Kajian Malaysia, Vol. VIII, No. 1 Jun 1990

A COMPARATIVE STUDY OF THE MEAN AND MEDIAN RAINFALL PATTERNS IN NORTHWEST PENINSULAR MALAYSIA

Chan Ngai Weng

Most rainfall studies in Malaysia have used the mean to represent the average rainfall characteristics of the respective regions under study. Given its limitations, usage of the mean may not be representative of the actual average rainfall conditions. The present study is an attempt to study both the mean and median rainfall patterns of 59 preselected rainfall stations over the north-western region of Peninsular Malaysia. To achieve this objective, a comparative discussion on the mean and median annual, seasonal and monthly rainfall patterns for the period 1948 to 1977 was carried out over the study area.

Kebanyakan kajian tentang pola hujan di Malaysia cenderung menggunakan min untuk mewakili ciri-ciri hujan purata di kawasan-kawasan yang dikaji. Memandangkan had-hadnya, penggunaan min mungkin tidak mewakili keadaan hujan purata yang sebenar. Kajian ini merupakan satu cubaan untuk mengkaji kedua-dua pola hujan min dan median terhadap 59 stesen hujan terpilih yang tertabur di wilayah barat laut Semenanjung Malaysia. Untuk mencapai matlamat ini, suatu perbincangan bandingan tentang pola hujan min dan median tahunan, musiman dan bulanan untuk tempoh 1948 hingga 1977 akan dilaksanakan di seluruh wilayah kajian.

A great deal of work has been documented with respect to the average rainfall patterns in various parts of Peninsular Malaysia at the regional scale (Gan, 1962; Leigh and Low, 1973; Hui and Lim, 1977; and Chan, 1981a and 1981b) and also on the peninsula itself at the national scale (Stewart, 1930; Dale, 1959 and 1960; Charlton, 1961; Nieuwolt, 1965; Wycherley, 1967; Lockwood, 1967; Morgan, 1971; and Chia, 1975). Almost all the above studies (except Chan, 1981a) have used the mean to represent the average rainfall characteristics of the respective regions under study. The present study is an attempt to analyse the mean and median rainfall patterns of 59 pre-selected rainfall stations (Fig. 1) over the northwestern region[1] of Peninsular Malaysia (Fig. 2). To achieve this objective, a comparative discussion of the mean and median annual, seasonal and monthly rainfall patterns for the period 1948 to 1977 over the Northwest was carried out.

MEASURES OF ASYMMETRY

Skewness is the degree of asymmetry, or departure from symmetry, of a certain distribution. Thus, the numerical difference between the mean and the median values is a measure of asymmetry.[2] The greater the difference the more

asymmetrical the distribution and *vice-versa*. If the mean is greater than the corresponding median, then the skewness is termed "positive". The reverse is true in the case of negative skewness.

The relationship between the mean and median, has been shown by Sandy (1960) in the formula:

$$100 = \frac{C - M}{M}$$

where C is the median and M the mean value. If the data has a symmetrical distribution there would be no difference between C and M. The smaller the difference between M and C the better will the mean represent the normal. This formula can be regarded as a measure of asymmetry. Based on this formula, the values of the percentage difference between the mean and median rainfall of the various stations for the monthly, seasonal and annual rainfall were calculated. It

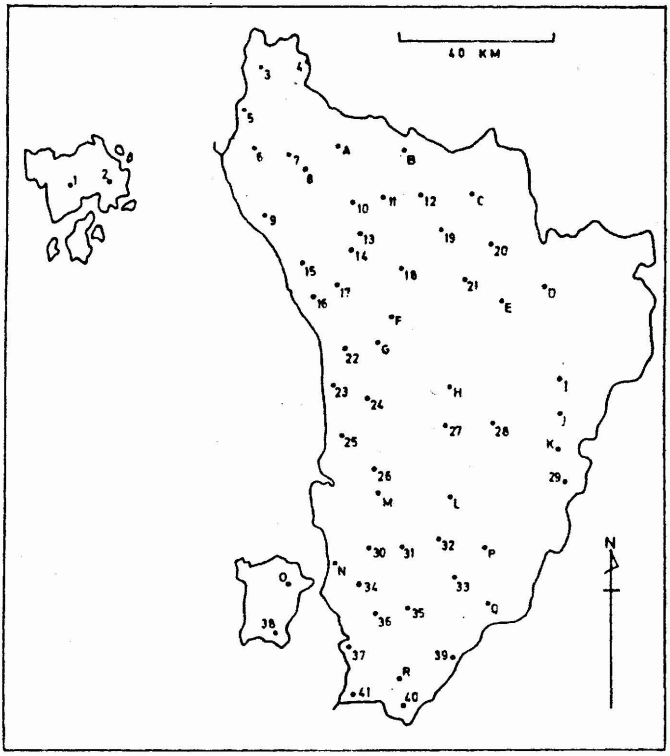

Fig. 1: Location of Selected Rainfall Stations in the Present Study in Northwest Peninsular Malaysia Stations numbers 1 to 41 are the main stations while those numbered A t R are the subsidiary stations

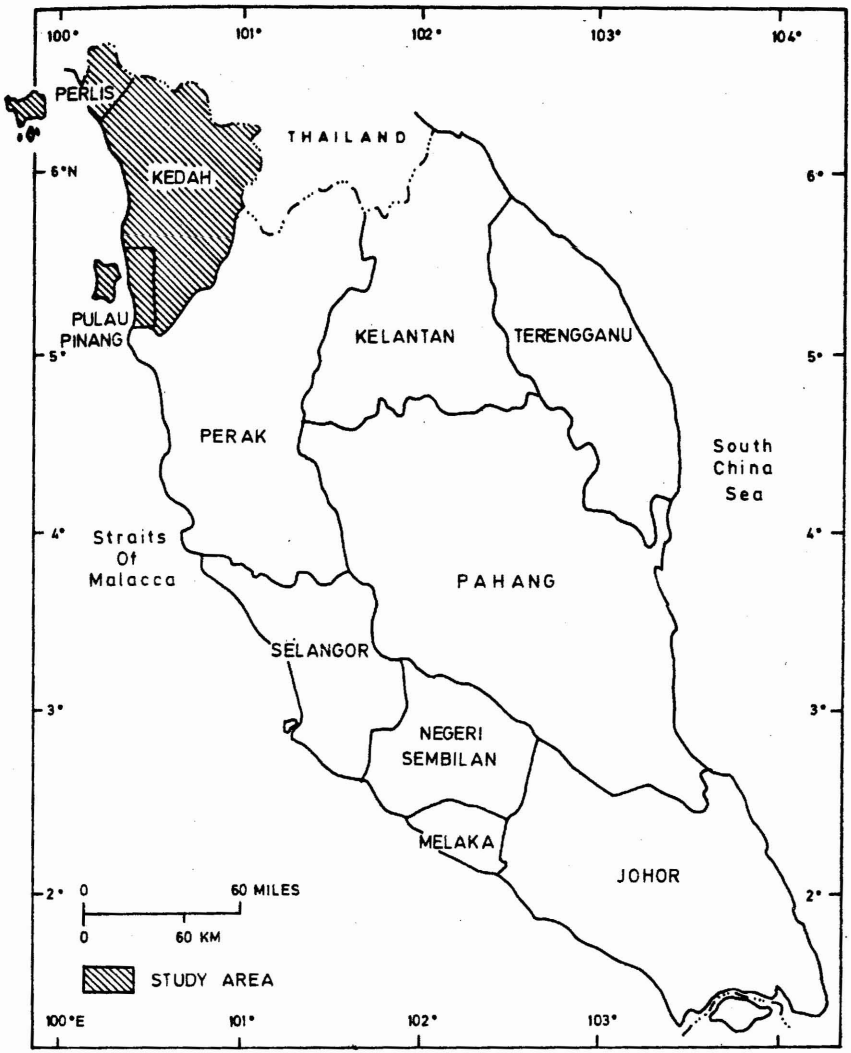

Fig. 2 Location of Study Area in Peninsular Malaysia

was found that the percentage difference between the two measures of central tendency was greatest for the dry months from November to March and smallest for the wet months from April to October. For the seasonal and annual rainfall values, there was little difference between the mean and its corresponding median values. As such, percentage differences between the two measures of central tendency was small.

THE ANNUAL RAINFALL DISTRIBUTION PATTERN

Peninsular Malaysia has often been described as having a relatively wet climate as a result of the uniformly high annual rainfall of over 2000 mm (Fig. 3). The Northwest, however, is a region of comparatively lower rainfall as it is considered to have a more monsoon-like climate rather than equatorial due to its latitudinal location. The average rainfall experienced in this region is between 1500 to 2000 mm per year. It is considered as one of the driest regions in the country which is at the same time most susceptible to the occurrence of drought (Chan, 1981a). The political division of the Northwest into the various States and Districts are shown in Fig. 4.

The annual median rainfall distribution pattern is more or less similar to the mean rainfall pattern (Fig. 5). This is due to the small differences between the annual mean and median rainfall values. However, larger differences occur in the drier northern areas. The median rainfall decreases towards the north with the northern parts of Perlis and Kedah receiving under 2000 mm of rain. This low rainfall area is larger in the median map than in the mean map, indicating that the mean is higher than the median. Two of the higher rainfall areas are found in Yan and Bandar Baharu Districts. A low rainfall area of less than 2200 mm found in the eastern part of the mean rainfall map is no longer apparent in the median map. In general, there is no appreciable difference between the mean and median rainfall as most of the isohyets are almost the same in both rainfall maps.

THE SEASONAL RAINFALL DISTRIBUTION PATTERN

During the **Main Season,**[3] the median rainfall distribution pattern is also quite similar to the corresponding mean rainfall pattern (Fig. 6). The only difference is that the wet areas are slightly more extensive in the former map. The extent of the dry areas, however, remain the same. The **Off-season**[4] median rainfall pattern also shows little variation from that of the corresponding mean rainfall pattern (Fig. 7). However, the areas with more than 900 mm of rain in the southern part of the region are slightly more extensive in the mean rainfall map.

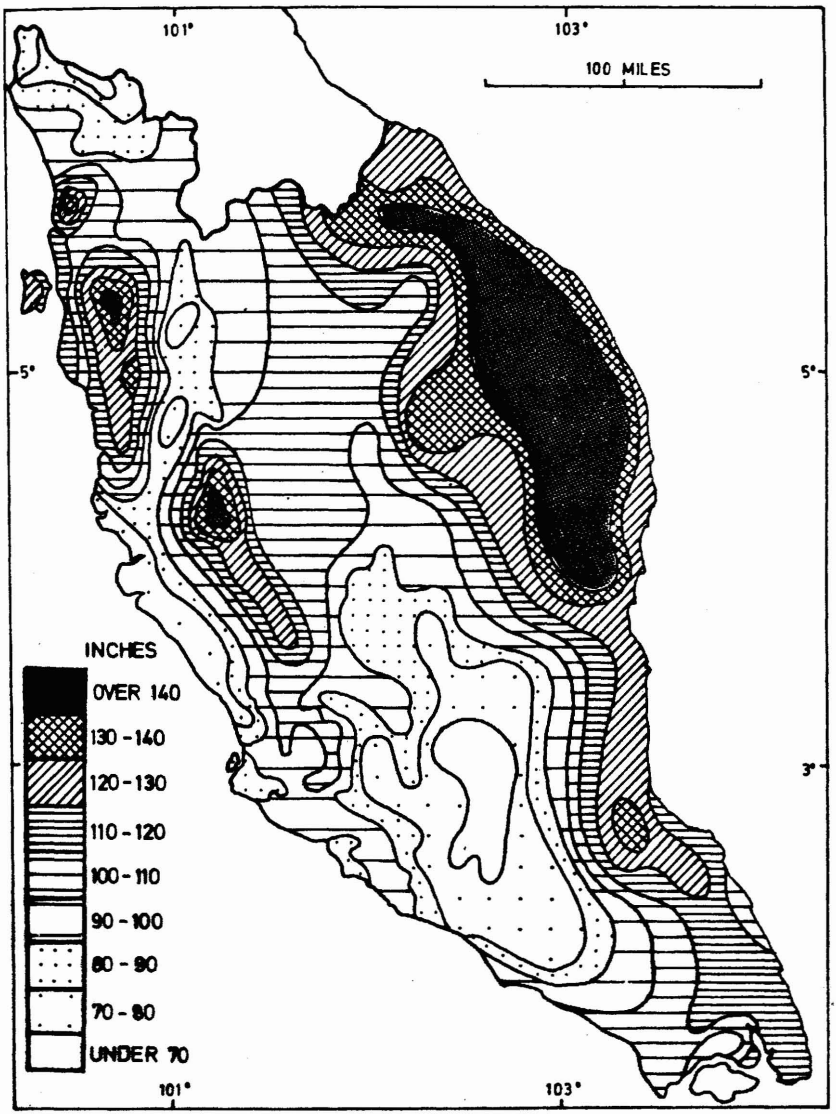

Fig. 3 Distribution at Mean Annual Rainfall in Peninsular Malaysia (After Dale, 1959)

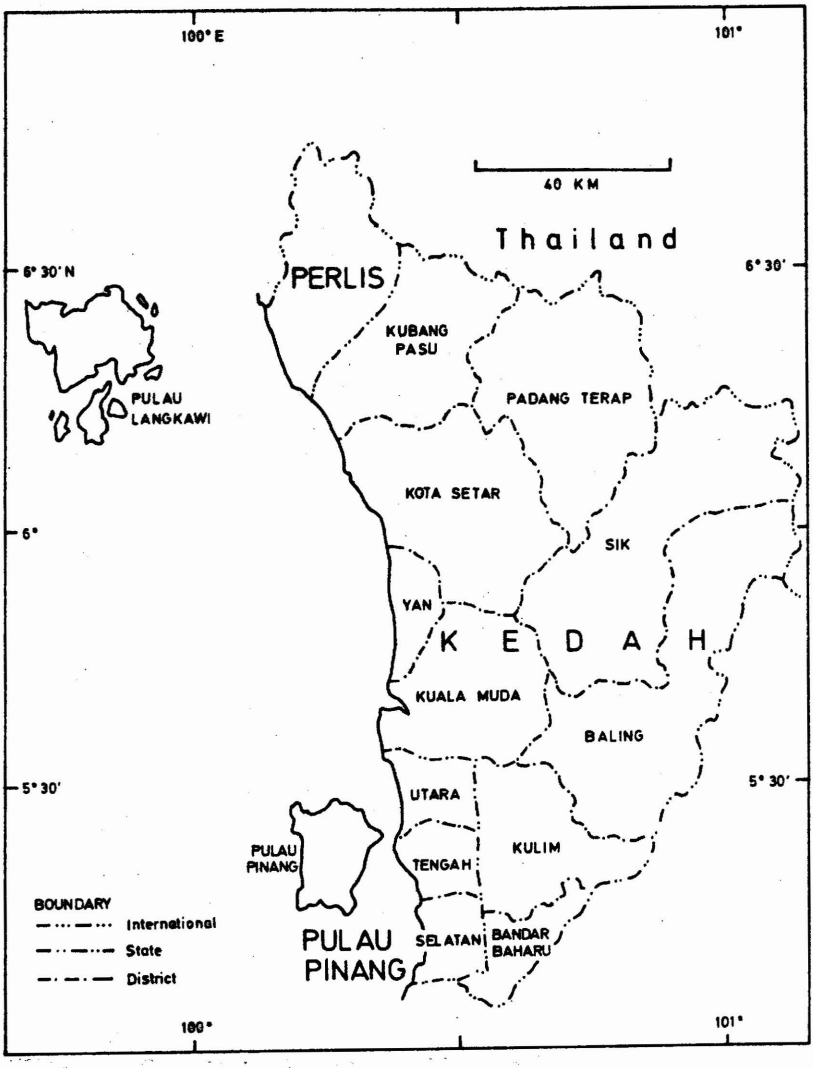

Fig. 4: Northwest Peninsular Malaysia by District

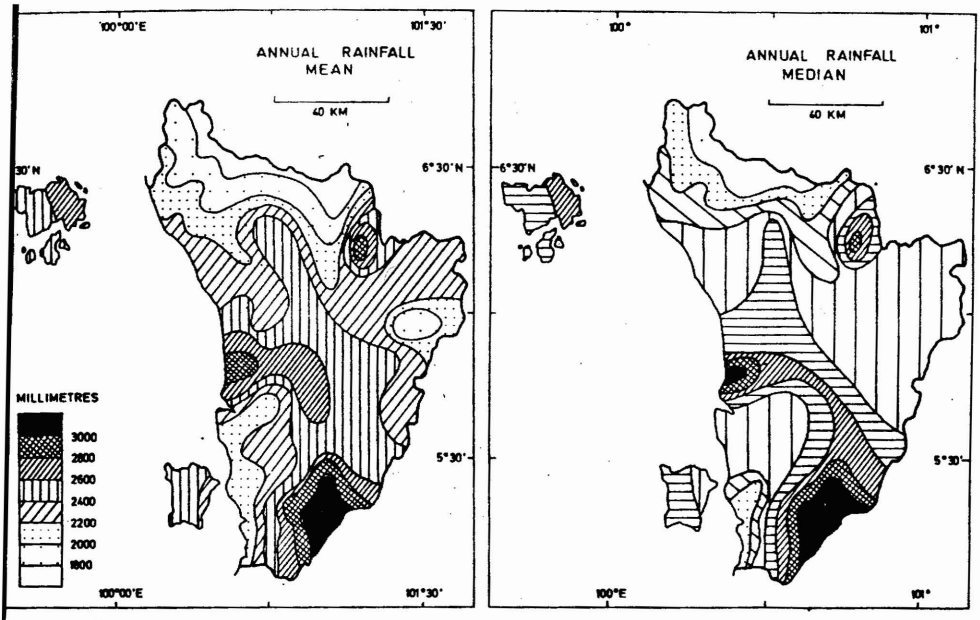

Fig. 5 Distribution of Mean And Median Annual Rainfall in Northwest Peninsular Malaysia

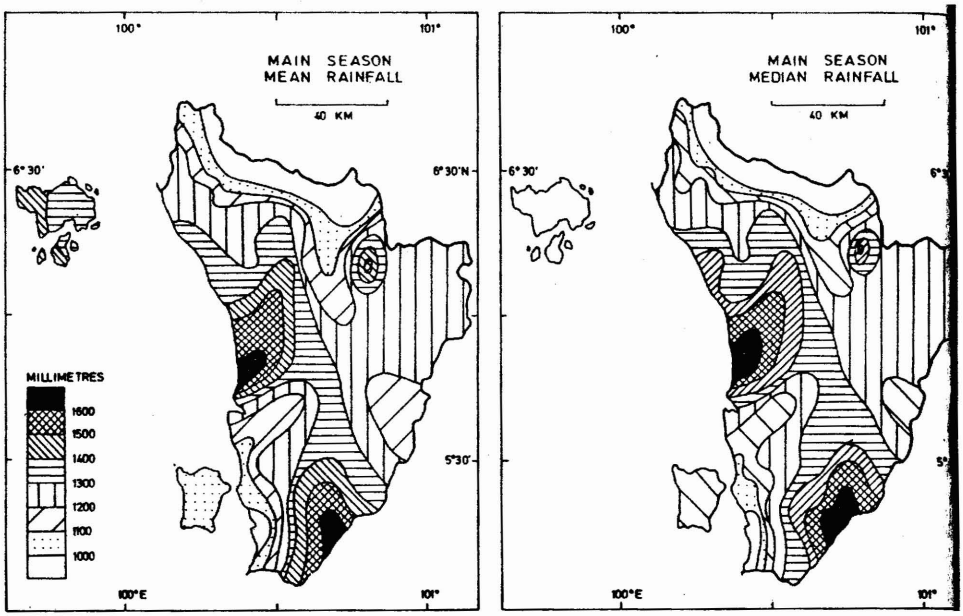

Fig. 6 Distribution of Mean and Median Rainfall During the Main Season in Northwest Peninsular Malaysia

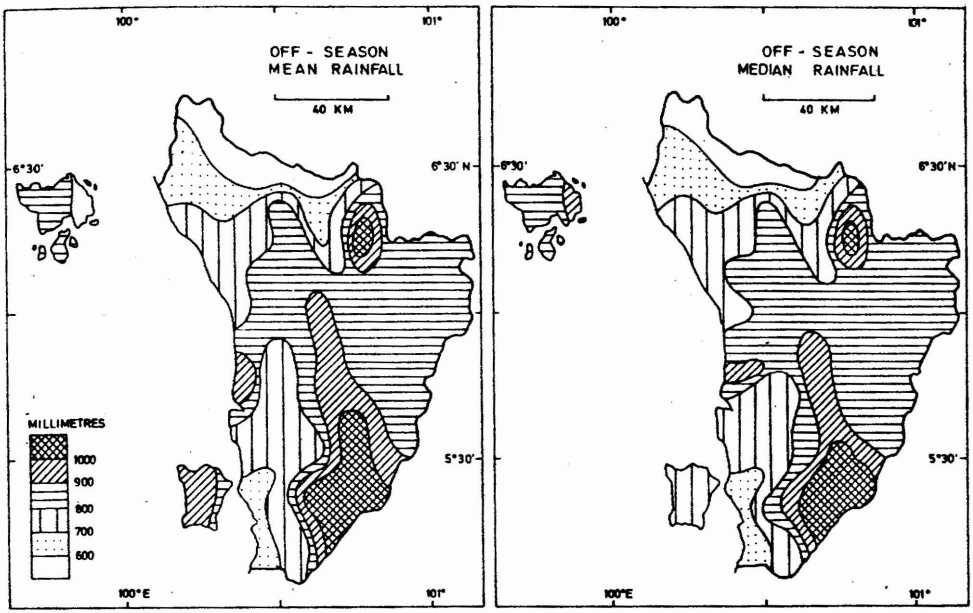

Fig. 7 Distribution of Mean and Median Rainfall During the Off Season in Northwest Peninsular Malaysia

On the whole, there is little difference between the mean and median rainfall of both the main and off-season rainfall amounts.

THE MONTHLY RAINFALL DISTRIBUTION PATTERN

Fig. 8 shows the monthly median rainfall distribution patterns from January to April. In January, the median rainfall values (Fig. 8A) were almost the same as that of the mean rainfall values (Fig. 9A) in the southern half of the region. Areas in the centre of the region receive a median rainfall of around 50 mm. This increases gradually to about 150 mm in the south. However, towards the northern part of the region the median rainfall received is considerably lower than the mean rainfall. Parts of North Perlis and Kedah register a median rainfall of less than 25 mm compared to more than 50 mm for the mean rainfall. Other areas with less than 25 mm of median rainfall include the western half of Pulau Langkawi, the coastal part of Kota Setar and South Padang Terap. In general, both the median and mean rainfall for this month increases as one moves southwards from the north. The median rainfall in February (Fig. 8B) is lower in most parts than that of the mean rainfall (Fig. 9B). Perlis, Padang Terap and Langkawi Island have less than 25 mm of rain. The isohyets in the southern part of the region, however, are almost the same in both the median and mean rainfall maps. In March, there are some slight differences between the median and mean rainfall distribution patterns. Towards the northwestern part of the region, especially in the inland districts of Sik and Padang Terap, the median rainfall received is less than 125 mm (Fig. 8C). This is slightly higher than that found in the mean rainfall map (Fig. 9C) where less than 100 mm of rain was recorded. In the south, however, rainfall in much higher in the mean map than in the median map. For example, a greater part of Bandar Baharu District has a mean rainfall of more than 300 mm but a median rainfall of only 225 mm. This is due to the relatively large differences found between the two measures of central tendency during the dry months. The month of April is a relatively wet month. Consequently, the small differences between the mean and the median have given rise to a more or less similar rainfall pattern in both maps (Fig. 8D and 9D). The only prominent difference is the presence of more pockets of heavy rainfall in the mean rainfall map.

May is a month where rainfall is well distributed over the region. It is a wet month and differences between the mean and median are small. As a result, one would expect a similar rainfall pattern between the two, but a comparison showed that significant differences do exist. There is an area in the east where lower median rainfall is received (Fig. 10A). In the nothern parts of the region, the area with less than 200 mm of rain (Fig. 11A) is larger in the median rainfall map. On the other hand, the pockets of heavy rainfall remain almost similar in both the median and mean rainfall maps. The median rainfall pattern in June (Fig. 10B) is very different from that of the mean rainfall (Fig. 11B). In the former, the interior areas receive less than 150 mm of rain. In fact, the northern

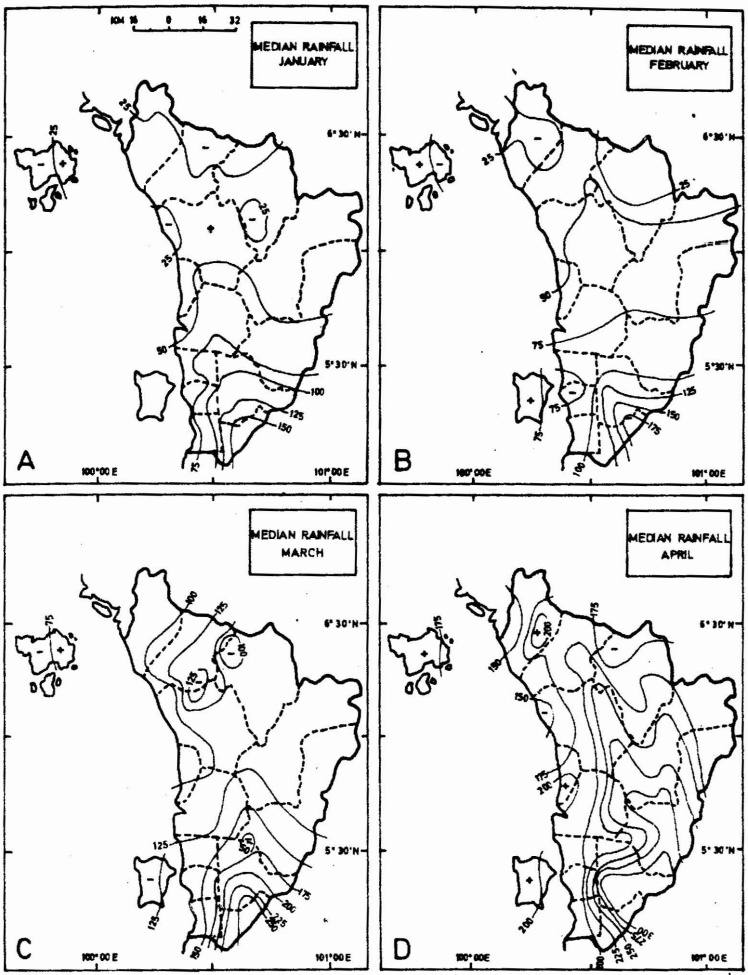

Fig. 8 Distribution of Median Monthly Rainfall from January to April in Northwest Peninsular Malaysia (in millimetres)

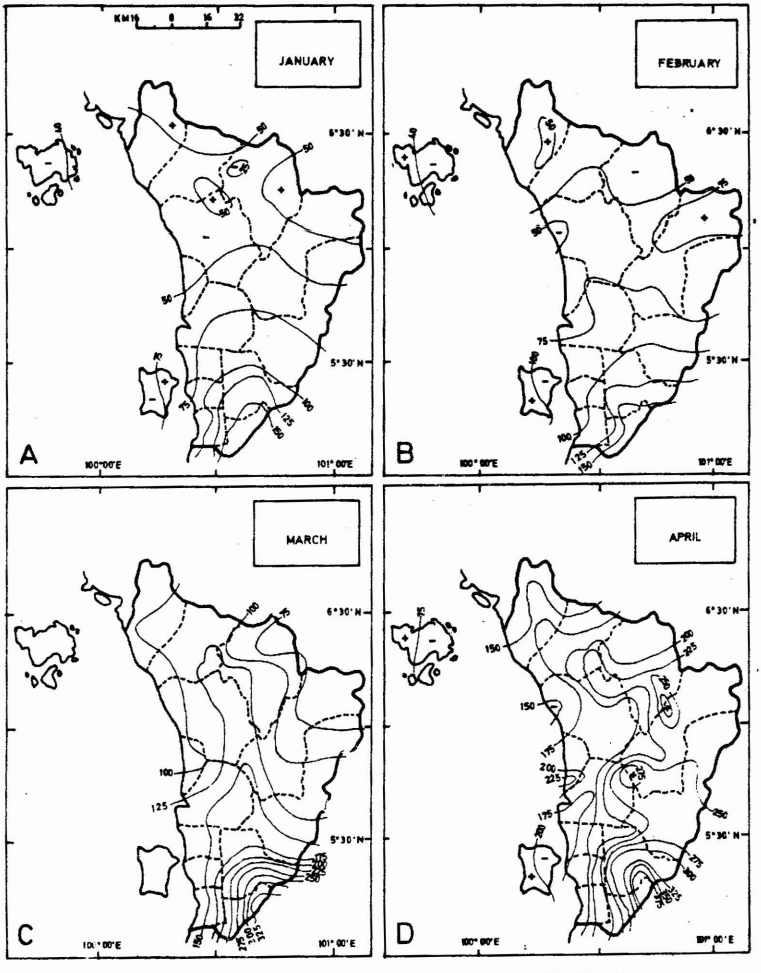

Fig. 9. Distribution of Mean Monthly Rainfall from January to April in Northwest Peninsular Malaysia (in millimetres)

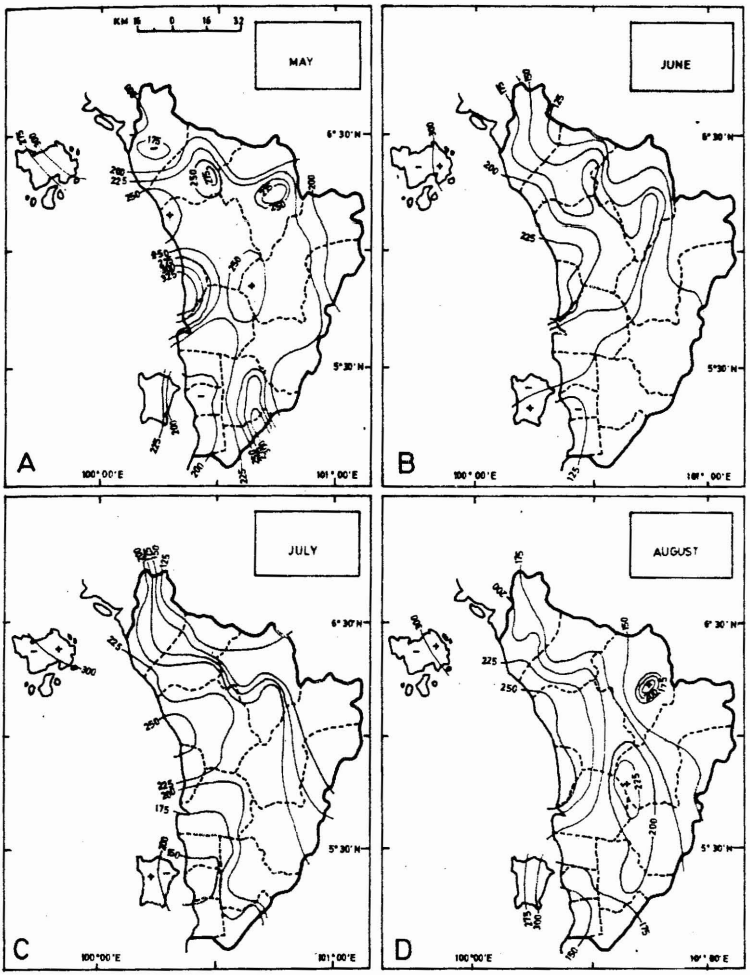

Fig. 10 Distribution of Median Monthly Rainfall from May to August in Northwest Peninsular Malaysia (in millimetres)

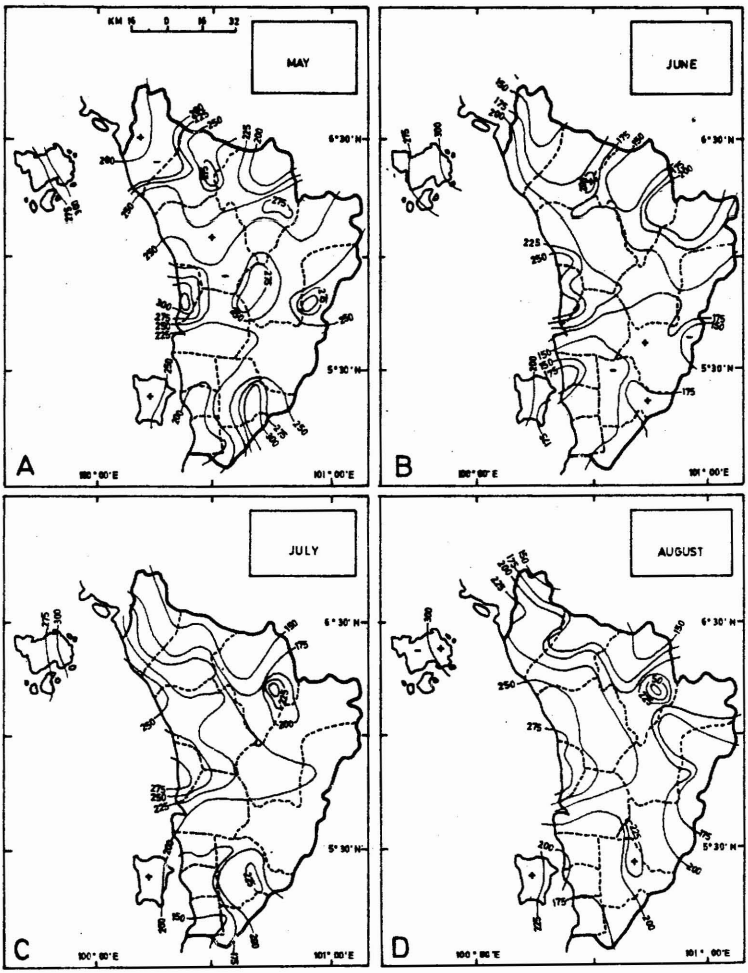

Fig. 11 Distribution of Mean Monthly Rainfall from May to August in Northwest Peninsular Malaysia (in millimetres)

parts of Sik, Baling, Padang Terap and Kubang Pasu have less than 125 mm of rain. On the mean rainfall map the same areas receive more than 150 mm of rain. The volume of rainfall in both maps, however, increases westward. The differences between the two measures can again be attributed to the fact that June is a relatively dry month. In July the median rainfall (Fig. 10C) received generally decreases inland. However, in the southern coast bordering Mainland Penang, rainfall increases inland. Compared to the many areas with a mean rainfall of more than 250 mm (Fig. 11C), the same volume of median rainfall is found only on the coast of Kota Setar and Pulau Langkawi. On the other hand, the areas of low rainfall of less than 150 mm occupy a larger area in the median map. There are also more areas in the median map with a rainfall of less than 150 mm and fewer areas with rainfalls of more than 250 mm. This was the result of the mean being influenced by a few years of extremely high rainfalls. The August rainfall pattern is quite similar in both rainfall maps. The only apparent difference is that the isohyets in the median map (Fig. 10D) have moved slightly towards the coast. This indicates that the mean is greater than the median at most stations. More areas inland are under the lower rainfall classes. For example, the northeastern portion of the region which recorded a mean rainfall (Fig. 11D) of less than 200 mm registered a median rainfall of less than 150 mm. The coastal areas receive a median rainfall of 225 mm compared to a mean rainfall of 250 mm in the mean rainfall map.

September is a fairly wet month and although the median isohyets in the south show different alignments from that of the mean map, the volume of rainfall received at most stations is about the same in both maps (see Fig. 12 A and 13 A). The wettest area is Yan District where 350 to 400 mm of rain is received. Towards the north, however, the 225 mm isohyet has replaced the 250 mm isohyet found in the mean map. Most parts of northern Sik and Baling Districts receive a median rainfall of less than 225 mm during this month. The wetter areas in the southern part of the region show a similar pattern in both maps. The mean and median rainfall pattern of October showed little difference (Fig. 12B and 13B). This is generally true for the southern and central parts of the region. However, the rainfall pattern in the north is quite different. Parts of North Perlis and Kedah have a lower rainfall in the median map. This is an area of positive skewness where the mean is appreciably higher than the median. The 400 mm isohyet in the mean map is more extensive than in the median map. November is still a relatively wet month but the rainfall pattern depicted in the median map is different from that of the mean map (Fig. 12C and 13C). Although the rainfall increases both from north to south and coast to interior in both the maps, the absolute amount of rainfall is much lower in the median map. This is particularly true for the south and eastern parts where the total rainfall received is much lower compared to the mean map. However, the heavy mean rainfall pocket found in Padang Terap have extended into Kubang Pasu. This is due to the median being greater than the mean (a case of negative skewness). The month of December is the beginning of the dry season and most

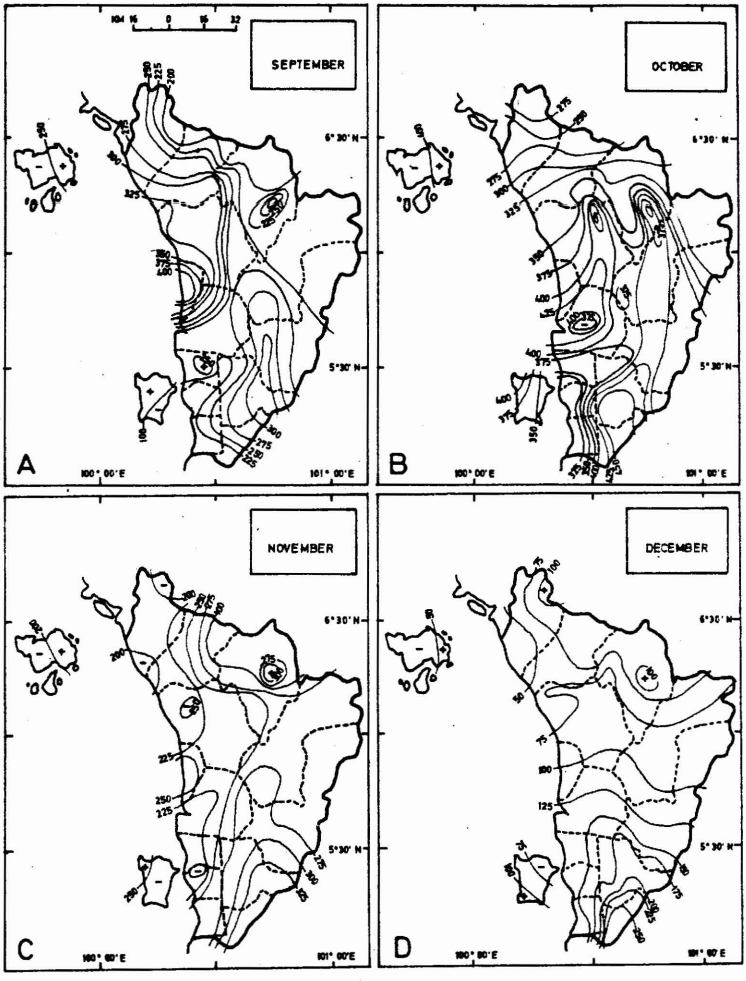

Fig. 12 Distribution of Median Monthly Rainfall from September to December in Northwest Peninsular Malaysia (in millimetres)

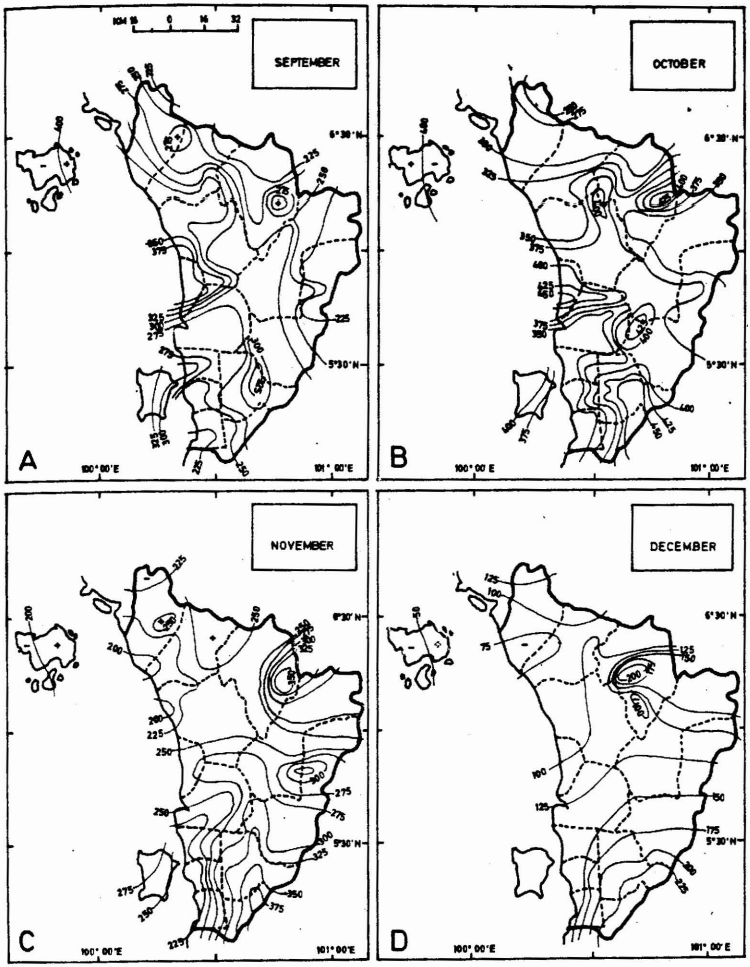

Fig. 13 Distribution of Mean Monthly Rainfall from September to December in Northwest Peninsular Malaysia (in millimetres)

stations in the south receive a median rainfall of more than 100 mm (Fig. 12D). Towards the north the values are less than 50 mm in coastal Perlis. The rainfall pattern is almost the same in the mean rainfall map (Fig. 13D). The only difference is in the northern half of the region where lower median rainfall is received. Parts of North Perlis and Kedah have only a median rainfall of less than 75 mm. These same areas have a mean rainfall of more than 100 mm. The well defined area of heavy rainfall in Padang Terap in the mean map has also diminished in size in the median map. However, the rainfall pattern in the southern part of the region remains the same.

CONCLUSION

The above analysis shows that the median rainfall for the dry season months from December to March is generally much lower than the mean rainfall for most stations in the northern parts of Northwest Peninsular Malaysia. However, in the southern part of the region, which receives a higher rainfall during these months, the differences between the mean and median rainfall values are negligible. On the other hand, during the wet season months from April to November, with the exception of June, the mean rainfall is slightly lower than the median rainfall. This is due to the influence of some extremely wet months during the dry season and some exceptionally dry months during the wet season on the mean rainfall value. The former will inflate the value of the mean above that of the corresponding median while the latter will pull down the value of the mean. On the whole, it can be concluded that there was no significant difference between the mean and median values during the wet months.

In general, there was also little difference between the mean and median rainfall in the wetter areas in the southern part of the region. The small difference in values between the mean and the median monthly rainfall, with the exception of the dry months, indicates that the mean is representative of the normal average rainfall conditions and that for all practical purposes it can be used to reflect the average monthly rainfall characteristics of any region in Peninsular Malaysia. The same can be said of the mean and median rainfall characteristics for the seasonal and annual rainfall values. The results of the analysis show that there were no significant differences between the mean and median rainfall patterns for both the seasonal as well as the annual rainfall values. This indicates that for rainfall periods of a few months or more, the differences between the mean and median values become almost negligible. As such, researchers in Malaysia can, for all practical purposes, use either the mean or median in describing the average rainfall of an area over a period of a few months or more. However, the usage of the mean becomes questionable during shorter periods of a month or less. This is particularly so during the dry months of November to March in the Northwest. During these months, it was discovered that differences between the mean and median rainfall were greatest. As such, the mean cannot be said to be representative of the normal rainfall of any particular station during any of these

months. Researchers using the mean rainfall for these months should always be aware of its limitations. However, researchers using the mean during the wet months can reasonably assume that it is representative of normal rainfall condition as no significant differences between the two measures of central tendency were found in the present study.

NOTES

[1] Hereafter to be referred to as the Northwest.

[2] A distribution will have a symmetrical curve when the mean and median values are the same. However, a symmetrical distribution is not synonymous with a normal distribution.

[3] The Main Season in the Northwest stretches over the months of July to December (see Chan, 1981a, *op. cit.*, p. 71).

[4] The Off-Season in the Northwest stretches over the months of January to June (see Chan, 1981a, *op.cit.* p. 71).

REFERENCES

Chan, N. W. (1981a), *A Quantitative Analysis of Rainfall Patterns and Drought Occurrences in Northwest Peninsular Malaysia.* (Unpublished M.A. Thesis, Universiti of Malaya).

_____(1981b), "The Reliability of Rainfall in Relation to Wet Rice Cultivation in Northwest Peninsular Malaysia", *Malaysian Journal of Tropical Geography*, Vol. 4, December 1981.

Charlton, F.G. (1961), "Hydrology in Malaya - Rainfall", *Malayan Forester*, Vol. 24, pp. 180-9.

Chia, L.S. (1975), *A Study of The Rainfall Patterns in West Malaysia.* (Unpublished Ph.D. Thesis, University of Singapore).

Dale, W.L. (1959), "The Rainfall of Malaya: Part I", Republished in Ooi, J.B. and Chia, L.S. (1974), *The Climate of West Malaysia and Singapore.* (Singapore), pp. 132-44.

_____(1960), "The Rainfall of Malaya: Part II", Republished in Ooi, J.B. and Chia, L.S. (1974), *The Climate of West Malaysia and Singapore* (Singapore), pp. 145-61.

Gan, T.L. (1962), "A Study of Some Heavy Rain-spells on the East Coast of Malaya during the Northeast Monsoon Season", *Memoirs*, No. 6, Malaysian Meteorological Service, Singapore, 15 pp.

Hui, H.C. and Lim, J.H. (1977), "Confidence Limits of Expected Monthly Rainfall for some Selected Stations in Peninsular Malaysia", *Indian Journal of Meteorology and Geophysics*, Vol. 28, No. 2, pp. 205-10.

Leigh, C. and Low, K.S. (1973), "A Note on the Reliability of Annual Rainfall Data for Selected Stations in Selangor", *Malayan Nature Journal*, Vol. 24, 3 and 4, pp. 152-8.

Lockwood, J.G. (1967), "Probable Maximum 24 Hour Precipitation over Malaya by Statistical Methods", *Meteorological Magazine*, Vol. 96, pp. 11-9.

Morgan, R.P.C. (1971), "Rainfall of West Malaysia - A Preliminary Regionalisation using Principal Components Analysis", *Area*, Vol. 3, No. 4. pp 222-7.

Nieuwolt, S. (1965), "Rainfall Probability in Malaya", *Memoirs*, No. 7, Malayan Meteorological Service, Singapore, 24 pp.

Sandy, I.M. (1960), *Statistical Analysis of Rainfall in Java.* (Unpublished Ph.D. Thesis, Clark University).

Stewart, C.D. (1930), "The Rainfall of Malaya", *Malayan Agricultural Journal*, Vol. 18, pp. 530-40.

Wycherley, P.R. (1967), "Rainfall Probability Tables for Malaysia", *Planting Manual*, No. 12, Rubber Research Institute of Malaysia, Kuala Lumpur.