

The rainfall data of Ceylon

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INTRODUCTION

Rainfall is one of the chief physical factors influencing agriculture in Ceylon. Therefore in order to understand the present pattern of agriculture, to plan for the future, and also to determine the proper sequence of agricultural operations and cropping that is suitable, monthly or seasonally, for a particular place or region, it is very necessary to have an adequate understanding of the rainfall factor. It is all too often obvious, that many persons concerned with agriculture in Ceylon do not have an adequate understanding of the rainfall factor. This is largely because there have been relatively few, simple, accurate and readable accounts of Ceylon rainfall, which caters to agricultural personnel. In fact, apart from the work of Thambyapillay (9, 10) @, there are hardly any other publications. The purpose of this paper is twofold: (1) to present a general account of Ceylon rainfall and demarcate rainfall regimen zones in a manner which would be useful in agricultural work; and (2) to indicate certain new studies which should be made, and new rainfall maps which should be prepared, so that there would be better information on the rainfall factor in Ceylon.

The meteorological phenomena which cause rainfall in Ceylon are not discussed in this paper. It is restricted to a description of past data and the processing of such data into a meaningful form, particularly in relation to agriculture.

THE RAIN GAUGING NETWORK

The printed monthly summary of the Department of Meteorology (December 1969) lists about 450 raingauging stations, while Walker (11) mentions that there were, in 1956, some 620 stations reporting daily rainfall data to the Department of Meteorology at Colombo.

@ These numbers refer to the list of references.

Of these, 20 are meteorological stations operated by the Department of Meteorology, with trained, full-time 'Observers'. At these twenty stations, rainfall is measured by the standard gauge, as well as by a continuous recording gauge. Thus, at these stations, the measurements are highly reliable, and free from major errors. At almost all other stations, only the standard gauge is used, rainfall is measured only once per day, and the care and skill exercised varies greatly from place to place and from time to time. Thus there are twenty stations with highly reliable data, and several hundred other stations, with less and varying degrees of reliability in the measurement, due to several sources of instrumental and observational errors. This network of stations is the basis of all systematic, regional rainfall work in Ceylon. Compared to most of the less-developed countries, Ceylon has a fairly good rain gauging network. The establishment of this network was one of the very progressive steps of the British regime in Ceylon.

The observed rainfall measurements have to be subjected to considerable statistical computation, in order to obtain a meaningful picture of the diversity and variation which is present in rainfall, both in place and in time. Most often, the statistics require to be presented as rainfall maps in order to obtain a more meaningful picture.

PUBLISHED RAINFALL MAPS

The long term record of rainfall in Ceylon is presented in the form of three maps published by the Department of Meteorology. These are: (1) the annual average (2) the average Southwest Monsoonal rainfall (i.e. the five-monthly period May-September), and (3) the average rainfall of the five monthly period October to February. These maps are published on a scale of 24 miles to the inch, and refer to the period 1911-1940. Recently a similar set of maps has been prepared for the period 1931-1960, and await publication. A comparison of the two sets of maps has been made by De Mel (4).

In order to rectify some of the errors, fill in gaps in the record and obtain a consistent set of data, Walker (11), for the first time in Ceylon, applied the method of double-mass analysis to the data of about 300 selected stations for the fifty-year period 1907-1956. The adjustment of data by the method of double-mass analysis, is a standard statistical procedure used with certain kinds of data, and it serves to rectify certain types of errors and inconsistencies, (7, 8).

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On the basis of the adjusted values, Walker presented isohyetal maps of mean monthly rainfall, mean rainfall for the five-month period May-September, mean rainfall for the three-month period December-February, and mean annual rainfall. These are all for the period 1907-1956, and the maps are on a scale of 8 miles to one inch.

In the book, "Hydrometeorology of Ceylon" Walker presents the adjusted values of monthly rainfall for the fifty-year period 1907-1956, for 318 selected stations. It is mentioned that as of 1956 only 167 stations had continuous records of 50 or more years. For about 150 stations, therefore, a fifty year record was "constructed" by extrapolation.

A comparison of the original observed values with the adjusted values reveals a rather disconcerting situation. It is seen that there are many large adjustments even in the data of the twenty meteorological stations. As mentioned earlier, the observed values at the meteorological stations can be regarded as correct; and the error, if any, would certainly not exceed one inch, for the monthly values. In Table 1, are given some pairs of values, indicating the large differences between observed and adjusted values, for the rainfall at Colombo Observatory. It is seen from Table 1, that the difference between adjusted and original values is highly variable, both in magnitude and direction. In some cases the adjusted value is five times (500 per cent.) higher than the original value. In one case, the adjusted value is 13 inches less and in another 13 inches more than the original.

There is neither comment nor explanation regarding these differences, which are indeed unbelievably large. It is stated however, that raingauging stations were grouped into three rainfall regimen zones (designated as Southwest Monsoon, Northeast Monsoon and Mixed Monsoon Zones) for the purpose of double-mass analysis and associated computations. The records of each station were tested against the group means of its particular regimen zone. The records of a meteorological station are also tested against the group means computed by the pooling together of its own record with data from a large number of stations with less reliable records. Thus no allowance was made for the very high reliability of the meteorological stations' data on the one hand, and the (often-times) less reliable data from the several hundred stations, on the other hand. The non-recognition of this simple yet important fact has unfortunately reduced the value of the double-mass analysis made by Walker. The grouping into only three rainfall regimen zones is also inadequate. In view of these

comments, the maps published by Walker should also be used with a certain amount of caution. The twelve monthly maps are very valuable however, because they are the only such maps available, on a large scale.

Apart from the maps of the Department of Meteorology and those of Walker, certain other rainfall maps have also appeared in some publications (5.10), but on very small map scales (smaller than 1: Two Million) and show very few isohyets.

PROPOSALS FOR NEW MAPS AND NEW STUDIES

Seven suggestions are made here with a view to improving the quality of rainfall information available in Ceylon.

1. Since the only monthly rainfall maps published are those of Walker, it would be desirable to publish a set of maps on unadjusted data:

2. Thambyapillay (10) has shown that the yearly rainfall can be distinguished into four rainfall seasons:

March—April

May—September

October—November

December—February

An examination of Walker's monthly rainfall maps also shows that the regional distribution of rainfall in the months within each group, is very similar. Therefore it would be very desirable to prepare rainfall maps for each of the four rainfall seasons. This is essential for demarcating the various rainfall regimen zones of the island.

3. An important decision that has to be made in the preparation of the above maps, is the period of record which should be considered for computing averages. Several factors influence the decision:

- (a) The fact that an average taken over a longer period would be better than one taken over a shorter period.
- (b) The fact that the earlier records are less reliable and have more gaps than the more recent.
- (c) The fact that there would be more raingauging stations with complete records, if a more recent short period is chosen, than for a longer period going back to an earlier date.
- (d) Secular changes in rainfall that may have occurred, if such changes are clearly evident.

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It will be seen that any decision made would be compromise between conflicting requirements.

A well considered decision should therefore be made. Tentatively, it is suggested that the fifty-year period 1920-1970 be taken for computing averages. For this period, about 250 stations would be available with complete records.

4. Map scale is another important consideration in the above work. It is suggested that most of the publications be on the scale of 1 : One Million.

5. A proper double-mass analysis of all the data is also very essential, in order to prepare accurate maps. For this work it is suggested that initially, the meteorological station records be accepted as standard. Every other station should be tested against the nearest meteorological station in the same rainfall regimen zone. Afterwards, group means could be computed and a second stage double-mass analysis made. A two step analysis of this kind would ensure a consistent set of data without over-adjustment of meteorological station records. Furthermore, the grouping into rainfall regimen zones must be made in a more detailed manner, such as described in the next section of this paper.

6. The practice in the past has been to present the picture of long term of rainfall records, in terms of the arithmetic mean ; the assumption being that this statistic is a suitable measure of central tendency. For annual values this assumption is quite valid, but for most monthly values it is not so. Furthermore the mean is influenced by extreme values, and thus the inclusion or exclusion of certain particular years of very high or very low rainfall, can cause a large shift in the mean value. For these reasons, the median and other percentile values would be more useful statistics, particularly in agriculture. Farmer (6) expressed the same view with regard to Ceylon rainfall as early as 1953. Percentile values have the advantage that they are not influenced by extreme values, and secondly they give a measure of precipitation probability. The later information is exceedingly useful, and indeed necessary in agricultural work. The disadvantages of percentiles values are : (1) they do not lend themselves to algebraic manipulation, and 2) they are unreliable for short period records. The latter reason is not of much importance in Ceylon, since most rain-gauging stations have records for several decades.

The Division of Agroclimatology of the Department of Agriculture has now compiled tables of the 10, 25, 50, 75 and 90 percentile-values, as well as tables indicating the chances of receiving rainfall equal to, or greater than 1, 3, 5, 7, 10, 15 and 20 inches, for each month of the year, for seventy raingauging stations in Ceylon. These tables are available in mimeograph form. Based on these tables, twelve rainfall maps have also been prepared on a scale of 8 miles to the inch, showing the median rainfall in the twelve months. In due course it is proposed to publish both the tables and the maps.

7. Lastly, it would be useful to compute precipitation probabilities by fitting a mathematical distribution to the data. In the first place, this should be done for monthly values and later for shorter periods such as a week. Alles (1) has shown that for most months, rainfall values show a non-normal, positively skewed distribution. The theoretical distribution which is used should therefore contain a skewness factor in its function, or else the data must be appropriately transformed to give a transformed variate which is normally distributed.

RAINFALL REGIMEN ZONES

The rainfall regimen zone map has been prepared in order to present a general picture of regional rainfall in Ceylon, which would be useful in agricultural work. The map would also be a useful guide for the purpose of double-mass analysis, suggested in this paper.

In spite of the small area of the Island, there is a wide variation in the annual amount and monthly distribution of rainfall. The average annual rainfall varies from about 35 inches (Yala) to about 225 inches (Kenilworth Estate, Ginigathhena). It has been customary to distinguish two regions in Ceylon, namely the Wet Zone and the Dry Zone. Geography text books on Ceylon (2,5) have long regarded the 75 inch average annual isohyet as the demarcation between the two zones, and this concept has become firmly fixed in the popular mind. However, on a spectrum of world rainfall, an annual isohyet of 75 inches would hardly be a valid criterion to demarcate a "dry" zone. However, the suitability of the term becomes evident when the monthly rainfall values are considered. At typical Dry Zone stations, the average rainfall during May, June, July, August and September, is less than three inches in each month, while in many cases it is less than one inch. In contrast, the same stations record about seven inches

or more in the months of October, November and December, while typical Wet Zone Stations have an average rainfall of at least seven inches in almost every month in the nine-month period April to December. January, February and March are months of low rainfall (less than seven inches) all over the Island, except for parts of the Dry Zone which receive more than seven inches in the month of January.

The 75-inch average rainfall isohyet does not adequately demarcate the regions of very low rainfall in the five months May—September (Yala season) from the regions which receive much higher rainfall. In fact, the Wet Zone as demarcated by the 75-inch isohyet includes certain areas with over 100 inches of average annual rainfall, but with less than 10 inches in the yala season, and some areas with over 150 inches but less than 20 inches in yala. Thus if any single criterion of rainfall is used to demarcate the two zones, some isohyet pertaining to the May—September period would be more appropriate than an annual rainfall isohyet. Dassanayake (3) and Thambyapillay (10) have suggested the 20-inch isohyet of the May-September period. This demarcation is far more satisfactory than the earlier one, particularly for agricultural work.

But there still exists however, a considerable diversity in the amount and distribution of rainfall within each of the two zones, and these differences have much agricultural significance.

It would have been desirable to make the detailed demarcation of zones based on maps showing the rainfall during each of the rainfall seasons recognized by Thambyapillay (10). But since detailed maps are not available for all these four seasons, the available maps of the Department of Meteorology (1911—1940), and the March and April monthly maps of Walker (1907—1956), have been used in this study.

The 40-inch isohyet of the May—September period has been used as the demarcation between an Intermediate Zone and the Dry Zone. The 20-inch and 40-inch isohyets may not be the most satisfactory to distinguish the three main zones, but since published maps do not indicate any other isohyet in the range 11—39 inches, there is no other choice. It must be recognized also, that the terms wet, intermediate and dry, refer to rainfall conditions only, in this article. In a Climatic classification (which takes into account temperature and other climatic elements), the boundaries between the zones may well be different. The objective in this paper is merely to represent the general rainfall pattern of Ceylon in a quantitative manner, in a single map.

In Table II are given the characteristics of each of the 15 rainfall regimen zones.

SUMMARY

The nature of the raingauging network in Ceylon and of the published rainfall information is discussed, and several lines of work are suggested for improving the quality of the rainfall data.

A map of rainfall regimen zones is presented which would be useful in agricultural work, and in the double-mass analysis of rainfall data.

TABLE I.—Some pairs of values of Colombo Observatory Rainfall, showing large differences between the original, observed values and the adjusted values given by Walker

Year	Month	Rainfall Value in Inches	
		Observed	Adjusted
1929	January	6.61	2.85
1935	January	0.69	3.11
1909	February	0.80	3.53
1950	February	10.60	4.23
1941	March	0.77	4.26
1949	March	6.08	2.38
1934	April	17.04	9.86
1952	April	8.30	14.60
1953	April	25.87	12.09
1932	May	29.38	16.26
1940	May	11.30	24.00
1944	May	9.50	17.49
1951	May	22.00	13.08
1932	June	1.68	5.03
1945	June	15.24	8.76
1956	June	4.90	12.47

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TABLE II.—Amounts of Rainfall in Inches received in 15 Regimen Zones during the period stated below

Zone	Sub-zone	May-September	October-February	March-April	Annual
Dry	D ₁	10	20-40	5-15	35-65
	D ₂	10	40-60	5-10	50-75
	D ₃	10	40-60	15-35	65-100
	D ₄	8-20	60-80	10-20	75-120
	D ₅	10-20	80-120	10-25	100-150
	D ₆	10-20	40-60	5-20	50-100
	D ₇	10-20	20-40	10-20	50-75
Intermediate	I ₁	20-40	20-40	10-20	50-100
	I ₂	20-40	40-60	15-25	75-125
	I ₃	20-40	60-120	10-30	100-150
Wet	W ₁	40-80	40-100	10-20	100-170
	W ₂	40-80	40-80	10-20	90-150
	W ₃	40-80	20-40	10-20	75-125
	W ₄	>60	>60	20-30	150-200
	W ₅	>100	>60	25-35	>200

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