MODULE 3

Unit 1 Tropical Climate
Unit 2 Weather and Climatic Hazards in the Tropics
Unit 3 Physiological Comfort

UNIT 1 TROPICAL CLIMATE

CONTENT

1.0 INTRODUCTION

Any of the approaches to climate classification (empirical, genetic, or applied) might be employed logically to identify patterns of climatic change, but far less is known about the nature and causes of climates in the distant past than those of the present. This system for organising climatic types is designed to facilitate the explanatory description of world climates. It follows the approach of Koppen, relying heavily on temperature and precipitation, their seasonal regimes, and (on land) the response of natural vegetation as criteria for subdivision.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- explain different approaches to climate classifications;
- define Tropical Humid climate, and other climate types; and
- explain climatic characteristics of tropical climate and other climate types.

2.1 HOW TO STUDY THIS UNIT

1. You are expected to read carefully through this unit at least twice before attempting to answer the self-assessment questions or tutor- marked assignment.
2. Do not look at the solution given at the end of the unit until you are satisfied that you have done your best to get all answers.
3. Share your difficulties with your course mates, facilitators and by consulting other related material, particularly the internet.
4. Note that if you follow the instructions you will feel self fulfilled that you have achieved the aim of studying this unit. This should stimulate you to do more.

3.0 WORD STUDY

Regime- mode of rule or a set of characteristic
Empirical- pertaining to physical observations
Arid- very dry

4.0 MAIN CONTENT

4.1 Approaches to Climate Classification

Climate classification has three interrelated objectives, they are:

- to bring order to large quantities of information,
- to speed retrieval of information, and
- to facilitate communication.

It is concerned with organisation of climatic data in such a way that both descriptive and analytical generalisations can be made, and it attempts to store information in an orderly manner for easy reference and communication, often in the form of maps.

Thus, in the design of a climatic classification we should begin by defining the purpose. There are three fundamental approaches to climatic classification.
(1) Empirical
(2) Genetic; and
(3) Applied.

Together they constitute a classification of classifications, but the features of all three may be incorporated into a single system.

Empirical classifications are based on the observable features of climate, which may be treated singly or in combination to establish criteria for climatic types. Temperature criteria, for example, might yield ‘’hot’’, ‘’warm’’, ‘’cool’’, and ‘’cold climates, each of which can be defined in terms of strict mathematical limits. Heat and moisture

factors, have dominated empirical classification, but all elements are inherently significant for one purpose or another.

Genetic classification attempts to organise climates according to their causes. Ideally, the criteria employed in the differentiation of climatic types should reflect their origins if climatology is to be explanatory as well as descriptive. In practice, however, explanations are often theoretical, incomplete, and difficult to quantify. Genetic classification also is subject to theoretical biases; a system based on causes tends to perpetuate faulty or over-generalized theories. A common genetic approach attempts to distinguish the relative continentality or maritimity (sometimes termed oceanity) of a climate. In practice, indices to express the influences of land of water surfaces have been determined from various empirical data, mainly temperature, precipitation, wind, and air mass frequency.

Applied (also known as technical or functional) classifications of climate assist in the solution of specialised problems that involve one or more climatic factors. They define class limits in terms of the effects of climate on other phenomena. Outstanding among modern attempts at climatic classification are those that seek a systematic relationship between climatic factors and the world pattern of vegetation. Natural vegetation integrates certain effects of climate better than any instrument that has so far been designed, and it is thus an index of climatic conditions.

There have been diverse opinions on what should be the basis for climate classification. The climate of any area is not created by a single climatic element, but by the distinctive combination and interrelation of several elements. The many variations of climate from place to place as determined by different combinations of climatic controls produce a correspondingly large number of climatic types. For each type of climatic, certain important common characteristics are recognised, and these enable the vast amount of climatic data available on the surface of the earth to be grouped together, so that some distributional patterns become apparent.

However, it is generally agreed that four main basic divisions can be recognised. These are (a) the tropical humid climates (b) the middle latitude humid climates (c) the arid climate and (d) the polar and arctic climates. In the discussions that follow, it is only the description of the characteristics of the tropical humid climates is given.

4.2 What is Tropical Humid (Koppen's 'A') Climate

The definition of the term tropical humid climate is a problem for which there is no completely acceptable solution. The term, humid has for example been defined in many ways depending upon the context in which it is used. Two issues need to be resolved. The first one is that of the length of seasonality before a station is classified as humid. The second one relates to the basis for delimiting the boundaries. One of the most widely used system of classification in its original form or with modifications is that of Wladimir Koppen (1846 – 1940), a German biologist who devoted most of his life to climatic problems. Koppen aimed at a scheme which would

relate climate to vegetation but would provide an objective, numerical basis for defining climate types in terms of climatic elements. Kuchler in 1961 employed vegetation as a criteria for delimiting the humid tropics and defines humid tropicality as optimum conditions for plant growth, organic productivity, agriculture and forestry. B. J. Garnier in the same year, used rainfall, temperature and vapour pressure as his criteria, instead of temperature and precipitation which were employed by Koppen, the concepts of precipitation effectiveness and temperature efficiency were introduced by Thornthwaite in his 1931 classification. In determining his climatic types, Thornthwaite, therefore used empirical approach, noting vegetation, soil and drainage pattern in relation to climatic characteristics.

4.3 Characteristics of Tropical Climates

The tropical humid climates experience high temperatures with a mean of about 27^oC throughout the year. They lie in low latitudes near the equator, covering between the equator and five degree or six degree north or south of the equator. They are also generally in the belt of intertropical convergence and the trade winds which originate in the subtropical high pressure cells around latitude 30^oN or S, and flow towards the equator. The location in the low latitudes implies that the area is characterised by all year abundance of insulation.

4.4.1 Tropical Rainy Climate Tropical rainy climates are located on lowlands on or near the equator. They are also found on tropical coasts exposed to trade winds and backed by highlands. The climate is dominated by the presence of plentiful rainfall, well distributed throughout the year, and by temperatures which are high with small diurnal ranges. The ranges are in the vicinity of 8^o to 10^oC around an average daily temperature of 25^o to 28^oC. Temperature conditions are remarkably steady and vary little from day to day or month to month. The intertropical convergence zone dominates the greater part of the tropical rainy climates.

4.4.2 Tropical Dry climates These climates constitute a direct contrast to tropical rainy climates. We have called them ‘dry’ because characteristically have too little rainfall at any time of the year to sustain much vegetation. They are, indeed the great tropical deserts of the world. They coincide with the zone dominated with subtropical high pressure cells. The principal areas covered by this climatic type are in the northern part of Africa (the Sahara and Somalia), the west coast of southern Africa, part of south-eastern Asia, from Arabia to Pakistan, and in both North and South America. Although described ‘dry’, these climates do have precipitations at a times.

4.4 Other Climate Types

Middle Latitude Humid Climates: The most distinguishing characteristic of the middle latitude humid climates is the lack of constant heat of the tropics and the constant cold of the polar areas.

Polar and Arctic Climates: In the polar climate mean monthly temperatures are all below 0^oC and vegetation is entirely lacking. Snow, ice, or barren rock covers such areas. The polar climate and the associated icecaps predominate over most of Greenland, the permanent ice of the Arctic Ocean, and Antarctica. The lowest mean annual temperatures are those of the polar icecaps on Greenland and Antarctica. Monthly means in the polar summers are well below freezing in spite of the continuous daylight. Winters in the polar climates are colder still; monthly means range from -20^oC to less than -65^oC. Diurnal variations of temperature are small throughout the year in polar climates. In summer they decrease generally toward the poles, where the change in altitude of the sun during the day is least.

Arid Climates: The classification of arid and semi-arid climates presents one of the most difficult climatological problems. The two most commonly employed parameters in the literature are temperature and precipitation. Examples of the definitions of the concept are those by Koppen and Thornthwaite in their respective climatic classifications. Of the many indices developed for defining aridity, none is completely satisfactory. They all express the idea of excess of potential evapotranspiration or water loss over precipitation. The semi-arid types are essentially a transition zone from the very dry regions to the bordering moister climates. In contrast to the semi-arid climates, the arid climates are located in the core areas of the regions of air subsidence, divergence and temperature inversion, which are opposed to the development of fronts or atmospheric disturbances which might give rainfall. The tropical arid and semi-arid climates are centred approximately on the latitudes 20^o to 25^o N and S, where the controlling air masses are those which subside in the subtropical highs. The arid and semi-arid climates of the middle latitudes primarily result from their location deep into the interior of the continents, and thus, far removed from the oceans, which are primary sources of atmospheric moisture (ie, the principal control of the middle latitude deserts is their location in the continents far removed from the windward coasts). The dry climates of the middle latitudes differ from the tropical arid and semi-arid climates in two important respects. (a) Average temperatures are lower and (b) migrating winds and pressure systems are not the chief controlling factors. The tropical arid and semi-arid area, an important temperature characteristic is the large annual range, a reflection of continental location. In common with the tropical arid and semi-arid climates, the middle latitude arid and semi-arid climates are characterised by low precipitation, usually lower than 500 mm for the semi-arid climates and less than 250 mm for the completely arid climates.

5.0 CONCLUSION

In conclusion, we learnt that the approaches to climate classification are empirical, genetic, or applied might be employed logically to identify patterns of climatic change, but far less is known about the nature and causes of climates in the distant past than those of the present.

6.0 ACTIVITY

1. Explain the empirical classification of climate and state 3 criteria it can be based on.
2. What can say above the following in the Polar and Arctic climates? i) mean monthly temperatures, ii) vegetation
   iii) Surface.
3. Assuming the average monthly temperature of an area is below 0^0C, what are the major features will such a region have? What climate type will you call it?

7.0 SUMMARY

This unit has within its limit defined and explained tropical humid climate and the different approaches to climatic classifications. Apart from explaining the characteristics of tropical humid climate, other climate types and their characteristics were also identified as middle latitude humid climate, polar and arctic climate, and arid climate.

8.0 ASSIGNMENT

1. What are the objectives of climate classification?
2. Explain the different approaches to climate classification.
3. Write a short note on Tropical humid climate.

9.0 REFERENCES/FURTHER READING

Ayoade, J. O. (1983). *Introduction to Climatology for the Tropics*. New York: John Wiley & Sons.

De Sherbinin, A, Schiller, A. & Pulsipher, A. (2007). "The Vulnerability of Global Cities to Climate Hazards." *Environ Urban,* 19. pp. 39–64.

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UNIT 2 WEATHER AND CLIMATIC HAZARDS IN THE TROPICS

CONTENT

1.0 INTRODUCTION

Sometimes people make daily adjustments to the changing weather, they also face decisions involving climate when planning a vacation or when they contemplate a change of residence for any reason, be it improved economic or social status, retirement, health, or climate itself. Human perception of climate and its hazards embraces the criteria of cause, magnitude, time and duration, spatial arrangement, uncertainty, and resultant effects. Many weather and climatic hazards are linked to major natural disasters. The nature of the hazards may vary from country to country, but their implications to society remain a common factor. The characteristics of weather hazards in the tropics have been explained and recent examples given in the passage.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- explain characteristics of weather hazards in the tropics;
- explain characteristics of climate hazards in the tropics;
- mention some weather and climate hazards in the tropics; and
- discuss the consequences of changes in our future climate.

2.1 HOW TO STUDY THIS UNIT

1. You are expected to read carefully through this unit at least twice before attempting to answer the self-assessment questions or tutor- marked assignment.
2. Do not look at the solution given at the end of the unit until you are satisfied that you have done your best to get all answers.

3. Share your difficulties with your course mates, facilitators and by consulting other related material, particularly the internet.
4. Note that if you follow the instructions you will feel self fulfilled that you have achieved the aim of studying this unit. This should stimulate you to do more.

3.0 WORD STUDY

Squally- sudden violent bursts of wind
Cumulonibus- a cloud with a tall structure and a flat base often associated with thunderstoms
Socio-economic – pertaining to social and economic factors

4.0 MAIN CONTENT

4.1 Characteristics of Weather Hazards in the Tropics

Although tropical weather has other features similar to those of mid-latitudes storms, they generally do not exhibit sharp discontinuities of temperature. Many have weak pressure gradients and lack well defined-wind systems. Extensive, shallow occasionally bring long periods of overcast weather with continuous rain. In the intertropical convergence there may be convective activity and thunderstorms, the smallest and most frequent type of tropical disturbance. Convergence tends to increase when the equatorial trough of low pressure moves poleward in summer, producing bands of cumulonimbus clouds and high overcasts of cirrus. A common feature of tropical weather is the easterly wave, which normally forms in the convergent flow of trade winds and moves slowly from east to west. Squally weather and precipitation frequently accompany such a disturbance. Some easterly waves move pole ward and curve toward the east to become extra tropical cyclones. Others may develop vortices, become tropical cyclones, and even grow to hurricane intensity. The violent and destructive forms of tropical cyclones are much better known than the weaker variety although the former are, fortunately, much less common. They originate over the tropical oceans only. In the Caribbean and off the Pacific Coast of Mexico they are known as hurricanes; in the seas off China, the Philippines, Japan, and the other islands of western Pacific they are called typhoons; in the Indian Oceans they are simply called cyclones, a term which should not be confused with cyclones in general. In the Southern Hemisphere they occur east of the African coast and along the northwest and northeast coast of Australia.

Some Weather Hazards
Recent weather hazards of the last few decades have been rather conspicuous to such an extent that the whole world is expressing the view that a major global climate change is going on. It has become aware of the increasing degree of devastation and insecurity to lives and property by weather hazards and the resultant impacts on the socio-economic development of nations. Records show that weather hazards date back from history. The existence of such hazards as droughts, desertification, storms, floods, heat waves, global warming, hurricanes, acid rains, erosion etc are very

rampant and have, over the last couple of years, become one of the world's major topical subjects. In the United States and the Caribbean for example, several thousand lives and property have been lost in the past through the occurrence of hurricanes and tornadoes. On the other hand, the ravages of tropical storms in India, Bangladesh and Pakistan are still annual events each time sweeping away whole villages and destroying crop-lands. In recent years, severe drought has affected countries in sub-Saharan Africa; Sudan, Madagascar, Mozambique, Comoros, Mauritius, Reunion, Seychelles, and China have been hit by worst flooding many times.

4.2 Characteristics of Climatic Hazards in the Tropics

Climate and its variability also affect many aspects of socio economic development and can take on the form of a meteorological hazard. In Africa, and elsewhere, an appraisal of climate as a natural resource is important, especially as this resource may now be subject to significant change. Projected global climate change due to the so called "greenhouse effect'' would be an unprecedented event in the history of human civilisation. Its magnitude is comparable only with changes on a geological time scale, and its rate is going to be much swifter than that of any past natural long term climatic fluctuations. It is this rate of change that makes us consider future climate change as a hazard, since ecological and socio-economic systems would find it difficult to adapt to it without serious implications.

5.0 CONCLUSION

Future climate change is very often referred to in terms of climate warming. Indeed, changes in atmospheric concentration of 'greenhouse gases' or GHGS (Carbon dioxide and other trace gases) would lead to warming near the Earth's surface and in the troposphere. It is generally agreed that the global mean surface temperature has increased by 0.6^{o} to 0.7^{o}C since 1860, when instrumental records began. Certainly many other meteorological and hydrological variables will change. There may be changes in regional climate patterns, global atmospheric circulation, and sea level. This can lead to changes in frequency, magnitude and location of such hazardous phenomena as floods, storms and droughts. Sea level rise associated with this warming, which is estimated to be 20 to 140cm, will constitute a very serious hazard for many islands and low lying coastal areas, especially in the topics.

6.0 ACTIVITY

1. State 5 major weather and climatic hazards in Nigeria
2. Explain the socio-economic effect of the above hazards
3. Suggest 3 measures to mitigate the above effects.

7.0 SUMMARY

This unit has within its limit explained the characteristics of weather and climatic hazards in the tropics. Some tropical weather hazards have also been mentioned in the passage. Also explained are the consequences of the regional future climate changes in the tropics.

8.0 ASSIGNMENT

1. What are the characteristics of weather hazards in the tropics?
2. What are the consequences of changes in regional future climate patterns?
3. (a) Enumerate some major weather hazards in the tropics.
   (b) Explain, how some major weather events can lead to hazards in the tropics.

9.0 REFERENCES/FURTHER READING

Ayoade, J. O. (1983). *Introduction to Climatology for the Tropics*. New York: John Wiley & Sons.

De Sherbinin, A, Schiller, A. & Pulsipher, A. (2007). "The Vulnerability of Global Cities to Climate Hazards." *Environ Urban,* 19. pp. 39–64.

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UNIT 3 PHYSIOLOGICAL COMFORT

CONTENT

1.0 INTRODUCTION

Human health, energy, and comfort are affected more by climate than by any other element of the physical environment. Physiological functions of the human body respond to changes in the weather, and the incidence of certain diseases varies with climate and the seasons. Our selection of amounts and types of food and clothing also tends to reflect weather and climate. The state of the atmosphere even influences our mental and emotional outlook. Among the climatic elements that affect the human body, the more important are temperature, sunshine, and humidity. The human body maintains a balance between incoming and outgoing heat by means of the chemical process of metabolism and the physiological processes of thermoregulation in response to external factors of radiation, temperature, moisture, and air movement.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- explain what is physiological comfort;
- explain climate and human comfort;
- mention some aspects of human physiology; and
- discuss the basic principles of physiological climatology.

2.1 HOW TO STUDY THIS UNIT

1. You are expected to read carefully through this unit at least twice before attempting to answer the self-assessment questions or tutor- marked assignment.
2. Do not look at the solution given at the end of the unit until you are satisfied that you have done your best to get all answers.
3. Share your difficulties with your course mates, facilitators and by consulting other related material, particularly the internet.
4. Note that if you follow the instructions you will feel self fulfilled that you have achieved the aim of studying this unit. This should stimulate you to do more.

3.0 WORD STUDY

Physiological- pertaining to the functions and activities of living matter
Metabolism- the complete set of chemical reactions that occur in living cells

4.0 MAIN CONTENT

4.1 What is Physiological Comfort?

Physiology is the science of the normal functions of living things, especially animals. Therefore, physiological comfort simply refers to the normal functions of living things, (plants and animals). Human health and comfort suggest another possible approach to defining climatic types, with potential applications in clothing design, housing, physiology and medicine. In much the same way that heat and moisture data are used to determine critical boundaries for natural vegetation or crops, optimum and limiting values of climatic elements afford a basis for classification in terms of human response. Plants, through photosynthetic processes, take up CO_2 and produce oxygen in the presence of sunlight, thereby synthesising organic compounds from inorganic raw materials and becoming food for other organisms.

4.2 Climate and Human Comfort

In considering climate and human comfort we are dealing with an application of climatology which looks at climatic conditions from the viewpoint of their effects on or relationship with human beings. Such a study is often known as physiological climatology or human bioclimatology. Most of us are aware of feeling different on different days. Very often this is due to the weather. People find some days exhilarating and stimulating: others too hot or too humid or too cold for comfort.

Some Aspects of Human Physiology: Human beings form part of a general group of living organisms known as homeotherms. This term is used for those organisms that have a mechanism for regulating their internal body temperature so as to keep it at the correct level for healthy operation in changing atmospheric or environmental conditions. Homeotherms contrast in this respect with organisms known as

poikilotherms (a lizard is an example of a poikilotherm) have no internal regulating process and have to conform to the conditions of their surroundings. Human beings produce internal heat through the chemical breakdown of carbohydrates and the food they eat. The process is known as metabolism and the rate at which it generates heat is known as metabolic rate. Every homeotherm has an ideal internal body temperature at which the rate of chemical combustion is at such a level that the organism does not have to deal with too great extremes in its rate of chemical combustion.

4.3 Basic Principles of Physiological Climatology

1. **Metabolic Heat Production:** One principle is to recognise the importance of action as a producer of heat in a human being. Different activities affect a person's metabolic rate. Some examples are sleeping, sitting, typing, standing etc.

2. **Clothing Insulation:** There is insulation provided by the clothes. In the example of an ideal comfort, the person considered was wearing light clothes.

3. **Heat Exchange with Environment:** There is exchange of heat between a human being and the surrounding conditions. Heat loss has been shown to occur by three main physical processes: radiation, convection and evaporation. All three depend on a gradient, either of temperature or humidity, between a human being and the surroundings.

5.0 CONCLUSION

Everyone is aware that the reaction of the body to a given air temperature is conditioned by wind, humidity, and sunshine. An individual's state of health, emotional outlook, type of clothing, degree of acclimation, and a host of other factors also influence personal reaction to climate. On the other hand, CO_2 is essential for life on earth.

6.0 ACTIVITY

1. State 3 major climatic elements that can affect the human body and activities
2. What are their effects on the human body and activities?
3. Suggest ways of reducing the above effects

7.0 SUMMARY

This unit has within its limit explained what a physiological comfort is. The passage also examined critically the effects of climatic elements and human comfort. In much the same way as animals, man reacts unconsciously in his first responses to favourable or unfavourable microclimatic conditions. Conscious direction of microclimatic conditions extends to the control of the plants and animals that provide nourishment

for men, and to their own lives, homes, and work. An individual's state of health, emotional outlook, type of clothing, degree of acclimation, and a host of other factors also influence personal reaction to climate. Also explained are some aspects of human physiology, for example, those organisms that have a mechanism for regulating their internal body temperature so as to keep it at the correct level for healthy operation in changing atmospheric or environmental conditions. Finally, the basic principles of physiological climatology are also introduced.

8.0 ASSIGNMENT

1. What is physiological comfort?
2. Explain the concept of climate and human comfort.
3. Discuss some aspects of human physiology.
4. Critically examine the basic principles of physiological climatology.

9.0 REFERENCES/FURTHER READING

Ayoade, J. O. (1983). *Introduction to Climatology for the Tropics*. New York: John Wiley & Sons.

De Sherbinin, A, Schiller, A. & Pulsipher, A. (2007). "The Vulnerability of Global Cities to Climate Hazards." *Environ Urban,* 19. pp. 39–64.

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