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IMPLICATIOIN OF KOPPEN'S CLIMATE CLASSIFICATION ON AGRICULTURE IN NIGERIA

***PIUS WILLIAMS WUAM *NAFIU UBAYO AND **IBRAHIM DAUDA**
**Department of Geography, Aminu Saleh College of Education, Azare, Bauchi State*
***Department of Educational Foundations, Federal College of Education (Technical) Gombe, Gombe State*

Abstract

Koppen's climate classification which is today the most widely used in the world based his classification on three elements of climate namely; temperature, vegetation and precipitation. However, there is no single classification of climate anywhere in the world that can serve more than a limited number of purposes satisfactorily even though many different classifications such as the Greek classification and Aristotle's schemes have been developed over the years. It is in the light of this that, this paper focuses on Koppen's climate classification system and its implication on agricultural production in Nigeria. Information in producing meaningful system of climatic classification, the origin of Koppen's climatic classification, application of the system, strengths and weaknesses of the scheme and its modification and the implications to agricultural production in Nigeria was looked at. It was concluded that, despite numerous weaknesses observed with the system it still remains the most widely used classification in the world today. Amongst others it was recommended that issues of climate be given priority attention by government as it serve as a veritable tool for agricultural production and results of weather forecast

KEYWORDS:
Implications, Climate classification and Agricultural production.

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should be made available to farmers to enable them take informed decisions on types of crops to plant at any point in time.

INTRODUCTION

The earth's climate has been classified in a variety of ways. The various schemes of climatic classification have the same goal, that is to reduce very many local climate to a relatively few types with important characteristics in common (Abgunde ***et al***. 1991). The purpose of any classification therefore, is to obtain an efficient arrangement of information in a simplified and generalized form. Wikipedia, the free encyclopedia also opined that the purpose of classification is to organize a set of data or information about something to effectively communicate it in an informative way. Classification helps synthesize information into smaller units that are more easily understood. It is also an attempt to distinguish various combinations of climatic elements throughout the world and show the units of areas in which they occur. In view of the fact that no single classification can serve more than a limited number of purposes satisfactorily, many different classification schemes have been developed. When considering the earth's climate there is such an enormous amount of information that one has to break down into areas of commonality to easily understand it. Climatologists have therefore created several ways to organize the wealth of information about earth's climate to bring order and understanding to it.

The Concept of Climate

In general terms climate is seen as the average weather condition of a place over a long period of time usually between 30-35 years. According to Ojo, Ologe and Ezechukwu (1992) climate is seen as the average condition of weather experienced at a particular place over a relatively long period of time of about 30 years or more. In a similar vein, Adeleke and Leong (1980) and Iwena (2012) opined that climate is the average atmospheric conditions of an area over a considerable time, noting that unlike weather climate of a place lasts for a very long time before it can be change. Meaning that for climatic averages to be realized a minimum of 35 years is desirable. This involves the systematic observation, recording and processing of the various elements of climate such as rainfall, temperature, humidity, air, pressure, winds, clouds and sunshine before any standardization of the climatic means of averages can be reached. Furthermore, Ayodele (2011) posited that climate is the synthesis of

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weather at a given location over a period of about 30-35 years. Going further, he noted that climate therefore, refers to the characteristics condition of the atmosphere deduced from repeated observations over a long period. Similarly, Monkhouse and Small (1979) observed that climate is the total complex of weather conditions, its average characteristics and range of variation over an appreciable area of the earth's surface. Usually conditions are over many years (e.g. 30-35) are taken into consideration.

Determinants of Meaningful System of Climate Classification

Abegunle, Adegoke, Onwumere and Dahiru(1991) observed that certain categories of information are very useful when it comes to producing a meaningful and reliable system of climate classification. They mention these information to include the following; net radiation, temperature, precipitation, soil moisture balance and vegetation. Others are soils and air mass source regions and frontal zones.

i. **Net Radiation:** It is an expression of the difference between incoming and outgoing energy in both short wave and long wave forms. Radiation from the sun is mostly short wave, while that leaving the earth is long wave. Climate classification by net radiation attempts to analyze the annual causes of net radiation with respect to the maximum values, the annual range of values and the form of the curve.

ii. **Temperature:** This involves the use of monthly mean air temperature as measurable in the standard thermometer shelter located in observing stations the world over.

iii. **Precipitation:** Monthly and annual precipitation data from the important basis of most of the widely used climatic classification. Precipitation data covering the globe are obtained with the aid of simple rain guage for long periods of time.

iv. **Soil Moisture Balance:** This scheme is based on the concept of potential evapor-transpiration and the moisture budget. The important principle involved is that o precipitation by itself does not indicate the amount of water actually available to plants. Vapor-transpiration must be subtracted from precipitation to reveal the net gravity of water as surplus or deficit.

v. **Vegetation:** There is an awareness that plants are highly responsible to differences in climate that is, plants tend to adapt themselves to the stresses of climate. It has also been observed worldwide that

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the several fundamental classes of mature soils are more strongly controlled by climatic elements than any other single factor.

vi. **Air Masses Source Regions and Frontal Zones:** Atmospheric circulation forms the genetic basis of large scale or macro climates. This can be related to regional climatology in terms of wind regimes or air masses.

Origin of Koppen's Climate Classification

Koppen's climate classification is the most widely used classification systems in the world (Abegunle ***et al*** 1991). It was first published by the Russian-German geographer, meteorologist, climatologists and Botanist Wladimir Koppen in 1884, with several modifications by Koppen himself, notably in 1918 and 1936. Later the German climatologist Rudoff Geiger collaborated with Koppen on changes to the scheme. Koppen's Classification is based on the concept that native vegetation is the best expression of climate. Thus climate zone boundaries have been selected with vegetation distribution in mind. It combines average annual and monthly temperatures and precipitation and the seasonality of precipitation. Koppen's classification as identified by Wikipedia, the free encyclopedia and collaborated by Iwena (2012) consist of six major climatic groups. These include the following:

i. Group A: Tropical/Mega thermal climates
ii. Group B: Dry (arid and semi arid) climates
iii. Group C: Temperature/Meso thermal climates
iv. Group D: Continental/Micro thermal climates
v. Group E: Polar climates
vi. Group F: Alpine climates

Application of Koppen's Climate Classification Scheme

According to Wikipedia the free encyclopedia, Koppen's climate classification divides the climate into five main groups and several types and sub-types. Each type is represented by a 2-4 letter symbol.

1. **Group A: Tropical/Mega thermal Climates:** Tropical climates are known to be characterized by constant high temperature (both at sea level and low elevations). All 12 months of the year have average temperature of 18 degrees (64 degrees Ferenhight) or even higher. They are sub-divided as follows:
    - Tropical rain forest (af)
    - Tropical Monsoon Climate (am)

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- Tropical Wet and dry or Savanna Climate (aw)

2. **Group B: Dry (arid and semi arid) Climates:** These are characterized by the fact that precipitation is less than potential vapor-transpiration.
3. **Group C: Temperature/Meso thermal Climates:** They have an average temperature above 10c (50F) in their warmest months and the coldest months averages between 3c (26.6 F) and 18c (64F). They are sub-divided as follows:
    - Mediterranean climates (csa, csb)
    - Humid sub-tropical climates (cfa, cwa)
    - Maritime temperature climates or oceanic climates (Cfb, Cwb, Cfc)
    - The temperature climate with the winters (Cwb)
4. **Group D: Continental/Micro thermal Climates:** These climates have average temperature above 10c (50 F) in their warmest months and coldest month average below -3c (0c). They are divided as follows:
    - Hot summer continental climates (Dfa, Dwa, Dsa)
    - Warm summer continental or Hemibozeal climates (Dfb, Dwb, Dsb)
    - Continental sub-artic or boreal (taiga) climates (Dfc, Dwc, Dsc)
    - Continental sub-artic climates with extremely severe winters (Dfd, Dwd)
5. **Group E: Polar Climates:** Average temperatures here are below 10c (50 F) in all 12 months of the year. The group is sub-divided thus:
    - Tundra climate (ET)
    - Ice cap climates (EF)
6. **Group F: Alpine Climates:** Examples, Cusco, Peru.

Strengths of Koppen's Climate Classification

The strengths of Koppen's classification lie in the following:

a. The system has been much used in the study of West African climates in actual practice and is found to work out well.
b. With this classification it is possible to assign a given place to a particular climate sub-region solely on the basis of the records of temperature and precipitation of that place, provided that the period of record is long enough to yield meaningful averages.
c. The system is strictly empirical; this is to say that each climate is defined according to fixed values of temperature and precipitation, computed according to the averages of the year or individual months.

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d. Also, Koppen's classification is simply a guide to the general climate of the regions of the planet; the borders do not represent instantaneous shifts in climate but are mainly transition zones where climate and especially weather can fluctuate.
e. The system is quite easy to understand.
f. The system can equally be used for further research purposes.

Weaknesses of Koppen's Climate Classification System

Despite the numerous strengths of Koppen's classification, there are some weaknesses as well. Some of these weaknesses as observed by Ojo ***et al*** (1992) include the following:

a. Some of Koppen's critics wondered if his climatic classification system is actually climatic. This because Koppen believed in the relationship between vegetation and climate. He considered major elements necessary for vegetation as five (i.e. A, B, C, D and E) all these five climatic groups have been determined by vegetation. Only one i.e. "B" is based on the combination of temperature and rainfall.
b. Critics also observed that Koppen's climate classification is not comprehensive enough because according to them the system does not account for the climates of highlands (mountainous) regions and climatic regions plagued by fog. It was Gaiger who added the letter "H" to account for highland regions and Trewartha added a tertiary code "n" for climatic regions plagued by fog.
c. Koppen's climate classification according to critics is not as simple as it appears to be, instead it appears very confusing.
d. Koppen was also criticized because his climate classification is strictly empirical in nature in respect of climatic boundaries.
e. It was also observed that there is a fundamental inconsistency in the definition of the major climatic groups. A, B, C, D and E are defined by temperature averages, whereas "B" is defined by precipitation and evaporations.
f. Another bone of contention observed by critics involves the dry "B" climates, the argument being that their separation by Koppen into only two thermal subsets is inadequate.

Modifications of Koppen's Climate Classification

Koppen's climate classification system was first published in 1884 by the Russia-German Climatologist and Botanist himself (Dr. Wladimir Koppen). After the first publication in 1884, ther was several modifications of the system,

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notably in 1918 and 1936 by Koppen himself. Later the German Climatologist Radolph Geiger collaborated with Koppen on changes to the classification system. In 1928 Koppen co-authored a wall map with his student Radolph Geiger and together with him the system was upgraded and modified periodically by Koppen until his death in 1940. Since that time it has been modified by several Geographers. The most common modification of Koppen's system today was that of the late University of Wiscosin geographer Glen Trewartha. The modified version uses six letters to divide the world into major climate regions based on annual precipitation, average monthly precipitation and average monthly temperature as follows:

- A for tropical humid
- B for dry climate
- C for mild mid-latitude
- D for severe mid-latitude
- E for polar
- H for highland

Implications of Koppen's Climate Classification on Agricultural Production in Nigeria

Accoding to Sadiq et al (2015) the geographical location of Nigeria between Latitudes 5° N and 14° N places most of the country in Koppen's Aw tropical continental climate characterized by wet summers and dry winters. Koppen's Af climate type or tropical wet climate characterized by all year rainfall exist in the Niger Delta region of Nigeria. The dominant climate regime is responsible for Nigeria's dual eco-agricultural zones (Northern and Southern zones). The northern zone due to short period of rainfall being experienced grows annuals and cereals such as sorghum, rice, groundnuts, cotton, millet and wheat while the southern part with heavy rainfall grows mainly tubers such as yams and cassava and perennial tree crops such as cocoa, cola nuts, palm produce and citrus fruits (Adeboye, 1989). Studies have shown that out of the estimated total land area of 923, 768 km^2, land area occupies 910, 768 km^2 while water accounts for 13, 000 km^2. The land use pattern consists of: 33% arable land, 3% permanent crops, 44% permanent pasture, 12% forest and woodlands and others 8% (Adamawa State Government, 2009). This is an indication that the scope for agricultural extension in Nigeria is quite large. Climate affects Nigeria's agricultural production in two major ways: Direct and indirect. The direct effect is the one mentioned above as being responsible for the two broad eco-agricultural zones of cereals and annuals in the north owing to short

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period of rainfall and tubers and perennials to the south due to heavy rainfall in the area. The indirect effects operates through climate's influence on pests, disease and land/soil degradation.

Conclusion

Despite the numerous weaknesses of Koppen's climate classification system observed by critics, it still remains the most widely used in the world today. Though certain modifications have been made to the original system by Koppen himself and several other geographers and climatologists, notably Glen Trewartha of the University of Wisconsin, such modifications have merely built on the foundation laid by Koppen. The system's implication to agricultural production in Nigeria is one of the positives derived from the classification scheme, where Nigeria fits into the tropical continental climate of wet summers and dry winters of the north and the tropical wet climate of southern Nigeria.

Recommendations

The paper recommends that:

1. Issues of climate should be given priority attention by government as it serves as a veritable tool for agricultural production.
2. Results of weather forecast should be made available to farmers at all times to enable them take informed decision on types of crops to plant at any point in time.

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