MODULE 4

UNIT 1 CLIMATE AND URBAN PLANNING IN THE TROPICS

CONTENT

1.0 INTRODUCTION

Climate is an active factor in the physical environment of all living things. Its influences on human welfare range from the immediate effects of weather events to complex responses associated with climatic change. City populations are expanding by natural increase and also because of urban migration. The increase of population in cities is accompanied by an expansion of buildings for accommodation and also to provide for industrial and commercial exploitation. The process of urbanisation produces major and fundamental changes to the surface and atmospheric properties of the area which has been urbanised.

2.0 OBJECTIVES

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

- discuss man and microclimate;
- explain climate and urban planning in the tropics; and
- explain the characteristics of City Climates.

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

Urbanization- the process of the formation and growth of cities
Diurnal- occurring during the day time or primarily active during the day

4.0 MAIN CONTENT

4.1 Man and Microclimate

Micro-climate is the climate of smaller regions near the ground where nearly all biological entities on earth are affected by the spatial and temporal variations of temperature, humidity, radiation and other climatic factors.

In much the same way as animals, man reacts unconsciously in his first responses to favourable or unfavourable microclimatic conditions. Men are also forever creating new kinds of microclimate. Every building constructed displaces the original climate of its site, creating a warm, sunny, and dry climate with a southern exposure on one hand, and a shady, cold, and damp northern climate on the other. Industrial works are shrouded with thick haze which alters the whole radiation economy. Replacement of the original order of creation by the all-encompassing economic order ordained by man makes changes in the general climate of a country as well, and the measures adopted to further the advancement of industry are, in a long-term view, by no means always such that they also favour the advancement of life. History has taught us more than once that increasing urbanisation has brought in its train great damage to the heat and water budgets of a land. The risk of bringing about a deterioration of climate by human intervention depends on the type of climate, and is greatest where plant life is fighting for its existence because of a shortage of water or heat.

4.2 Climate and Urban Planning in the Tropics

As more and more people crowd into the world's cities, it becomes increasingly important for city planners and developers to ensure that cities are comfortable places

to live in. One step towards this is to recognise the contribution of climate to this objective. It is true that most cities have not been planned with climatic principles in mind. Urban expansion is taking place in many areas; also redevelopment and construction take place as city centres age and need renewal. Such activity provides an opportunity for 'climatic engineering' to enter into the urban development picture along with other considerations. Heat island and pollution effects rank high in the local climate produced by a city. 'Climatic engineering' should aim to reduce to a minimum their adverse consequences.

In tropical cities it is especially important to try to reduce the additional heat stress produced by urbanisation. Planning in relation to natural climatic conditions can help towards this end. Many tropical cities are coastal. The sea breeze effect, therefore, can be used to help ventilate the city by day. Yet it is surprising how many high-rise buildings line the seashore of tropical cities, effectively blocking the sea-breeze from cooling the built-up area behind them. At night outgoing longwave radiation and the effects of nocturnal air drainage may be used in a cooling role. Few cities are designed to take full advantage of this. To do so involves radiation from vegetation, parks and water surfaces which, unlike buildings, will not have absorbed and stored large amounts of heat during the day. Moreover, the presence of vegetation and parks within the city fabric will contribute notably to a reduction in the city heating effect. The object of planning is to achieve the best possible outcome. It involves making appropriate land-use decisions backed up by appropriate environmental policies. Climatologists can contribute through the data they provide. They can also contribute by emphasising the benefits that can be achieved by recognising and putting into practice the principles of climatic science in the field of urban development and growth.

4.3 City Climates

The total transformation of natural landscape into houses, streets, squares, great public buildings, skyscrapers, and industrial installations has brought about changes of climate in the region of large cities. The basic reason for the differences found in city climate is the alteration of the heat and the water budgets. This is caused by natural ground becoming largely replaced by stone, from which precipitated water is quickly lost, and because the roughness of the surface has been increased by the presence of buildings. In addition, heat is supplied by domestic and industrial fires, and finally, city air is rich in dust stirred up by traffic, and in exhaust fumes from vehicles, from fires, and from industrial works. Cities concentrate people and their activities in small areas, thereby providing excellent opportunities to examine cultural modifications of climate. Urban areas also differ from their rural counterparts in surface materials, surface shapes, and heat and moisture sources. In turn these affect radiation, visibility, temperature, wind, humidity, cloudiness, and precipitation. Concentrations of pollutants in the air above a city create an urban aerosol, which attenuates insolation, especially when the sun angle is low. Temperatures normally are highest near the city centre and decline gradually toward the suburbs, beyond which there is a steep downward temperature gradient at the rural margin. Owing to the blanketing effect of

pollutants on the radiation budget, diurnal ranges of temperature are less in urban areas than over the countryside.

5.0 CONCLUSION

You learnt that climate is an active factor in the physical environment of all living things. Its influences on human welfare range from the immediate effects of weather events to complex responses associated with climatic change.

6.0 ACTIVITY

1. State 2 major hazardous local climate produce by the city.
2. List some of the features of such climate.
3. Suggest ways of preventing or mitigating their effects.

7.0 SUMMARY

This unit has within its limit explained the relationship between man and the microclimate. Replacement of the original order of creation by the all-encompassing economic order ordained by man makes changes in the general climate of a country as well, and the measures adopted to further the advancement of industry are, in a long-term view, by no means always such that they also favour the advancement of life. Heat island and pollution effects rank high in the local climate produced by a city. Planning in relation to natural climatic conditions can help towards this end.

8.0 ASSIGNMENT

1. How has man influenced the microclimatic factors in his environment?
2. What are the necessary climatic requirements for urban planning in the tropics?
3. (a) Examine the extent of modification of city climate by man.
   (b) How does the urban climate differ from its rural counterpart?
4. What are the climatic characteristics of an urban area?

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 TROPICAL DISTURBANCES

CONTENT

1.0 INTRODUCTION

Daily synoptic streamline charts show many features which are absent from mean annual or monthly charts. This is due to the smoothing which occurs when average values are taken. The synoptic systems found on daily charts include various types of eddies or vortices, wave patterns and convergence zones. These may be associated with convergence and divergence. Ascent or descent of the air takes place, resulting in many different types of weather on a synoptic scale. These, in turn are modified by local effects in the various localities. The most vigorous tropical disturbances are the intense cyclonic storms that form over warm tropical waters.

2.0 OBJECTIVES

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

- define a tropical disturbance;
- identify some of the synoptic systems associated with the tropical disturbances; and
- explain where and how the disturbances are located in a weather chart.

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

Synoptic- obtained simultaneously, over a wide area, for presenting a comprehensive and nearly instantaneous picture of the atmosphere

Eddy- a current of air or water running back, or in opposite direction to the main current or a circular current

4.0 MAIN CONTENT

4.1 What is Tropical Disturbance?

We shall use the term tropical disturbance to describe any feature of the circulation which disturbs the basic tropical air currents. Unlike the mid-latitude depressions, tropical disturbances are rarely frontal. They vary widely according to their location, and there are many different systems of classification. The most commonly recognised are: (a) Wave disturbances (b) Monsoon depressions (c) Linear depressions (including line squalls or other equatorial trough disturbances) and (d) Cyclones and Cyclonic vortices.

Wave Disturbances: These are troughs developed in the trade winds and in the equatorial easterlies. They are unlike depressions, being scarcely detectable in the surface pressure field, but form a closed low pressure area in the middle troposphere. They are sometimes referred to as tropical streamlines. The origin of the phenomenon is rather difficult to trace. Possible causes include weak trade-wind inversions which tend to disturb the pressure and wind systems, and the penetration of cold fronts into the low latitudes. A sequence of weather conditions usually occur with the passage of these waves. In the ridge a head of the trough, fine weather with scattered cumulus cloud and some haze occur. Close to the trough are cumulus clouds, occasional showers and poor visibility. Finally, behind the trough, the wind veers in the direction, heavy cumulus and cumulonimbus clouds form with moderate to heavy thundery showers, temperatures decrease and there is a general clearing of the air. This is very similar to the passage of mid-latitude depressions.

Monsoon Depression: These are weak cyclones which occur in many portions of oceanic and continental tropics. They are most prominent over southern Asia in the mid-summer, when the equatorial low pressure is extended to the Asiatic continent. They also happen in West Africa and Central America. They move westward in strong easterly air stream around 8,000 – 10,000m (25,000 to 30,000 feet) above the ground surface. There are various types depending on the intensity of the development.

Linear Depressions: These comprise line squalls, linear depressions, or equatorial rough disturbances and are another variant of the weak cyclonic weather common in the tropical regions. They are associated mainly with a trough of low pressure at the surface. They happen in the region where trade winds converge, and causing a major

building of tropical cumulus clouds. The weather pattern associated with linear systems is often traced to the breakup of the trade wind system into small cyclones which move from east to west. These cyclones form disturbance lines which are very important causes of rainfall particularly in West Africa.

Tropical Cyclones: These are the violent disturbances termed hurricanes in the Atlantic and eastern Pacific, typhoons in the western pacific and cyclones or hurricanes in other areas of occurrence. Unlike the middle latitude depressions, they are found only at certain seasons in certain regions of the tropics. The life cycle of a tropical cyclone averages six days from the time of their inception until they enter land and recurve into the middle latitudes. The regions of formation are normally characterised by high temperatures and high water vapour content. The first sign of the development of a tropical cyclone is a pressure drop accompanied by a wind circulation which is clockwise in the northern hemisphere and anti-clockwise in the south. After some days, the pressure in the centre drops more rapidly and the winds get stronger. The wind rises to gale force over a confused sea; the clouds get thicker and lower finally forming dense nimbostratus with continuous rain. At maturity, the surface pressure at the centre of the cyclone no longer falls and the wind speeds no longer increase. Many hurricanes sometimes break out of the tropics into the middle latitudes and thus recurving pole ward and subsequently eastward into the belts of westerly's. Alternatively, others may move over the land and dissipate quickly within the tropics, particularly in areas where the convective rains generally cool the air in the low levels. The centre of the tropical cyclone known as the eye is usually a region with diameter varying from 16 and 32 km (10 and 20 miles) at the surface, and widening upwards to about 50 or even 80 km at a height of about 10 km.

4.2 Location of Tropical Disturbances on a Weather Map

Daily synoptic streamline charts for tropical regions sometimes indicate more complex patterns than those found on mean annual or monthly charts. In many localities local effects, such as topography or differential heating, may accentuate these developments. In the absence of tropical disturbances, the synoptic charts would consist of more or less smooth straight streamlines with no variations in wind speed.

5.0 CONCLUSION

Various types of eddies, indrafts, outdrafts, wave patterns, convergence zones, etc can be located. Particular attention needs to be given to areas of convergence and divergence, as ascent or descent of the air in those regions can lead to many different types of weather on the synoptic scale.

6.0 ACTIVIY

1. State the tropical disturbances experience in Nigeria.
2. List and explain how they affect the seasons.
3. Why are the seasons in places like Jos and Biu different from its surroundings.

7.0 SUMMARY

This unit has **6**ithin its limit explained what a tropical disturbance is all about. The various types of tropical disturbances have been mentioned and discussed in the passage. Some synoptic systems associated with the tropical disturbances have been mentioned. The synoptic systems found on daily charts include various types of eddies or vortices, wave patterns and convergence zones. The most vigorous tropical disturbances are the intense cyclonic storms that form over warm tropical waters.

8.0 ASSIGNMENT

1. Mention some of the tropical disturbances you know and describe any two.
2. Describe the characteristics of a tropical cyclone.
3. Explain how some physical processes can lead to the formation of different types of weather on a synoptic scale.

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 TROPICAL AGRO-CLIMATOLOGY

CONTENT

1.0 INTRODUCTION

There is perhaps no other human activity which is more affected by weather than agriculture. Weather and climate pervade every phase of agricultural activity. No doubt, crop growth depends on its genetic constitution, but it is the environmental condition of soil and climate, which affects crop in all its phenological stages and ultimately determines its yield. It will be obvious that meteorological expertise and advice can make a valuable contribution to decisions in agricultural management and practice, both on climatological-strategic matters and on actual weather applications for tactical decisions. Too often the agricultural community has to ask for raw weather data series, to be analysed by agro specialists without much real meteorological insight, because the weather service is not providing the minimal locally necessary amount of agro-climatological information. The weather service should know and care about more operational application aspects of their data than is needed for synoptics.

2.0 OBJECTIVES

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

- define Agro-climatology;
- identify some of the agro-climatic data used in the tropics; and
- state the importance of agro-climatic classifications.

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

Phenological- pertaining to the study of the effect of climate on periodic biological phenomena

4.0 MAIN CONTENT

4.1 What is Agro-Climatology?

Agro-climatology deals with the science for the study of climatic features such as distribution of wind speed, temperature, humidity etc, and factors such as energy and water balance characteristics of underlying surfaces that influence them. It deals with environmental conditions of open surfaces, inside and above crops, forests and other vegetation. The climatic water balance provides, apart from actual evapotranspiration, an assessment of water surplus, water deficit and run-off. Climate and agriculture are closely linked.

Benefits of Agro-Climatological Studies: Apart from many applications of climatology and weather forecast to current agricultural problems, Agro-climatological studies can be of considerable interest in three other fields.

1. Selection of the production sites for a given crop. This is because lack of detail knowledge on plant-climate relationships has hampered intelligent planning of land use on a wider scale.

2. Climatic analysis for proper interpretation of results of agronomic experiments. A comprehensive climatic analysis and documentation with a limited number of field trials would yield more practical information than a large number of trials without such analysis.

4. Irrigation, row spacing, timing of fertilizer application, variety selection and transplanting, etc, can best be planned and implemented when viewed in the light of appropriate climatic analysis.

5.

4.2 Types of Agro-Climatic Information that is required

(a) Air Temperatures

- Temperature probabilities
- Degree Days
- Hours or days above or below selected temperatures
- Interdiurnal variability
- Maximum and Minimum temperature statistics
- Growing season statistics (onset and cessation)

(b) Precipitation

- Probability of specified amount during a period
- Number of days with specified amounts of precipitation
- Probabilities of thunderstorms, hail
- Probability of extreme precipitation amounts

(c) Wind

- Wind rose (frequency distribution per direction sector of 30^o or 45^o width)
- Average wind speed (hourly, daily)
- Maximum wind (average and gust)
- Diurnal variation
- Hours of wind less than selected speed

(d) Sky cover, sunshine, radiation

- Percentage of possible sunshine
- Number of clear, overcast, scattered, and few
- Amounts of global and downward IR radiation

(e) Humidity

- Probability of specified relative humidity
- Duration of specified threshold exceeding humidity

(f) Free water evaporation

- Total amount
- Diurnal variation of evaporation
- Relative dryness of air
- Evapotranspiration

(g) Dew

- Duration and amount of dew
- Diurnal variation of dew
- Association of dew with vegetative wetting
- Probability of dew formation with season

(h) Soil temperature

- Mean and standard deviation at standard depth
- Depth of frost penetration
- Probability of occurrence of specified temperatures at standard depths
- Dates when thresholds values of temperature (germination, vegetation) are reached

(i) Soil moisture

- Mean value at standard depth

Plants and Crop Microclimate: development and growth of plants depend on environmental conditions at every stage. An understanding of the interrelation between the structure of the environment (ground cover, surface slope, degree of shelter, etc) and the local microclimate, in the crop and around the crop, may result in actions aimed at the long-term improvement of the growth situation. Even before planting, the influence of the weather should be considered. The quality of the seed sown depends on meteorological conditions during the year in which it was produced. The productivity of long-rotation crops, e.g, vines, fruit and forest trees, can also be affected by weather experienced over many previous seasons. Post-harvesting operations, such as drying grass and other crops, and the capacity to maintain the quality of stored farm crops are affected by seasonal weather. Weather and climate are important in the occurrence of forest, bush and grass fires, and knowledge of them is important for the defence against such hazards.

4.3 Agro-Climatic Classification

The saying that farmers learn to live within the limitations of their local conditions through trials and errors over generations, is no longer completely true. It is now evident, that deriving maximum benefit from agriculture and silviculture calls for an in depth knowledge of agro-climatic conditions, without which the most effective cropping pattern and the development of additional irrigation schemes, which are needed in different zones, cannot be planned. Most of the earlier climatic classifications used vegetation as an index of climate. Starting at the middle of the 20th century, a group of climatologists tried to develop climatic / agro-climatic classifications, with a view to using them for maximising crop production.

5.0 CONCLUSION

The Moisture Availability Index (MAI) developed by Hargreaves is now well recognised in agroclimatic classification. The index is the ratio of probabilistic rainfall and potential evapotranspiration. Each country is expected to develop its own regional classification based on its climate types**.**

6.0 ACTIVITY

1. State some environmental factors that can affect the development and growth of a plant.
2. List 4 ways that the microclimate of an area can affect plant.
3. Give reasons for your answers in question (2) above.

7.0 SUMMARY

This unit has within its limit explained what agro-climatology is all about. The passage has been able to identify some of the agro-climatic data that are used in the tropics. The benefits of agro-climatological studies have also been explained. Climatic analysis assumes a great significance in nearly every phase of agricultural activity, from the selection of sites to agronomic experiments and from long term planning to daily operations.

8.0 TUTOR-MARKED ASSIGNMENT

1. What are the advantages of Agro-climatological studies?
2. Why do farmers need Agro-climatological data?
3. Enumerate some of the Agro-climatological information required in farm planning.

9.0 REFERENCES/FURTHER READING

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

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