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Component-I (B) - Description of Module

Items	Description of Module
Subject Name	**Geography**
Paper Name	**Climatology**
Module Name/Title	THORNTHWAITE'S CLIMATIC CLASSIFICATION
Module Id	CL-26
Pre-requisites	
Objectives	• explain the design of climatic classification, • name various measurements that characterize a climate group, • explain combination of letters, • discuss the utility of water balance, • state the climatic conditions during different seasons.
Keywords	

Introduction
Learning Objectives
Historical Development in Thornthwaite's Climate Classification
Method of Calculation
    PET Index:
    Heat Index:
    Moisture Index:
    Thermal Index:
Design of Classification
    First capital alphabet for moisture regimes
    Second capital alphabet with dash for thermal provinces
    Third small alphabet for seasonal surplus or deficit of moisture
    Aridity index for humid climates
    Humidity index for arid climates
Water Balance and its Explanation
Soil-Water- Balance (SWB)
Spatial Distribution of World Climates
Criticism of the Classification:
Climates of India by Thornthwaite
Difference between Koppen and Thornthwaite's Classification of Climates
Summary and Conclusions
References
Web Links
Multiple Choice Questions
Answer Key

THORNTHWAITE'S CLIMATIC CLASSIFICATION

Introduction

Charles Warren Thornthwaite, an American climatologist attempted classification of world climates in 1931. The climatic classification was revised and improved further in 1948. The classification incorporates evapotranspiration, temperature and precipitation information and is widely used in studying the animal species diversity and potential impacts of climate change. Thornthwaite's classification is an improved and modified form of Koeppen's classification of climates. It is assumed that precipitation, temperature and plant association are strongly correlated. Natural vegetation is the true representation or the product of the climate. It is an outcome of precipitation and thermal conditions prevailing at a specific place over a long period of time. Growth and development of natural vegetation not only depended upon precipitation alone but also on the rate of evaporation. The classification of climates is based on the concept of potential evapotranspiration (PET). By potential evapotranspiration we mean the total amount of water vaporized and transpired over a certain area if sufficient amount of water is available.

Learning Objectives

After studying this module, you will be able to:

Historical Developments in Thornthwaite's Climatic Classification

Being a Professor of Climatology, Thornthwaitewrote a research paper entitled "The Climates of North America according to a new classification". It was publishedin 1931 in *Geographical Review* Vol. 21. Later, in 1946, Thornthwaite attempted a study on the "Moisture factor in Climate". The article was published in 1948 in*Transactions of American Geophysics Union,* Vol. 27. Themodified version of Thornthwaite's climate classification was published in 1948 entitled"An Approach towards a Rational Classification of Climates" in *Geographical Review,* in Vol. 38.Further elaborated work of Thornthwaite in association with Mather was published in 1955 ina seminal researcharticle on "Water Balance" in *Climatology,* Vol. 8. Both the scholars have written "Instructional Manuals and Tables for computing evapotranspiration and water balance" in 1957 which was published in *Climatology,* Vol.10. Thornthwaite is credited to have established a Laboratory of Climatology at Drextel Institute of Technology, Centerton, New

Jersey, USA. These tables and manuals are even now being used across the world for studies related to the classification of climates and climate change assessments.

Studies on water balance are now widely used to assess the soil moisture and surplus and deficit situations of water at any place. Rebeiro and Recardo (20011) published an article on the “The Evapotranspiration in Climate Classification”. Similarly, Das (2015) published an article on the “Water Balance and Climatic Classification of a Tropical City Delhi- India”. The applied aspect of the work relates to disciplines such as hydrology, agriculture, ecosystem situations, human health and medical sciences.

Method of Calculation

Thornthwaite used a set of indices to work out classification of climates. The indices used in the exercise are potential evapotranspiration (PET) index, heat index (I), moisture index (MI) and thermal index (TI).The potential evapotranspiration (PET) is calculated from mean monthly temperature (in ^{0}C) in association with day length for a 30 day month (12- hour days). Heat index (I) is worked out by monthly mean heat index adjusted for the number of hours of day light and days in specific months. It is linked to mean monthly air temperature. Moisture index (MI) is worked out by subtracting PET values with precipitation (P) divided by PET and the coefficient multiplied by 100. Thermal index (TI) is worked out by adding minimum temperature values to maximum and the sum divided by two. Equation form of each Index is given below:

a) **PET Index:**

Potential evapotranspiration (PET) index is worked out using mean monthly air temperature in ^{0} C.

$$PE=1.6\ (\underline{10Ta})^a$$

Where,

PE= Monthly potential evaporation in centimeters.

Ta=Mean monthly air temperature in ^{0} C.

^{a}= is a cubic function of I, given as,

$^a= (6.75x\ 10^{-7})\ x\ I^3 – (7.75\text{-}10^{-5})\ x\ I^2$

$+ (1.792\ x10^{-3})\ x\ I+ 0.49$

The above equation and values have been derived from Thornthwaite's article published in Geographical Review, Vol.38,1948.

b) **Heat Index:** Heat index refers to the mean monthly air temperature (^{0}C) for each month from month 1stto month 12th in degree Celsius. It is further adjusted to number of hours of day light and days in a month. The total values of temperature were then divided by 5, a constant value of average. The coefficient so derived is raised by the power value of 1.514. Thus, heat index refers to sum total of monthly temperature values adjusted to hours of day light divided by a constant value. The final index is further raised to the power 1.514to ascertain the heat index.

I= Annual heat index, given by

$I=\sum_{N-1}^{n-12}(Ta/5)^{1.514}.(Ta/5)^{1.514}=i$ =Mean heat index of the nth month.

$E_T = 1.60\ L_a\ (10\ T \div I_T)^a$

E_T =monthly PET (cm)

L_a=adjustment for the number of hours of day light and days in the month (depends on latitude)

T=mean monthly air temperature (^{0}C)

I_T =total of 12 monthly values of heat index i=$\sum_1^{12} i$

i= $(T/5)^{1.514}$

a= empirical cons tan t= $6.75x10^{-7}(I_t)^3 - 7.71x10^{-5}(I_t)^2 + 1.792\ x10^{-2}(I_t) + 0.49239$

c) **Moisture Index:**The proportion of precipitation that ultimately remains available for practical purposes after evaporation is known as moisture index. It is being worked out bysubtracting the value of potential evapotranspiration (PET) from precipitation and the balance is divided by potential evapotranspiration (PET). The coefficient is then multiplied by 100 to get the moisture index.

(MI) = (P-PET÷PET) x100

Where,

P = Precipitation

PET =Potential evapotranspiration

d) **Thermal Index**: The index is being worked out by adding together the maximum temperature value of each day for the month and the sum divided by total number of days in the month. Similarly, average minimum temperature is also worked out by adding together diurnal minimum temperature values for a month and the sum divided by the total number of days in the month. Thermal index is calculated by the addition of average maximum temperature and average minimum temperature and the sum divided by two. Thermal index is, thus, the middle most value lying between maximum and minimum values of temperature.

$$(TI) = (T_{max} + T_{min}) \div 2$$

Where,

T_{max} = Maximum temperature
T_{min} = Minimum temperature

Monthly water surplus (S) or deficit (D) is calculated from a moisture budget assessment including stored soil moisture. A scheme of moisture index (MI), humidity province (expressed in capital alphabets), rainfall (in centimeters), precipitation effectiveness (PE) based on heat (I) and moisture indices (M) and thermal province (expressed in capital alphabets with superscript dash) is presented in Table-1. Heat and thermal indices are extremely useful in working out precipitation effectiveness, which in its turn, is an important indicator of plant growth. Heat index refers to hours of sun light and air temperature whereas thermal index relates to the average thermal condition, i.e. sum total of maximum and minimum temperature divided by two. The table below summarizes different indices and their limits.

Table -1: Major Parameters of Climatic Classification

Moisture index	**Humidity province**	**Rainfall (in Cm)**	**PE/I m**	**Thermal province**
100 and above	Pre –humid (A)	114	44.9	Tropical or Mega thermal (A’)
20-100	Humid (B_1 to B_4)	57-114	22.4-44.9	Meso thermal(B'_1 to B'_4)
0 to 20	Moist sub-humid (C_2)	28.5-57	11.2-22.4	Micro thermal (C_1 to C_2)
-20 to 0	Dry sub-humid (C_1)	14.2-28.5	5.6-11.2	Steppe
-40 to -20	Semi- arid (D)	<14.2	<5.6	Taiga (D’)
-60 to – 40	Arid (E)	<14.2	<5.6	Tundra (E’)Frost (F’)

Source: Based on climatic type and moisture index on page 76, in C.W. Thornthwaite (1948), “An Approach toward a Rational Classification of Climates” **The Geographical Review,** Vol. 38, No.1, pp. 55-94.

Thornthwaite’s classification is, thus, based on two important indices:

1. Precipitation Effectiveness (PE). Effectiveness of precipitation depends on the distribution pattern of rainfall in a calendar year and evaporation of moisture back to

the atmosphere through different surfaces and means. Seasonal deficiency and surplus of rainfall affects plant growth significantly.

2. Temperature Efficiency (TE). Temperature efficiency relates to variation in temperature and its role in the growth of plants. Equatorial areas where sunlight and temperatures are usually high with insignificant variation in a calendar year, growth of plants remains high. Contrary to it, arid areas reflect high variation in temperature and sun-light, hence plant growth is retarded significantly. Potential evaporation is, thus, an index of temperature efficiency.

Design of classification:

Thornthwaite's design of climate classification is a combination of three letter alphabets.

1) First alphabet used in the major climatic classification is any one of the English capital letter from A to E which denotes world's five moisture regimes. Further, sub division in a major climate is expressed by small numerical values such as 1, 2, 3 denoting variation within moisture regimes. These are:

A =Wet or Per humid (with moisture index as 100)

P/E index= 127 and type of vegetation **'rainforest'**.

B = Humid (with moisture index 20 to 100) B_1, B_2, B_3 and B_4

P/E index= 64-127 and type of vegetation **'forest'**.

C= Moist sub humid (with moisture index 0 to 20),

P/E index =32-63 and type of vegetation **'grasslands'**.

D = Dry sub humid (with moisture index -30 to 0)

P/E index= 16-31 and type of vegetation '**steppe'**.

E =Arid (E with moisture index -100 to -67)

P/E index= <16 and type of vegetation **'desert'**.

2) The second letter used in the climatic classification is also an English capital alphabet superscript with dash. It denotes thermal provinces. Thornthwaite has divided the world in to six thermal provinces. They are expressed as:

A'= Mega thermal (Tropical), T/E index= 127.

B'= Meso thermal expressed as B_1, B_2, B_3 and B_4
T/E index= 64-127.

C'= Micro thermal, T/E index = 32-63.

D'= Taiga T/E index = 16-31.

E'= Tundra T/E index = 1-15

F'= Frost T/E index = 0.

Based on the moisture and thermal indices, 9 major climates were identified.

3) Third letter in combination of alphabets is denoted by a set of 8 small English alphabets. They are used to express the seasonal pattern of the availability of moisture from acute deficit to abundant surplus situations. The expression of small alphabets is explained below:

- Rainfall adequate in all seasons = r
- Rainfall deficient in all the seasons = d
- Rainfall deficient (normal) during winter season = w
- Rainfall deficient (normal) during summer season = s

Aridity index for humid climates

Moisture deficit acute during winter = w_2

Moisture deficit acute during summer =s_2

Humidity index for arid climates

Moisture surplus abundant during winter =s_2

Moisture surplus abundant during summer = w_2

Thornthwaite has been concerned about working out seasonal deficiency of moisture in humid climates which appears to be the cause of dryness and apparently halting the growth of plants for specific period. Similarly, places in arid climates do represent moisture surplus seasonally which serves as storage of soil moisture and a basis for growth of plants as grasslands and xerophytes.

Thus, precipitation effectiveness (PE) and temperature efficiency (TE) are closely related and are the expressions of vegetation type. Both the indices record high values where variations in the distribution of pattern of rainfall and temperature reflect little variation. Contrary to this, both the indices record low values if the distribution pattern of rainfall and temperature reflect high variation. However, both the indices are aimed at a common point of reference i. e. vegetation which is true representation of a climate type.

The third alphabet classification is largely based on the seasonal characteristics of precipitation. The following four small alphabets were used to denote the seasonal characteristics of rainfall. Based on four seasonal characteristics of rainfall, 20 climatic divisions have been recognized. They are presented in Table-2.

Table-2: Classification of Climates Based onMoisture Regimes and Seasonal Characteristics of Moisture.

Moisture regimes / Seasonal pattern of moisture	**Wet or Per Humid**	**Humid**	**Moist Sub Humid**	**Dry Sub-Humid**	**Arid**
Adequate rainfall in all the seasons	Ar	Br	Cr	Dr	Er
Rainfall deficient in summer	As	Bs	Cs	Ds	Es
Rainfall deficient in winter	Aw	Bw	Cw	Dw	Ew
Rainfall deficient in all the seasons	Ad	Bd	Cd	Dd	Ed

Besides surplus and deficient rainfall at seasonal level, Thornthwaite has also considered the level of seasonal moisture deficiency for humid climates and seasonal abundance of moisture for arid climates as crucial elements in plant growth and the characterization of climates. As such, an attempt was made to work out season specific moisture deficiency from normal to acute for humid climates and moisture surplus from normal to abundant for arid climates. To make it distinct from normal situation, seasonal characteristics were further assigned with numerical values.

$$M = Ih - 0.6\ Ia$$

Or

$$M = \frac{100\,\alpha - 60\,\beta}{\gamma}$$

Where,

Ih is the index of humidity,
Ia is the index of aridity,
Alpha (α) is the water surplus,
Beta (β) is the water deficit,
Gamma (γ) is the water need or potential evapotranspiration.

The above concept relates to the status of moisture at a specific place. If alpha (α) exceeds the potential evapotranspiration (PET) or water need (γ), the situation is termed as humid. Similarly, if beta exceeds the potential evapotranspiration (PET) or water need (γ), the situation is termed as arid.

The seasonal characteristics are explained below:

Aridity index for humid climates A, B, and C_2

Proportion of moisture deficit is denoted by:

No moisture deficit 0-10 = r
Moisture deficit (normal) during summer season 10-20 = s
Moisture deficit (normal) during winter season 10-20 = w
Moisture deficit acute >20% in winter = w_2
Moisture deficit acute >20% in summer =s_2

Humidity index for arid climates C_1, D and E

Proportion of moisture surplus is denoted by:

Water surplus negligible 0-16.7 =d
Winter moisture surplus (normal) 16.7-33.3=s
Summer moisture surplus (normal) 16.7-33.3=w
Moisture surplus abundant >33.3% in summer =w_2
Moisture surplus abundant >33.3% in winter =s_2

The seasonal variation of effective moisture and summer concentration of temperature efficiency has been further refined for the climatic classification. Details have been presented in the table-3.

Table – 3: Thermal Efficiency and its Summer Concentration

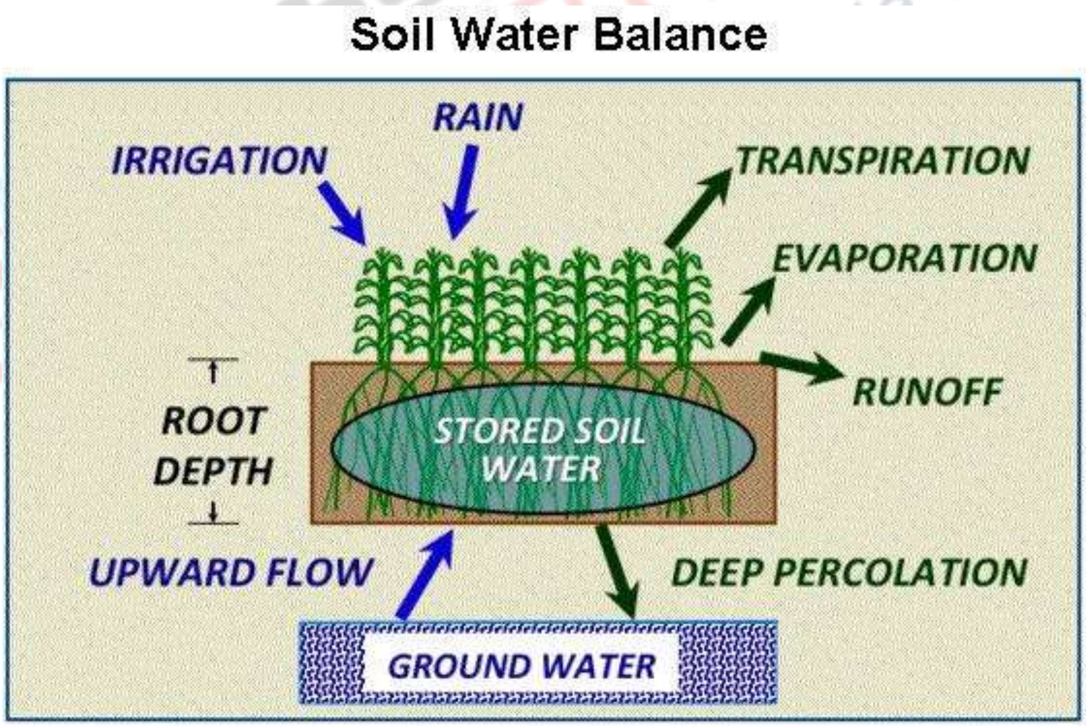
Thermal	Climate type	Index value	Type of summer	Percentage of

efficiency			concentration	concentration
A^1	Mega thermal	>114	A	< 48.0
$B^1{}_4$	Meso thermal	99.7 – 114	b_4	48 - 51.9
$B^1{}_3$	Meso thermal	85.5 - 99.7	b_3	51.9 - 56.3
$B^1{}_2$	Meso thermal	71.2 – 85.5	b_2	56.3 - 61.6
$B^1{}_1$	Meso thermal	57.2 – 71.2	b_1	61.6 - 68.0
$C^1{}_2$	Micro thermal	42.7 – 57.2	c_2	68.0 - 76.3
$C^1{}_1$	Micro thermal	28.5 - 42.7	c_1	76.3 - 88.0
$D^1{}_1$	Tundra	14.2 - 28.5	D	>88.0
E^1	Frost	<14.2	E	>88.0

Water Balance and its Explanation: There is a close relationship between rainfall, temperature and potential evapo-transpiration, though they are not linked to a common cause and are evidently the result of different causes. The potential evapo- transpiration rates increase with an increase in temperature and decrease in relative humidity which varies with precipitation. In Indian situation, rates increase steadily from January to May, with increasing temperature and aridity, followed by a rapid decline from June onwards with the onset of summer monsoon. The minimum is ultimately reached in the month of August which also records the heaviest rainfall and resultant humidity. The effect of relative humidity on the rates may be seen from the examples of the months April and July which have mean maximum temperatures of 36^0 C and 34^0 C. respectively and the corresponding potential evapo-transpiration rates of 30 and 15 centimeters. A gradual rise in rates is noted from September with a slight increase in air temperature following a decline in rainfall and cloudiness. However, the rise in rates does not continue beyond October because of approaching cold season. The actual evapo- transpiration, as distinct from potential evapo- transpiration, depends upon the amount of water actually available for the growth of plants. As such, it is a function of precipitation provided there is no soil-moisture recharge by capillary action from the water table and that artificial irrigation is not prevalent. Further the actual evapo- transpiration in any month will be less than or equal to the corresponding potential evapo- transpiration according to an existence or otherwise of a water deficit in that month. As such, actual equals the potential only in July, August and September when water deficit is non- existent.

Soil-Water-Balance (SWB): Thornthwaite and Mather (1957) developed a method for estimating the recharge, storage and abstraction in the process of water percolation to subsoil layers. Thornthwaite as a climatologist, developed the concept of the soil-moisture balance, and he preferred to use it as the foundation of his climate system. He was convinced that soil-moisture balance represents availability of moisture for the plants and an assessment of the availability surplus moisture to supply stream flow and ground water. This concept implies that precipitation alone does not indicate the amount of water actually available to plants. The moisture requirement of plants become higher as temperature increases. A schematic illustration is presented below. It illustrates that rain and irrigation are the two sources of the soil moisture. Evaporation and transpiration are the two ways of moisture transfer to atmosphere. Runoff and percolation are the processes of water flow. Stored soil water has deep percolation and upward movement of soil moisture (Figure 1).

Figure 1: Soil-Water -Balance



Source: http://passel.unl.edu/Image/NolanDiane1129928529/ch4fig.JPG

The method developed by Thornthwaite is given below:

Recharge= (Precip+ snow melt +inflow) – sources (1)

(Interception+ Outflow +ET)-▲ soil moisture sinks

$$R = \frac{(P - I_a)^2}{(P + (S_{max} - I_a))} \quad P > I_a \qquad (2)$$

Where,

R is run off,

P is daily precipitation,

S_{max} is maximum soil moisture holding capacity and

I_a is initial abstraction, the amount of precipitation that must fall before any runoff is generated.

The initial abstraction (I_a) term is related to a maximum storage term (S_{max}) as follows:

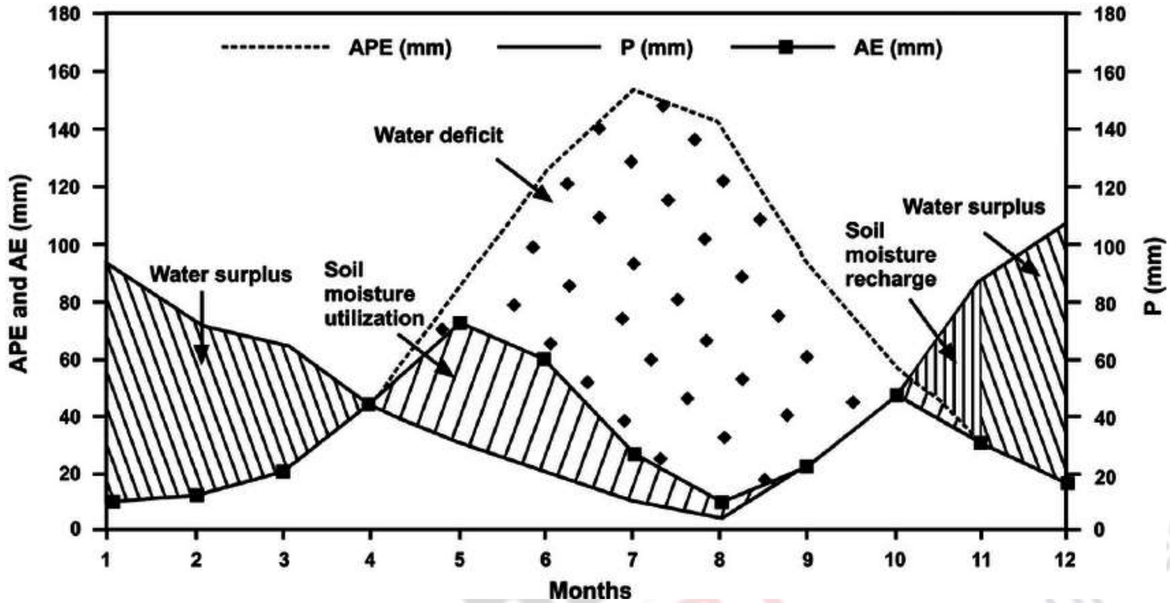
$$I_a = 0.2\, S_{max} \qquad (3)$$

The maximum storage term is defined by the curve number for the land- cover type under consideration:

$$S_{max} = \underline{(1000)} - 10/CN \quad (4)$$

Thus, it has been established that availability of water is crucial to the survival and growth of plants and animals including humans. Currently, the world is faced with water crisis and declining bio diversity. Thornthwaite could percieve the prospective crisis of water nearly seventy years before and for that he developed the method and a diagram to represent the situation so that possible solutions could be searched out. Figure-2 represents a water balance diagram.

Figure 2: Plotting of Water Balance



Source:https://www.researchgate.net/figure/262057727_fig4_Fig-4-Thornthwaite-water-budget-diagram-of-the-Canakkale-weather-station-for-the-period

Three parameters PE, TE and seasonal characteristics of surplus and deficit moisture conditions formed the basis for dividing world into 32 types of climates. Moisture provinces A and E have three subdivisions in each. Similarly, B and D moisture provinces have seven and six sub divisions each while C moisture province has a maximum of 10 sub divisions. Thermal provinces D', E', and F' have been represented by single climate type without having further subdivisions in them. Major climate types have been presented in following Table-4.

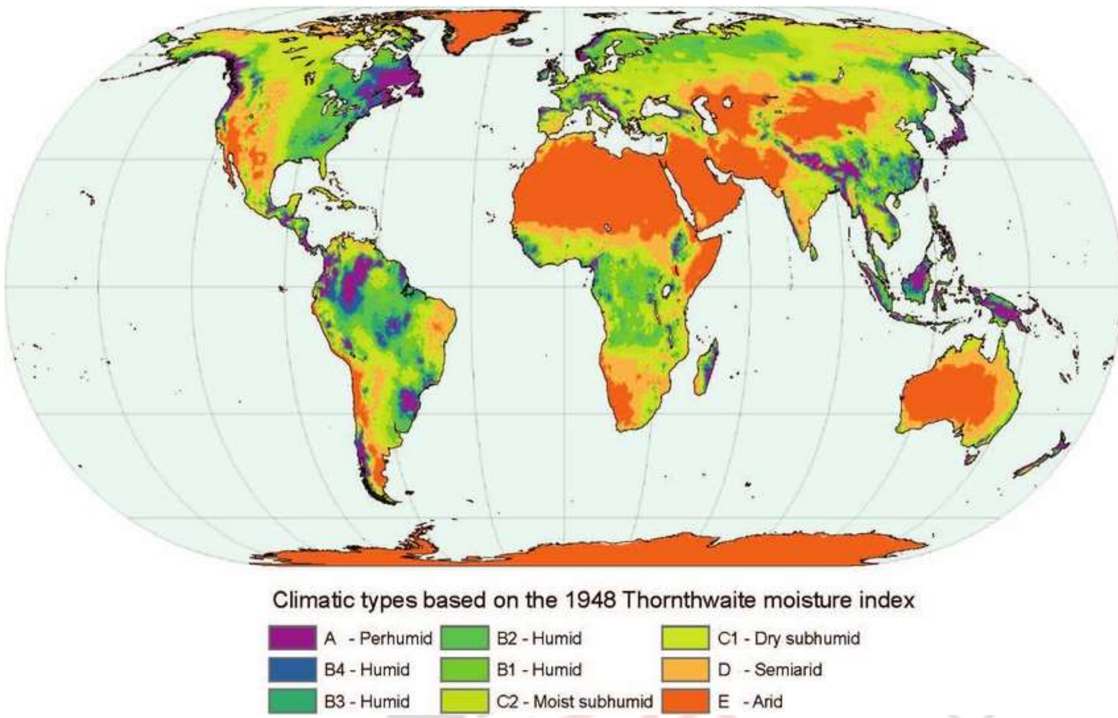
Table-4: Major climate types (based on moisture regime, thermal province and seasonal characteristics)

Per humid *Mega thermal*	**Humid** *Meso thermal*	**Moist sub humid** *Micro thermal*	**Dry Sub-humid** *Steppe*	**Semi-arid** *Taiga*	**Arid** *Tundra*	**Arid** *FrostFrost*	
AA’r	BA’r	CA’r	DA’w	EA’d	D’	E’	F’
AB’r	BA’w	CA’w	DA’d	EB’d			
AC’r	BB’r	CA’d	DB’w	EC’d			
	BB’w	CB’r	DB’s				
	BB’s	CB’w	DB’d				
	BC’r	CB’s	DC’d				
	BC’s	CB’d					
		CC’r					
		CC’s					
		CC’d					
3	**7**	**10**	**6**	**3**	**1**	**1**	**1**

Note: The first row of the table relates to titles: Moisture regimes (bold letters) and thermal provinces (italicized) for each column.

A workable scheme for identifying the type of climate based on potential evapotranspiration, average annual thermal efficiency, seasonal variation of effective moisture, and summer concentration of thermal efficiency has been presented by Thornthwaite. A map accessed from internet is also presented below. It is easy to recognize polar climates at the top closely followed by tundra type climate towards south. Close to equator, one can notice A, B, and C type of climates given successively northward. Desert climates (D type) are recognizable along the margins of tropical and subtropical belts. The map showing climatic divisions of the world, as per Thornthwaite’s classification, is presented in Figure-3.

Figure-3: Thornthwaite’s Climatic Zones



Source:https://www.researchgate.net/publication/250171991_A_Revised_Thornthwaite-Type_Global_Climate_Classification

Spatial distribution of world climates: The pattern of spatial distribution of climates reveals a pattern of zonation from equator to poles. While equatorial areas with high P/E and T/E index values express luxuriant vegetation in the form of rain forests, Tundra and Polar areas with low P/E and T/E indices express scanty and limited vegetation. Similarly, eastern coasts in subtropical areas have high P/E values and moderate T/E values and thus have forests which are mostly deciduous in nature. While humid climates (A, B, and C) are characterized by normal seasonal deficiency of moisture, arid climates (D & E) do have normal seasonal surplus of moisture in at least one season. Thus dry climates usually occupy a large place in interior parts of the continents, the western margins of the continents in tropics and eastern margins of the subtropics and temperate zones. London (U.K.) is an example of humid oceanic climate, while Athens (Greece) is an example of mild winters in Mediterranean climate. Lima (Peru) represent dry continental climate while Denver in (U.S.A.) humid continental climate. La Paz (Bolivia) at an altitude of 3664 meters above sea level has very low P/E and very low T/E index. It represents highland climate (refer to Figure-3).

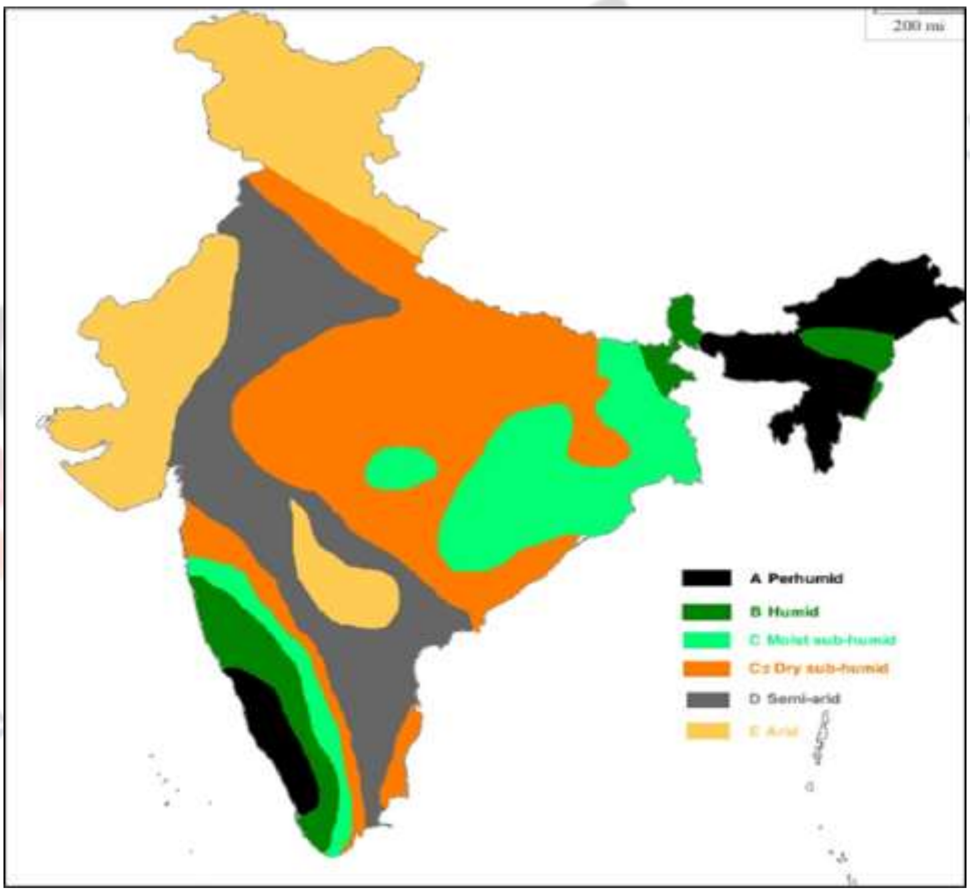
Criticism of the classification:

1. Thornthwaite's classification of world climates is improved qualitatively. However, classification seems to have ignored the role of prevailing winds, relative humidity, air pressure and air masses.
2. The classification system has proved most satisfactory in case of North America where vegetation boundaries nearly coincide with particular P/E values. But it is not satisfactory for tropical and semiarid areas.
3. The calculation of soil moisture balance for different natural regions and vegetation zones poses basic problem. Several combinations at local and regional levels increase complexity obscuring clarity of classification.
4. Availability of data for all the meteorological variables over time and space is a serious problem.
5. Despite being an improved classification qualitatively, it is being less used and of limited application because of its complex nature.
6. Thornthwaite's classification of world climates is improved qualitatively. However, classification of climate seems to have ignored the role of relief, position of sun with reference to incidence of solar radiation on the earth.
7. Current issues of global warming, climate change and increasing incidence of extreme events does not find a place in Thornwaite's classification of world climates.

Climates of India

Climates of India using Thornthwaite's modified scheme of classification (1948) have been explained with the help of a map accessed from internet location. Results reveal that per humid 'A' typeof climates have two distinct clusters in India. One in the North Eastern parts of India excluding some parts of plains of Assam and adjoining Nagaland. Second cluster is found along Malabar Coastal region. The 'B' type of climate (humid) is found in northern part of the state of West Bengal, Sikkim and parts of Assam valley. It is also found along Western Ghat Mountains in proximity to Malabar Coast. The 'C' type (moist sub - humid) of climate is experienced in large parts of Orissa, Jharkhand, eastern Bihar and Chhattisgarh regions. A small zone of moist sub humid climate is also experienced along Nilgiri hills, Western Ghat Mountains and along coastal Maharashtra. The 'C_2'(dry sub - humid) type of climate is found in large parts of pennisular India, in northern plains and along Tamil Nadu Coast. The semiarid 'D' type of climate is experienced in southern parts of Punjab- Haryana plains, Mathura- Agra belt, eastern Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Andhra Pradesh and central Tamil Nadu. The arid ‘E’ type climates are found in three major pockets. The northern most pocket of ‘E’ type of climate is found in Himalayan states of Jammu &Kashmir, Himachal Pradesh and Uttarakhand. The second major pocket of ‘E’ type of climate is found in western parts of Rajasthan state and large parts of Gujarat state including Kutchh and Kathiawad regions. Besides these arid regions, a relatively small pocket of ‘E’ type of climate is also found in parts of north eastern Maharashtra and adjoining Andhra Pradesh (Figure-4).

Figure-4: Climates of India Based on Thornthwaite’ Modified Classification 1948



Source: https://www.iasmania.com/wp-content/uploads/2016/02/Thornthwaite-Scheme-of-Climate-classification.png

Difference in the classification of climates by Koppen and Thornthwaite: The scheme of the classification of world climates presented by scholars Koppen and Thornthwaite present marked difference in arrangements of alphabets, their combinations and indices. For example arid and semiarid climates find second place in the arrangements in Koppen's scheme whereas these climates find fourth and fifth place in Thornthwaite's scheme. While Koppen seems to attach higher weightage to contrasting climatic characters, Thornthwaite seems to attach higher weightage to gradual succession of characters from humid to arid. Koppen's scheme is more popular as it involves simple calculations of broad parameters whereas Thornthwaite's scheme requires rigorous calculation of moisture conditions, soil moisture balance and acute shortage and abundant surplus conditions. Therefore, the two scholars have contributed significantly in advancing our understanding about climatic elements, climate change and its impact assessments on life forms on the earth.

Summary and Conclusions:

Thornthwaite's classification of world climates is based on the precipitation and temperature indices to explain the vegetation. The classification provides an efficient way to describe biotic life of plants and animals through precipitation and temperature and their seasonality. Influences of climate are well reflected in both plant as well as animal life and as such, exercise direct influence on ecosystem and bio-diversity. The issues related to water balance is unique and it is now widely used in hydrology, agriculture, medical sciences, biological studies etc. Therefore, the Thornthwaite's scheme of classification is significant ecologically also as it considers the aspects of moisture recharge, porosity and permeability of soil etc.

The most valuable contribution of Thornthwaite is his concept of evaporation-evapotranspiration. It has helped in studying water balance in an applied sense. Not only devising equations for the identification of climate group, Thornthwaitehas also established a laboratory of climatology atDrextel Institute of Technology, Centerton, New Jersey. Instructional manuals and tables were also published for solving difficulties of calculations. Similar to the use of statistical tables in mathematical calculations, tables on climate developed by Thornthwaite are widely used in studying climate types and climate change. The method and means of representation is simple and helps in devising solutions for the increasing incidence of the scarcity of water with which world is currently faced. The classification is widely used to map long term climate and associated ecological conditions. It is simple and easy to work out the type of climate if alphabetical (letter)) codes are known. Similarly, if data on temperature, precipitation and seasonality is available, it is easy to code the climate type.

With the increasing incidence of extreme climate events, there has been an increasing interest in using the classification to identify changes in climate and potential changes in different life forms such as plants, animals and humans. The most useful significance of Thornthwaite's climate classification is that it helps to predict the dominant vegetation type based on climatic data and vice versa. From different scientific reports, it has been established that more than 5% of all the land area worldwide had moved from wetter and colder classifications to drier and hotter classifications. The concept of water balance is essential to monitor the requirement of water for crops in different seasons.