4: Same as figure 2, but for Batu Bajau and Apin- Apin.

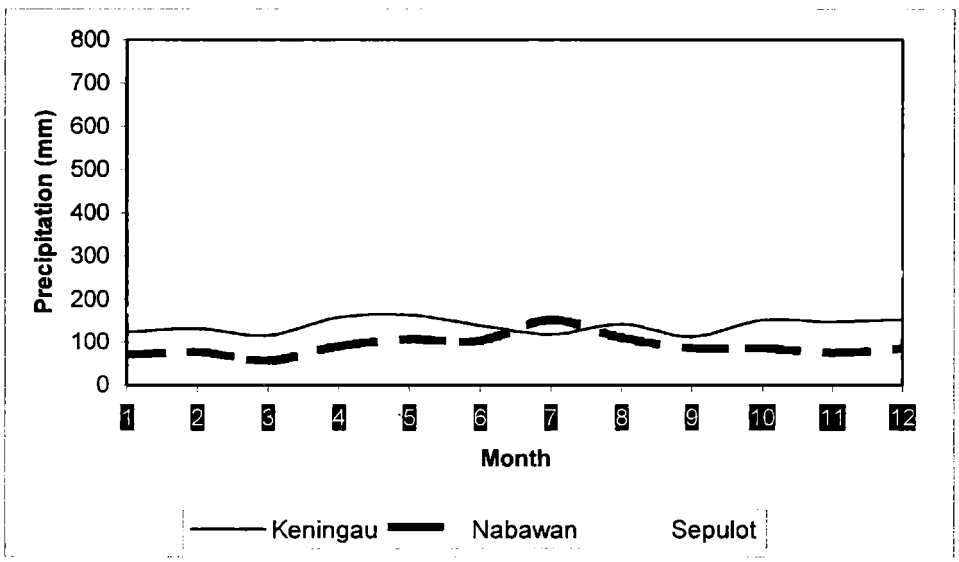

Figure 5: Same as figure 2, but for Keningau, Nabawan and Sepuloh.

3.4. Western side of the mountain range

The monthly rainfall distribution of Tenom (Lugud) and Sapong Estate is like the ones of Keningau, Batu Bajau and Apin- Apin (figures. 4, 5 and 6). This is due to the fact that the former two stations are largely unaffected by the rainfall associated with

both the SW and the NE monsoon winds. This may largely be attributable to the particular location of these two stations.

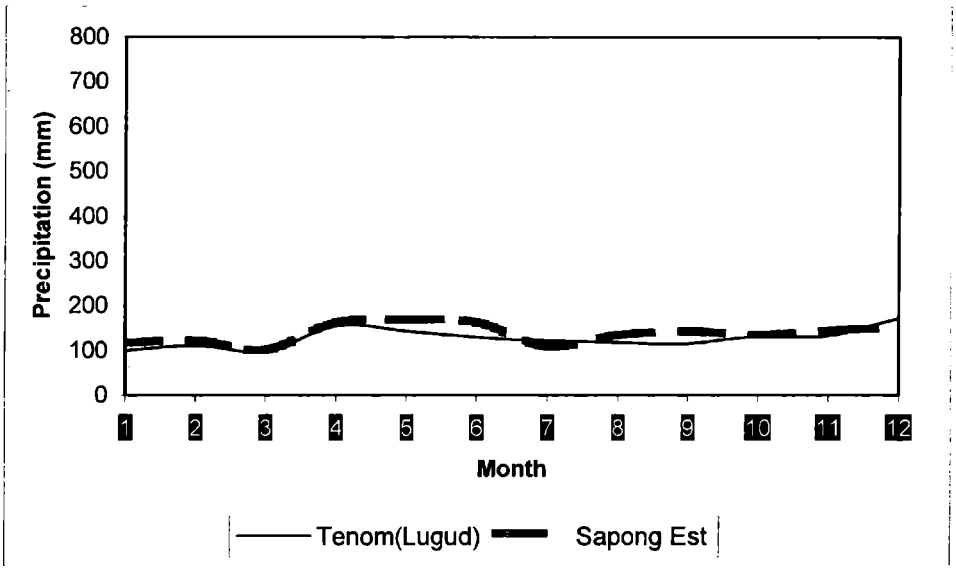

Figure 6: Same as figure 2, but for Tenom (Lagud) and Sapong Estate.

3.5 Northern west coast region

At the west coast, larger values are observed throughout the boreal summer, as these stations are largely exposed to the SW monsoon winds. As a consequence of this, Labuan, Kuala Penyu and Kimanis, starting in April, experience a considerable monthly rainfall increase (figure 7). As such, from May onwards, the monthly average of these three stations is roughly 250 mm. On the other hand, the monthly average of these same stations is 150 mm in the first quarter.

A rainfall decrease is observed, starting in November, in these three stations. This decrease is more significant during the first quarter, where minimum values are observed in March. It may be concluded that the monthly rainfall distribution of these stations is largely unaffected by the NE monsoon winds.

3.6. Central west coast region

In the tropics, rainfall increases with altitude up to a certain level (Dale, 1959; Hastenrath, 1990). Larger rainfall values of Lawa Madau as compared to both Tuaran Agricultural Station and Kota Belud may largely be attributable to this effect (figure 8). The monthly rainfall distribution of these three stations is similar to the ones of Labuan, Kuala Penyu and Kimanis: a sharp increase during the first inter-monsoon period (i.e., May), sustained larger rainfall values during the boreal summer (with a

relative maximum in the October inter-monsoon period) followed by a slight decrease in December. This decline in monthly rainfall is further accentuated from January to March, where a minimum in this particular month is also observed.

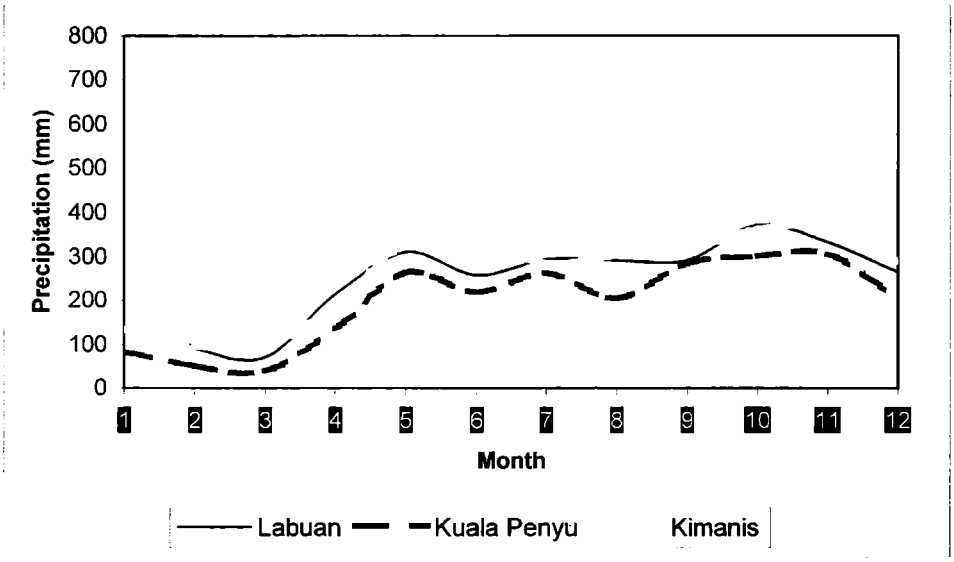

Figure 7: Same as figure 2, but for Labuan, Kuala Penyu and Kimanis.

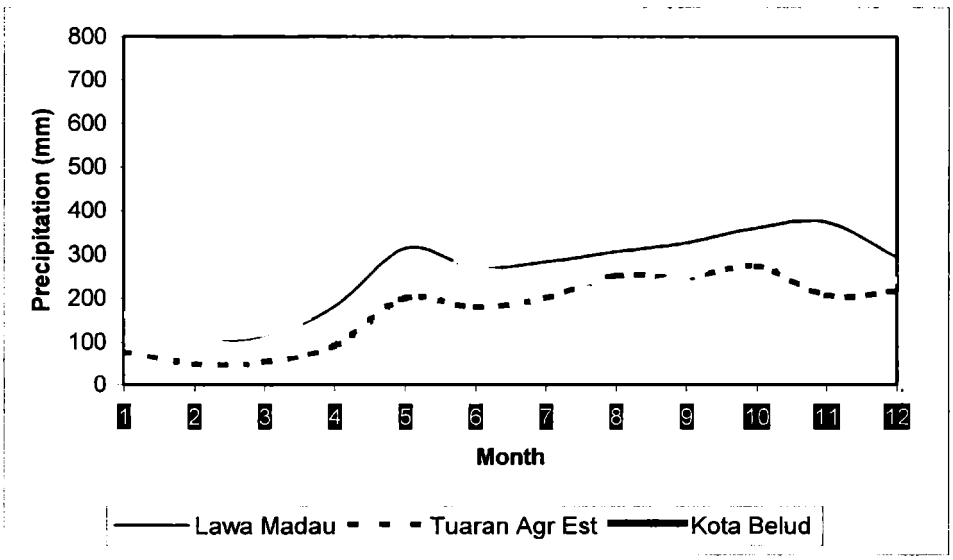

Figure 8: Same as figure 2, but for Lawa Madau, Tuaran Agricultural Estate and Kota Belud.

3.7. Northern east coast region

Stations located at the east coast are largely exposed to the NE monsoon winds. As a consequence of this larger values are observed both in December and January in Sandakan and in Tomanggong (figure 9). The equatorward migration of the NE monsoon occurs in April. Minimum values, recorded in April in these two stations, may be attributable to this effect. A similar phenomenon is detected at Peninsular Malaysia eastern coast.

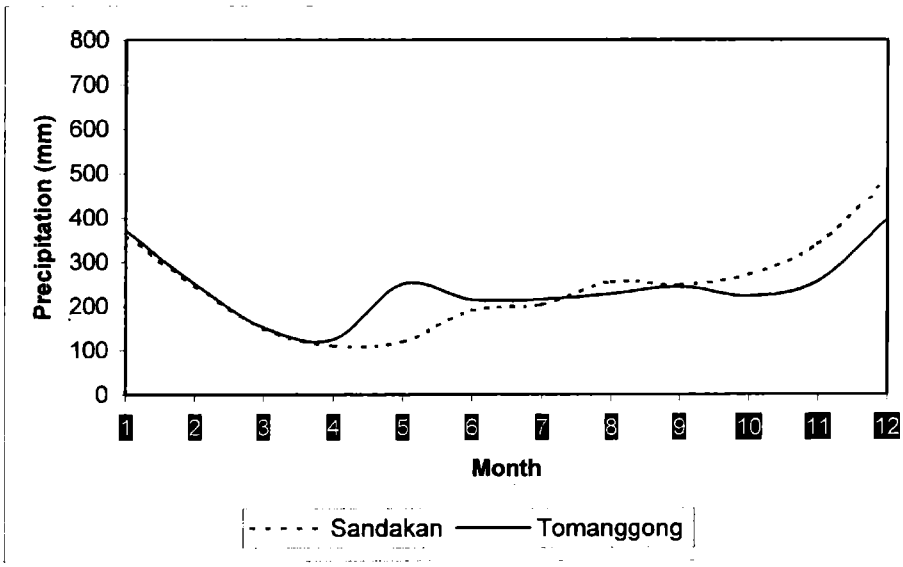

Figure 9: Same as figure 2, but for Sandakan and Tomanggong.

3.8. Southern east coast region

Further to the south, but close to the east coast, lower rainfall values (as compared to both Sandakan and Tomanggong) are observed during the boreal winter (figure 10). This is due to the fact that humidity of the air mass (from Sulu Sea) has been discharged further to the north of these stations.

Due to both (a) their distance from the east coast and (b) their particular location, the stations Quion Cocoa Estate, Lahat Datu Agricultural Station and Kunak Cocoa Proyect have lower rainfall values than both Sandakan and Tomanggong during the boreal summer.

4. CONCLUSIONS

In this manuscript the monthly rainfall distribution of selected regions of Sabah is addressed. The main conclusions of this study are:

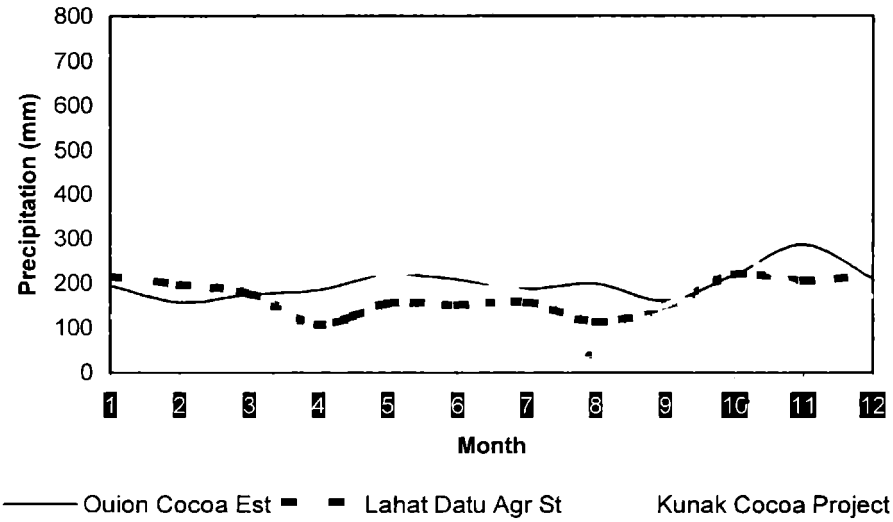

Figure 10: Same as figure 2, but for Quion Cocoa Estate, Lahat Datu Agricultural Station and Kunak Cocoa Project.

1. Excluding certain atypical mountain stations during the boreal summer, larger values of precipitation are recorded all along the west coast. This is not the case in Peninsular Malaysia, where larger values are observed at the windward side of the Titiwangsa mountain range (Camerlengo *et al.*, 1998);
2. Higher rainfall values are observed in the northern east coast region as compared to the southern east coast region during both monsoon seasons;
3. Sabah' s east coast has larger monthly rainfall values than Peninsular Malaysia' s east coast during the boreal summer;
4. From November to January rainfall values in Peninsular Malaysia' s east coast are considerable larger than the ones in Sabah' s east coast (Camerlengo *et al*, 1998);
5. Inland from the east coast, in most stations, in a similar way as in Peninsular Malaysia, monthly rainfall maximum is recorded in either one or the other inter-monsoon period;
6. On an annual basis, lesser rainfall values are noticed at the eastern side of the mountain range as this particular region remains largely unaffected by the monsoon season.

Acknowledgments: This study was supported by an IRPA grant. The author gratefully acknowledges this support. My thanks are also extended to the Malaysian Meteorological Service for providing the necessary data to carry out this investigation. Comments made by anonymous reviewers contributed to a considerable improvement of this manuscript.

REFERENCES

Camerlengo, A. L, M. Nasir S., A. S. Aziz and M. R. Othman, 1998: Monthly distribution of precipitation in Peninsular Malaysia. Pertanika J. of Sci. & Technol., 6(1), 59-70.

Camerlengo, A. L., L. Y. Rang and N. Somchit, 1999: A rainfall study in Sabah. Submitted for publication to Science International

Dale, W. L., 1959: Rainfall in Malaya, part I. J. Trop. Geogr., **13**, 23-37.

Hastenrath, S., 1990: Climate Dynamics of the Tropics. Kluwer Academic Publishers, 488 pp.

Nieuwolt, DS., 1981: The climates of Continental Southeast Asia, chapter I. World Survey of Climatology, Elsevier Scientific Publishing Co., Takahasi & Arakawa (eds.), 1-37.

Ramage, C. S., 1964: Diurnal variation of summer rainfall over Malaya, J. Trop. Geogr., **19,** 62-68.

Watts, I. E., 1955: Rainfall in Singapore Island. J. Trop. Geogr., **7**, 71 pp.