
CLIMATIC REGIONS OF CEYLON—I: ACCORDING TO THE KÖPPEN CLASSIFICATION

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INTRODUCTION

THE GREEKS must be credited with the earliest attempt to conceive of the concept of climate, as derived from the term *klima*, meaning "to incline". However, since then the term climate came to be used not in strict adherence to the original connotation but in respect of a wider significance. While "weather" may be vividly understood, in terms of the 'momentary state of the atmosphere', the term climate quite paradoxically must retain a sense of abstractness. It may be understood only in respect of time and space, involving also a composite idea. Numerous definitions have been suggested to lend clarity to the concept of climate. While in a broad sense, "the average state of the atmosphere" may denote climate, it is interesting to note that in the mid-nineteenth century work entitled *Kosmas*, "the term climate, taken in its general sense indicates all the changes in the atmosphere which sensibly affect our organs . . ." (Humboldt, 1844). By the beginning of the twentieth century the term is defined with more clarity, "by climate we mean the sum total of the meteorological phenomena that characterise the average condition of the atmosphere at any one place on the earth's surface . . . (it) is the sum total of the weather . . ." (Hann, 1903). Finally we may note the significance of the geographical aspect of climate "... climate has geographical extent; ... the interest of the geographer in climatology arises from the space variation and his system of climatic classifications are clumsy but effective ways of getting out of the difficulty of handling continuous variation in both time and space". (Hare, 1957.)

It must not be misunderstood that since considerations of climate involve some form of 'generalization', that it is of little value, since at no time will the weather of a place conform to the composite idea of climate. The Greeks in strict conformity to the original connotation of *klima* defined climatic 'regions' in respect of latitudinal

extent. Hence the three great qualitatively defined climatic regions of the world—the Torrid, the Temperate and the Frigid—were eventually conferred some quantitative demarcating criteria by Supan. Temperature being the only aspect considered, these ‘climatic regions’ were in effect only ‘temperature regions’. Subsequent attempts based on increasing observations of other climatic elements, particularly of temperature and precipitation, conceived of ‘climatic homologues’ or areas of similar climatic characteristics. As climatological statistics accumulated the geographer’s interest was focussed on the recognizance of climatic regions over the earth. The more refined attempts at climatic classifications being attempts at simplification and generalization of statistical meteorology came to be essentially geographic in technique. Since climate is reflected by the soil and climax vegetation of a place, it came to be realized that the economic consequences of climate would be expressed in respect of the agricultural potential of that place or ‘climatic region’. Thus climatic classifications came to be expressed in terms of statistical values defining climatic ‘regions’. A climatic classification *per se* while exemplifying refinements in the context of quantitative criteria, must nevertheless reflect qualitative characteristics as borne out by the biota complex of each climatic ‘region’. In view of the above considerations and since climate is closely related to the agricultural potential of Ceylon, it need hardly be emphasized that a satisfactory demarcation of the climatic regions and the idea is more than justified. However, the attempt will first be made to demarcate the island into climatic regions on the basis of existing world-wide climatic classifications, the most noteworthy being those by Köppen and Thornthwaite. Eventually a ‘new’ but tentative climatic classification will be suggested and the island demarcated into climatic ‘regions’.

THE KÖPPEN CLIMATIC CLASSIFICATION

The climatic classification devised by Wladimir Köppen, a St. Petersburg-trained biologist, may rightly be considered the earliest comprehensive scheme suggested for this purpose. It was a bold attempt to provide for the first time an objective, quantitatively-determined classification. Köppen must also be credited for demonstrating the then not sufficiently understood relationship between the biota complex and the climate of a particular environment. Thus his climatic boundaries, while quantitatively determined were not merely an expression of convenient arrangement of meteorological statistics, but in effect reflected remarkable correlation with vegetation boundaries. Hence it is not strange that the Köppen classification

shows strong resemblance to phytogeographical maps. One must also not forget that the Köppen classification is a unique attempt, to reduce the complex statistical data of meteorological elements, to a simple system of grouping, so that climatic regions on a world-wide basis may be represented by convenient yet easily remembered symbols. The objection, that the classification represents numerical complexity is not truly justified, in view of the tremendous amount of statistical data that have to be expressed in terms of symbols.

The Köppen classification as it appears today is far removed from his original scheme, envisaged in 1884 (Köppen, 1884). This classification based on temperature alone was however not much of an improvement upon the earlier Supan classification. Köppen recognized only three 'climates', namely:—

I. Tropical over 20° C : Mean annual temperature.

- (a) all 12 months, e.g. Batavia.
- (b) sub-tropical 4-11 months.

II. Temperature 10°-20° C : Mean annual temperature.

- (a) warm summers (Rome).
- (b) cold winters (Paris).
- (c) (Messina).

III. Polar below 10° C ; Mean annual temperature.

It is noteworthy that Köppen himself realized the shortcomings of his 'climatic regions' and thus continued to revise his scheme for over half a century. In the next revised scheme appearing at the turn of the century (Köppen, 1900), the moisture factor was introduced; this classification eventually appeared eighteen years later (Köppen, 1918). He also published (with Geiger), a wall map showing the world distribution of his climates. In the final form resembling that available today, Köppen's scheme appeared in *Grundriss der Klimakunde* (Köppen, 1931) and again in a more comprehensive form in the *Handbuch der Klimatologie* (Köppen and Geiger, 1936). Fully comprehensive representations of the classification appear in a number of English publications (James, 1943; Hauritz and Austin, 1944).

In the late nineteenth century there appeared an outstanding work dealing with a world-wide classification of vegetation (de Candolle,

1875), on a physiological basis. De Candolle recognized five major plant groups and designated them :—

- A. Megatherms—high temperature and abundant moisture ;
- B. Xerophytes—short hot season, tolerance of dryness ;
- C. Mesotherms—moderate heat and moderate moisture ;
- D. Microtherms—less heat and moisture ; tolerance of shorter summers and colder winters ;
- E. Hekistotherms—polar zone beyond forest limits.

Köppen adopted the de Candolle scheme as the basis for his climatic classification, bearing in mind the pytogeographical role of climate. He provided quantitative criteria of temperature and moisture to define the boundaries introducing both the mean annual and the mean seasonal values. Thus, to briefly outline the Köppen classification :—

- A. Rainy climates (Megathermal)—temperature of coldest month over 18°C (64.4°F) ; no winters (cool or cold season).
- B. Dry climates (Xerophytic)—arid or semi-arid ; the distinction of this climate is in terms of 'precipitation effectiveness' which is determined by the use of formulae.
- C. Humid climates (Mesothermal) with mild winters—temperature of coldest month less than 64.4°F , but warmer than 26.6°F (-3°C) ; warmest month above 50°F (10°C) ; short winters.
- D. Humid climates (Microthermal) with severe winters—temperature of warmest month above 50°F , coldest month below 26.6°F ; severe long winter ; ground frozen for several months.
- E. Polar climates (Hekistothermal)—no warm season ; warmest month temperature below 50°F .

These major climates are further sub-divided in terms of specific precipitation and temperature characteristics ; combinations of the various symbols designate climatic types. The merit of this classification is in its scientific character ; the use of distinctive quantitative criteria of climatic elements ; the use not only of average annuals, but also of seasonal considerations ; the use of vegetation as a basis for the choice of the climatic values ; the use of symbols to designate,

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simplify and effectively, the innumerable climatic types—a minimum of two and a maximum of four symbols for the designation of any climatic type. The modifications that were introduced are not to discredit the classification but to lend it more refinement, in terms of increasing data and verification of the limiting boundaries.

Only the A, B and C climates will be considered here, since the D and E climates do not occur in Ceylon. While the A and C climates occur in Ceylon, the B climate will also be discussed because 'dryness' is an important consideration in the Island's climate.

The A climates are sub-divided on precipitation considerations :

f : precipitation of driest month is at least 2.4 inches (6 cm.);

m : short dry season exists but is compensated by heavy precipitation during the rest of the year ;

w : dry season exists, which is not compensated during the rest of the year ; dry season comes during the low-sun period of the hemisphere ;

w' : used if the precipitation maximum is in the autumn of hemisphere ;

w'' : used if there are two distinct maxima of precipitation separated by two dry seasons ;

s : used when dry season comes during the high-sun period.

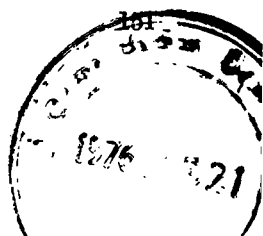
It must be noted that the distinction between m and w (w', w'' and s) is made on the quantitative relationship between the precipitation of the driest month and the average annual precipitation. This involves a 'compensation' principle and is derived from the equation :—

$$Am : r_{dm} = 3.9 - R/25.$$

where r_{dm} = precipitation of the driest month.

R = average annual precipitation.

To facilitate a simpler means of determining the assignment of Am or Aw, a special table based on the formula has been prepared by Kendall and is shown in Table V. It is thus seen from the table that a station with a driest month precipitation of zero (0) would be assigned the 'm' characteristic provided the average annual precipitation is at least 98.5 inches. Correspondingly the w characteristic



will be assigned if the compensation values are not fulfilled. A diagram has been prepared for this purpose (Fig. I).

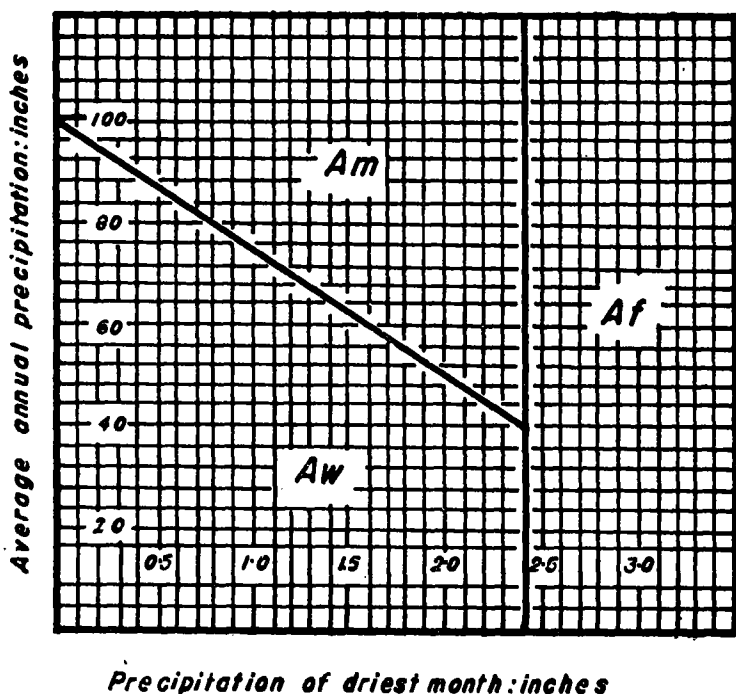


Fig. 1. Diagrammatic representation to illustrate the principle of compensation involved in the designation of the characteristics Af, Am and Aw according to the Köppen classification.

Further tertiary criteria have been provided in respect of the temperature factor. Thus:—

- i=range of mean annual temperature less than 9°F;
- g=hottest month comes before the solstice.

THE C CLIMATES

In similar form the C climates may be assigned secondary characteristics in respect of precipitation and temperature. Thus:—

- f: no dry season; precipitation difference between driest and wettest months, less than that required for s or w; if winter rain and summer drought, driest summer month receives more than 1.2 inches (3 cm.);
- s: dry season in summer; rainiest month of winter receives at least three times as much as driest month in summer; driest summer month has less than 1.2 inches;

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- w: dry season in winter; rainiest summer month receives ten times as much as in driest winter month;
- a: hot summers; temperature of warmest month over 71.6°F (22°C);
- b: cool summers; temperature of warmest month below 71.6°F ;
- c: cool, short summers; only 1-3 months above 50°F ;
- i: temperature range (annual) less than 9°F ;
- x: maximum rainfall in spring or early summer;
- s': maximum rainfall in autumn;
- n: frequent fogs.

It will be noticed that in both the A and C climates, the primary climatic assignment is based on temperature, while the secondary characteristics are based on precipitation; the tertiary characteristics are again based on temperature values. It must further be pointed out that the same secondary letter f assigned to the A and C climates, while being similar qualitatively differs quantitatively. The driest month precipitation in respect of f in A climate is 2.4 inches, while the corresponding value for f in the C climate is only 1.2 inches, i.e. half the value under A climate. This could be explained in terms of "effectiveness" of precipitation. Thus the lower mean and seasonal temperatures of the C climate permits of lower precipitation to be "effective", since evaporation is less than in the A climate. Similarly in respect of the distinction of the primary climatic criteria the guiding principle is that of "temperative efficiency" for vegetation.

THE B CLIMATES

The B climate stands out distinctly from the rest of the Köppen climates. It may be noted that the A, C, D and E are in effect 'humid' climates. In other words, their primary characteristics are based on "temperature efficiency", while the B climate is primarily defined on the basis of precipitation. Thus the designation 'Dry Climate' with the vegetation complex being xerophytic. Hence the first step in assigning the Köppen climatic classification is to determine whether the station concerned exhibits characteristics of the Humid climates or the Dry climate. In view of the seasonal nature of precipitation incidence which thereby affect the "effectiveness" of precipitation three formulae are available. The B climate is again demarcated into the Dry or Semi-Arid (BS) and the Arid (BW) types. Thus the formulae are assigned under two bases, namely BS/H, i.e., Dry or

Humid and BW/BS, i.e., Arid or Semi-Arid. Thus if a station does not fulfil the criteria to be designated under the Humid climates, it is further analysed for assignment into the Arid (Desert) or the Semi-Arid (Steppe) climates (BW/BS) criteria.

In its original form the formulae were as follows:—

	BS/H	BW/BS
(a) Precipitation chiefly in summer ..	$r = 2(t+14)$	$r' = t+14$
(b) Precipitation evenly distributed ..	$r = 2(t+7)$	$r' = t+7$
(c) Precipitation chiefly in winter ..	$r = 2t$	$r' = t$

r : annual average precipitation in centimeters.

t : mean annual temperature in °C.

The characteristics "chiefly in summer" and "chiefly in winter" denote a 70 per cent. incidence during the respective seasons.

The application of these formulae in terms of inches and °F have been made possible by consulting a special table prepared by Kendall (Tables VI and VII) based on the corresponding formulae devised by Meyer. Thus:—

	BS/H	BW/BS
(a) Precipitation chiefly in summer	$r : .44 (t-7)$	$r' : .22 (t-7)$
(b) Precipitation evenly distributed	$r : .44 (t-19.5)$	$r' : .22 (t-19.5)$
(c) Precipitation chiefly in winter	$r : .44 (t-32)$	$r' : .22 (t-32)$

r = annual average precipitation in inches.

t = mean annual temperature in °F.

Two tertiary criteria are also available in respect of temperature distinctions, namely:—

h =hot desert or steppe: mean annual temperature 65°F.

k =cool desert or steppe: mean annual temperature 65°F.

Once again it is possible to note that the refinements of "precipitation effectiveness" and "temperature efficiency" are implied in the climatic criteria considered here. The characteristics 's' and 'w' may also be applied in respect of summer and winter 'dry season', respectively.

It is to Köppen's credit that despite numerous criticisms levelled at his classification, it continues to retain its position as a scheme that is studied and applied over and over again. Nevertheless this is not to discredit the many valid shortcomings pointed out by a number of climatologists. During his lifetime Köppen continued to modify and add refinements to his classification, in the light of more data and

shortcomings revealed in the application of his system. There have been very valuable 'criticisms' in respect of the criteria of the demarcating boundaries of particularly the C/D climates and regional assignments of the BS/BW climates. Many of these are in effect 'refinements' adding to the value of Köppen's classification. It must be remembered that Köppen undertook to provide a climate classification of world-wide applicability. In this aspect alone one should expect inherent shortcomings that are inevitable. His task involved the reduction of a mass of climatic data to assimilable form so as to be represented by simple yet effective symbols. Though he did adopt de Candolle's vegetation classification as a base, yet he eventually provided substantive qualitative criteria to designate climatic types. These seemingly arbitrary values have on the whole proved to concord with the biota expression of climate. Köppen in selecting the physiological classification of de Candolle for his climatic base, departed from the approach of the ecologists, who were rather concerned with plant associations. During the period that Köppen revised his original 1884 classification he did have available a physiognomic classification of vegetation (Schimper, 1894) which however appeared almost two decades after de Candolle's classification. As pointed out by the most eminent of Köppen's critic (Thorntwaite, 1943) it was a pity that Köppen chose the physiologic in preference to the physiognomic classification. Though Köppen did not specifically use the terms, "temperature efficiency" and "precipitation effectiveness", yet throughout his classification this theme is dominant. Perhaps of all the merits the two outstanding ones are (a) the objective perspective of his classification whereby climatic regions may be defined in exact quantitative terms and (b) the use of widely available climatic data of temperature and precipitation, which in manifold forms, may be used to define climatic boundaries. The primary, secondary and tertiary characteristics that have been used to designate climatic types, represent in their hierarchy of orders a remarkable. The hierarchy exemplified by the primary, secondary and tertiary characteristics of the Köppen classification represent in remarkable form, a symbolic description of the climates of the earth.

THE CLIMATES OF CEYLON ACCORDING TO KÖPPEN

The Available Data

While reliable precipitation data are readily available for a large number of rain-gauge stations in Ceylon, temperature data are confined to only sixteen (16) meteorological stations (*Figure 2; Table I*). It was found that in respect of precipitation records

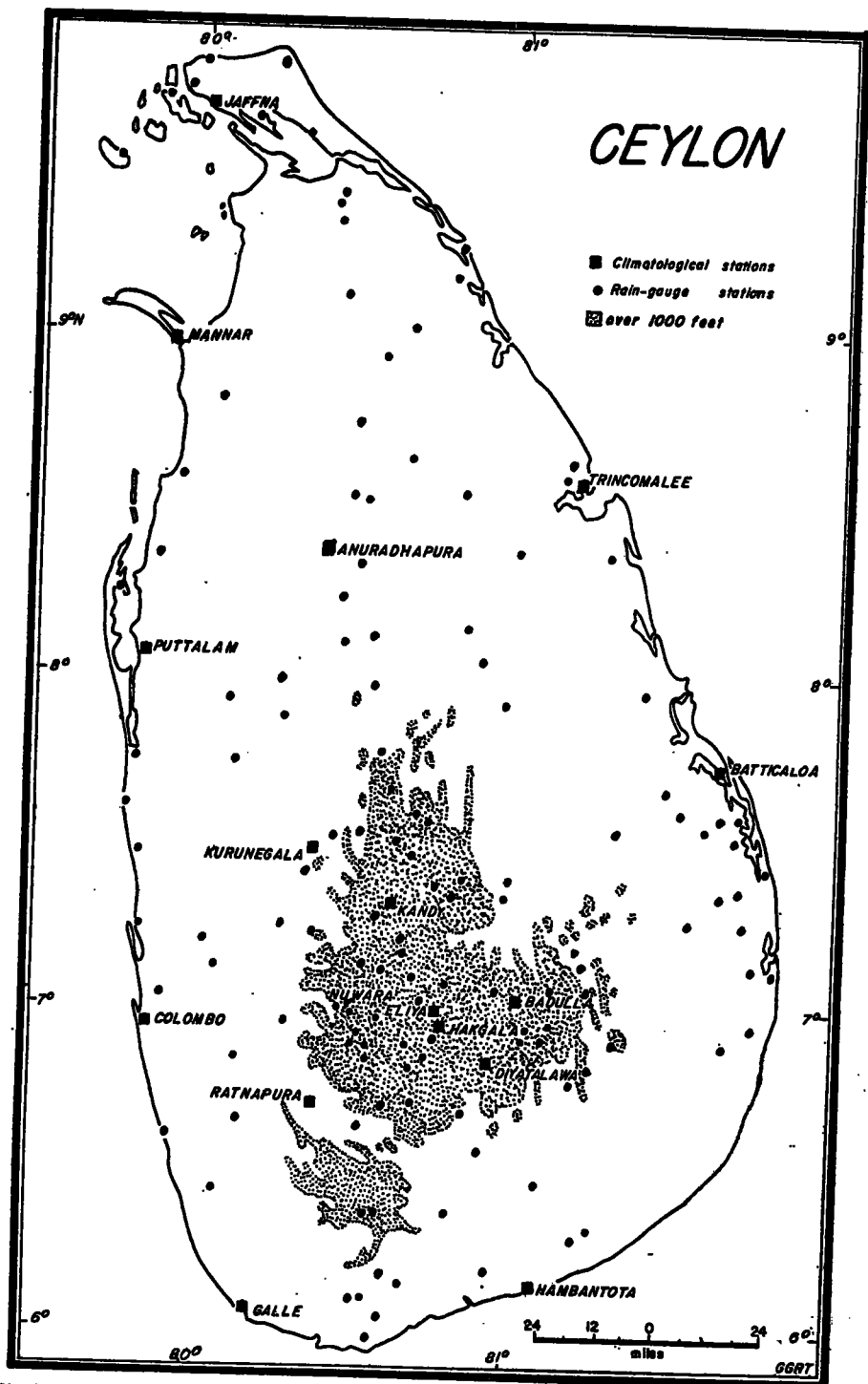


Fig. 2. Map to indicate the location of the main meteorological stations and the rain-gauge stations whose records have been consulted in the application of the Köppen classification to Ceylon.

covering the climatological Standard Period (1911-1940) for Ceylon, there are 177 rain-gauge stations (*Tables II, III and IV*) whose values could be used in this study. The derivation of temperature values for these stations was made possible by the construction of a temperature-elevation ratio chart (Thambyahpillay, 1955). It has also been demonstrated elsewhere that the 4000-foot contour represents a critical vegetation boundary (Thambyahpillay, 1952), demarcating the montane forest zone from the lowland forest zone. It was thus possible to determine carefully the temperature values of those stations located above 4,000 feet.

The B Climates of Ceylon (*Fig. 3 : Table III*)

The B climates may be considered first since (as brought out earlier) a strong distinction may be made between the Humid (H) and the Dry (BS/BW) climates. Köppen's formulae were applied to the precipitation records of all the stations located in the so-called Dry and Arid zones of the island. None of the stations however was found to qualify to be designated even the BS, i.e., semi-arid or steppe climatic type. Thus taking into consideration Mannar with reliable temperature and precipitation data, it may be noted that of the average annual precipitation of 39.74 inches, as much as 32.0 inches occur during the 'winter' of the northern hemisphere. Applying the corresponding formula, i.e., the BS/H 'chiefly in winter'

$$39.74 = .44 (82.1 - 32)$$

it is seen that Mannar must be assigned to the Humid climates! Only two other stations record precipitation lower than that of Mannar; Silavaturai (37.50 inches) and Marichchukaddi (37.90 inches) both located in the Mannar environment. Though these stations do not record temperature it may be safely surmised that their temperature values will not be less than 80.0°F. Applying the corresponding formulae these stations will enjoy features of the humid climates. This aspect will be discussed at a later stage when considering the 'modifications' of the Köppen climate for Ceylon.

The C Climates of Ceylon (*Fig. 3 : Table IV*)

The C climatic regions may be considered next, since they constitute only small areas in the island. In strict conformity with station designations only two stations (Nuwara Eliya and Hakgala) would exhibit characteristics of the C climate. However, computed temperature values for stations over 4,000 feet seem to suggest a coincidence between the 5,000 foot contour and the C climate boundary. It is thus seen that in Ceylon (*Fig. 3*) the C climate would include the north-south trending Pidurutalagala-Horton Plains ridge and the western (up to Adam's Peak) and the eastern (up to and

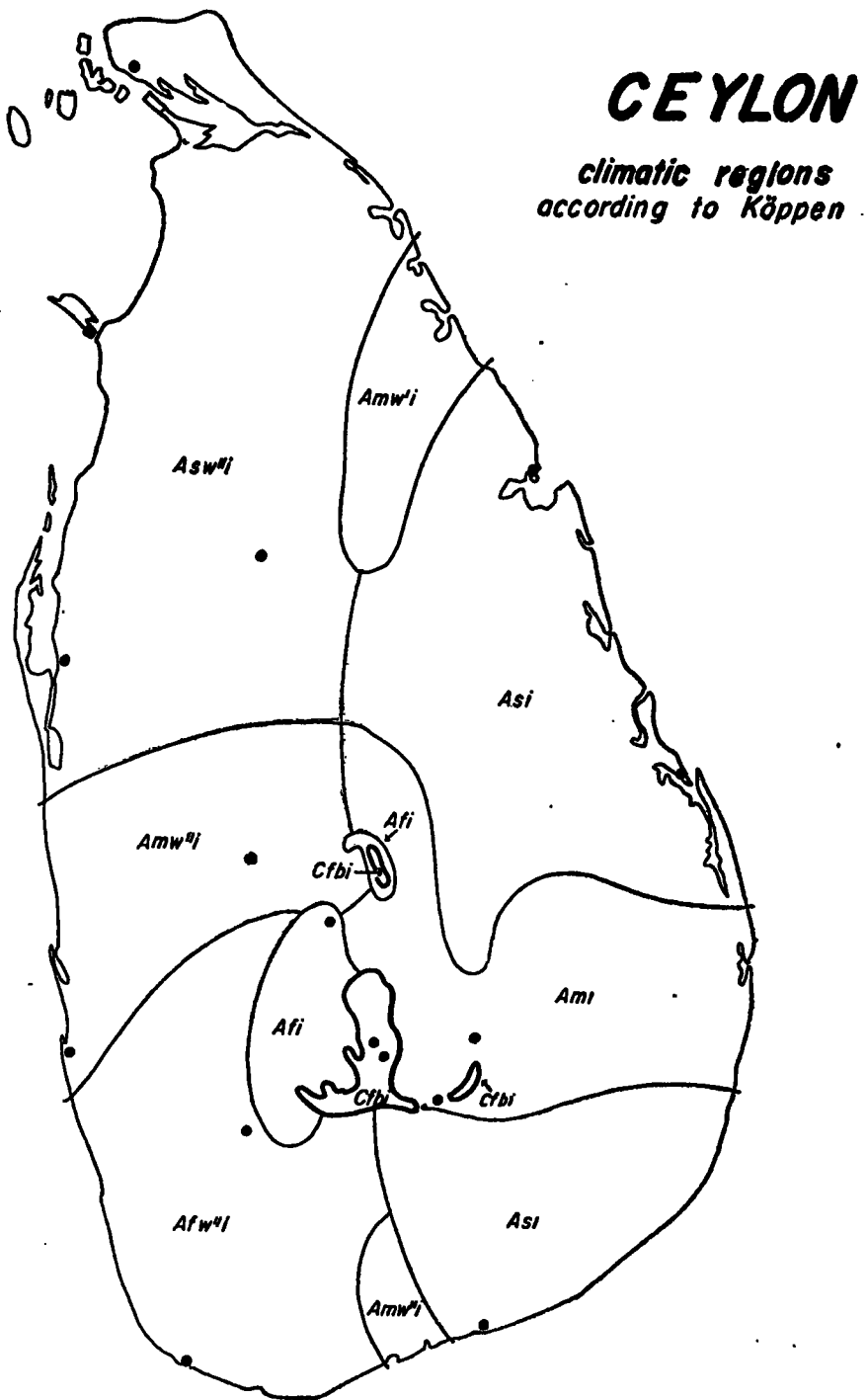


Fig. 3. Map showing the climatic regions of Ceylon based on the original (1936) classification of Köppen.

including the Namunukula Range) extensions bordering the Southern Mountain Wall. The stations, Diyatalawa and Badulla, are thus excluded, since their temperatures exceed the stipulated coldest-month-value of 64.4°F. The Knuckles Range, of over 5,000 feet, would also be included under the C climate. The climatic regions would be designated Humid Mesothermal, since the stations Nuwara Eliya and Hakgala would qualify to be Cfb in their characteristics. There is no 'dry' season (i.e., f) since no month receives less than 1.2 inches and summers are 'cool' since warmest-month-temperatures do not exceed 71.6°F. Both stations exhibit the tertiary 'i' characteristic, the mean annual temperature range not exceeding 9°F. The main vegetation associations correspond to the montane forest type.

The A Climates of Ceylon (*Fig. 3: Table II*)

The rest of the island, therefore, would reflect the A climate characteristics. But in view of the marked seasonability of precipitation incidence in Ceylon, the A climate would be exemplified in terms of distinct 'regions'. At the outset it may be pointed out that all the stations exhibit 'isothermal' characteristics, i.e., the mean annual temperature range nowhere exceeds 9°F.

A strict application of the Köppen criteria reveals the interesting fact that eight (8) 'types' and thirteen (13) 'regions' may be recognised under the category of the A climate:—

(i) The Afi climatic region. Two regions may be recognized :

(a) This region is confined to an area immediately to the west of the Cfb region and the characteristics are clearly evident in the data pertaining to twelve stations, each of them with a driest month precipitation of not less than 2.4 inches. Most of the stations receive average annual precipitation of over 100 inches, with Watawala (218.5 inches) and Padupola (206.6 inches) representing the type stations. All stations reflect the single maximum during 'summer', i.e., southwest monsoon period; the precipitation during this period constitute 40 to 60 per cent of the average annual value. The typical vegetation is the Tropical Rainy Forest. This area in fact forms the western flanks of the central Highlands and includes the Hatton plateau.

(b) This region forms the eastern counterpart of the Watawala-Hatton-Kandy-Pelmadulla climatic region. It exhibits a similar 'regime' pattern except for the opposite-seasonal feature; the single maximum occurs during the 'winter', i.e., north-east monsoon period,

the precipitation during this period amounting to over 75 per cent of the average annual value. St. Martin's (Rangala) represents the type station which receives 83 per cent of its annual total precipitation of 173.4 inches during the 'winter' season. The driest month receives 4.0 inches.

(ii) **Afw "i climatic region.** This covers the whole of the south-west quadrant of the island except for the small Afi zone, mentioned before and the extension of the Cfbi zone. Heavy precipitation of over 90-200 inches occur annually, while the main contribution is from the SW Monsoon (May to September) 'summer' rains—over 40 per cent of the total; the rest is divided equally between the NE Monsoon and the convectional rains. The stations exhibit double maxima, the 'peaks' of precipitation occurring about April-June and October-November; while the contribution of the SW Monsoon is not to be neglected during the earlier 'peak', the effect of the convectional circulation during the near-equinoctial period is clearly in evidence. Galle, Ratnapura and other stations (*Table II*), though situated at varying distances from the coast, reflect the 'double maxima'. The vegetation, though still of the Tropical Rainy type, has marked differences from that in Afi.

(iii) **Amw "i climatic region.** There are two distinctive areas:

(a) The first is a fairly large area, lying north of the Afw "i zone; its northward extension reflects the decreasing precipitation in that direction from the south-west. The annual precipitation is from 60-90 inches and the tendency for lower amounts during the SW Monsoon period and markedly higher amounts during the other months has increased; the double-maxima characteristic still prevails. The vegetation begins to include occasional deciduous trees among the evergreens; toward the northern border, this tendency increases.

(b) The second region is a small area located between the Afw "i and the Asi region to the east. The only available station is Udukiriwila (*Table II*) and a northerly elongated region may be recognised with an average annual precipitation of between 50 and 75 inches. In effect this region forms almost a true boundary, separating the SW Monsoonal from the NE Monsoonal precipitation incident regions. In other words it demarcates the region with a westerly 'aspect' from that with an easterly 'aspect' (Asi region).

(iv) **Asw "i climatic region.** The entire western part of the northern half of the island comes within this zone. The precipitation is low (35-60 inches), a slight double maxima; with one of the dry seasons

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more marked than the other prevail ; the two rain 'peaks' are due to the convectional and the NE Monsoon (the latter in the 'winter' season). The vegetation is characteristically deciduous, with the evergreens almost entirely absent ; in the north-west some xerophytic features prevail. Around Mannar and the central part of the Jaffna peninsula, only xerophytic vegetation occurs ; however, this is due perhaps more to edaphic factors (the underlying limestone) rather than to the climatic features. Reference will be made to this aspect at a later stage.

(v) Asi climatic region. There are two regions :

(a) The eastern half of the northern lowland has a slightly different climatic type from the western half (Aw "si), mainly reflected by the single maximum rain 'peak' in 'winter' ; this of course is due to the strong NE Monsoon dominancy (50-60 per cent of the average annual precipitation of slightly over 60 inches). The 'dry season' rainfall is less marked than in the Aw "si zone and the vegetation as a result does not reflect xerophytic characteristics to the degree shown in the western zone. Deciduous forest type prevails with occasional evergreens.

(b) A region around the Hambantota-Yala-Southern Platform (eastern part) exhibits climatic characteristics to warrant its being assigned to the Asi region ; low precipitation (average annual is just over 40 inches), and dry seasons during the high-sun period. However, to assign it to a similar climatic zone as that of the eastern part of northern lowland seems unjustified ; the marked 'winter' rains in the Trincomalee-Batticaloa zone and the dry seasons are significantly absent. But, in terms of the climatic classification adopted here, it has no other assignable type. The rainfall in this zone is comparable to that of the Aw "si zone (43 inches) but it lacks the w" character ; its vegetational type (xerophytic tendency) is also comparable.

(vi) Ami climatic region. In somewhat counterpart relationship to that of the Amw "i is this zone ; covering a larger area, and extending west from the coast including the Uva Basin and the Dumbara Valley. This region reflects the effect of the NE Monsoon 'winter' rain dominancy as opposed to the SW monsoon 'summer' dominancy in the Amw "i region. The total precipitation, however, is smaller because of the lesser moisture carrying capacity of the NE Monsoon, while the strong SW Monsoon as it spills over the Central Ridge is a dry wind which warms adiabatically in its descent to blow over this

area as a fahn type wind and termed the *Kâchchân* (Thambyapillay, 1958). The vegetation exhibits more deciduous trees while the evergreens occur sparingly; the 'dry' season from June to August, which comes during the high-sun period of the hemisphere, becomes marked enough to acquire a clear distinction.

(vii) **The Amw 'i climatic region.** In the north-eastern part of the island may be recognized a climatic region reflecting unique characteristics. This region extending from the coast (north of Trincomalee and including the Mullaitivu-Pulmodai environment) southwards in an elongated form separates the Asw 'i from the Asi region. The stations located in this region (Mullaitivi, Kanukkeni, Nedunkeni and Horowupotana) reflect strong monsoonal precipitation compensation, but derived particularly from the periodical incursions of tropical cyclones and 'disturbances'. In most years these stations have received nearly 40 per cent of their average annual precipitation from 'storms' occurring during the period October to December. However, on the average the precipitation regimes reveal an autumnal 'peak' and hence the assignment of the w' characteristics.

SUGGESTIONS FOR A MODIFIED KÖPPEN CLASSIFICATION WITH SPECIAL REFERENCE TO ITS APPLICATION TO CEYLON

In the attempt in applying the Köppen classification to Ceylon it was observed that certain shortcomings were inherent in the quantitative criteria designating climatic types. While three major modifications may be suggested, a number of minor 'refinements' have also been incorporated and the results shown in Figure 4.

A/C boundary. First, with regards to the A/C boundary; there is no doubt that montane vegetation in tropical latitudes exhibits features distinct from lowland Rainy Forest types, the former reflecting the effect of lower temperature. The 'below 64.4°F. coldest month temperature' represents the Köppen criterion for distinguishing the A/C boundary. According to the Oxford School of Forestry Studies, 70°F (average annual) seems to accord remarkably with the zone of contact between the 'montane' and the 'lowland' forest types. Other studies too have substantiated this temperature-vegetation relationship. Of course, the seasonal temperatures also should be taken into consideration, in suggesting new criteria to designate the climatic boundary between the montane and lowland vegetation, in the tropical latitudes. A case in point was revealed during the application of the Köppen criteria to Ceylon. Certain vegetation zones in the highland area,

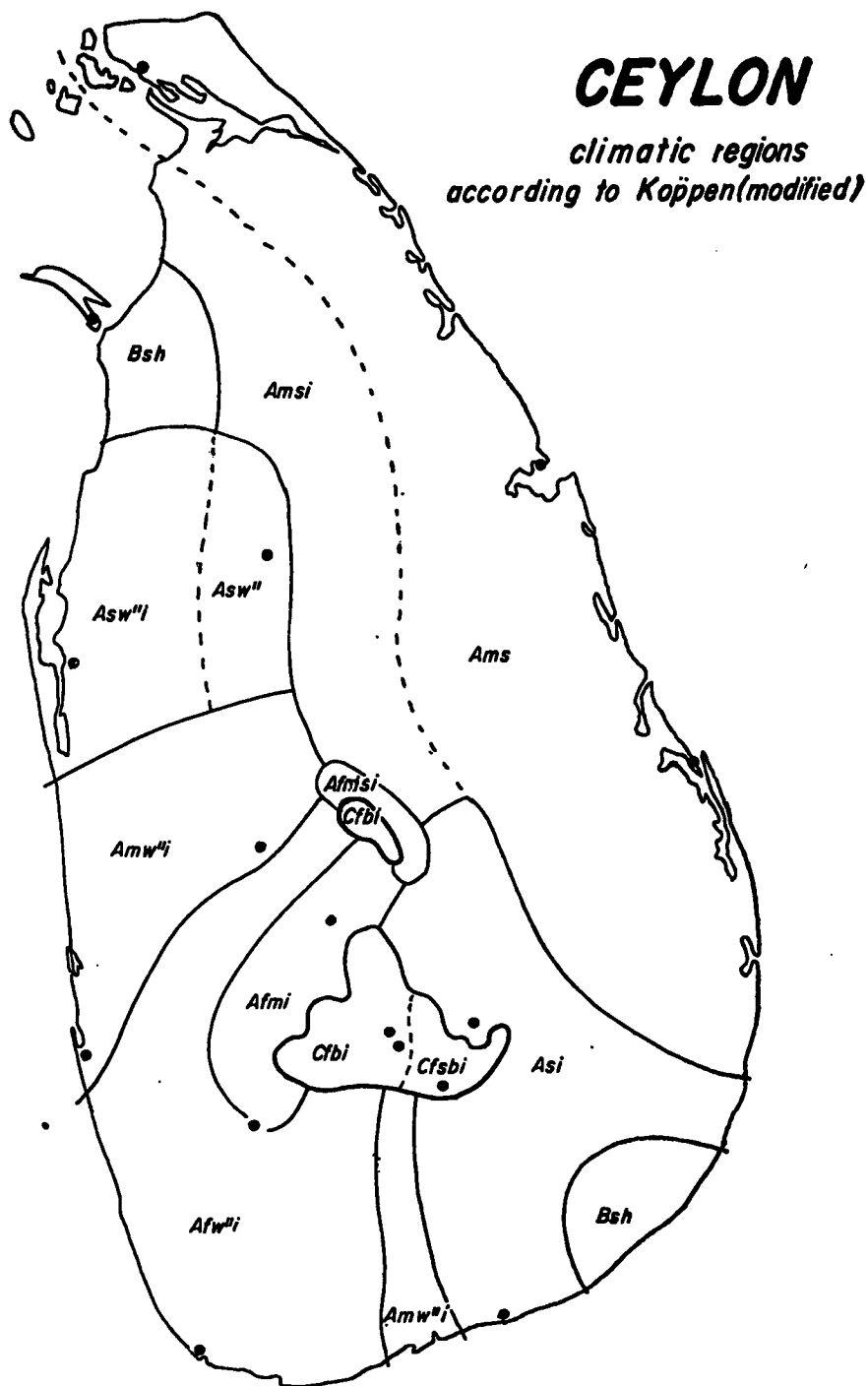


Fig. 4. Map showing the climatic regions of Ceylon according to the suggested modifications of the Köppen classification.

according to Köppen, fall under the A climates (Fig. 3) because no month exhibits less than 64.4°F , though the vegetation is of the montane type. Diyatalawa has an annual average temperature of 68°F , with three months below 66°F and one month with 64.4°F . Only three months' record over 70.4°F . The lack of more temperature records in the highland zone makes it difficult to compare this isotherm with other stations; however, by a process of 'interpolation' the 3,000 foot contour seems to coincide satisfactorily with the 70°F isotherm, as well as with the contact zone between the montane and lowland vegetation. According to the 64.4°F criterion, only areas above 6,000 feet can be categorized as C climatic types. Thus in modified form a larger area (including parts of the Hatton plateau and the Knuckles Range area) would be included under the C climate.

The Am/Aw boundary. A second modification suggested is that the Monsoon regimes in the tropical latitudes, especially in South-east Asia, have a strong 'opposite-seasonal' orientation. The Am/Aw boundary criterion needs modification, as the compensatory values (Table V) does not prove satisfactory. The adoption of 'effective precipitation' criteria would prove more satisfactory. Many of the stations with a high incidence of 'Monsoon tendency' (contributing 40 to 60 per cent of the total precipitation) on the Köppen compensatory criterion, fall under the Aw climatic type. There must also be a method of indicating the dominant 'Monsoon season'. The only possibility of so doing under the present basis is in terms of the 'dry' season during the 'low-sun' period of the particular hemisphere. In the equatorial latitudes, the 'low-sun' period has little significance with regards to the Köppen climatic consideration.

The Bsh climatic region (Table III). It was brought out earlier that no part of Ceylon could be considered 'Arid' or even Semi-Arid (BS) by the Köppen standards. But from the standpoint of the vegetation climax in the Mannar zone and the area east of Hambantota it is clear that these two regions do exemplify at least the semi-arid (BS) climatic characteristics. It may be suggested that it is the limestone basement in the north-western part of Ceylon that is responsible for the thorny scrub-xerophytic vegetation associations. However, this does not seem to be an entirely valid argument since the vegetation climax of the area east of Hambantota is not the expression of an underlying limestone base. It may be remembered that these two areas are also known popularly as the 'Arid' zones, in view of the

low average annual precipitation. The vegetation climax of these regions therefore warrant the designation BShs; the last two characteristics indicate that the average annual temperature is over 64.4°F and the 'rainy' season comes during the 'winter' of the hemisphere.

In terms of Ceylon, therefore, minor modifications to the Köppen classification have been made, and a map prepared (Fig. 4) to compare with the one made using the Köppen classification (Fig. 3) in its strict sense. In making the above comment about the need for modifications to satisfy tropical areas, the writer is aware of the difficulty of formulating world climatic classification, that would be applicable to all parts of the world with perfect satisfaction. There is no doubt that this classification still stands out with distinction in many respects in its application to tropical areas.

Four important 'refinements' are embodied in the map (Fig. 4):—

(a) The letter '1' according to the original Köppen criterion designates 'an annual temperature range of less than 9°F '. It is found that in Ceylon, all the climatological stations would, therefore, be assigned the '1' characteristic. However, from local considerations, it is revealed that the stations Jaffna, Anuradhapura, Batticaloa and Trincomalee exhibit annual ranges distinct from those revealed by the rest of the island; therefore, these stations must be distinguished from the others. It may be also brought out that unusually 'hot' periods are associated in Jaffna and Batticaloa with the prevalence of the föhn wind—the *Káchchān* (Thambyahpillay, 1958). Furthermore these areas are also subjected to strong cold 'outbursts' from across the Bay of Bengal and the Indian mainland. The use of the letter '1' to designate 'annual temperature ranges less than 7°F ' would satisfactorily bring this distinction out. Thus they would be designated:—

Trincomalee	..	Ams	Anuradhapura	..	Asw"
Batticaloa	..	Ams	Jaffna	..	Ams.

(b) Many of the stations according to the original Köppen assignments are designated Asw" and Asi, e.g., Mannar, Batticaloa and Trincomalee; however these stations undoubtedly exhibit marked monsoonal characteristics. Using the Köppen compensation formulae, this monsoonal feature is not revealed (Figure 3). These stations in the north-eastern lowland have, therefore, been assigned to the Ams and Amsi climatic types (Figure 4). These stations also exhibit 'drought'

conditions and thus warrant being assigned the letter 's' (to indicate 'dry' season during the 'high-sun' period). Thus the following stations have been assigned accordingly :—

Kurunegala	..	Amw "i
Batticaloa	..	Ams
Trincomalee	..	Ams

This monsoonal feature is also revealed by the station already designated Afi, e.g., St. Martin's estate, Rangala. According to the new assignment, this station has been designated Afmsi (*Figure 4*) since a 'by' season is also evident. Similarly the original Afi zone west of the Ctbi zone has been designated an afmi climate.

(c) The third modification is the one dealt with already, namely the inclusion of Diyatalawa within the C climate region. According to the original Köppen assignments, this station was assigned to the Ami type, thus not in the least indicative of the sub-Montane climatic characteristics of these environs. The biota as well are certainly not of the Tropical Rainy Forest type, but unmistakably those of Montane or at least sub-Montane characteristics. These stations are now assigned (*Figure 4*) the Cfsbi designation and which is justified.

(d) The two areas around Mannar and east of Hambantota have been assigned the BShs climate in consideration of the vegetation climax.

CONCLUSION

The application of the Köppen classification, both in its original as well as the 'modified' forms, serves to demonstrate clearly that the island of Ceylon, despite its relatively small areal extent, does exemplify a number of 'climates'. This is certainly in strong contrast to the common place demarcation of the island into the Wet, Dry and Arid zones. These latter climatic zones are in effect precipitation zones demarcated purely on convenient quantitative average annual values of 75 and 50 inches. Even discussions on soils, vegetation and land use continue to be dominated by the three-fold so-called climatic zones. Thus, the dry zone for example, which in fact is a climatic misnomer, has provoked innumerable investigations and reports; nevertheless the main characteristic underlying these studies is its climatic perspective. It is assumed that the whole areal extent of the dry zone is exemplified by a simple and single type of climate. The wet zone again is similarly considered in respect of its single climatic type. The maps embodied in this paper provide the

absurdity of the single climatic perspective of these two zones. The Köppen classification, it was brought out earlier, makes use of two vital climatic vegetation expressions, namely the concepts of "temperature efficiency" and "precipitation effectiveness". These concepts have continued to dominate the many climatic classifications that have been formulated from time to time. In the Köppen scheme, this classification makes use of empirically derived equations justified eventually in terms of 'climatic indicators', i.e., vegetation associations. In the subsequent paper the Thornthwaite climatic classification will be applied to the island and finally on the basis of the results accruing from both these studies, and from the author's own investigations, a tentative classification will be suggested for Ceylon.

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CLIMATIC REGIONS OF CEYLON

TABLE I—Meteorological Stations (Ceylon), their Climatic Characteristics and Climatic Assignment according to the Köppen Classification

<i>Station</i>	<i>Height above M. S. L. (feet)</i>	<i>Mean Annual Tempera- ture (°F)</i>	<i>First Year of observa- tion</i>	<i>Mean Annual Rainfall (inches)</i>	<i>First Year of observa- tion</i>	<i>Köppen climate</i>
Anuradhapura	.. 295	.. 81.1	.. 1881	.. 56.98	.. 1871	.. Asw "
Badulla	.. 2225	.. 73.6	.. 1883	.. 71.97	.. 1870	.. Asi
Batticaloa	.. 26	.. 81.4	.. 1881	.. 68.95	.. 1870	.. Ams
Colombo Obs.	.. 24	.. 80.5	.. 1908	.. 93.19	.. 1908	.. Amw <i>"</i> i
Diyatalawa	.. 4093	.. 68.2	.. 1901	.. 65.65	.. 1901	.. Cfsbi
Galle	.. 70	.. 79.8	.. 1881	.. 95.49	.. 1869	.. Afw <i>"</i> i
Hakgala	.. 5580	.. 63.1	.. 1884	.. 99.96	.. 1884	.. Cfsbi
Hambantota	.. 60	.. 80.7	.. 1881	.. 43.24	.. 1869	.. Asi
Jaffna	.. 10	.. 81.6	.. 1881	.. 53.08	.. 1871	.. Ams
Kandy	.. 1610	.. 77.0	.. 1881	.. 86.84	.. 1870	.. Afmi
Kurunegala	.. 400	.. 80.6	.. 1887	.. 84.67	.. 1885	.. Amw <i>"</i> i
Mannar	.. 10	.. 82.1	.. 1881	.. 39.76	.. 1871	.. Bsh
Nuwara Eliya	.. 6170	.. 59.4	.. 1881	.. 90.47	.. 1869	.. Cfsbi
Puttalam	.. 10	.. 81.0	.. 1881	.. 44.29	.. 1869	.. Asw <i>"</i> i
Ratnapura	.. 130	.. 80.8	.. 1881	.. 173.59	.. 1869	.. Afmi
Trincomalee	.. 30	.. 82.1	.. 1881	.. 64.80	.. 1870	.. Ams

TABLE II—Primary Rain-Gauge Stations (Ceylon) assigned the A climate according to the Köppen Classification

<i>No.</i>	<i>Station</i>	<i>Height (feet) above M. S. L.</i>	<i>Year of first Observa- tion</i>	<i>Mean annual Rainfall (inches) 1911-1940</i>	<i>Köppen climate</i>
1	Alagalla	.. 1060	.. 1911	.. 103.0	.. Afmi
2	Allai Tank	.. 20	.. 1876	.. 67.6	.. Ams
3	Aluthnuwara	.. 300	.. 1900	.. 87.2	.. Asi
4	Ambanpitiya	.. 660	.. 1872	.. 111.4	.. Amw <i>"</i> i
5	Amparai Tank	.. 90	.. 1876	.. 72.4	.. Ams
6	Andankulam Tank	.. 40	.. 1871	.. 67.3	.. Ams
7	Anninkande Es., Deniyaya	.. 1550	.. 1878	.. 137.9	.. Afw <i>"</i> i
8	Aranayake	.. 1000	.. 1906	.. 99.1	.. Afmi
9	Avissawella Es.	.. 250	.. 1898	.. 161.1	.. Afw <i>"</i> i
10	Avissawella Hospital	.. 100	.. 1871	.. 159.9	.. Afw <i>"</i> i
11	Baddegama Es.	.. 50	.. 1909	.. 131.5	.. Afw <i>"</i> i
12	Batalagoda Tank	.. 420	.. 1896	.. 77.1	.. Amw <i>"</i> i
13	Battulu Oya	.. 20	.. 1911	.. 52.6	.. Asw <i>"</i> i
14	Beausejour Es., Nakiadeniya	.. 200	.. 1902	.. 146.0	.. Afw <i>"</i> i

No.	Station	Height (feet) above M. S. L.	Year of first Observa- tion	Mean annual Rainfall (inches) 1911-1940	Köppen climate
15	Berna Es., Narammala	250	1911	76.7	Amw ^w i
16	Bibile	790	1900	82.8	Asi
17	Buttala	510	1896	66.2	Asi
18	Chadaiyantallavai	60	1878	70.8	Ams
19	Chavakchcheri	20	1894	56.7	Ams
20	Chilaw	10	1910	55.5	Amw ^w i
21	Colombo (Fort*)		1870	79.2	Amw ^w i
22	Colombo (Maligakande)	70	1894	94.3	Amw ^w i
23	Crystal Hill Es., Matale	1400	1882	84.6	Afw ^w i
24	Dambulla Hospital	400	1881	66.7	Amsi
25	Dandagamuwa	70	1903	70.9	Amw ^w i
26	Dandeniya Tank	160	1880	76.9	Afw ^w i
27	Delft	10	1911	43.2	Amsi
28	Delwita Es., Kurunegala	490	1898	87.1	Amw ^w i
29	Denegama Tank	290	1876	81.7	Afw ^w i
30	Gigalle Es., Dehiowita	400	1886	172.9	Afmi
31	Diwella Es., Kegalle	800	1910	108.6	Afmi
32	Diwulana Tank	140	1871	79.4	Ams
33	Dunedin Es., Yatiyantota	400	1883	164.6	Afw ^w i
34	Ellawella Tank	260	1891	83.2	Afw ^w i
35	Franklands Es., Veyangoda	100	1885	105.5	Amw ^w i
36	Gala Oya anicut	740	1910	90.1	Asi
37	Galewela	650	1905	70.1	Amsi
38	Galgamuwa Tank	300	1899	55.3	Asw ^w
39	Galphela Es., Wattegama	2300	1896	87.4	Afmi
40	Gammaduwa Es., Gammaduwa	2400	1876	114.7	Afmsi
41	Geekiyanakande Es., Neboda	350	1874	105.6	Afw ^w i
42	Hali Ela Tank	200	1872	97.6	Afw ^w i
43	Hambegamuwa Tank	500	1896	56.6	Asi
44	Heneratgoda	30	1891	102.4	Amw ^w i
45	Hiniduma	80	1909	178.5	Afw ^w i
46	Hiyare	340	1910	117.2	Afw ^w i
47	Horaborawewa	350	1910	73.4	Asi
48	Horakele Es.	50	1869	66.1	Amw ^w i
49	Horawupotana	210	1892	64.2	Ams
50	Irakkamam	40	1870	67.0	Ams
51	Iranaimadu Tank	100	1911	61.6	Ams
52	Jaffna College	10	1890	56.5	Ams
53	Kadukkamunai Tank	10	1909	67.3	Ams
54	Kalewewa Tank	470	1889	57.5	Amsi
55	Kalmuani	10	1878	63.1	Ams
56	Kalpitiya	10	1912	40.3	Asw ^w i
57	Kalutara (P. W. D.)	10	1871	112.5	Afw ^w i
58	Kanana Es., Bentota	30	1911	143.1	Afw ^w i
59	Kanangama Es., Dehiowita	200	1883	165.4	Afw ^w i
60	Kankesanturai (Hospital)	20	1895	50.9	Ams

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No.	Station	Height (feet) above M. S. L.	Year of first Observa- tion	Mean annual Rainfall (inches) 1911-1940	Köppen climate
61	Kantalai Tank ..	250	1876	69.8	Ams
62	Kanukkeni ..	100	1911	61.5	Ams
63	Katugastota ..	1500	1871	82.1	Afmi
64	Kayts ..	10	1901	50.3	Ams
65	Keenagaha Es., Balangoda	2100	1907	99.7	Afw ^w i
66	Kekenadure ..	160	1871	76.2	Afw ^w i
67	Kilinochchi ..	80	1905	60.3	Ams
68	Kirama ..	260	1875	93.5	Afw ^w i
69	Kosgolla ..	360	1905	70.3	Amw ^w i
70	Koslanda ..	2200	1897	94.9	Asi
71	Kumbukkan ..	600	1891	67.4	Asi
72	Kurunegala (P. W. D.)	400	1880	85.0	Amw ^w i
73	Labugama ..	380	1870	163.4	Afw ^w i
74	Madawachchiya ..	280	1891	56.4	Asw ^w
75	Magallewewa ..	180	1872	57.8	Amw ^w i
76	Maha Illupalana Tank	380	1905	58.4	Asw ^w
77	Maha Uswewa ..	180	1892	51.1	Asw ^w i
78	Mahawalatenne ..	1800	1894	78.8	Amw ^w i
79	Mamadola ..	60	1895	45.1	Asi
80	Manalputty Aar ..	20	1895	64.5	Ams
81	Mankulam† ..	130	1892	61.0	Amsi
82	Maradankadawela ..	440	1889	64.6	Amsi
83	Mariawatte Es., Gampola	1600	1881	109.0	Afmi
84	Marichchukaddi ..	10	1894	37.0	Asw ^w i
85	Matale ..	1210	1873	81.2	Afw ^w i
86	Modagama ..	800	1907	83.7	Asi
87	Mediyawa Tank ..	20	1905	61.3	Amw ^w i
88	Mihintale ..	350	1884	59.0	Asw ^w
89	Minneriya ..	310	1899	74.0	Ams
90	Moneragala ..	700	1898	76.2	Asi
91	Morawake ..	300	1909	147.5	Afw ^w i
92	Mullaitivu ..	10	1871	61.9	Ams
93	Nachchaduwa Tank	400	1906	57.9	Asw ^w
94	Nedunkeni ..	120	1894	66.5	Ams
95	Negombo ..	10	1871	77.4	Amw ^w i
96	Orange Hill Es., Ragama	50	1885	98.7	Amw ^w i
97	Orwell Es., Gampola	1700	1898	114.0	Afmi
98	Padupola ..	1600	1871	206.6	Afmi

No.	Station	Height (feet) above M. S. L.	Year of first Observa- tion	Mean annual Rainfall (inches) 1911-1940	Köppen climate
99	.. Pallai ..	.. 20 ..	1881 ..	51.6 ..	Ams
100	.. Palugaswewa Es. ..	.. 40 ..	1910 ..	60.5 ..	Amw <i>"</i> i
101	.. Panilkande Es., Deniyaya ..	.. 1900 ..	1897 ..	138.1 ..	Afw <i>"</i> i
102	.. Pathregalla Es., Pothuhera ..	.. 550 ..	1900 ..	94.3 ..	Afw <i>"</i> i
103	.. Pelmadulla ..	.. 480 ..	1871 ..	129.7 ..	Afw <i>"</i> i
104	.. Peradeniya (Gardens) ..	.. 1540 ..	1883 ..	92.2 ..	Afmi
105	.. Periyakulam Tank ..	.. 50 ..	1876 ..	65.8 ..	Ams
106	.. Point Pedro ..	.. 20 ..	1892 ..	52.0 ..	Ams
107	.. Pomparippu ..	.. 20 ..	1911 ..	40.2 ..	Asw <i>"</i> i
108	.. Pulkunavi ..	.. 90 ..	1908 ..	67.3 ..	Ams
109	.. Rajawela Es., Kandy ..	.. 1500 ..	1870 ..	65.1 ..	Afmi
110	.. Rayigam Es., Ingiriya ..	.. 300 ..	1897 ..	169.6 ..	Afw <i>"</i> i
111	.. Rotawewa Tank ..	.. 30 ..	1887 ..	60.5 ..	Ams
112	.. Rukam Kulam ..	.. 80 ..	1869 ..	78.8 ..	Ams
113	.. Sakamam Tank ..	.. 40 ..	1872 ..	65.0 ..	Ams
114	.. Sudupanawela ..	.. 610 ..	1910 ..	76.6 ..	Asi
115	.. Taldena ..	.. 1100 ..	1900 ..	77.8 ..	Asi
116	.. Tanamalwila ..	.. 550 ..	1898 ..	51.1 ..	Asi
117	.. Tangalle ..	.. 70 ..	1874 ..	55.5 ..	Amw <i>"</i> i
118	.. Thumpenkeni Tank ..	.. 40 ..	1902 ..	68.4 ..	Ams
119	.. Topawewa ..	.. 200 ..	1891 ..	68.6 ..	Ams
120	.. Udukiriwila ..	.. 160 ..	1872 ..	60.9 ..	Amw <i>"</i> i
121	.. Unichchai Tank ..	.. 120 ..	1901 ..	81.7 ..	Ams
122	.. Vaganeri ..	.. 120 ..	1901 ..	71.7 ..	Ams
123	.. Vavuniya ..	.. 320 ..	1885 ..	61.0 ..	Amsi
124	.. Vicarton Es., Matale ..	.. 3250 ..	1891 ..	98.0 ..	Afw <i>"</i> i
125	.. Viragoda ..	.. 100 ..	1910 ..	72.6 ..	Ams
126	.. Waragalande Es., Madulkele ..	.. 2000 ..	1903 ..	91.0 ..	Afmi
127	.. Wariapolle Es., Matale ..	.. 1200 ..	1886 ..	80.6 ..	Afw <i>"</i> i
128	.. Yatederiya Es., Undugoda ..	.. 650 ..	1888 ..	152.6 ..	Afmi

* Observations from roof-level.

† Discontinued from September 1953.

TABLE III—Primary Rain-Gauge Stations (Ceylon) assigned the B Climate according to the Köppen Classification.

No.	Station	Height (feet) above M. S. L.	Year of first Observa- tion	Mean annual Rainfall (inches) 1911-1940	
1	.. Mantota ..	.. 20 ..	1893 ..	42.7 ..	Bsh
2	.. Murunkan ..	.. 50 ..	1898 ..	43.6 ..	Bsh
3	.. Tissamaharama ..	.. 80 ..	1873 ..	41.5 ..	Bsh

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TABLE IV.—Primary Rain-Gauge Stations (Ceylon) assigned the C Climate according to the Köppen Classification

No.	Station	Height (feet) above M. S. L.	Year of first Observation	Mean Annual Rainfall (inches) 1911-1940	Köppen climate
1	.. Abergeldie Es., Rozelle	.. 3600	.. 1884	.. 162.6	.. Cfbi
2	.. Annfield Es., Dickoya	.. 4300	.. 1888	.. 111.5	.. Cfbi
3	.. Blair Athol Es., Dickoya	.. 3740	.. 1878	.. 136.9	.. Cfbi
4	.. Caledonia Es., Lindula	.. 4270	.. 1881	.. 91.7	.. Cfbi
5	.. Champion Es., Bogawantalawa	.. 5000	.. 1887	.. 97.1	.. Cfbi
6	.. Dooroomadella Es.	.. 3300	.. 1904	.. 144.5	.. Cfbi
7	.. Boragalla Es., Pussellawa	.. 4400	.. 1908	.. 140.0	.. Cfbi
8	.. Buckwari Es., Rangala	.. 3300	.. 1888	.. 116.4	.. Cfbi
9	.. Dunsinane Es., Punduluoya	.. 5040	.. 1886	.. 121.2	.. Cfbi
10	.. Gourakelle Es., Badulla	.. 4200	.. 1877	.. 94.2	.. Cfsbi
11	.. Haputale ..	.. 4880	.. 1897	.. 85.7	.. Cfsbi
12	.. Hatton ..	.. 4140	.. 1896	.. 140.1	.. Cfbi
13	.. Helboda Es., Pussellawa	.. 3490	.. 1879	.. 135.1	.. Cfbi
14	.. Holmwood Es., Agrapatana	.. 5240	.. 1881	.. 103.7	.. Cfbi
15	.. Hope Es., Hewaheta	.. 4600	.. 1889	.. 111.7	.. Cfbi
16	.. Kabaragalla Es., Maturata	.. 4750	.. 1885	.. 125.8	.. Cfbi
17	.. Kobonella Es., Urugala	.. 3300	.. 1882	.. 137.2	.. Cfbi
18	.. Kurundu Oya Es., Maturata	.. 5150	.. 1883	.. 111.6	.. Cfbi
19	.. Labookele Es., Ramboda	.. 5000	.. 1886	.. 143.1	.. Cfbi
20	.. Ledgerwatte Es., Badulla	.. 4000	.. 1894	.. 116.3	.. Cfsbi
21	.. Lr. Spring Valley Es.	.. 3650	.. 1885	.. 93.1	.. Cfsbi
22	.. Luccombe Es., Maskeliya	.. 3600	.. 1902	.. 162.8	.. Cfbi
23	.. Lunugala Div., Bandarawela	.. 4500	.. 1911	.. 108.9	.. Cfsbi
24	.. Mahadova Es., Madulkele	.. 4500	.. 1882	.. 106.0	.. Cfsbi
25	.. Maskeliya ..	.. 4200	.. 1884	.. 119.0	.. Cfbi
26	.. Maturata ..	.. 3230	.. 1906	.. 90.2	.. Cfsbi
27	.. Meeriabedde Es., Koslanda	.. 3600	.. 1873	.. 103.7	.. Cfsbi
28	.. Mousagalle Es.	.. 4500	.. 1880	.. 102.6	.. Cfsbi
29	.. New Forest Es., Galaha	.. 3500	.. 1876	.. 115.0	.. Cfbi
30	.. Norwood (New Valley)	.. 3600	.. 1871	.. Cfbi	..
31	.. Ohiya ..	.. 5820	.. 1911	.. 90.7	.. Cfsbi
32	.. Passara ..	.. 2800	.. 1900	.. 85.8	.. Cfsbi
33	.. Patiagama Es., Deltota	.. 3500	.. 1908	.. 109.0	.. Cfbi
34	.. Pussellawa ..	.. 3000	.. 1880	.. 119.1	.. Cfbi
35	.. Sandringham Es., Agrapatana	.. 5250	.. 1881	.. 86.0	.. Cfbi

No.	Station	Height (feet) above M. S. L.	Year of first Observation	Mean Annual Rainfall (inches) 1911-1940	Köppen climate
36	.. Sogama Es., Pussellawa	.. 3500	.. 1886	.. 127.9	.. Cfbi
37	.. South Wanaraja Es., Dikoya	.. 3700	.. 1885	.. 128.8	.. Cfbi
38	.. St. Martin's Es., Rangala	.. 3800	.. 1887	.. 173.4	.. Cfbi
39	.. Udahena Es., Bandarawela	.. 4500	.. 1880	.. 110.8	.. Cfsbi
40	.. Upper Ohiya Es., Ohiya	.. 6000	.. 1905	.. 97.8	.. Cfsbi
41	.. Watagoda	.. 4400	.. 1911	.. 121.1	.. Cfbi
42	.. Watawala	.. 3260	.. 1911	.. 218.6	.. Cfbi
43	.. Welimade Gp., Welimade	.. 3790	.. 1911	.. 60.3	.. Cfsbi
44	.. Woodside Es., Urugala	.. 3000	.. 1898	.. 93.2	.. Cfbi
45	.. Yarrow Es., Pussellawa	.. 3350	.. 1883	.. 117.3	.. Cfbi

TABLE V:—For the Determination of the AM/AW Boundary according to the Köppen Classification

Yearly Rainfall in Inches	Rainfall of Driest Month in Inches	Yearly Rainfall in Inches	Rainfall of Driest Month in Inches	Yearly Rainfall in Inches	Rainfall of Driest Month in Inches
39.5	.. 2.36	.. 59.5	.. 1.56	.. 79.5	.. .76
40	.. 2.34	.. 60	.. 1.55	.. 80	.. .74
40.5	.. 2.32	.. 60.5	.. 1.53	.. 80.5	.. .72
41	.. 2.30	.. 61	.. 1.51	.. 81	.. .70
41.5	.. 2.29	.. 61.5	.. 1.48	.. 81.5	.. .68
42	.. 2.26	.. 62	.. 1.47	.. 82	.. .66
42.5	.. 2.24	.. 62.5	.. 1.45	.. 82.5	.. .63
43	.. 2.22	.. 63	.. 1.42	.. 83	.. .61
43.5	.. 2.20	.. 63.5	.. 1.41	.. 83.5	.. .59
44	.. 2.18	.. 64	.. 1.38	.. 84	.. .58
44.5	.. 2.16	.. 64.5	.. 1.36	.. 84.5	.. .56
45	.. 2.14	.. 65	.. 1.34	.. 85	.. .54
45.5	.. 2.12	.. 65.5	.. 1.33	.. 85.5	.. .51
46	.. 2.10	.. 66	.. 1.30	.. 86	.. .50
46.5	.. 2.08	.. 66.5	.. 1.28	.. 86.5	.. .48
47	.. 2.07	.. 67	.. 1.26	.. 87	.. .46
47.5	.. 2.04	.. 67.5	.. 1.24	.. 87.5	.. .44
48	.. 2.02	.. 68	.. 1.22	.. 88	.. .42
48.5	.. 2.00	.. 68.5	.. 1.20	.. 88.5	.. .40
49	.. 1.98	.. 69	.. 1.18	.. 89	.. .37
49.5	.. 1.96	.. 69.5	.. 1.15	.. 89.5	.. .36
50	.. 1.84	.. 70	.. 1.13	.. 90	.. .34
50.5	.. 1.92	.. 70.5	.. 1.11	.. 90.5	.. .32

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<i>Yearly Rainfall in Inches</i>	<i>Rainfall of Driest Month in Inches</i>	<i>Yearly Rainfall in Inches</i>	<i>Rainfall of Driest Month in Inches</i>	<i>Yearly Rainfall in Inches</i>	<i>Rainfall of Driest Month in Inches</i>
51 ..	1.90 ..	71 ..	1.10 ..	91 ..	.29
51.5 ..	1.88 ..	71.5 ..	1.08 ..	91.5 ..	.28
52 ..	1.86 ..	72 ..	1.06 ..	92 ..	.26
52.5 ..	1.85 ..	72.5 ..	1.03 ..	92.5 ..	.24
53 ..	1.82 ..	73 ..	1.02 ..	93 ..	.22
53.5 ..	1.80 ..	73.5 ..	1.00 ..	93.5 ..	.20
54 ..	1.78 ..	74 ..	.98 ..	94 ..	.18
54.5 ..	1.77 ..	74.5 ..	.96 ..	94.5 ..	.16
55 ..	1.75 ..	75 ..	.94 ..	95 ..	.14
55.5 ..	1.73 ..	75.5 ..	.92 ..	95.5 ..	.11
56 ..	1.70 ..	76 ..	.90 ..	96 ..	.09
56.5 ..	1.68 ..	76.5 ..	.88 ..	96.5 ..	.07
57 ..	1.66 ..	77 ..	.86 ..	97 ..	.06
57.5 ..	1.64 ..	77.5 ..	.84 ..	97.5 ..	.04
58 ..	1.63 ..	78 ..	.81 ..	98 ..	.02
58.5 ..	1.60 ..	78.5 ..	.80 ..	98.5 ..	.00
59 ..	1.58 ..	79 ..	.78 ..		

TABLE VI.—For the Determination of the BS/H Boundary according to the Koppen Classification

<i>Average Annual Temperature (°F)</i>	<i>At least 70 Per Cent in Winter</i>	<i>Even Distribution</i>	<i>At least 70 Per Cent. in Summer</i>
50 ..	7.88 ..	13.40 ..	18.90
51 ..	8.32 ..	13.84 ..	19.34
52 ..	8.74 ..	14.26 ..	19.76
53 ..	9.18 ..	14.71 ..	20.20
54 ..	9.62 ..	15.14 ..	20.64
55 ..	10.06 ..	15.58 ..	21.08
56 ..	10.50 ..	16.02 ..	21.52
57 ..	10.94 ..	16.46 ..	21.96
58 ..	11.38 ..	16.90 ..	22.40
59 ..	11.82 ..	17.34 ..	22.84
60 ..	12.26 ..	17.78 ..	23.28
61 ..	12.68 ..	18.20 ..	23.70
62 ..	13.12 ..	18.64 ..	24.14
63 ..	13.56 ..	19.08 ..	24.58
64 ..	14.00 ..	19.52 ..	25.02
65 ..	14.44 ..	19.96 ..	25.46
66 ..	14.88 ..	20.40 ..	25.90
67 ..	15.30 ..	20.82 ..	26.32

<i>Average Annual Temperature (°F)</i>		<i>At least 70 Per Cent in Winter</i>		<i>Even Distribution</i>		<i>At least 70 Per Cent in Summer</i>
68	..	15.74	..	21.26	..	26.76
69	..	16.18	..	21.70	..	27.20
70	..	16.62	..	22.14	..	27.64
71	..	17.06	..	22.58	..	28.08
72	..	17.50	..	23.02	..	28.52
73	..	17.94	..	23.46	..	28.96
74	..	18.38	..	23.90	..	29.40
75	..	18.82	..	24.34	..	29.84
76	..	19.24	..	24.76	..	30.26
77	..	19.68	..	25.20	..	30.70
78	..	20.12	..	25.64	..	31.14
79	..	20.56	..	26.08	..	32.08
80	..	21.00	..	26.52	..	32.08
81	..	21.44	..	26.96	..	32.46
82	..	21.88	..	27.40	..	32.90
83	..	22.30	..	27.82	..	33.32
84	..	22.74	..	28.26	..	33.76
84	..	23.18	..	28.70	..	34.20

TABLE VII.—For the Determination of the BW/BS Boundary according to the Koppen Classification

<i>Average Annual Temperature (°F)</i>		<i>At least 70 Per Cent. in Winter</i>		<i>Even Distribution</i>		<i>At least 70 Per Cent in Summer</i>
50	..	3.94	..	6.70	..	9.45
51	..	4.16	..	6.92	..	9.67
52	..	4.37	..	7.13	..	9.88
53	..	4.59	..	7.35	..	10.10
54	..	4.81	..	7.57	..	10.32
55	..	5.03	..	7.79	..	10.54
56	..	5.25	..	8.01	..	10.76
57	..	5.47	..	8.23	..	10.98
58	..	5.69	..	8.45	..	11.20
59	..	5.91	..	8.67	..	11.42
60	..	6.13	..	8.89	..	11.64
61	..	6.34	..	9.10	..	11.85
62	..	6.56	..	9.32	..	12.07
63	..	6.78	..	9.54	..	12.29
64	..	7.00	..	9.76	..	12.51
65	..	7.22	..	9.98	..	12.73
66	..	7.44	..	10.20	..	12.95
67	..	7.65	..	10.41	..	13.16
68	..	7.87	..	10.63	..	13.38
69	..	8.09	..	10.85	..	13.60
70	..	8.31	..	11.07	..	13.82
71	..	8.53	..	11.29	..	14.04

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<i>Average Annual Temperature (°F)</i>		<i>At least 70 Per Cent. in Winter</i>		<i>Even Distribution</i>		<i>At least 70 Per Cent. in Summer</i>
72	..	8.75	..	11.51	..	14.26
73	..	8.97	..	11.73	..	14.48
74	..	9.19	..	11.95	..	14.70
75	..	9.41	..	12.17	..	14.92
76	..	9.62	..	12.38	..	15.13
77	..	9.84	..	12.60	..	15.35
78	..	10.06	..	12.82	..	15.57
79	..	10.28	..	13.04	..	15.79
80	..	10.50	..	13.26	..	16.01
81	..	10.72	..	13.48	..	16.23
82	..	10.94	..	13.70	..	16.45
83	..	11.15	..	13.91	..	16.66
84	..	11.37	..	14.13	..	16.88
85	..	11.59	..	14.35	..	17.10