CHAPTER 7 ENVIRONMENTAL INTERACTION

Objectives

After studying this chapter, students should be able to:

- define ecosystem and describe its major components.
- describe the major types of ecosystems.
- describe the concept of environmental balance and the various cycles that operate within it.
- describe the major interventions within the environment.

7.1 Ecosystem

An ecosystem or an ecological system is an area of nature containing a community of living organisms interacting with one another and with their physical environment through the exchange and use of energy and matter. The living things include plants, animals and micro organisms. The physical environment is the habitat where the living organisms live in or regard as a home.

Living and non-living things exist within the physical environment and relate with one another in a manner that is similar to that of an interacting system. It is the smooth interaction that makes an ecosystem to function or operate optimally. The ecosystem is maintained by the constant flow of energy supplied almost by solar radiation as well as the cycling of matter by the environment.

7.2 Components of an Ecosystem

An ecosystem is made up of two major components namely:

(a) The physical or inorganic or abiotic component.

(b) The biological or organic or biotic component.

(i) The physical or inorganic or abiotic component: This consists of the inorganic substances such as gases, water, soil, rocks and all other inorganic mineral components. The abiotic components provide the energy, raw materials and living space for the use of the organisms of the biotic, biological or organic community.

(ii) The biotic or biological components: This consists of the living organism of the ecosystem. It includes plants and animals. This component can be grouped into three sub-classes. These are:

(a) The primary producer or the AUTOTROPHS: These are green plants which can manufacture their own food from simple inorganic substances through the process of photosynthesis using solar energy.

(b) The consumer or the HETEROTROPHS: These are also known as PRIMARY and SECONDARY CONSUMERS. These are organisms which cannot manufacture their own food but depend directly or indirectly on plants for their own food. Examples include man, parasites, saprophytes, etc. In other words, they feed on organic matter provided by plants and other animals.

(c) The reducers or the DECOMPOSERS: These are largely micro-organisms that decompose dead organic matter in order to release nutrients required by producers to prepare their food e.g. fungi and bacteria.

In all, the components of an ecosystem is made up of land (soil, rocks, minerals etc) water (lake and oceans, plants, animals, drainage (river, etc) and the climate (atmosphere).

7.3 Types of Ecosystem

Ecosystem may be sub-divided into two broad groups:

(a) Land ecosystem

(b) Water ecosystem

(i) **Land Ecosystem:** There are several types of land ecosystem within a definite geographical entity whether a country, a continent or on the Earth's surface as there are spatial variations in environmental conditions. Indeed, there is no limitation as to the spatial extent which an ecosystem can occupy as several variations exists from one place to other all over the Earth's surface. What is significant perhaps in the identification of a land ecosystem is that there must be a degree of reciprocal interrelationship existing between the abiotic components and the available biotic components. In essence, landform units can be used as the main criterion for delincating land ecosystem. In all land ecosystems may vary from a small field or farm plot to as large as big forests or geographical area.

(ii) **Water ecosystem:** This is an ecosystem that is based on simple water bodies or aquatic ecosystem such as rivers, lakes, ponds, oceans and seas.

In summary, ecosystems vary in size and complexity. It could be a small aquarium placed in a sitting room or an entire big forest, deserts, etc. What is perhaps paramount, is the fact that there must be interactions between the various components of an ecosystem so that it can function effectively. For example, an ecosystem functions in a simple manner beginning from the sun which provides energy for the function of the ecosystem. The energy obtained from the sun is used by plants during photosynthesis to produce carbohydrates in them. Animals then feed on plants including the carbohydrates in order to grow and operate well. When the plants and the animals die, they ecompose to form soil which is the major source of water and mineral nutrients. Soil in this manner also provide support or medium (anchor) for plant growth. In addition, they

provide land space for animals. For effectiveness, every ecosystem possesses the following attributes or characteristics:

(i) It is integrative in the sense that an ecosystem brings together all components within an environment: man, plants and animals within a single framework, where they can interact and their activities closely observed.

(ii) It is structured in a more or less orderly, rational and comprehensive way such that it reveals how an ecosystem functions in an organization within a natural world that may appear complex and chaotic to comprehend.

(iii) It functions regularly because it generates continuous output of matter and energy.

(iv) It contains the attributes or features of a general system because it operates exactly in a precise manner in which a system operates.

7.4 Functioning and Interactions in Ecosystems

An ecosystem functions or operates in two ways, namely:

(a) the flow of energy through the operations of a food chain

(b) the cycling of matter.

These two basic operations and functioning within an ecosystem ensures a state of balance and equilibrium. Collectively, this is known as environmental balance. Environmental balance simply refers to the way and manner matter is being recycled with the flow of energy within an ecosystem so as to ensure continuous supply or availability. Hence, environmental balance is achieved through the following processes or cycles, wherein matter is being recycled.

The continual flow of water and other chemical elements from the physical environment causes the following cycles, namely:

(i) hydrological or water cycle

(ii) Carbon cycle
(iii) Mineral content cycle
(iv) Nitrogen cycle
(v) Sulphur cycle
(vi) Phosphorous cycle

The above cycles are collectively referred to as BIOGEOCHEMICAL CYCLES. The functioning of these cycles has mentioned earlier, helps maintain a balance within the environment or the ecosystem.

The hydrological or water cycle is the natural exchange or circulation of water between the oceans, the atmosphere and the land. It is responsible for surface run off and erosion, availability of water in the soil for plants' use and the availability of water in the ground for continuous weathering and formation of soils.

The carbon cycle involves a series of processes which contribute to the circulation of carbon in nature. Carbon is usually circulated in form of carbon dioxide. The carbon cycle dwells on the movement of carbon in the atmosphere as carbon dioxide and its eventual return to the Earth's surface where it is absorbed and stored up by the vegetation through the process of photosynthesis. It shows the inter-relationship that exists between plants and the atmosphere as it is from the atmosphere that plants derive the carbon dioxide that they need. Then, man and other animals give out carbon dioxide through the process of respiration.

The nitrogen cycle is a complex process involving the presence of nitrogen in the atmosphere, soil, plants and animals and the exchange of the nitrogen within the ecosystem. The cycle depends on the activities of various bacteria in the soil. The nitrates in the soil are absorbed by plants which build them up into proteins for the use of animals which eat the plants. When the plants and animals die, they are decomposed by the action of certain bacteria. Then, nitrogen in the decomposed matter comes

in the form of ammonia. Ammonia is oxidized by the nitrates through the action of nitrifying bacteria e.g. nitrate and nitrate bacteria.

The action of these bacteria is very important in replenishing the environment with nitrates which plants and animals depend upon as their source of protein. The most important feature of the nitrogen cycle is that the amount of nitrogen available in the atmosphere is maintained by a balance between the processes which withdraw nitrogen from the atmosphere and those that add nitrogen to it.

Since it is not possible in all cases for plants to access the abundant nitrogen in the atmosphere, it becomes necessary that ways should be developed whereby plants can convert the nitrogen in the atmosphere to a form that they can use for producing the protein content of their tissues. Hence, the process of converting the nitrogen in the atmosphere to that form which plants can use is called NITROGEN FIXATION. There are three ways this takes place, namely *atmospheric fixation, industrial fixation* and *biological fixation.*

Atmospheric fixation occurs during the process of lightning in the atmosphere, especially after a torrential or copious rainfall. Lightning within the atmosphere fixes nitrogen by changing it into the oxides of nitrogen. In the process of rain falling down, nitrogen is brought down in form of nitric acid which later reacts with substances in the soil to form nitrates which soil can directly use.

Industrial fixation occurs when nitrogen fertilizers are added into the soil during planting in order to replace the nitrogen that has been used up by plants. The fertilizers may be artificial, chemical or organic (remains of dead plants and animals especially leguminuous plants) in nature.

The mineral nutrients cycle refers to the circulation of mineral nutrients such as sulphur, phosphorus, magnesium, potassium, calcium, manganese, iron, boron, zinc, copper, chlorine, carbon, hydrogen and

oxygen. The last three of these, that is, carbon, hydrogen and oxygen come from the atmosphere while the remaining ones come from the soil. These nutrients move around in the ecosystem in cycles. The mineral nutrients cycle is also known as biochemical cycles. Plants take the nutrients from the soil or from the atmosphere and use them for life processes. From plants, the nutrients are passed on to grass-eating animals (herbivores) and flesh-eating animals (carnivores). When plants die or shed their leaves or when animals die or excrete, the dead organic materials are decomposed and the nutrients are released back to the soil or to the atmosphere as the case may be. The mineral nutrients cycle therefore shows the interaction between biotic and abiotic components of the ecosystem through the exchange between the atmosphere, the soil and the plants.

B. Energy Flows within the Ecosystem: Food Chains and Food Webs

This is another important aspect of the operations of the ecosystem which to a large extent, reveals the interdependence between the biotic and the abiotic components of ecosystems. The sun, which is the major source of energy and from which other sources of energy are obtained, is an important player in this process. Indeed, other sources of energy based on that are derived from the sun and from there, are transformed into other uses. Green plants are the only organisms that possess the ability to fix the radiant energy of the sun and convert it to chemical energy through the process of photosynthesis. As a result of this, plants are regarded as **PRODUCERS** in the ecosystem. When the energy passes from plants (producers) to the animals (consumers) and from one type of consumer (herbivore) to another (carnivore) within the biotic community in the ecosystem, a **FLOW OF ENERGY** is established. Through this flow of energy, a chain is revealed of how organisms derive their food and how

food is passed from one organism to the other. Hence, the term **FOOD CHAIN** describes the consumption of one organism by another in succession. It is the basic link between the herbivores that feed on green plants and carnivores that feed on or consumes the herbivores.

In essence, the food chain depicts the linkage formed by the feeding relationships between the plant and animal communities within the biotic component. It is this type of linkage of consumer levels and their nutritional sequences that is called food chain and is formed by organisms existing in an ecosystem through which energy flows.

A **FOOD WEB** is created when different herbivores serve as preys to consumers and an interconnection is established. Hence, a food web is a complex feeding relationship of organisms made up of many interrelated food chains. It involves a wider range of energy transfer.

In reality, food chains are interesting to study as they show the relationship and arrangements whereby herbivores feed on plants and are fed on by carnivores in which case they become preys. The green plants eaten up by herbivores are used up in the following ways:

(i) Part of it is converted into tissue.

(ii) Part of it is lost as heat to the environment as a result of various activities performed by animals.

(iii) Some of it is passed out as waste.

In a food chain, an organism passes on to the next organism, less energy than it has stored up. Thus, as the food chain progresses, less and less energy is transferred and less and less energy is stored. The result is that the amount of energy thus transferred, can be represented in the shape of a pyramid known as the **PYRAMID OF ENERGY**.

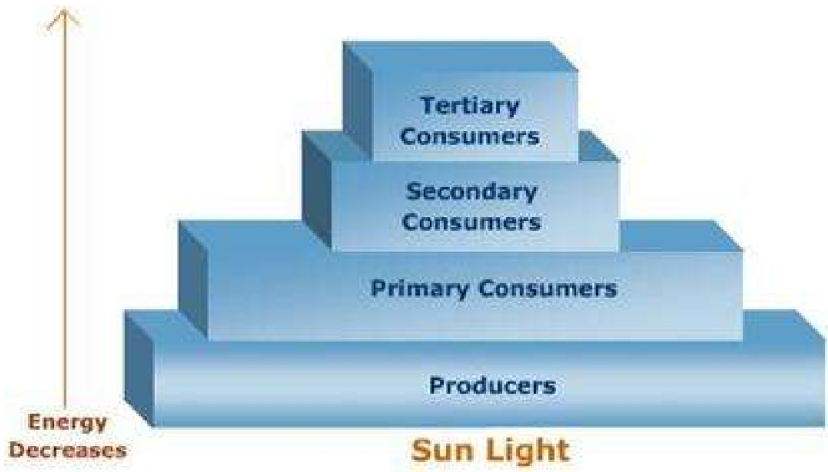

Fig. 7.7: The pyramid of energy

The pyramid of energy is very important because it is one of the ways by which environmental balance is enhanced and maintained. The pyramid is so arranged that the total energy used by the organisms in an ecosystem or lost by them to the atmosphere, is replaced through photosynthesis. Any attempt to increase the rate at which energy is transferred within the ecosystem will lead to the disturbance of the balance. For example, if there are too many herbivores in an area, they will soon eat up the vegetation such that food will become scarce for them and they must migrate or they will die in large numbers. Also, the soil will become exposed to erosion.

In most cases, food chains and food webs are complex as simple ones are rare in nature. Hence, it is common to have a very complicated relationship in which an organism may feed on many different organisms and be fed upon by many different organisms. Such a complicated feeding relationship is called a food wed.

However, just as in the food chain, the arrangement of energy usage or transfer is in the form of a pyramid, and as already noted, the pyramid of energy is important for environmental balance and should be preserved.

7.5 Interventions within the Natural Environment

Even though, environmental balance assumes that the factors or elements of the environmental balance do not change so that a state of equilibrium or stability is maintained between the various compounds. However in reality, this is not always so, as an equilibrium is rarely maintained in any environment for a long period. Changes are always occurring and these result from intentional and unintentional activities by man and animals.

Interventions within the physical environment are basically caused by natural forces and certain human activities that change the natural existence of the components of the ecosystem.

Types of Environmental Interventions

There are two types of interventions in the physical environment. These are: natural and human interventions.

(a) Natural interventions: These are caused by the interplay of some natural processes such as desert encroachment, flooding, volcanism, sea level changes, earthquakes, tectoric movements, climatic changes, drought, hurricanes, etc. These natural processes are hazards that occur within the physical environment that are capable of altering the state of the ecosystem. The changes or alterations that may occur quite may be significant especially where their occurrences have affected large areas of the Earth's surface. The first effect of this intervention is to destabilize the scale of operation of environmental processes within the natural systems.

(b) Human interventions: This is caused by the increasing pressures which the rise in human population activities and demands for the basic necessities of life have been exerting on available

environmental resources. For a long time, in several parts of the world, human activities have become a dominant force for altering the natural environment in man's effort at improving his living conditions. The effect of such alterations are better felt on the processes of the natural systems. Such activities have resulted in climate changes, landform degradation, soil pollution, vegetation destruction, etc. In most cases, the effects of several human activities have resulted in severe environmental disasters or hazards which have seriously degraded the quality of the natural environment.

Human interventions have resulted from the following human activities namely:

(i) Agricultural activities such as overcropping, bush burning, etc., which involve the clearing of original forest and its replacement with different types of crops. At times, former farmlands are left fallow and covered with secondary type of vegetation which differs significantly from the original or natural vegetation.

(ii) Overgrazing

(iii) Afforestation through the cultivation of new tree plantations so that the vegetation type is changed from the original natural vegetation to man-made forests.

(iv) Pollution due to the use of toxic materials which damage the original vegetation thus leaving a degraded vegetation type.

(v) The indiscriminate use of toxic materials such as pesticides, insecticides, weedicides, etc.

(vi) The creation of new cities which often involves the destruction of original vegetation to accommodate new houses and buildings.

(vii) Land reclamation which involves the restoration of disused or fallow to productive lands, vegetation or crops.

(viii) Other human activities such as industrialization, mining, hunting, cloud seeding, fishing, etc., are capable of altering the environment in a negative way either through the destruction of plants, distortion of drainage system, loss of rainfall, reduction of soil moisture content and the loss of some biological organisms.

It must be equally stressed that even though, some human activities can lead to environmental hazards that are capable of altering the physical environment, yet, there is the need to monitor, control and regulate the mode and magnitude of human intervention in any part of the physical environment. It should be noted that there are some aspects of human intervention that instead of imposing a negative impact, have in real sense, enhanced the quality of the natural environment by creating some beneficial changes. Examples in this regard include afforestation, land reclamation, artificial fertilization and irrigation schemes. However, great care should be taken so that such activities are not allowed to create fresh environmental problems that will defeat or nullify the purpose of their intended positive changes.

Summary

Interactions within the physical environment occurs within the interrelated spheres of the Earth, that is, the lithosphere, atmosphere, hydrosphere and biosphere, and the various living and non-living elements.

Interactions between living and non-living things depend on the extent they relate with each other in a complex and diverse manner.

The ecosystem provides a basis for understanding the nature of interactions and interdependence that exist within the natural environment.

The constant flow of energy from solar radiation and a constant recycling of matter between the abiotic and biotic components of the ecosystem.

There are two types of ecosystems: land and water ecosystems.

A high degree of environmental balance exists within each ecosystem. This balance is as a result of the processes involved in the flow of energy and exchange of matter within each system.

There are several interventions that occur within the environment which result from natural factors. The interventions are capable of creating short or long term changes which can negatively modify the character of the environment.

The occurrence of some natural situations and human activities can have significant impacts, both negative and positive, on the environment.

Revision Questions

Objectives

1. An ecosystem consists of all but one of the following:
   - A. Lithosphere
   - B. Troposphere
   - C. Soils
   - D. Asteroids
2. Which is the odd one out?
   - A. Monsoon forest
   - B. Selvas
   - C. Taiga
   - D. Mangrove

3. The layer comprising the plant cover of the Earth and the soil in which roots grow and animal organisms live is called the
   A. lithosphere.
   B. biosphere.
   C. hydrosphere.
   D. bathysphere.
4. Which of the following have led to soil erosion?
   I. Overgrazing
   II. Shifting Cultivation
   III. Removal of natural vegetation
   IV. Crop rotation
   A. I and II
   B. I and III
   C. II and IV
   D. I and IV
5. Which of the following factors least affects man's activities?
   A. Relief
   B. Climate
   C. Vegetation
   D. Accessibility
6. Indiscriminate grazing by which of the following animals is most likely to lead to widespread soil erosion?
   A. Camel
   B. Cattle
   C. Pigs
   D. Horses
7. Which of the following is not a method of controlling soil erosion?
   A. Contour ploughing
   B. Transhumance

C. Terracing

D. Shelter belts

8. Which of the following factors least affect the amount of moisture available for plant growth?

A. Evaporation

B. Height of water table

C. Character of rainfall

D. Steepness of slope

9. Which of the following is irrelevant to the food chain?

A. Producers

B. Carnivores

C. Fertilizers

D. Omnivores

10. Which of the following aspects is not important in the hydrological cycle?

A. Water vapour

B. Evapotranspiration

C. Surface runoff

D. Stream load

Essay

1(a.) Define an ecosystem.

(b.) Describe the two main components of an ecosystem.

2(a.) Describe any two cycles that operate within an ecosystem.

(b.) Suggest three effects of hydrological cycles on living organisms in an ecosystem.

3(a.) What is environmental balance?

(b.) Enumerate five ways of attaining environmental balance.

4(a.) Suggest two differences between a food chain and a food web.

(b.) Describe four ways in which man has interfered with his natural environment.

5(a.) Suggest four components of the ecosystem.

(b.) How does the hydrological cycle explain the interdependence of the components in the ecosystem?