COURSE GUIDE

EMT 300
ENVIRONMENT, ECOSYSTEM AND MAN

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MODULE 1

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UNIT 1 HUMAN POPULATION GROWTH

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1.0 INTRODUCTION

The term “population” refers to a group of individuals of a specie occupying a definite geographic are at a given time. The sum of all populations of the same kind constitutes a specie. Human population over the world belongs to single species- Homo sapiens. The ever-growing human population is over-exploiting natural ecosystems to satisfy the variety of needs. This, overexploiting is disturbing the natural balance.

Modern human (Homo sapiens) appeared around fifty thousand years ago. Initially, the human population was small hence human interference with nature was minimal. Human population reached the one billion mark around 18040 it increased to 2 billion by 1930 and revealed 6.1 billion by 2000.

2.0 OBJECTIVES

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

- explain the meaning of population growth and its rates;
- discuss factors affecting population growth; and
- outline reasons for population growth.

3.0 MAIN CONTENT

3.1 What is Human Population Growth?

Population growth is the change in population over time, and can be quantified as the change in the number of individuals in a population using "per unit time" for measurement. The term population growth can technically refer to humans, and it is often used informally for the more specific demographic term. Population growth rate and is often used to refer specifically to the growth of the population of the world. The rapid growth of the world's population over the past one hundred years results from a difference between the birth rate and death rate. The human population will increase by 1 billion people in the next decade. This is like adding the whole population of China to the world's population. The growth in human population around the world affects all people through its impact on the economy and environment.

No one knows how many people have ever lived on earth. It has been estimated that based on an assumed constant population growth rate, over 168 billion people have been born into this world since *Homo Sapiens* (human being) appeared in this world in 50,000 BC. The world has experienced an unprecedented increase in population growth since the industrial population. The population has grown from 1.6 billion at the beginning of the 20th century to about 7.3 billion todays. While there are several factors that are responsible for the phenomenal increase in world population, two main revolutions are worth mentioning. These are the Agricultural Revolution and the Industrial Revolution. The agricultural revolution led to the development of agriculture which was anchored on the domestication of crops and livestock and development of storage systems.

3.2 Population Growth Rate

Human population growth rate is a measurement of the change in population size over time. The growth of a population is the interplay of births (fertility), deaths (mortality) and migration. When the proportion of deaths per head is subtracted from that of births, we have the rate of natural increase. When the effects of migration is taken into consideration, the result is growth rate.

NRI=BR – DR

Where *NRI* is Natural Rate of Increase
BR is the Birth Rate
DR is the Death Rate

GR =BR-DR ± MR

Where GR is Growth Rate

BR is the Birth Rate
DR is the Death Rate
MR is Migration Rate (plus or minus)

The components of population change are taken to mean the variables that act together to lead to a positive or negative change in the population. This change is what referred to as population growth. When there is an increase in population within a period under consideration, were refer to the growth as positive, and when there is a decrease in population over a period we refer to it as negative growth.

i. **Fertility:** It is the actual manifestation of child bearing. Fertility is the determinant of current growth of population. Crude **Birth Rate (CBR)** is the demographic measure of fertility and it is the number of babies per thousand of the population.

ii. **Mortality:** Mortality is the cessation of life and Crude Death Rate (CDR) is the simple measure of mortality. It is the number of deaths per thousand of the population. In most countries, the death rate has dropped almost continuously since the industrial revolution, mainly due to improvement in personal hygiene, sanitation and modern medicine. A decrease in death rate would result in an increase population growth rate.

iii. **Migration:** Migration is the movement of individuals from one place to another, usually involving a change in residence. Most modern migration occurs within a delineated territory (or country). This type of migration is known as internal migration. When people move across national boundaries it is referred to as international migration.

3.3 Population Explosion

In the last century, a phenomenal rise in the world population has taken place. It has almost tripled since 1900 to the present level. The world population rose from 1 billion in 1804 to 2 billion in 1930, 4 billion in 1974 and 6 billion 1999. The world's population reached 7 billion in 2011. A careful look at the pattern of growth indicates that before the First World War, the growth was relatively gradual, as it took the population over 100 years to double. However, from 1960, the increase in world's population was very rapid. The rapid increase in human population over a relatively short period of time is known as **population explosion.** The increase in human population with such an alarming rate could lead to an absolute scarcity of even basic needs, such as, food, shelter and clothing inspite of significant progress made in these areas in the past few decades.

3.4 Factors Affecting Population Growth

There are many factors which affect the human population. Those include the physical, demographic, political, technological, cultural and socio-economic factors:

i. **The Physical factors:** These includes temperature, rainfall, soil, terrain and natural resources.

a) The **climate** plays a crucial role in the growth of human population. Areas with conducive climate tend to have high population growth. The areas with extreme variation in the temperature like deserts in the Rajasthan and artic oceans have low population growth. Most areas within the tropics have conducive climate for food production which necessary for population sustenance.

Also, areas with abundant rainfall, ensures the practice of agriculture that supports human population. This is why areas such as South East Asia, South West Asia, Coastal areas of West Africa and the Mediterranean Region have high population growth and concentration.

b) The rich soils are necessary for agriculture. Areas with rich soils have high population growth because rich soils support agriculture and hence such areas have surplus food to support a rapidly growing population.

c). Areas that have relatively gentle terrain tend to support more population. Such areas are generally known to be easily accessible and to be naturally ideal for settlements and thus attractive to human population.

ii. **The demographic factors**: The structure of the population has significant impact on population growth. The higher the proportion of the population under the age of 15 years, the more likely the proportion of tomorrow's parents. This pattern of the population is indicative of high Total Fertility Rate (the number of children a woman will have throughout her reproductive years). The lower the death rate the higher the rate of population increase in the short run. Migration is also another factor for population growth. Areas with rich agricultural soils like the South East and South West Asia have high population growth because of migration into these regions by workers from other regions.

iii. **The socio-economic factors:** Socio-economic factors play important role in the growth of population. Among the socio-economic factors are:

a. Level of economic development. Countries that are economically, developed tend to experience minimal population growth rate.
b. Literacy level. Countries with very high literacy rate tend to experience modest population growth rate, while countries with low literacy rate tend to experience rapid population growth rate.
c. Human Development Index (HDI). Countries with very high HDI have low TFR, which means low population growth rate. High poverty is a major driver of high population. Families rely on domestic labour to work in the farm, because they cannot afford hired labour.
d. Cultural beliefs. In many societies, children are considered as asset and the number of children one has is a measure of wealth, as it will mean more hands to work. The cultural practices of wife inheritance, wife capture and widowhood rites are all factors that tend to lead to higher population growth in communities where such practices exist.
e. Availability of family planning is also factor for population growth.
f. Participation of women in the labour force. Where women are allowed and encouraged to work in the formal sector, the lower the TFR and vice visa.
g. The degree of industrialisation is a factor for population growth. The developed or industrialised countries have less growth of the population. They are mostly stable. But the developing countries, there has been an increase in the growth of population.

h. The wellbeing of children, nutritional and social status have inverse relationship with population growth.

i. As a country becomes increasingly urbanised, the birth rate tends to rise and death rate tends to fall.

3.5 Reasons for population Growth

Some of the identified reasons of the increase in population are given below:

i) Illiteracy, particularly among women

ii) Ignorance about the importance of small family size and comfort and future available of resources

iii) Many people think that having more children will bring more income to the family.

iv) Belief that social security comes with more human beings at a place or in a religion.

v) Opposition of birth control methods by certain religions

vi) Lack of propaganda about the population size and availability resources

4.0 CONCLUSION

In this, we have examined population growth and population rate which are fertility, mortality, migration and age/sex structures. Also factors affecting population growth and reasons for population growth were discussed.

5.0 SUMMARY

In this unit students have learnt that:

- Human population growth is the change in population over time and can be quantified as the change in the number of individual in a population using “per unit time” for measurement.
- Population growth rate is measured as the annual average growth which can be calculated using a number of formulae as explained in the main text.
- Population growth rate depends on several factors such as rates on birth, death, migration and age- sex ratio.
- Factors affecting population growth includes the physical, demographic and socio-economic factors.
- Reason for population growth are illiteracy among women, ignorance, cultural beliefs about children, poverty levels, nature of the occupation, opposition to birth control methods and lack of propaganda about the population size.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is human population growth rate? List and explain the socio-economic factors affecting population growth.
2. Explain any five reasons for population growth in any society known to you.

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UNIT 2 EFFECTS AND CONTROL OF OVERPOPULATION AND SPECIES ABUNDANCE

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1.0 Introduction
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3.2 Control Overpopulation
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3.4 Scale Used to Describe Species Abundance
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7.0 References/Further Reading

1.0 INTRODUCTION

In the past, infants and childhood deaths and shorts life spans used to limit population growth. In today's world, trend to improved nutrition, sanitation and medical care, more babies survive their first few years of life. However, there are various programmes to limit or slow population growth. The meaning of species abundance, population density and growth, will be discussed in this unit.

2.0 OBJECTIVES

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

- explain the effects of overpopulation
- discuss the control of overpopulation
- discuss species abundance
- explain population density and growth

3.0 MAIN CONTENT

3.1 Effects of Overpopulation

The combination of a continuing high rate, a decline in mortality rates, an increase in immigration or unsustainable biome is creating a rapid population increase. When increase in population reaches an undesirable condition where an organism's number exceed the current carrying capacity of its habitat or ecological niche, it is known as **Overpopulation.**

Overpopulation has a definite effect on a country's economy first of all when countries are over populated; they hardly have enough food to support themselves. Overpopulation does not just affect the standard of living, but also leads to the degradation of the environment.

The other effects of overpopulation are:

- People struggling to live under poor conditions
- Low birth rate due to the inability of mothers to get enough resources to sustain a badly from fertilization to birth
- Low life expectancy
- Low level of literacy
- High rate of unemployment in urban areas (leading to social problems)
- Insufficient arable land
- Little surplus food
- Poor diet with ill health and diet-deficiency diseases (e.g. rickets)
- Low per capita Gross Domestic Product (GDP)
- Low savings
- Lack of investment
- Low per capital information
- Unhygienic living conditions for many
- Economically stretched government
- High crime rate
- Mass extinctions of plants and animals as habitats are used for farming and human settlements and etc.

3.2 Control of Overpopulation

Population control is a government programme to limit or slow population growth. This programme are initiated under general programmes of family planning, increase enrollment of women or the girl-child in school. Rapid population growth has been a cog in the wheel of progress for most developing countries. It has been obstacle to development and programmes of self-reliance. The effective measures to control overpopulation will include:

i. **Rise in per-capita income:** Demographic history of various advanced countries shows that there is an inverse relationship between per-capita income and a country's birth rate. When per-capita income is high, the desire for more children in order to supplement their income is lower. Increase in per-capita income will have its positive impact on birth rate after a period of time

ii. **Urbanisation and Industrialisation:** The increasing rise and focus on the nuclear family, is tending towards a decline in the family size. When society becomes more urbanised and industrialised, the emerging family structure is tended towards a nuclear setting. A nuclear family is generally found in an Urbanized and Industrialised economy. Hence, our efforts should be to industrialized and urbanised our economy to reduce the high birth rate.

iii. **Late marriage:** When marry early they tend to have longer years of exposure to the risk of child bearing. A UN report has pointed out that there would be a significant decline of birth of seven per thousand, if the average age of marriage of females were to rise from 16 to 20 years.

iv. **Lowering infant mortality rate:** Poor people, in order to ensure that some children do survive, reproduce more. Therefore, the lowering of infant and child mortality rates through the widespread of vaccinations and proper child and maternity care will lead to a significant reduction of excess population

v. **Spread of Education:** In developing country like Nigeria, a relatively high percentage of the total populations are illiterate. They regard children as the gift of God and are not conscious about the problems of rapid population growth. To remove illiteracy and blind beliefs, provision of education to the population is essential. Education arms people with the knowledge and the latitude to small family size.

vi. **Women education and employment:** The government therefore, should take steps to provide education to the girl child and also ensure that women are reasonably provided job opportunities in the formal sector to empower them.

vii. **Provision of Family Planning (FP) Facilities:** Many poor people in the rural areas in so many developing nations do not get family planning facilities easily. There is need for family planning centres with trained personnel to be established in rural areas to provide services to women in their immediate environment. This could go a long way to lower fertility and consequently, population growth.

viii. **Provision of Incentives:** The government should provide both monetary and real incentives to people for adopting family planning measures.

ix. **Publicity:** Publicity on the need for birth control and other family planning services is required. Efforts should be targeted at reaching the women in the rural areas through messages placed on radio and television.

x. **Legislation:** Time has reached for government to enact appropriate laws and legislation for birth control. There could be laws for number of children per couple as was in the 1988 National Population Policy; laws that will set the minimum age at marriage; laws on compulsory education; laws on abortion and laws against child labour. These laws when enacted will reduce the value placed on children.

3.3 Species Abundance

In ecology**, abundance** is the relative representation of species in a particular ecosystem. It is usually measured as the number of individuals found per sample area. How species abundances are distributed within an ecosystem is referred to as relative species abundances. Both indicators are relevant for computing biodiversity.

Abundance is contrasted with, but typically correlates with incidence, which is the frequency with which the species occur at all in a sample. When high abundance is accompanied by low incidence, it is considered locally or sporadically abundant.

A variety of sampling methods are used to measure abundance. For larger animals, these may include spotlight counts, track counts and road kill counts, as well as presence at monitoring stations. In many plant communities the abundances of plant species are measured by plant cover, i.e. the relative area covered by different plant species in a small plot. Relative species abundance is calculated by dividing the number of species from one group by the total number of species from all groups.

3.4 Scale Used to Describe Species Abundance

The acronym used for a simple, somewhat subjective scale used to describe species abundance within a given area is known as ACFOR**.** It is normally used within a sampling quadrat to indicate how many organisms there are in a particular habitat when it would not be practical to count them all. Instead, a smaller representative sample of the population is counted instead.

The **A.C.F.O.R.** scale is as follows:

- **A –** The species observed is "Abundant" within the given area.
- **C –** The species observed is "Common" within the given area.
- **F** – The species observed is "Frequent" within the given area.
- **O –** The species observed is "Occasional" within the given area
- **R –** The species observed is "Rare" within the given area.

This method of sampling is simple and easy to implement, but can be subjective. Species frequency is the number of times a plant species is present in a given number of quadrants of a particular size or at a given number of sample points. Frequency is usually expressed as a percentage and sometimes called a Frequency Index. The concept of frequency refers to the uniformity of a species in its distribution over an area. No counting is involved just a record of species present. Each individual of the species present is recorded, is a more accurate and reliable method of sampling.

3.5 Population Density and Growth

An organism's life history is the sequence of events related to survival and reproduction that occur from birth through death. Populations from different parts of the geographic range that species inhabit may exhibit marked variations in their life histories. The patterns of **demographic** variation seen within and among populations are referred to as the structure of populations. These variations include breeding frequency, the age at which reproduction begins, the number of times an individual reproduces during its lifetime, the number of offspring produced at each reproductive episode (clutch or litter size), the ratio of male to female offspring produced, and whether reproduction is sexual or asexual. These differences in life history characteristics can have profound effects on the reproductive success of individuals and the **dynamics, ecology**, and **evolution** of populations.

Of the many differences in life history that occur among populations, age at the time of first reproduction is one of the most important variable for understanding the dynamics and evolution of a population. All things being equal, natural selection will favour, within species, individuals that reproduce earlier than other individuals in the population. By reproducing earlier an individual's genes enter the **gene pool** (the sum of a population's genetic material at a given time) sooner than those of other individuals that were born at the same time but have not reproduced. Nonetheless, the "all else being equal" qualification is an important one because delayed reproductive strategies that ensure larger and more-robust offspring may be selected for in some species of long-lived organisms. Individuals whose genetic makeup allows them to reproduce earlier in life will come to dominate a population if there is no counterbalancing advantage to those individuals that delay reproduction until later in life.

Not all populations, however, are made up of individuals that reproduce very early in life. In the course of a lifetime, an individual must devote energy and resources to physiological demands other than reproduction. This is referred to as the cost of reproduction. To reproduce successfully, a plant will have to first grow to a certain height and out compete its neighbours. An animal may have to devote energy to growth so that it can reach a size at which it can fend off predators and successfully compete for mates. In many populations, individuals that delay reproduction have a better chance of surviving and leaving offspring than those that attempt to reproduce early. The opposing demands of growth, defense, and reproduction are balanced within the constraints of different environments to produce populations that have a **diverse** range of life history strategies.

Populations often can be divided into one of two extreme types based on their life history strategy. Some populations, called ***r*-selected**, are considered opportunistic because **their reproductive behaviour** involves a high **intrinsic** rate of growth (*r*)—individuals give birth once at an early age to many offspring. Populations that exhibit this strategy often have been shaped by an extremely variable and uncertain environment. Because mortality occurs randomly in this setting, quantity of progeny rather than quality of care, serves the species better. In another strategy, called ***K*-selected**, populations tend to remain near the **carrying capacity (*K*)**-the maximum number of individuals that the environment can sustain. Individuals in a *K*-selected population give birth at a later age to fewer offspring. This equilibrium life history is exhibited in more stable environments where reproductive success depends more on the fitness of the offspring than on their numbers.

Adult and young African savanna Elephants (*Loxodonta africana*) crossing a stream. Elephants are classic examples of *K*-selected species—that is, species characterised by relatively stable populations. Such species produce a few large young instead of many small young. *Jeff Vanuga/Corbis.*

4.0 CONCLUSION

In this unit, we have examined the effects and various effective control measures of overpopulation. Also, species abundance was also discussed.

5.0 SUMMARY

In this unit, students have learnt that:

- When increase in human population reaches an undesirable condition where an organism's number exceed the current carrying capacity of its habitat or ecology niche, this is referred to as overpopulation.
- Overpopulation has a definite effect on a country's economy
- Overpopulation has other effects like people struggling to live under poor conditions, low life expectancy, little surplus of food, high rate of unemployment in urban area etc.
- There are effective control measures to overcome overpopulation like rise in per-capita income, urbanisation and industrialisation, late marriage, spread of education, family planning facilities etc.
- Species abundance is the relative representative of a species in a particular ecosystem. It is usually measured as the number of individual found per sample
- An organism's life history is the sequence of events related to survival and reproduction that occurs from birth through death

6.0 TUTOR-MARKED ASSIGNMENT

1. Write short note on the effects of overpopulation
2. Discuss the ways of controlling overpopulation
3. What do you understand by the term species abundance?
4. Explain the acronym A.C.F.O.R

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UNIT 3 COMMUNITY ECOLOGY

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1.0 INTRODUCTION

Community structure is often very diverse. A woodland community for example, will generate many different niches and microhabitats and supply many different food sources as a result of its vertical structure and spatial variation beneath and between the mature tree canopies. The concept of succession is most easily illustrated by a **bare rock surface**. The initial rock surface presents a hostile environment for most living organism.

2.0 OBJECTIVES

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

- explain the meaning of ecological community
- list the structure and characteristics of the community
- explain the dynamics of the community.

3.0 MAIN CONTENT

3.1 What is Community?

By definition, community represents the population of all species living and interacting in an area at a particular time. Population can, within limits, adapt to changes in environmental conditions. The major driving force of adaptation to environmental changes is believed by most biologists to be biological evolution, the change in a population's genetic makeup through successive generation.

3.2 Community Structure

Communities may be small, consisting of few species populations in a small space, or large, comprising several species populations in a large area. The community structures, composition and other characteristics can be readily described by visual observation without actual measurement.

This is a qualitative approach which is easier than the quantitative population analysis where measurements are actually made. Communities usually categories by the ecologists in various ways primarily based of habitat features like water availability, high exposure, or other habitat features.

For instance, depending on the amount of water availability, plant communities may be **hydrophytic** (aquatic habitats), **mesophytic** (moderately moist soil habitat) and **xerophytic** (dry or arid habitat).

Similarly communities growing on conditions of abundant light are called **heliophytic** and those growing in shade are **sciophytic**. Identically communities growing on various habitats designated as desert communities, mountain communities and estuarine communities and so on.
In general, a community is dynamic since it changes over time. This dynamic nature is reflected in the succession of organisms in a habitat. A series of changes results in the development of a relatively stable community, which maintains its structure and influences the climate of the area.

Such a stable and mature community is called a climax community, while communities of successional stages are called serial communities. The plant community structures, composition and other characterise can be described in both qualitative and quantitative means.

3.3 Characteristics of a Community

A community has the following characteristics:

(a) Structure:
Structure of a community can be studied by determining the density, frequency and abundance of species.

(b) Dominance:
Usually a community has one or more species which occur in large numbers. Such species are called dominants and the community is often named after them.

(c) Diversity

The community consists of different groups of plants and animals of different species, they may be large and small, may belong to one life form or another but are essentially growing in a uniform environment.

(d) Periodicity

This includes study of various life processes (respiration, growth, reproduction etc.) in the various seasons of the year in the dominant species of a community. The recurrence of these important life processes at regular intervals in a year and their manifestation in nature is termed periodicity.

(e) Stratification

Natural forest communities possess a number of layers or stores or strata related to the height of plants, for example, tall trees, smaller trees, shrubs and herbaceous layers form the different strata. This phenomenon in a plant community is called stratification.

(f) Eco-tone and Edge-effect

A zone of vegetation spreading or separating two different types of communities is called eco-tone. These are marginal zones and are easily recognizable. Usually, in eco-tones, the variety of one species is larger than in any of the adjacent communities. A phenomenon of increased variety and intensity of plants at the common junction is called edge-effect and is essentially due t6 wider range of suitable environmental conditions.

(g) Ecological Niche

Different species of animals and plants fulfill different functions in the ecological complex. The role of each is spoken of as its ecological niche i.e. the role that specie plays in its ecosystem: what it eats, who eats it, its range of movement etc., in other words, the total range of its interaction with other species of its environment.

We can also say that ecological niche is a small habitat within a habitat, in which only a single species can survive. Morin (2011) has differentiated habitat and ecological niche by saying that the habitat is an organism’s address and the ecological niche is its profession.

(h) Interspecific Association

This is the study of two or more species grow- ing together in close association in regular occurrence.

(i) Community Productivity

The study of production of biomass (organic matter) is known as production ecology. The net production of biomass and storage of energy by a community per unit time and area is called community productivity.

(j) Biotic Stability

A biotic community has the ability to quickly regain equi- librium after a disturbance in population fluctuation. This is called biotic stability and is directly proportional to the number of interacting species it contains i.e. the diversity in the community.

3.4 Community Dynamics

Communities are dynamic systems constantly interacting with another system in the environment, which is equally dynamic. The community charges are gradual and imperceptible at any time but easily recognisable if observed at regular intervals over a long period of time. Seasonal changes in plant communities always occur at every place, particularly in areas where temperature variation is significant.

However, in course of very long period of time and at many places, the communities have reached peak stage and attained dynamic balance with the environmental changes. The process of change in communities and their environment at one place in the course of time is called "**ecological succession".**

3.5 Primary and Secondary Succession

All biotic communities are continually changing. They change in response to external factors, such as changing climate, or as a result of internal factors caused by the organism themselves such as accumulation of **D**ead **O**rganic **M**atter (DOM). The biotic community will develop through time from an initial bare rock or open water start point to a **climax community**. The climax community is considered to be the most complex, diverse and productive community a given area can sustain. It may vary seasonably or fluctuate in a minor way, but it is essentially stable unless some catastrophic intervention occurs.

The change from bare rock or open water is rapid, especially in the initial stages and follows a series of recognisable and hence predictable stages. This process is called **succession.** Individual successions are known as series and the developmental phase are called **serial stages.** A succession developing on newly emerged land or water is termed a **primary succession.** A succession developing following a file or similar major disruption to an established community is called a **secondary succession.**

Opportunity for primary succession is relatively uncommon. Examples could be land or lakes emerging during glacier retreat or a new island created by volcanic activity as it occurred when Surtsey appeared off Iceland in 1963. Secondary successions are much more common. Scrub invasion on the lowland health and chalk downloads of southern England are widespread of secondary succession.

4.0 CONCLUSION

In this unit, we have examined the concept of ecological community. We have equally examined the community structure and characteristics which includes dominance, diversity, periodicity, stratification, eco-time, edge-effect, ecological niche, interspecific association, community productivity and biotic stability. Finally, the community dynamics was also discussed.

5.0 SUMMARY

In this unit students have learnt that;

- Community represent the population of all species living and interacting in an area at a particular time;
- Communities may be small, consisting of few species populations in a small space or large, comprising several species populations in a small space, or large, comprising several species populations in a large area;
- Characteristics of a community includes; structure, dominance, diversity, periodicity, stratification, eco- tone, edge- effect ecological niche, interspecific association, community productivity, and biotic stability;
- Communities are dynamic system constantly interacting with another system, the environment which is equally dynamic; and
- The process of change in communities and their environment at one in the course of time is ecological succession**,** which is divided into primary and secondary succession.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is ecological community and briefly explain the structure of the community
2. List and explain any ten (10) characteristics of the community
3. Discuss primary and secondary succession with relevant examples

7.0 REFERENCES/FUTHER READING

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UNIT 4 COMPONENT OF THE ECOSYSTEM

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
 3.1 Abiotic (Non-living) Component of the Ecosystem
 3.2 Biotic Components of the Ecosystem
 3.3 Table Showing the Component of an Ecosystem
 3.4 Functional Group
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

A biotic community lives in an environment, which provides material, energy requirement and other living conditions to it. The biotic community together with the physical environment forms an interacting system called **ecosystem.** The term ecosystem was introduced by **Arthur Tansely (1935).** An ecosystem can be defined as **a structural** and **functional unit** of biosphere or segment of nature consisting of community of living beings and the physical environment both interacting and exchanging material between them. In ecosystem the biotic communities and abiotic environment influence each other. This relationship is called **holocoenosis.** An ecosystem consist of two types of characteristic or components: which are **biotic** and **abiotic.** The components include all types of living things while the abiotic components include non-living substances and physical factors of the environment.

2.0 OBJECTIVES

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

- define ecosystem;
- explain the various abiotic and biotic components; and
- discuss the ecosystem function attributes.

3.0 MAIN CONTENT

3.1 Abiotic (Non-Living) Components of the Ecosystem

Abiotic components are and ecological factor that acts of living components during any part of their life. Abiotic factors are the factors that are either **physica**l or **chemical** factors that are the characteristic of the environment under study. A lot of ecological studies have been conducted on the significance or importance of the main abiotic factors which control the physical and biological components in an ecosystem at different periods of time and space.

Abiotic factors are the non-living components of a habitat. The abiotic factors in an ecosystem are grouped into **soil (edaphic)(** the soil the home for all living organisms including worms, insects, rodents and microorganisms, and it also supports growth), **atmosphere (** the atmosphere consists of carbon dioxide, oxygen and nitrogen), **topography**, **meteorology or climatic**, **availability of water** and **quality of water**, **radiation**, and every **organic** (e.g. carbohydrates, proteins, lipids, humic substances etc.) and **inorganic** substances (e.g. carbon, nitrogen, hydrogen, oxygen, phosphorus, Sulphur etc.

The **meteorological or climatic factors** are temperature, wind, sun, humidity and precipitation. The activities and growth of plants and animals are a result of many of these abiotic factors. The quantity of the abiotic components available in the ecosystem is referred to as '**the standing stage'**.

Abiotic components of an ecosystem therefore are made up of **the inorganic aspects** of the environment that decides the living things that can survive in that particular ecosystem.

Temperature of an ecosystem differs by latitude; locations close to the equator are hotter than locations that are closed to the poles or the temperate zones. **Humidity** regulates and determines the amount of water and moisture in the air and soil, which, in turn, influence rainfall.

Topography is the layout of the land in relation to its elevation. For instance, according to the University of Wisconsin, land situated in the rain shadow of a mountain will experience less precipitation of rainfall. Natural disturbances include things like tsunamis, lightning storms, hurricanes and wildfires.

3.2 Biotic Components of the Ecosystem

The biotic components of an ecosystem are the living organisms that live in an ecosystem. These living organisms in an ecosystem assist in the **transfer** and **cycle of energy** inside any given ecosystem. They are classified based on the source of energy requirement of their body.

Producers like plants manufacture their own energy without consuming other living organisms; plants obtain their energy through the process of **photosynthesis** with the energy for the reaction obtained from sunlight. **Consumers** can be seen on the subsequent level of the food chain. There are **three major types** of consumers**: herbivores, carnivores** and **omnivores**.

Herbivores e.g. grasshopper, mice, rabbits, deer, cows, sheep, goats and etc. feed on plants or plant products**; carnivores** e.g. foxes, frogs, snakes, hawks, spiders etc. get their food by eating other living organisms whether carnivores or herbivores, and **omnivores** e.g. bears, turtles, squirrels, humans are animals that possess the ability to digest both plant and animal tissue.

Decomposers are the living component of the ecosystem that breaks down waste material and dead organisms. Examples of decomposers include **earthworms, dung beetles** and **many species of fungi and bacteria**. They perform a vital recycling function, returning nutrients incorporated into dead organisms to the soil where plants can take them up again. They, by this process, also harvest the last of the sunlight energy initially absorbed by producers. **Decomposers** represent the final step in many of the cyclical ecosystem processes.

Therefore, the biotic components of the ecosystem which is composed of the plants, animals and microbes work together and are reliant on the abiotic factors.

3.3 Table Showing the Components of an Ecosystem

ABIOTIC COMPONENTS	***BIOTIC COMPONENTS***
Sunlight	Primary producers
Temperature	Herbivores
Precipitation	Carnivores
Water or moisture	Omnivores
Soil or water chemistry (e.g., P, NH_4^+)	Detritivores

By and large, this set of environmental factors are very essential in virtually all ecosystems.

3.4 Functional Group

A functional group is a biological class composed of organisms that carry out majorly the same type of function in the system; for example, all of the photosynthetic plants or primary producers constitute a functional group. Belonging to a functional group does not rely immensely on who the real players (species) are rather on what function they carry out in the ecosystem.

4.0 CONCLUSION

In this unit, we have examined the abiotic (non-living) components and the biotic (living) components of this ecosystem. We also break down in a concise manner the components of an ecosystem and finally, we examined the functional group of the ecosystem.

5.0 SUMMARY

In this unit students have learnt that:

- An ecosystem includes a group of biotic communities of species interacting with one another in an area, the ways in which they interact with each other and exchange energy and matter;
- Ecosystems are composed of a variety of abiotic and biotic components that function in an inter-related fashion;
- Abiotic factors in an ecosystem are grouped into soil (edaphic), atmosphere, topography, meteorology or climate, availability of water and quality of water, radiation and organic and inorganic substances;
- The plants, animals and micro-organisms (e.g. fungi and bacteria) present in an ecosystem form the biotic components; and
- A functional group is a biological class composed of organisms that carry out majorly the same type of function in the system.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is an ecosystem? Discuss briefly the components of an ecosystem.
2. Describe the biological importance of decomposers.

7.0 REFERENCES / FURTHER READING

Sharma, J.P. (2009). *Basics of Environmental Studies*. New Delhi: University Science Press.

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UNIT 5 ENERGY FLOW IN ECOSYSTEM AND PRODUCTION

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
 3.1 Energy Flow in Ecosystem
 3.2 Components of Energy Flow in the Ecosystem
 3.3 Energy Transformation
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Energy may be defined as the capacity to do work. All living organisms may be regarded as working machines which require continuous supply of energy in order to keep working, and to stay alive. Energy can neither be created nor destroyed (the law of conservation of energy). Energy can be transferred from one form to another as we will see in this unit.

2.0 OBJECTIVES

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

- list the process of energy flow in ecosystem
- explain the two aspects with respect to energy flow in the ecosystem
- discuss energy transformation in ecosystem.

3.0 MAIN CONTENT

3.1 Energy Flow in Ecosystem

Energy and carbon enter the ecosystems through photosynthesis and are incorporated into living tissue, transferred to other organisms that feed on the living and dead plant matter, and eventually released through respiration.

The carbon and energy incorporated into plant tissues (net primary production), is either consumed by animals while the plant is alive, or it remains uneaten when the plant tissue dies and becomes detritus. In terrestrial ecosystems, roughly 90% of the net primary production ends up being broken down by decomposers. The remainder is either consumed by animals while still alive and enters the plant-based trophic system, or it is consumed after it has died, and enters the detritus-based trophic system.

In aquatic systems, the proportion of plant biomass that gets consumed by herbivores is much higher. In trophic systems photosynthetic organisms are the primary producers. The organisms that consume their tissues are called primary consumers or secondary producers—herbivores. Organisms which feed on microbes (bacteria and fungi) are termed microbivores. Animals that feed on primary consumers—carnivores—are secondary consumers. Each of these constitutes a trophic level.

The sequence of consumption—from plant to herbivore, to carnivore—forms a food chain. Real systems are much more complex than this—organisms will generally feed on more than one form of food, and may feed at more than one trophic level. Carnivores may capture some prey which is part of a plant-based trophic system and others that are part of a detritus-based trophic system (a bird that feeds both on herbivorous grasshoppers and earthworms, which consume detritus). Real systems, with all these complexities, form food webs rather than food chains (see Figure 5.1).

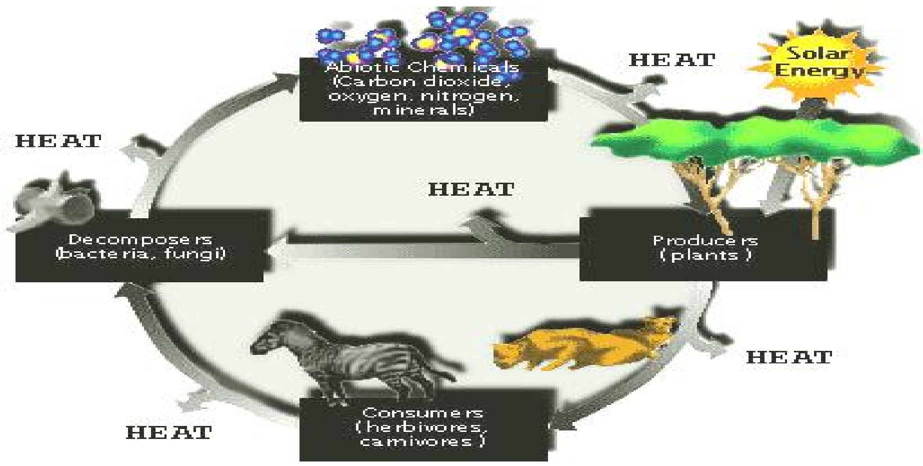

Fig.5.1: Energy Flows and Material Cycles.
Source: Sharma, 2009.

3.2 Components of Energy Flow in the Ecosystem

There are two components with respect to energy flow in ecosystem. These include:

(i) Unidirectional or one way flow of energy in the ecosystem i.e., from producers through herbivores to carnivores. The energy cannot be transferred in the reverse direction i.e. the energy that is captured by the autotrophs does not revert back to solar input; or the energy which passes to the herbivores does not pass back to the autotrophs.

(ii) The amount of energy flow decreases with successive trophic levels. Producers capture only a small fraction of solar energy (1–15% of total radiation) and the bulk of unutilised energy is dissipated mostly as heat. Part of energy captured in gross production of producers or Gross Primary Production (GPP) is used for maintenance of their standing crop (respiration and for providing food to herbivores (herbivory). The unutilised Net Primary Production (NPP) is ultimately converted to detritus, which serves as energy source to decomposers.

3.3 Energy Transformation

The transformations of energy in an ecosystem begin with the input of energy from the sun. Energy from the sun is captured by the process of photosynthesis. Carbon dioxide is combined with hydrogen (derived from the splitting of water molecules) to produce carbohydrates (the shorthand notation is "CHO"). Energy is stored in the high energy bonds of adenosine triphosphate, or ATP.

The prophet Isaiah said "all flesh is grass", earning him the title of first ecologist, because virtually all energy available to organisms originates in plants. Because it is the first step in the production of energy for living things, it is called ***primary production***. ***Herbivores*** obtain their energy by consuming plants or plant products, ***carnivores*** eat herbivores, and ***detritivores*** consume the droppings and carcasses of us all.

4.0 CONCLUSION

In this unit, we have examined the principle of energy flow in an ecosystem. Also, two aspects with respect to energy flow in the ecosystem were discussed. The transformation of energy in an ecosystem was also examined.

5.0 SUMMARY

In this unit, students have learnt that:

- Energy may be defined as the capacity to do work;
- Flow of energy in an ecosystem takes place through the food chain and it is this energy flow which keeps the ecosystem going;
- There are two aspects with respect to energy flow in ecosystem that energy flow is unidirectional or one-way flow unlike the nutrients which move in a cyclic manner and the amount of energy flow decreases with successive trophic levels; and

- The transformation of energy is an ecosystem begins first with the input of energy from the sun.
- Primary production is the first step in the production of energy for living things from plants.

6.0 TUTOR-MARKED ASSIGNMENT

- Give an account of energy flow in an ecosystem.
- Explain the two components of energy flow in the ecosystem.

7.0 REFERENCES/FURTHER READING

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UNIT 6 FOOD CHAIN AND FOOD WEBS

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
 3.1 Food Chain
 3.2 Trophic Level
 3.3 Types of Food Chain
 3.4 Food Web
 3.5 Significance of Food Chains and Food Webs
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Charles Elton (1900–1991) is a pioneer of the study of animal and plant forms in their natural environments, and of animal behavior as part of the complex patter of life. The concept of the 'food chains' will be discussed extensively. In nature, the food chains are not isolated sequences but are rather interconnected with one another called food web which will also be discussed.

2.0 OBJECTIVES

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

- explain the concept, relationship of food chain and food web
- list the different types of food chain
- discuss the significance of food chain and food web.

3.0 MAIN CONTENT

3.1 Food Chain

Within an ecosystem, nutrients are recycled as living things go about their daily business of eating food and excreting waste products. All living things exist as part of a nutrient recycling chain – an enormous chain defined by what eats what. This is called the food chain. Food chains are the pathways along which nutrients pass through an ecosystem. It requires constant supplies of new energy to make up for the continual losses.

The transfer of food energy from the producers to the higher level consumers through a series of organism (herbivores to carnivores to decomposers) constitutes food chain. **The sequence of eating and being eaten in an ecosystem is known as food chain**. All organisms, living or dead, are potential food for some other organisms and thus, there is essential no waste in the functioning of a natural ecosystem.

3.2 Trophic Level

Plants capture the sun's energy and convert it to glucose, herbivores eat plants and carnivores eat herbivores - different feeding levels. These different feeding levels are known as trophic levels (in Greek, trophe is food). Thus, trophic level is the position that an organism occupies in a food chain, or a group of organisms in a community that occupy the same position in food chains:

- Trophic level 1 – Producers
- Trophic level 2 – Herbivores (Primary consumer)
- Trophic level 3 – Carnivores (Secondary consumer)
- Trophic level 4 – Carnivores (Tertiary consumer)

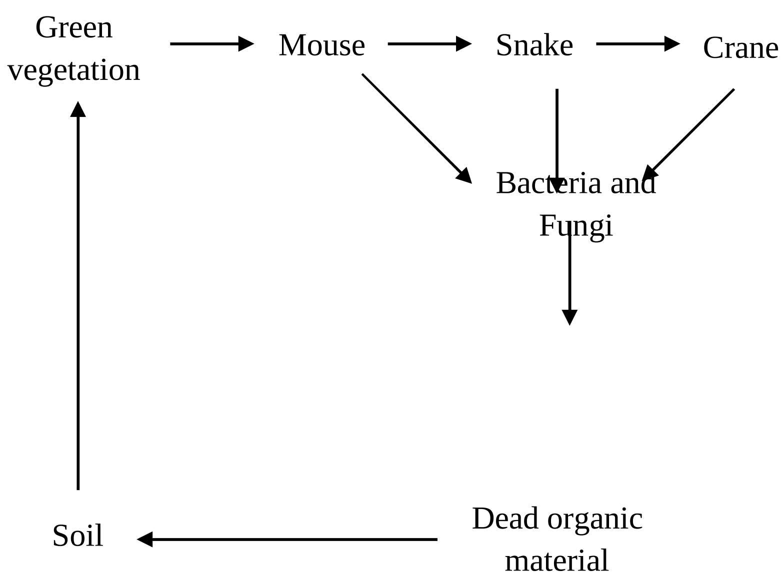
The first trophic level, the autotrophs supports the energy requirements of all other trophic level above.

3.3 Types of Food Chain

Three basic types of food chains are found in a typical ecosystem through which energy assimilated by plants can flow:

Grazing Food Chain: It starts with green plants (primary producers) and via herbivores culminates in carnivores. It may be terrestrial and aquatic type. For example:
Green Plant ⟶ Rabbit ⟶ Fox

Detritus Food Chain: Disintegrated dead bodies of plants are called detritus. A group of minute organism for which detritus serves as a source of energy are called detritivores. The food chain so formed is called detritus food chain. Millipedes, earthworms, fungi, moluscs, etc., are the examples of detritivores. It starts with dead organic matter and the detritivores and decomposers consume. The detritus food chain is more common in terrestrial ecosystem than in aquatic ecosystem. For example:



In ecosystem such as grassland, pond or lake, a substantial part of the primary production is grazed on by herbivores. In grassland, cattle and rodents are the main grazers and zooplanktons are in a pond or lake ecosystem. Usually up to 50% of the net primary production is consumed by these animals in their respective ecosystems and remaining 50% goes to the decomposer organisms as dead organic matter.

On the other hand, the dominant primary consumers are the insects, which usually consume less than 10% of the Net Primary Production (NPP) in forest ecosystem. The remaining 90% is consumed later as dead plant material by the detritus feeding organism like micromethods, oligochaetes and micro-organisms like protozoa, fungi and bacteria. The detritus food chain exists in every ecosystem depending upon availability of decomposers and is very important for circulation of material.

Parasitic Food Chain: In parasitic food chain either the producer or the consumer is parasitised and therefore the food passes to smaller organism. For example:

Tress (Producers) → Fruit Eating Birds (Herbivores) → Lice and Bugs (Parasite on Herbivores) → (Hyperparasite on lice and bugs)

Bacteria and Fungi

Terrestrial Food Chains

1. Vegetation → Grasshopper → Shrew → Hawk
2. Vegetation → Rabbit → Fox → Wolf → Tiger
3. Vegetation → frog → Snake → Peacock
4. Plant → Butterfly → Frog → Snake → Hawk

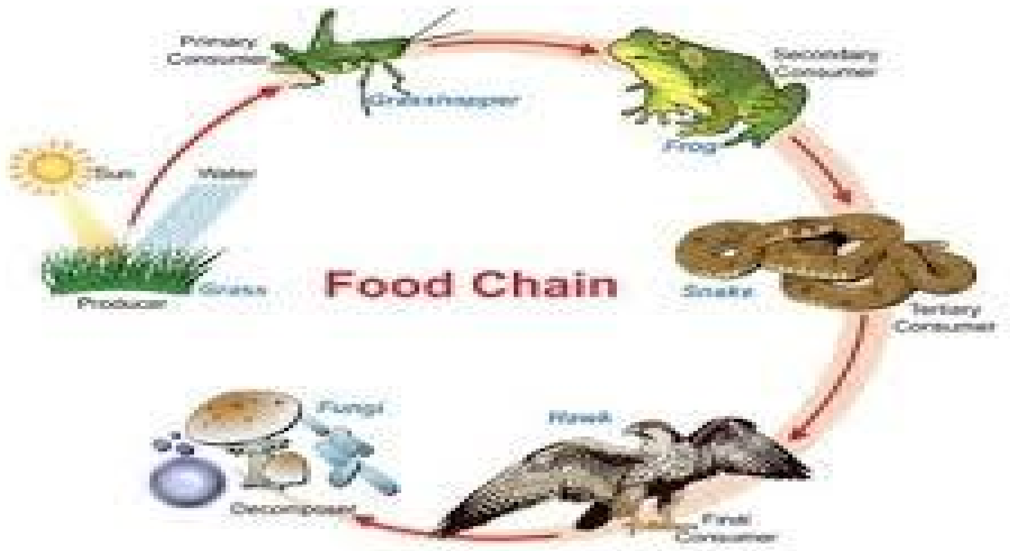


Fig. 6.1: Diagram of Terrestrial Food Chain

Aquatic Food Chains

1. **Phytoplankton** → Zooplankton → **Small Crustaceans** → Predator Insects → Small Fish → Stork/King fisher → **crocodile**
2. **Phytoplankton** → Zooplankton → **Small Fish** → Large Fish → **Shark**
3. **Phytoplankton** → Zooplankton → **Fish** → Crane → **Hawk**

   Grazing and detritus food chains both exist in ecosystem but they have few difference. As grazing food chain begins with green plants at the first trophic level and detritus level and detritus food chain begins with decomposer at the first trophic level. Energy in grazing food chain comes from sun and in detritus food chain it comes from remains of detritus. Grazing food chains add energy into the ecosystem and detritus food chain take up energy from detritus, ensuring maximum utilization and minimum wastage.

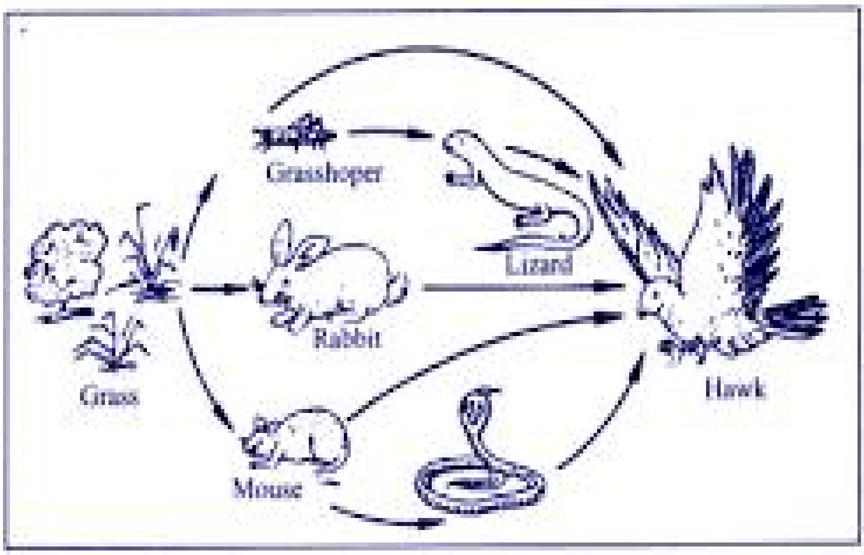
3.4 Food Web

Food web is a **network of food chains** where different **types of organisms** are **connected** at different **trophic levels**, so that there are a number of options of eating and being eaten at each trophic level.

Food web is a set of inter-connected food chains by which energy and materials circulate within an ecosystem. The food web is divided into two broad categories: the grazing web, which typically begins with green plants, algae, or photosynthesizing plankton, and the detrital web, which begins with organic debris. These webs are made up of individual food chains. In a grazing web, materials typically pass from plants to plant eaters (herbivores) to flesh eaters (carnivores). In a detrital web, materials pass from plant and animal matter to bacteria and fungi (decomposers), then to detrital feeders (detritivores) and then to their predators (carnivores).

Generally, many inter-connections exist within food webs. For example, the fungi that decompose matter in a detrital web may sprout mushrooms that are consumed by squirrels, mice and deer in a grazing web. Robins are omnivores, i.e., consumers of both plants and animals and thus are in both detrital and grazing webs. Robins typically feed on earthworms, which are detritivores that feed upon decaying leaves.

Fig.6.2:Diagrammatic sketch Showing a Food Web in a Grassland Ecosystem



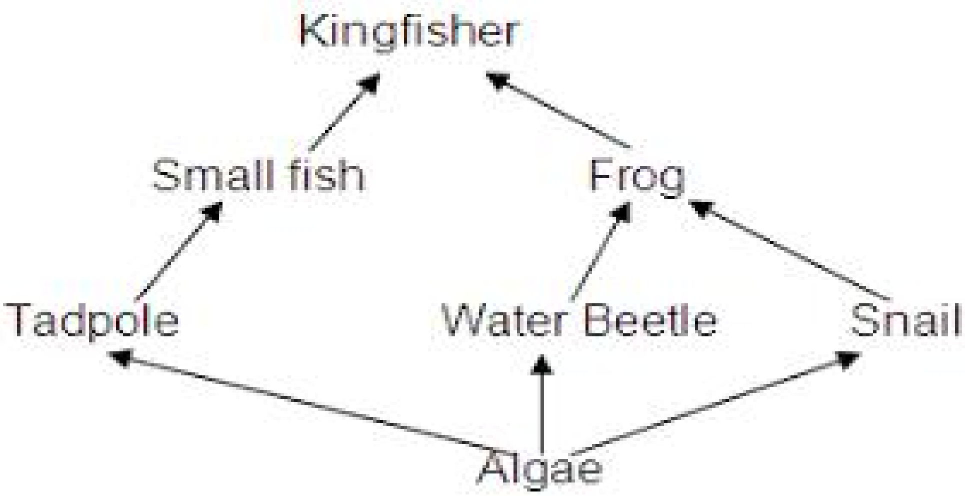


Fig. 6.3: Diagram of Aquatic Food Web

3.5 Significance of Food Chains and Food Webs

- The energy flow and nutrient cycling take place through them.
- They help to understand the feeding relationships and the interaction between organisms in any ecosystem.
- Food chains show a unique property of biological magnification of some chemicals.
- Food chains and webs ensure that one particular species cannot become too large and therefore destroy the species it feeds on, creating a massive imbalance. This means that energy creature has a predator and/or environmental threats so their population cannot increase to an amount are unhealthy for the surrounding ecosystem.
- The food chain keeps species that reproduce more rapidly from over populating the area and eating all the resources, by being eaten by animals that do not reproduce as often and one higher up in the food chain.
- Food webs distinguish levels of producers and consumers by identifying and defining the importance of animal relationships and food sources, beginning with primary producers such as plants, insects and herbivores.
- They are important tool in understanding that plants are the foundation of all ecosystems and food chains. Plants sustain life by providing nourishment and oxygen needed for survival and reproduction.
- Food chains and food webs aid in the understanding of natural selection, showing the hierarchy of species, with carnivorous, omnivorous and tertiary animals at the top of all food chains.
- Food webs are helpful in explaining how disruptions in populations due to over hunting, poaching, global warming and habitat destruction result in food scarcities leading to extinction.

4.0 CONCLUSION

In this unit, we have examined the concept and relationship of food chains and food webs. We have equally examined the different types of food chain. To conclude this unit, we also look at the significance of food chain and food web.

5.0 SUMMARY

In this unit, students have learnt that:

- The sequence of eating and being eaten in an ecosystem is known as food chain.

- Trophic level is the position that an organism occupies in a food chain, or a group of organisms in a community that occupy the same position in food chains.
- Three basic types of food chains are found in a typical ecosystem through which energy assimilated by plants can flow through grazing food chain, detritus food chain and parasitic food chain.
- Food web is a network of food chains where different types of organisms are connected at different trophic levels, so that there are a number of options of eating and being eaten at each trophic level.
- Food chains and food webs have great significance to the ecosystem.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define a food chain and food web.
2. Draw a four or five organism's terrestrial and aquatic food chain.
3. Mention eight significance of food chain and food web.

7.0 REFERENCES/FURTHER READING

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UNIT 7 ECOLOGICAL PYRAMIDS

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
 3.1 Ecological Pyramid
 3.2 Pyramid of Number
 3.3 Pyramid of Biomass
 3.4 Pyramid of Energy
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

In an ecosystem, trophic structure can be represented by comparing standing crop (either number of individuals, or number of biomass or number of energy fixed per unit area at different trophic levels. When the ecological parameters such as number of organisms, biomass or energy at successive trophic levels are plotted, they assume a shape of pyramids.

2.0 OBJECTIVES

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

- define ecological pyramid
- explain the pyramid of number and biomass
- discuss the pyramid of energy.

3.0 MAIN CONTENT

3.1 Ecological Pyramids

Graphical representation of trophic structure and function of an ecosystem, starting with producers at the base and successive tropic levels forming the apex is known as an ecological pyramid. Ecological pyramids are of three types: pyramid of number, pyramid of biomass and pyramid of energy.

3.2 Pyramid of Number

It is a bar diagram that indicates the **relative number of organisms** at each trophic level in a food chain. The length of each bar gives a measure of the relative numbers. It shows the relationships among the number of producers (irrespective to taxonomic position), **primary consumers** (herbivores), **and secondary consumers** (carnivores) and so on in any ecosystem. It also represents the number of individual organisms per unit area at each trophic level. We may have upright (grassland/pond ecosystem) or inverted (parasitic ecosystem) pyramid of number depending upon the type of ecosystem and food chain.

Advantage of Number Pyramid
This is a simple easy method of giving an overview and in good at comparing changes in population number with time or season.

Disadvantage of Number Pyramid
All organisms are included regardless of their size; therefore, a system would be inverted. Also they do not allow for juveniles or immature forms. Numbers can be too great to represent accurately.

3.3 Pyramid of Biomass

An ecological pyramid of biomass is **graphical representation** of the relationship between **biomass** and trophic level by quantifying the amount of biomass present at each trophic level. Biomass is the quantity of dry organic material in an organism, (a population), a particular trophic level or an ecosystem. It is chemical energy stored in the organic matter and energy lost in each trophic level.

Biomass = Mass of each individual x No. of individual at each trophic level

Graphical representation of Pyramids of forest and pond ecosystem

Their energy is usually concentrated at the base, which is represented as being wide and decreases as one moves up to the apex. The pyramid as is used as a manner of clarifying the movement of the biomass as well as the energy through the ecosystem. According to law of thermodynamics, the energy can neither be created nor destroyed it can only be transferred from one form to another. When herbivores eat producer, and carnivores to herbivores and lastly when decomposer consumers all. The energy is transferred through the chain and converted in the biomass.

In oceanic ecosystem (or pond ecosystem) where the producers are phytoplankton. In winter, phytoplankton reproduces fast but in small amounts. So the phytoplankton bar may be far shorter than that of the zooplanktons (which are the primary consumers) and we get an inverted pyramid of biomass as pyramid represents biomass at particular time only.

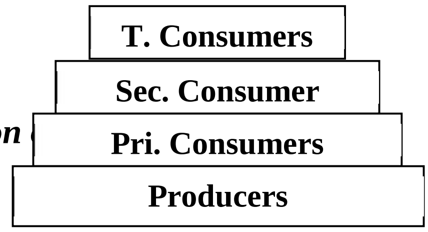
Advantage of Pyramid of Biomass
It overcomes the problems of pyramids of numbers.

Disadvantages of Pyramid of Biomass
This only uses samples from population, so it is impossible to measure biomass exactly. We have to kill organism to measure dry mass. The time when biomass is measured affects the result and the shape (upright or inverted) of the pyramid would depend on the season.

3.4 Pyramid of Energy

The **amount of energy** present at each trophic level is considered as pyramid of energy. Pyramid of energy gives the best representation of the trophic relationship. According to Lindman (1942), only 10 per cent of energy is converted at each trophic level. For example, in case of pond ecosystem, each 1000 calorie of energy produced in producers (algae, etc.), 100 calories may be converted in primary consumers (zooplanktons), 10 calories by secondary consumers and one calorie by tertiary consumers (top consumers). Thus, the amount of energy gradually decreases at successive trophic levels and it is always upright.

Diagrammatic representation (



Advantage of Pyramid of Energy
Most accurate system shows the actual energy transferred and allows the rate of production.

Disadvantage of Pyramid of Energy
It is difficult and complex to collect energy data.

4.0 CONCLUSION

In this unit, we have examined the meaning of ecological pyramid. Also, examined the three types of ecological pyramid namely; pyramid of number, pyramid of biomass and pyramid of energy.

5.0 SUMMARY

In this unit, students have learnt that:

- Ecological pyramid is a graphical representation of trophic structure and function of an ecosystem.
- Ecological pyramids are of three types: pyramid of number, pyramid of biomass and pyramid of energy.
- Pyramid of number is a bar diagram that indicates the relative number of organisms at each trophic level in a food chain.
- Pyramid of biomass is a graphical representation of the relationship between biomass and trophic level by quantifying the amount of biomass present at each trophic level.
- Pyramid of energy is the amount of energy present at each trophic level.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is ecological Pyramid?
2. With an annotated diagram, describe the pyramids of numbers, biomass and energy.

7.0 REFERENCES/FURTHER READING

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UNIT 8 TYPES OF ECOSYSTEM 1 TERRESTRIAL ECOSYSTEM

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
3.1 Terrestrial Ecosystem
3.2 Forest Ecosystem
3.3 Grassland Ecosystem
3.4 Desert Ecosystem
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Different ecosystems like a pond, a lake, a river, a stream, a spring, an estuary, the sea, a forest, grassland, a desert and a cropland are operating as self-sufficient interacting systems in the atmosphere. The major ecosystems with their groups of climax plants and associated animals are called **biomes**. These ecosystems have a more or less similar fundamental plan of their gross structure and function. However, they differ in respect of their species composition and productivity rates. The ecological characteristics of the terrestrial ecosystems are described in this unit.

2.0 OBJECTIVES

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

- define terrestrial ecosystem
- explain the forest and grassland ecosystem
- discuss the desert ecosystem

3.0 MAIN CONTENT

3.1 Terrestrial Ecosystem

Terrestrial ecosystems are known by the type of main vegetation in them. For example, if the main vegetation in an ecosystem is grass, then the terrestrial ecosystem will be known as grassland ecosystem. If the ecosystem is forest, then the terrestrial ecosystem will be known as forest ecosystem and finally, if the ecosystem is desert, then the terrestrial ecosystem will be known as desert ecosystem.

3.2 Forest Ecosystem

Forests are natural plant communities with dominance of trees. In India, the forest occupies roughly 19% of the total land area. The major forest biomes found in India are: (i) Tropical rainforest (ii) Tropical deciduous forest (iii) Temperate broad leaf forest (iv) Temperate needle leaf or coniferous forest.

The different components of forest ecosystems are as follows:

Abiotic Components
These include inorganic and organic substances present in the soil and atmosphere. The climate (temperature, light rainfall etc.) and soil (minerals) vary from forest to forest. In addition to minerals the occurrence of litter is characteristic feature of majority of forests.

Biotic Components

(i) **Producers:** These are mainly trees that show much species diversity and greater degree of stratification especially in tropical rain and tropical rain and tropical deciduous forests. Besides trees, there are also present shrubs and ground vegetation. In these forests, the producers include the dominant tree species such as *Dipterocarpus*, *Tectona grandis (Teak), Butea frondosa (Dhak) and Shorea robusta (sal)*. In temperate broad leaf forests several species of *Quercus* (Oak), occur as dominant species, whereas in temperate coniferous forests the dominant trees are *Pinus* (Pine), *Cedrus* (Deodar), *Picea* (Spruce) and *Abies* (Silver fir), etc.

(ii) **Consumers.** Following types of consumers occur in the forest biomes.

- **(a)** **Primary Consumers.** These are the herbivores that include smaller animals feeding on tree leaves as ants, flies, beetles, lead-hoppers, bugs, spiders, etc., and larger animals grazing on shoots and/or fruits of producers as elephants, neelgai, deer, moles, squirrels, shrews flying foxes, mangooses, etc.
- **(b)** **Secondary Consumers.** These are the carnivores like snakes, birds, lizards, fox, etc., feeding on the herbivores.
- **(c)** **Tertiary Consumers.** These are the top carnivores like lion, tiger, etc., that eat upon carnivores of secondary consumer's level.

(iii) **Decomposers.** These are wide variety of microorganisms including fungi (species of *Aspergillus*, *Polyporus, Alternaria, Fusarium*, *Trichoderma*, etc.), bacteria (species of *Bacillus, Pseudomonas*, *Clostridium*, etc.) and actiomycetes (species of

Streptomyces). Rate of decomposition in tropical and subtropical forests is more rapid than in the temperate one.

3.3 Grassland Ecosystem

The grassland biomes occur in the regions, where the climate is cool to cold during winters and hot in summers. The different components of a grassland ecosystem are as follows:

Abiotic Components

These include nutrients present in soil and the atmosphere. Thus the elements like C, H, O, N, P, S, etc. are supplied by carbon dioxide, water, nitrates, phosphates and sulphates present in the air and soil of the area.

Biotic Components

(i) **Producers.** The grasslands are characterized by treeless herbaceous plant cover dominated by a wide variety of grass species. The main grasses are species of Dichanthium Cynodon, Phragmites, Cenchrus, Imparata and Saccharum, etc. Besides them a few herbs and shrubs also occur as producers.

(ii) **Consumers.** The various types of consumers occurring in grassland are as follows:

- (a) **Primary Consumers.** The herbivores feeding on grasses are mainly such grazing animals as cows, buffaloes, deer, sheep, rabbit, mouse, etc. Besides them, there are also present are insect species as Leptocorisa, Dysdercus, Oxyrhachis, Cicindella, Coccinella, and some termites, millipedes, etc. that feed on the leaves of grasses.
- (b) **Secondary consumers**. Snakes, lizards, birds, jackals, fox, etc. are common secondary consumers which feed on herbivores.
- (c) **Tertiary consumers.** These include hawks, which feed on secondary consumers.

(iii) **Decomposers.** Several fungi (Mucor, Aspergillus, Penicillium, Cladosporium, rhizopus, Fusarium, etc.), actinomycetes and bacteria decay the dead organic matter of different forms of higher life. They bring about minerals back to the soil, thus making them available to the producers.

3.4 Desert Ecosystem

The desert biomes are characterised by extremely low rainfall (less than 25cm). They occupy about 17 per cent of the land. Due to scarcity of water and high temperature, the biota is poorly represented. The various components of desert biomes are as follows:

Abiotic components
In desert ecosystem temperature is found to be very high and rainfall is very low. The nutrient cycling is poor due to scanty biota.

Biotic components
(i) Producers. These are shrubs, especially bushes, some grasses, and a few trees. The shrubs have widespread-branched root system with their leaves, branches and stems variously modified. Sometimes a few succulents like cacti are also present. Some lower plants like lichens and xerophytic mosses may also be present.
(ii) Consumers. Insects, reptiles, nocturnal rodents, birds, camels, etc. are the main consumers.
(iii) Decomposers. These are very few, as due to poor vegetation the amount of dead organic matter is correspondingly less. These are some fungi and bacteria, most of them are thermophilic.

4.0 CONCLUSION

In this unit, we have examined the terrestrial ecosystem and the different types of the terrestrial ecosystem.

5.0 SUMMARY

In this unit, students have learnt that:

- Terrestrial ecosystems are known by the type of main vegetation in them.
- The ecological characteristics of the terrestrial ecosystem are the forest, grassland and desert ecosystem;
- Forests are natural plant communities with dominance of trees
- Grassland biomes occur in the regions, where the climate is cool to cold during winters and hot in summers.
- The desert biomes are characterized by extremely low rainfall (less than 25cm).

6.0 TUTOR-MARKED ASSIGNMENT

1. Briefly discuss the terrestrial ecosystems.
2. Write short notes on
   a. Grassland ecosystem and
   b. Desert ecosystem

7.0 REFERENCES/FURTHER READING

Sharma, J.P. (2009). *Basics of Environmental Studies*. New Delhi: University Science Press.

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UNIT 9 TYPES OF ECOSYSTEM 2 AQUATIC ECOSYSTEM

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
  3.1 Aquatic Ecosystem
  3.2 Pond or Lake Ecosystem
  3.3 River or Stream Ecosystem
  3.4 Ocean or Marine Ecosystem
  3.5 Estuaries Ecosystem
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignments
7.0 References/Further Reading

1.0 INTRODUCTION

Different ecosystems like pond, lake, river, stream, spring, estuary and the sea, are operating as self-sufficient interacting systems in the hydrosphere. These ecosystems have a more or less similar fundamental plan of their gross structure and function. However, they differ in respect of their species composition and productivity rates. The ecological characteristics of the aquatic ecosystems are described in this unit.

2.0 OBJECTIVES

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

- Understand the meaning of aquatic ecosystem;
- Understand the pond or lake and river or stream ecosystem; and
- Understand ocean or marine and estuaries ecosystem.

3.0 MAIN CONTENT

3.1 Aquatic Ecosystem

An aquatic ecosystem is distinguished from terrestrial one on the basis of its salt content. The aquatic ecosystems have dissolved compounds like salt in the water. Such ecosystem occupies about 70% of this planet. There are many kinds of aquatic ecosystems ranging from small temporary puddles to large ocean. They differ widely with regards to abiotic factors and living organisms.

3.2 Pond or Lake Ecosystem

A pond or lake is a good example of a self-sufficient and self-regulating ecosystem. Location size, depth and substratum of a pond or lake constitute the biology of the ecosystem. The various components of the ecosystem are as follows:

Abiotic components

Temperature, light, water, and several inorganic substances like C, H, O, N, P, Ca, S, and carbohydrates, proteins and lipids make abiotic components. Some proportions of nutrients are in solution state but most of them are present stored in particulate matter as well as in living organisms. The amount of minerals present at any time in the physical environment of the pond is called **standing state**.

Biotic components

(i) **Producers.** These include green photosynthetic organisms and are of two types: Phytoplanktons and Macrophytes.

- **(a)** **Phytoplanktons.** These are minute floating or suspended lower plants belong to some algae and flagellates. Ulothrix, Spirogyra, Oedogonium, Chlamydomas, Zygnema, Volvox, Pandarina,Cosmarium, Scenedesmus, Closterium, Anabaena, Pediatrum, Microcystis, diatoms, etc. are common algal phytoplanktons.
- **(b)** **Macrophytes.** Ceratophyllum, Hydrilla, Utricularia, Vallisneria, Jussiaea, Nitella, Wolfa, Lemna, Spirodella, Pistia, Eichhornia, Azolla, Salvinia, Trapa, Typha, Marsilea, etc. are included in this category. This may be classified further into submerged, free floating and amphibious plants.

(ii) **Consumers**

- (a) **Primary consumers.** These include zookplanktons and benthos forms. Zookplankton comprises ciliates, flagellates, other protozoans, small crustacean like copepods and Daphnia, etc. These animals drift in the water current and are found along with phytoplankton upon which they feed. Benthos or bottom forms comprise the bottom dwelling animals, e.g. annelids and mollusks, which feed on plants directly or on plant remains at the bottom.
- (b) **Secondary consumers.** These are the carnivores which feed on the herbivores, e.g. insects and fish.
- (c) **Tertiary consumers.** These are some large fishes as game fish that feed on the smaller fishes.

(iii) **Decomposers or Microconsumers.** Several bacteria, fungi (Aspergillus, Cephalosporium, Phythium, etc.) and actinomycetes represent the group.

3.3 River or Stream Ecosystem

The running water of a stream or a river is usually well oxygenated because it has a large surface area to absorb oxygen from the air. The various components of river or stream ecosystem are as follows.

Abiotic components

The river or stream water has lesser mineral content and greater penetration of light. In the lower reaches water is usually muddy cutting down the light at the river bed.

Biotic components

(i) **Producers.** In slow moving water of banks, phytoplanktons, attached algae, water grasses and other amphibious plants are the producers. In swift water floating populations of plankton are generally absent.

(ii) **Consumers.** These include flatworms, leeches, water insects, snails, fishes and crocodiles. Many birds and mammals also get their food from rivers and streams.

(iii) **Decomposers.** Several bacteria and fungi represent this group.

3.4 Ocean or Marine Ecosystem

Oceans cover more than two thirds of the earth's surface. The marine environment is characterised by its high concentration of **salts** and mineral **ions**. The ocean represents a very large and stable ecosystem. The main components of the ocean ecosystem are as follows.

Abiotic Components

Marine environment as compared with freshwater, appears to be more stable in chemical composition due to being saline. The other physio-chemical factors such as dissolved oxygen, light and temperature are also different waves of various kinds and tides prevail there.

Biotic Components

(i) **Producers.** This category includes phytoplanktons and larger marine plants. The former group includes diatoms and dinoflagellates. The latter group includes sea weeds (algae) belonging to chlorophyceae, phaeophyceae and rhodophyceal; and angiosperms, Ruppia, Zoetera, Posidonia, Halphila, Enhalus, etc. are true marine angiosperms, while various species of Rhizophora, Avicennia, Sonneratia, carapa, Aegiceros, etc. represent the mangrove complex tidal woodlands.

(ii) **Consumers.** These are heterotrophic macro-consumers, being dependent for their nutrition on the primary producers. These are:

(a) **Primary consumers.** The herbivores that feed directly on producers are chiefly crustaceans, mollusks, fish, etc.
(b) **Secondary consumers.** Carnivorous fishes, such as Herring, Sahd, Mecheral, etc.
(c) **Tertiary consumers.** Fishes like cod Hadock etc. are the tertiary or top consumers.

(iii) Decomposers. They are chiefly bacteria and some fungi, which participate actively in decomposition of dead organic matter.

3.5 Estuaries Ecosystem

An estuary is a semi-closed coastal body of water that has a free connection with sea. It is strongly affected by tidal action, and within this sea water is mixed with fresh water from land drainage. River mouths, coastal bays, tidal marshes and bodies of water behind barrier beaches are some of the examples of estuaries ecosystems.

Estuaries are generally productive because of water flow subsidies and abundant of nutrients. The chief biotic components of estuaries ecosystems are as follows:

(i) **Producers.** These are macrophytes such as marshgrasses, seaweeds, sea grasses, benthic algae and phytoplankton.
(ii) **Consumers.** Oysters, crabs, several kinds of shrimp and many commercial sport fish represent this group.

4.0 CONCLUSION

In this unit, we have examined the aquatic ecosystem and the different types of the aquatic ecosystem.

5.0 SUMMARY

In this unit, students have learnt that:

- Aquatic ecosystem is distinguished from terrestrial one on the basis of its salt content.
- There are different types of aquatic ecosystem which differ widely with regards to abiotic factors and living organisms.
- A pond or lake is a good example of self-sufficient and self-regulating ecosystem.
- River or stream ecosystem is usually well oxygenated because it has a large surface area to absorb oxygen from the air.
- Oceans cover more than two thirds of the earth’s surface and they are characterized by its concentration of salts and mineral ions.

While estuaries ecosystem is a semi-closed coastal body of water that has a free connection with sea.

6.0 TUTOR-MARKED ASSIGNMENT

1. Give the salient features of a pond or a lake ecosystem.
2. Describe the biotic components of a grassland ecosystem.

7.0 REFERENCES/FURTHER READING

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UNIT 10 ENVIRONMENT

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
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  3.3 Factors Influencing the Environment
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5.0 Summary
6.0 Tutor-Marked Assignment
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1.0 INTRODUCTION

Nowadays the word **environment** is often being used by almost all people around us, on television and in newspapers. Everyone is speaking about the protection and pre-serration of environment. Global summits are being held regularly to discuss environmental issues. During the last hundred years, the mutual relationship among environment, social organization and culture has been discussed in sociology, anthropology and geography. All this shows the increasing importance of environment. Besides, it is a fact that life is tied with the environment.

2.0 OBJECTIVES

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

- define environment
- list the basic components and types of the environment
- explain the factors influencing environment

3.0 MAIN CONTENT

3.1 Meaning of Environment

The term **environment** has been derived from a French word "**Environia**" means to surround. It refers to both **abiotic** (physical or non-living) and **biotic** (living) environment. The word environment means surroundings, in which organisms live. Environment and the organisms are two dynamic and complex component of nature. Environment regulates the life of the organisms including human beings. Human beings interact with the environment more vigorously than other living beings. Ordinarily environment refers to the materials and forces that surrounds the living organism.

Environment is the sum total of conditions that surrounds us at a given point of time and space. It is comprised of the interacting systems of physical, biological and cultural elements which are interlinked both individually and collectively. **Environment** is the sum total of conditions in which an organism has to survive or maintain its life process. It influences the growth and development of living forms.

In other words, **environment** refers to those surroundings around living beings from all sides and that affect their lives in completely. It consists of atmosphere, hydrosphere, lithosphere and biosphere. Its chief components are soil, water, air, organisms and solar energy. It has provided us all the resources for leading a comfortable life.

3.1.1 Components of the Environment

Environment consists of four components or segments; they are:
(1) Atmosphere (air);
(2) Hydrosphere (water);
(3) Lithosphere (land); and
(4) Biosphere (life bearing layer).

3.1.2 Atmosphere

The invisible protective thick gaseous cover of air which envelopes the earth is known as **atmosphere**. It sustains life on earth and saves living organisms from the hostile environment of outer space. It extends to a height of about 1600km. from the earth's surface. The major components of the atmosphere are nitrogen and oxygen while the minor components are argon, carbon dioxide and some trace gases.

Some important functions of atmosphere are outlined below:
(i) It maintains heat balance of the earth through absorption of infrared radiation emitted by the sun and re-emitted from the earth.
(ii) It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.
(iii) It filters tissue damaging ultraviolet radiation below 300 nm.
(iv) It is a source of oxygen (for respiration), carbon dioxide (for photo-synthesis) and nitrogen (for nitrogen fixation).

(v) It is a medium for the operation of different bio- geochemical cycles.
(vi) It acts as a carrier of water from ocean to land.
(vii) It maintains and stabilises weather and climate.

3.1.3 Hydrosphere

The **hydrosphere** includes all types of water resources such as oceans, seas, rivers, lakes, streams, reservoirs, glaciers, polar ice caps and ground water. Out of the total water resources, 97 per cent is present in oceans as salty water, two per cent is present as ice cap and rest one per cent is available as fresh water for our day-today use.

Some important uses of water are as follows:
(i) It is used for drinking, cooking and cleaning purposes
(ii) It is used for irrigation and power generation.
(iii) It is used in different industrial operations.
(iv) It is used for navigation, fisheries and aquaculture.
(v) It is most important use is waste disposal.

3.1.4 Lithosphere (Land)

Land forms the crucial platform for a dynamic interaction in between the biotic and abiotic environment. It is the outer mantle of the solid earth, consisting of minerals occurring in the earth's crust and the soil. The soil consists of a complex mixture of minerals, organic matter, air and water. In the present technologically developed world, changes in the farming practices with continued use of agricultural chemicals, industrial proliferation, mining activities and unplanned urbanization have altered the land forms and their quality, making land more and more scarce.

Some important uses of land are as follows:
(i) It is used for agriculture and horticulture (to get food)
(ii) It is used for afforestation.
(iii) It is used for industrialisation and urbanisation.
(iv) It is used for transportation by road and rail.
(v) It is used for amenity and recreation.

3.1.5 Biosphere

Biosphere is that part of atmosphere, hydrosphere and lithosphere where all the living organisms survive together and interact with one-another. In atmosphere, the living organisms exists up to a distance of six km from the surface of the earth and in ocean, the living organism exists up to a depth of seven km from the surface. Such a distance of 13 km is known as biosphere. The living species in biosphere may be animals or plants.

The living organisms in biosphere differ from one-another by their shape, size, distribution and characteristics. Both the biosphere and environment are influenced considerably by each other. For example, green plants use carbon dioxide for photosynthesis and in turn release oxygen in the atmospheres. On the other hand, animals inhale oxygen during respiration and release carbon-dioxide.

Thus, a continuous set of interactions takes place among the living organisms of the biosphere. Besides, all the living organisms depend upon abiotic environment for their survival and entire unit is responsible for the existence of living organism or biosphere.

3.2 Types of Environment

Environment can be roughly divided into two types such as (a) Micro environment and (b) Macro environment. It can also be divided into two other types such as (c) Physical and (d) biotic environment.

(a) **Micro environment** refers to the immediate local surrounding of the organism.
(b) **Macro environment** refers to all the physical and biotic conditions that surround the organism externally.
(c) **Physical environment** refers to all abiotic factors or conditions like temperature, light, rainfall, soil, minerals etc. It comprises of atmosphere, lithosphere and hydrosphere.
(d) **Biotic environment** includes all biotic factors or living forms like plants, animals, micro-organisms.

3.3 Factors Influencing the Environment

The life of an organism is surrounded and affected by a number of external forces. These forces are known as environmental or ecological factors. There are actually four categories of ecological factors which affect the environment.

These factors may be outlined as follows:
(a) **Topographic or Physiographic factors**:
These factors include altitude, direction of mountain chains, plateaus, plains, lakes, rivers, sea level and valleys etc.
(b) **Climatic or Aerial factors**:
These include atmosphere, light temperature, humidity, rainfall etc.
(c) **Edaphic factors:**
These comprise lithosphere or soil.
(d) **Biotic factors:**

These include all types of interactions between different forms of life. For example, man, animals, plants, micro-organisms etc. All these ecological factors operate in conjunctions and not individually, affecting the life of organisms.

4.0 CONCLUSION

In this unit, we have examined the meaning of environment. We looked at the components and types of the environment and the factors influencing the environment.

5.0 SUMMARY

In this unit, students have learnt that:

- The term **environment** has been derived from a French word "**Environia**" means to surround. It refers to both **abiotic** (physical or non-living) and **biotic** (living) environment.
- Environment consists of four components or segments, which are Atmosphere (air), Hydrosphere (water), Lithosphere (land) and Biosphere (life bearing layer).
- Environment can be roughly divided into two types such as (a) Micro environment and (b) Macro environment. It can also be divided into two other types such as (c) Physical and (d) biotic environment.
- There are actually four categories of ecological factors which affect the environment which are outlined as Topographic or Physiographic factors, Climatic or Aerial, Edaphic factors and Biotic factors.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define the term environment and write a brief note on the four components of the environment.
2. Mention the factors influencing environment.

7.0 REFERENCES/FURTHER READING

Khoiyangbam, R.S. & Gupta, N (2015). *Introduction to Environmental Science*. New Delhi: TERI Press.

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MODULE 2

Unit 1 Ecology of Niche
Unit 2 Overlap Competition Coexisting and Resource Shift
Unit 3 Habitat: Primary Terrestrial Habitat which Affect Man
Unit 4 Habitat: Primary Aquatic Habitat which Affect Man
Unit 5 Alteration Imposed on the Habitats by Man.
Unit 6 Integration of Ecology and Environment into Development Planning

UNIT 1 ECOLOGY OF NICHE

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  3.2.1 Niche as the Description of Species' Habitat Requirements.
  3.2.2 Niche as Ecological Function of the Species
 3.3 Fundamental and Realised Niche
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5.0 Summary
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1.0 INTRODUCTION

In ecology, **a niche** is a term with a variety of meanings related to the behavior of a species living under specific environmental conditions. The ecological niche describes how an organism or population responds to the distribution of resources and competitors. The ecological niche concept expresses the relationship of an individual or a population to all aspects of its environment. Studies on the relationship between human population and environmental resources have employed niche concept. Ecological niche comprehends all conditions necessary for an organism to exist.

2.0 OBJECTIVES

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

- explain the ecology of niche
- discuss the concepts of niche
- explain the fundamental and realised niche.

3.0 MAIN CONTENT

3.1 Ecology of Niche

What is ecological niche?
According to the Psychology Dictionary (2014), Ecological niche can be taken to mean:

1. The position or function of an organism or a population within a biological and physical environment.
2. The area within a habitat occupied by an organism. The ecological niche is an organism position in the habitat.

The ecological niche concept, as proposed by Hutchinson (1957), expresses the relationship of an individual or a population to all aspects of its environment. Studies on the relationship between human population and environmental resources have employed niche concept (Silva and Begossi, 2009). According to Hardesty (1972), ecological niche comprehends all conditions necessary for an organism to exist. Considering the ecological niche, it can analyse each one of all interactions. For example, trophic or food niche (food relationship, such as species preferred and availability), spatial niche (climatic, chemical, and geographical factors, a species needs to survive), and behavior niche (way in which a species interacts with others, such as: foraging, activity period (Raj, 2010).

3.2 Concepts of Niche

3.2.1 Niche as the Description of Species' Habitat Requirements

The first formulations of the concept of ecological niche were close to the general meaning of the term: the ecological niche was defined by a place a species can take in nature, determined by its abiotic requirements, food preferences, microhabitat characteristics (for example a foliage layer), diurnal and seasonal specialization, or predation avoidance. This concept is associated mostly with Joseph Grinnell, who first introduced the term. He was especially interested in factors determining where we can find a given species and how niches, generated by the environment, are filled. The knowledge of a species niche determined by its habitat requirements is essential for understanding and even predicting its geographic distribution; this concept of the niche is thus more relevant in biogeography and macro-ecology than in community or ecosystem ecology.

3.2.2 Niche as Ecological Function of the Species

In this concept of niche, each species has a particular role in an ecosystem and its dynamics, and one such role can be fulfilled by different species in different places. The observation of distant species adapted to equivalent ecological roles (the resemblance between jerboa and kangaroo rat, between many eutherian and marsupial species, or the Galapagos finches diversifying to highly specialised roles including those normally taken by woodpeckers) was clearly influential to Charles Elton, who emphasised the functional roles of species. According to Elton, there is the niche of burrowing detritivores, the niche of animals specialising in cleaning ticks or other parasites, or the pollination niche. Elton's niche can apply to several species, for example "the niche filled by birds of prey which eat small mammals". This **functional niche** therefore refers to a species position in food webs and trophic chains, and the concept is thus especially relevant for ecosystem ecology.

3.3 Fundamental and Realised Niches

Hutchinson (1957), recognizes a species' **fundamental niche**, a multidimensional 'cloud' of favourable conditions determined by all environmental (abiotic and biotic) variables where the species can reproduce and survive, and the **realised niche**, which is a subset of the abstract fundamental niche, where the species can persist given the presence of other species competing for the same resources. Realised niche thus always has a narrower extent along respective dimensions; a species which could potentially live in a broad range of humidity conditions, for instance, may occupy a much narrower range of these conditions in an environment with competing species, since its population growth rate decreases to negative values in some conditions.

According to Hutchinson's formalisation, niches of different species can be separated along any of these dimensions or by a combination of them (i.e. their interaction). Although this formal model of the niche has quite straightforward theoretical consequences, in practice it can be quite difficult to describe properly the ecological niches of real species, because the number of niche dimensions is potentially infinite, and the significant niche axes (and appropriate measurements) may be rather hard to find: a niche overlap among species may mean we did not succeed in determining the crucial niche axes of separation. However, often a few variables are sufficient to separate species' realised niches, and they or their correlates can be inferred assuming we understand the species' biology reasonably well. The distinction between the fundamental and realised niche may also be blurred, as species' interactions need not fit to our discrete categories **-** for example, competitors may act also as predators.

4.0 CONCLUSION

In this unit, we have examined the meaning of Ecology of Niche and the concept of ecology of niche. We have also examined the fundamentals and realised niche

5.0 SUMMARY

In this unit students have learnt that:

- The ecological niche is an organism position in the habitat.
- (ii)The ecological niche concept, as proposed by Hutchinson (1957), expresses the relationship of an individual or a population to all aspects of its environment.
- In this concept of niche, each species has a particular role in an ecosystem and its dynamics, and one such role can be fulfilled by different species in different places.
- Functional niche therefore refers to a species position in food webs and trophic chains, and the concept is thus especially relevant for ecosystem ecology.
- A species' **fundamental niche**, a multidimensional 'cloud' of favourable conditions determined by all environmental (abiotic and biotic) variables where the species can reproduce and survive, and the **realised niche**, which is a subset of the abstract fundamental niche, where the species can persist given the presence of other species competing for the same resources.

6.0 TUTOR–MARKED ASSIGNMENT

1. What do you understand by ecology niche?
2. Describe the concept of niche.

7.0 REFERENCES/FURTHER READING

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UNIT 2 OVERLAP COMPETITION, COEXISTENCE AND RESOURCE SHIFT

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
  3.1 Overlap Competition Coexistence
  3.2 Modes of Species Coexistence
  3.3 Niche Divergence and Resource Shift
4.0 Conclusion
5.0 Summary
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1.0 INTRODUCTION

Theoretical and empirical research on positive species interactions over the last two decades has altered the once prevailing view that negative species interactions and the physical environment alone determined species' distribution and abundance Yet, despite substantial advances in our understanding of the mechanisms controlling switches in the intensity and direction of species interactions ,formal inclusion of positive species interactions into broad theories of community structure and organization and ecosystem functioning is still in its infancy(Dangles *et al.*, 2013; Angelini & Silliman, 2014).

2.0 OBJECTIVES

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

- discuss the overlap competition coexistence
- explain the modes of species coexistence
- explain the niche divergences and resource shift.

3.0 MAIN CONTENT

3.1 Overlap Competition Coexistence

Historical development of the niche theory is very closely related to one of the most important topics of ecology, i.e. the problem of species competition and coexistence. Since the beginning of the ecological niche concept, it has been assumed that no two species sharing a single niche could locally coexist. Originally, the later **Volterra-Gause principle** states that "under constant conditions, no two species utilising, and limited by, a single resource can coexist in a limited system" and was formulated and proved by Vito Volterra, whilst Alfred Gause showed experimental evidence of competitive exclusion in an undiversified environment. The explanation of the competitive exclusion lies in the fact that utilization of a limited resource leads to its depletion, and the population growth, therefore, necessarily leads to a moment when the resource level is insufficient for further growth. If only one population utilises the resource, this situation leads to simple negative feedback, causing the decrease of population growth rate and thus a release of resource consumption, stabilising the population size. However, in the case of two species sharing the resource, there will likely exist a resource level when the first species population can still grow up even if the second cannot, leading to further decrease of population growth rate of the second species, and eventually to its extinction. Even if two species sharing several resources have exactly the same requirements and ability to utilise them, the coexistence of such species is not stable in a stochastic environment (if their total population density is limited): one of the species would ultimately become extinct by chance over infinite time (unless there is an advantage for the less abundant species).

The "competitive exclusion principle" is the core principle in community ecology, and much of this field has been devoted to study how species with similar ecological requirements can coexist. This question has transformed into the problem of "limiting similarity": how similar can ecological niches be to still ensure local coexistence.

3.2 Modes of Species Coexistence

Species coexistence is often ensured by niche separation. The **niche shift** can follow from the competitive exclusion of one species from the part of ecological space where the niches overlap, or from coevolution of competing species, favouring in each species phenotypes differing from the phenotype of the competitor. The latter case is often referred to as the **ghost of competition past**, emphasising that current niche segregation can be due to the processes that took place in distant evolutionary past. If morphological differences arose due to divergent evolution of sympatric competitors, we speak of **character displacement**. Typically, sympatric populations of competing species evolve towards more different sizes of characters associated with food consumption (beaks, teeth) than allopatric populations – if there is only one species of Galapagos finches on an island, it has an intermediate beak size enabling to utilize wide spectrum of seed sizes, whereas if there are two species, one has bigger and the other smaller beak than the species occurring without competitors. If there are more than two locally coexisting species, we often observe regularly spaced sizes of morphological characters, again indicating past competition leading to maximum niche separation.

Simple separation of niche optima is not, however, the only way that stable local coexistence of species is attained. Many species pairs, for instance, consist of one species which is competitively dominant, and the other species which is less specialised and can thrive in a broader range of ecological conditions. An example is the pair of two closely related species of redstarts, where the black redstart *Phoenicurus ochruros* is bigger and more aggressive, but the common redstart *Phoenicurus phoenicurus* can utilize a wider spectrum of habitats, such that it has always an option to thrive out of the range of conditions preferred by black redstart. Such niche division between dominant aggressive specialist and subordinate generalist has also been observed in many mammal species, and is apparently stable. In plants, competitively inferior species are often those with higher rate of spreading and growth, which enables them too quickly occupy empty places before arrival and eventual overgrowth of competitively superior species.

3.3 Niche Divergence and Resources Shift

The diversity of ecological niches even among closely related species is enormous and demands explanation. What is the reason for such diversity? We have already mentioned one of the most important factors – interspecific competition, which pushes ecological niches of species far way, to avoid niche overlap. More specifically, natural selection prefers such phenotypes of competing species which utilise different resources than those which share them. Competition thus leads to the increase of resource range utilised by a given taxon, and this process is faster when other taxa do not constrain this diversification. Indeed, the increase of the breadth of utilised resources in the course of evolution is fastest in such situations where other taxa with similar requirements are absent. For example, eco-morphological diversification of Galapagos finches and Hawaiian honeycreepers has been much faster than the diversification of related taxa on the mainland, here the utilisation of new resources was constrained by other taxa already utilising them. Availability of resources almost always increases diversification rate, indicating the role of interspecific competition for this process.

Interspecific competition is not, however, the only force driving niche diversification. Each species has its own evolutionary history, and thus can adapt to different resources by an independent process of evolutionary optimization, as phenotypes which are more efficient in transforming obtained energy into offspring are favoured by natural selection. If there are several mutually exclusive ways to achieve this, it is likely that each species will go by a different route due to evolutionary contingency, and niche diversification will follow without competition. Notably, optimisation does not lead to an advantage of the whole species in terms of the resource utilisation, but only to an individual advantage regardless of the evolutionary fate of the whole species. As evolution is opportunistic, species can evolve too extremely specialised forms in terms of either habitat utilisation or food preference, which is apparently disadvantageous for future species persistence in ever changing world.

4.0 CONCLUSION

In this unit, we have examined the overlap competition coexistence and the modes of species coexistence. The niche divergence and resources shift was comprehensive examined.

5.0 SUMMARY

In this unit students have learnt that:

- when two species are sharing the resource, there will likely exist a resource level when the first species population can still grow up even if the second cannot, leading to further decrease of population growth rate of the second species, and eventually to its extinction.
- the “competitive exclusion principle” is the core principle in community ecology, and much of this field has been devoted to study how species with similar ecological requirements can coexist.
- species coexistence is often ensured by niche separation. The **niche shift** can follow from the competitive exclusion of one species from the part of ecological space where the niches
- Overlap.
- interspecific competition, which pushes ecological niches of species far away, to avoid niche overlap.
- each species has its own evolutionary history, and thus can adapt to different resources by an
- independent process of evolutionary optimization, as phenotypes which are more efficient in
- transforming obtained energy into offspring is favoured by natural selection.

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the modes of species coexistence.
2. Discuss niche divergence and resources shift.

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UNIT 3 HABITAT 1 PRIMARY TERRESTRIAL HABITAT

COTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
  3.1 Meaning of a Habitat
  3.2 Limiting Factors of Terrestrial Life
  3.3 Types of Terrestrial Habitat
    3.3.1 Forest Biome: Tropical Rain Forests
    3.3.2 Temperate Forests
    3.3.3 The Grass Land
    3.3.4 The Tundra
    3.3.5 The Savanna
  3.4 Typical Terrestrial Environments
  3.5 Methods in Mapping Terrestrial Mapping
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Environment is the total set of circumstances surrounding life. The circumstance may be land or water-based. The habitat can be classified as terrestrial if they belong to the land. We live on land along with several other lives. Land based habitat are called as terrestrial habitat. This is the most complex type of environment having a great variation of environmental factors. The interaction of physical, climatic and biotic factors, generates a wide variety of ecological conditions over the land. Most of the limiting factors of terrestrial environment are highly variable both with reference to time and space. This unit will cover the following: Limiting factors of terrestrial life, terrestrial communities, Types of terrestrial ecosystems, forest biome, some extreme terrestrial environments.

2.0 OBJECTIVES

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

- define habitat
- explain the limiting factors of terrestrial habitat
- discuss the types of terrestrial habitat and methods in mapping terrestrial habitat.

3.0 MAIN CONTENT

3.1 Meaning of a Habitat

In ecology, a **habitat** is the type of natural environment in which a particular species of organism lives. It is characterized by both physical and biological features. A species' habitat is those places where it can find food, shelter, protection and mates for reproduction. The physical factors are for example soil, moisture, range of temperature, and light intensity as well as biotic factors such as the availability of food and the presence or absence of predators. Every organism has certain habitat needs for the conditions in which it will thrive, but some are tolerant of wide variations while others are very specific in their requirements.

The habitat of an organism provides the requirements for that species to survive. The early concept of habitat arose because naturalists started to question why some species were present in one location but not in another. The paradigm of habitat is now firmly embedded as one of the key concepts of nature and is therefore often the focus of conservation.

Species are dependent on their habitat for their survival. Habitat loss and fragmentation has been identified as one of the primary causes of species range decline, numerical abundance decline, and extinction. There is also some research which indicates that habitat loss may cause the selective extinction of key species which are important for ecosystem function.

3.2 Limiting Factors of Terrestrial Life

Terrestrial environments are different from aquatic environments with reference to the following factors:

1. Moisture which is helpful to the transpiration of plants and evaporation of water
2. Temperature variations **-** (Extreme)
3. Rapid circulation of air
4. Solid support by soil
5. Discontinuous Landscape. Land is not continuous as water. This is a barrier for free movement.
6. Soil as a vital source for nutrients.

These fall under two major categories as Climatic and Substrate factors.
The variation in climate is due to the non-uniform distribution of Sun's radiation.

The abiotic factors of terrestrial habitat are, moisture, temperature, light and land.

l. **Moisture**: Water is a limiting factor on land. It exists as water vapor and soil moisture. Water is an intimate part of protoplasm. Water vapor and is an important factor in terrestrial environment. It is controlled by precipitation, wind and humidity.
2. **Temperature** is a limiting factor for the growth and distribution of plants and animals. The influence is universal.
3. **Light**: The rate of photosynthesis is affected by the wavelength of light. It is directly proportional to the intensity of light up to an optimum level.
   Based on this, the plant communities are classified as `shade-loving' or `sun loving' plants.
4. **Stable factors**: the stable factors include the soil, slope of the land, direction of gradient, elevation and altitude of the ground, nature of soil and subsurface basement rock.
   Soil is also a major subsystem in the terrestrial environments. It controls the cycling of nutrients and energy flow in land based conditions.

The soil is composed of five major components as:

l. Mineral species as inorganic substances
2. Water as soil moisture
3. Air
4. Organic matter and
5. Living organisms.

3.3 Types of Terrestrial Habitat

There are no firm boundaries between the terrestrial biomes. They grade into one another.

Although biomes are named for predominant vegetation, each biome may also be characterized by microorganisms, animals, and fungi.

The important terrestrial habitats of the world:

1. Forest habitat
2. Grassland
3. Deserts
4. Tundra
5. Mangroves
6. Savanna
7. Mountain
8. Cave.

Forest is a large uncultivated and uninhabited tract of land, covered with trees of different height, shrubs and herbs.

A forest receives relatively a good rainfall, and is characterised by a high humidity, optimum temperature and enough space.

The upper most level (tree tops) forms a canopy. The canopy is exposed to the sunlight and wind action. The canopy does not permit the sunlight to fall on the ground.

Based on the nature of variation in the native vegetation and animal life, **forests** are classified into the following types.

1. **Tropical rain forests**
2. **Temperate forests** which is further classified into
a. Temperate rain forests
b. Temperate evergreen forests
c. Temperate deciduous forests
d. Temperate woodland.
3. **Boreal coniferous forests.**

3.3.1 Forest Biome: Tropical Rain Forests

1. This type of forest grows in regions where there is enough moisture and heat without any winter.
2. The average annual rainfall may be 200-225 cm.
3. The temperature, humidity and productivity are high in these forests.
4. They are characterized by a rich fauna and flora.
5. The average height of trees may be 25 - 40 m with evergreen plants.
6. The density of vegetation is 200 - 300 species of trees per sq. km, with a very good diversity.
7. Soils are subjected to leaching and are rich with micro-organisms and soil fauna. Termites are abundant.
8. There is a stratification in the trees and other vegetation, with a well-developed canopy and crowns covering the shade plants.
9. The net primary productivity may be 30 tonnes per acre per year. The decomposition rate is
10. Animal species are more diverse. There is a greater variety of niches.

The stratification of life includes several feeding strata.
They are, life above the canopy, within the canopy, below the canopy and ground segments.

a) Above the canopy includes insectivorous and carnivorous group (bats and birds).
b. Within the canopy – includes Birds, Fruit bats and mammals which feed on the leaves, fruits and nectar.
c. Below the canopy is the world of flying animals, birds, and insectivorous bats.
d. Trunks of trees are used by large mammals.
e. The ground segment is for large ground animals like mammals and some plant feeders.
11. Some of the typical animals characterising these forests are brightly colored birds, colored butterflies, beetles and bees. In the hidden parts, there will be more snails, worms, millipedes, centipedes, scorpions and spiders. Termites and ants will be more in the soil.

3.3.2 Temperate Forests

They are characterised by a moderate climate with seasonal variations. They are classified into the following types base on the Climate, Vegetation and Animal Life. Temperate rain forests, having large coniferous trees, red woods. The animal life includes snails, mammals, insects, reptiles and amphibians.

Temperate deciduous forests, belonging to glaciated zones with shrubs mosses and lichens. The animal life includes deer, fox, bear, bobcats and wild-turkeys.

3.3.3 The Grass lands

These are grass- dominated ecosystems associated with large rivers and alluvial soils. The conditions of these locations do not permit the growth of trees. Sometimes, they may be fire induced. The treeless zone adjacent to forests is called Prairie. The soil in the grass land may be clayey - loam and alkaline with a hard sub-stratum. The rocky substratum stops the percolation. The invertebrates include insects, grass-hoppers, termites, etc. Birds, foxes, and rodents are
common. Grass lands provide natural pastures for grazing animals. Today's agricultural food crops have been evolved from these grasses, by artificial selection.

3.3.4 The Tundra

The term tundra has been derived from the Finish word `tunturi' meaning a "treeless plain".

This area is characterised with lakes and streams. The ground is low and moist with extensive bogs. Vegetation is scant and scattered on high and drier lands. There are two areas covered by this landscape as Alpine tundra and Arctic tundra.

3.3.5 The Savanna

This is a landscape where forests merge with grasslands.
This is a biome characterised by the presence of grasslands with scattered trees or clumps of trees. The climate may be warmer with a longer summer. It could be seen in tropical countries. (Africa, Australia and South America). Zebra, giraffe and Antelopes feed on the vegetation. Number of species may not be large. Grasses dominant over trees. Insects are more abundant during wet season. The primary productivity is very high. Hence, large number of herbivores are found.

3.4 Typical Terrestrial Environments

In addition to these there are some terrestrial environments, which are typical in their habitat and some are considered to be extreme environments.
They are: Deserts, mountains and caves.

3.5 Methods in Mapping Habitat: Terrestrial Mapping

Habitat mapping in a terrestrial environment usually involves recording features such as vegetation type across areas of land. At a local scale habitat mapping can be conducted by walkover surveys. However, it is not possible or practical to carry out large scale mapping with this level of effort. At regional or global scale land cover is often used as a proxy for habitat mapping. Land cover is often mapped using aerial and satellite images. Land cover is the visible features of the Earth surface including the vegetation layer as well as natural (e.g. rivers) and manmade (e.g. cities and roads) features. These features reflect solar radiation in different ways and therefore demonstrate unique spectral characteristics which can be mapped using satellites.

4.0 CONCLUSION

Terrestrial ecosystems are the major ecosystems encompassing all land-based life. Human population is mainly depending upon the conditions of terrestrial climate and resources. The man’s impact of these ecosystems will affect the parameters of these units. It is very essential to maintain the terrestrial ecosystem for all our sustainability.

5.0 SUMMARY

In this unit students have learnt that:

- in ecology, a **habitat** is the type of natural environment in which a particular species of organism lives. It is characterised by both physical and biological features.
- terrestrial environments are different from aquatic environments with reference to the following factors: Moisture which is helpful to the transpiration of plants and evaporation of water, Temperature variations - (Extreme), Rapid circulation of air, Solid support by soil, Discontinuous Landscape. Land is not continuous as water. This is a barrier for free movement and soil as a vital source for nutrients.
- the important terrestrial habitats of the world are forest habitat, grassland, deserts, tundra, mangroves, savanna, mountain and cave.
- there are some terrestrial environments, which are typical in their habitat and some are considered to be extreme environments like deserts, mountains and caves.
- habitat mapping in a terrestrial environment usually involves recording features such as vegetation type across areas of land.

6.0 TUTOR-MARKED ASSIGNMENT

1. What do you understand by a habitat?
2. Describe the limiting factors of terrestrial habit.
3. Describe the characteristics of the tropical rainforest, grassland and savanna.

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UNIT 4 HABITAT AQUATIC HABITAT

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        3.3.3 Distribution of Organisms in the Marine Habitat
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        3.3.1 Distribution of Organisms in an Estuarine Habitat
    3.4 Fresh Water Habitat
        3.4.1 Types of Fresh Water
    3.5 Methods in Mapping Aquatic Habitat
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

When considering aquatic habitats, many variables come to mind. Obviously, there is a continuum of salinity ranging from essentially distilled water at glacier faces and high mountain streams, to other freshwaters, to estuaries where fresh and salt waters mix, to oceans, to hyper- saline environments such as the Great Salt Lake. Current is another factor; water may be still and stagnant, or flow in currents of various velocities. Currents may be unidirectional, such as in streams, or multidirectional, such as when waves wash across a beach. This unit describes aquatic habitats, the types of organisms that inhabit them, and the processes affecting life in these habitats.

2.0 OBJECTIVES

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

- define aquatic habitat
- explain the different types of aquatic habitat, their characteristics, distribution of plants and animals; and
- discuss the methods in mapping aquatic habitat.

3.0 MAIN CONTENT

3.1 Meaning of Aquatic Habitat

An aquatic habitat is a habitat with water. It includes areas that are permanently covered by water and surrounding areas that are occasionally covered by water. The aquatic habitats include **marine**, **estuarine**, and **fresh water**. The water in an estuary is like a vegetable soup. There are many small pieces of plants and detritus suspended throughout the water. Microscopic organisms and algae grow in the water. Fine sediment and minerals also thicken the water.

Aquatic habitats may occur in open water, or they may be associated with the bottom of the body of water, and both will be affected by the mechanical and chemical makeup of the local geology. All sorts of daily and seasonal temperature regimes can be expected. Aquatic habitats vary in the amount of light they receive and range in size from tiny pools at the base of a plant to the Pacific Ocean in size.

3.2 Marine Habitat

Marine habitat is concerned with the organisms living in salty or non-fresh water. These organisms possess an interrelationship that helps different organism living in them to co-habituate. There are different characteristics of the marine habitats that makes them possible. These characteristics are outlined below;

1. **Salinity of sea water**: This water contains many dissolved ions, e.g. sodium, potassium, calcium etc. The salinity of sea water is high and also increases during the dry season due to evaporation.
2. **Density of Sea Water**: This is about 1.028 and this helps organisms to float with ease.
3. **Temperature**: This falls with increase in the depth of the sea.
4. **Light Penetration**: Light penetrates into the sea only to a maximum depth of 200m.
5. **Oxygen Concentration**: This is highest at the surface of the water which is in contact with atmospheric oxygen.
6. **Hydrogen Ion Concentration**: The pH of sea water is about 8.0 to 8.5 near the surface hence making it alkaline.
7. **Waves, Ocean Currents and Tides**: These improves transparency, air circulation, nutrients and temperature in water.

3.2.1 Major Zones of the Marine Habitat

The major zones in a marine habitat are:

1. Splash or Supra tidal zone.
2. Neritic or Intertidal or Planktonic or Euphotic zone.
3. Littoral or Subtidal zone.
4. Lenthic or Oceanic zone.
5. Pelagic or Abyssal zone and
6. Hadal or Aphotic zone.

3.2.2 Characteristics of Marine Zones

These are given below;

a. **Splash Zone**: the splash zone is above the high tide. It is exposed and also has occasional moisture as a result of constant prey from breaking waves.
b. **Intertidal Zone**: this zone is exposed at low tide or covered by water at high tide. It has high photosynthetic activity, abundant light and fluctuating water temperature.
c. **Littoral Zone**: this zone is constantly under water. It has high abundant light and enough nutrients.
d. **Benthic Zone**: this zone has low light penetration or low light intensity.
e. **Pelagic or abyssal Zone**: this zone has low temperature, high pressure, and low photosynthetic activity through chemosynthesis.
f. **Hadal Zone**: there is no light penetration and no photosynthetic activities in this zone.

3.3.3 Distribution of Organisms in the Marine Habitat

Splash Zone: Sand- crab and ghost-crab.
Inter tidal Zone: Starfish, anemones, sponges, sea urchins, clam, annelids, molluscs, and barnacles.
Subtidal Zone: Snails, Crabs, Lobsters, and crayfish.
Bathyal and Abyssal Zones: these are unfavourable for life.
Neritic Zone: Plankton, nekton and fish.
Oceanic Zone: Shark, Croaker, Sea cat-fish, mackerel and moon fish.

3.3 Estuarine Habitat (Mangrove Swamp)

Characteristics of the habitat are as follows;

1. A fluctuating salinity.
2. Saturated soil that lacks oxygen.
3. Mild wave action.
4. High and low tidal influence
5. Soil erosion.

3.3.1 Distribution of Organisms in an Estuary Habitant

Plants: Red and white mangrove plants, plankton and algae.
Animals: Crabs, Starfish and barnacles

3.4 Fresh Water Habitat

Characteristics of Fresh Water Habitats Include;

1. Low salt content.
2. Relatively small body of water.
3. Shallow water.
4. Variable temperature with depth and season.
5. Low density water.
6. Available oxygen in all parts of water but more at the surface.

3.4.1 Types of Fresh Water

1. Stagnant water: Pools, pond, puddles and lakes.
2. Running water: Springs, Streams and Rivers.

3.5 Methods in Mapping Aquatic Habitat

Mapping the marine environment is more challenging because water surfaces demonstrate more complex reflective properties when compared to terrestrial surfaces. Satellite sensors are therefore designed differently for use in the marine environment. Only a small fraction (5-10%) of the seafloor has been surveyed, to identify bathymetry (underwater depth information), with an equivalent resolution to similar terrestrial studies. It is possible to measure biological characteristics in the marine environment, and some physical characteristics, such as sea surface temperature, by satellite. However, there still remains considerable challenges to improve marine habitat mapping.

4.0 CONCLUSION

In this unit, we have examined what is an aquatic habitat and the different types of aquatic habitat and how plants and animals are distributed in the different zones of the aquatic habitat. The methods in mapping aquatic habitat was also examined.

5.0 SUMMARY

In this unit students have learnt that:

- an aquatic habitat is a habitat with water. It includes areas that are permanently covered by water and surrounding areas that are occasionally covered by water;
- marine habitat is concerned with the organisms living in salty or non-fresh water and there are different characteristics of the marine habitats that makes them possible like salinity of sea water, density of sea water, temperature, light penetration, oxygen concentration, hydrogen ion concentration, waves, ocean currents and tides;
- estuarine habitat (mangrove swamp) characteristics of the habitat are as follows; a fluctuating salinity, saturated soil that lacks oxygen, mild wave action, high and low tidal influence and soil erosion;
- the two types of fresh water are majorly made up of stagnant water, e.g. pools, pond, puddles and lakes and running water e.g. Springs, Streams and Rivers; and
- mapping the marine environment is more challenging because water surfaces demonstrate more complex reflective properties when compared to terrestrial surfaces. Satellite sensors are therefore designed differently for use in the marine environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. What do you understand by aquatic habitat?
2. Describe the characteristics and distribution of organisms in a marine habitat
3. Enumerate the characteristics of fresh water habitat.

7

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UNIT 5 ALTERATION IMPOSED ON THE HABITATS BY MAN

CONTENTS

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5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Every living creature needs room to exist and reproduce. The natural home of a plant, animal or other organism is known as its **habitat** and maintaining this space is crucial to the ongoing survival of both individuals and species. Unfortunately, the habitats of large numbers of the Earth's plant and animal species are under threat due to the impact of human beings on the planet. Habitat loss is contributing to the permanent loss of species, the weakening of ecosystems, and is impacting on both the overall health of the planet and the quality of human life.

2.0 OBJECTIVES

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

- explain what is habitat alteration and the causes
- discuss the impacts of habitat loss
- explain the impacts of human activity and protecting habitats.

3.0 MAIN CONTENT

3.1 Meaning of Habitat alteration

Habitat alteration is a change in land use or land cover that has an impact on local ecosystems. Plants and animals live in specific places that have the conditions of climate and food resources needed for survival. Habitats vary from forest and grassland to urban areas, streams, ponds, and oceans. Over time, a habitat is subject to alteration, especially under the influence of human activities. Habitat alteration, which may lead to habitat loss, is the greatest current threat to living species. Large areas of land and water are damaged by activities such as urbanisation, agriculture, and overfishing. These cause fragmentation of habitats, which threatens those animals that need a large habitat for breeding and survival. Many species have already become extinct, particularly in tropical areas. This loss of biodiversity impacts food resources, such as fish stocks. Loss of trees can increase soil erosion and accelerate climate change. Sustainable use of land and water is therefore needed to minimise the impact of habitat alteration.

3.2 Causes of Habitat Loss

Human activity is by far the biggest cause of habitat loss. The planet's human population has doubled in the past 50 years and the pressure to house and feed more than seven billion people has seen incursions into previously pristine natural habitats increase dramatically. At the same time, human impacts on the Earth's climate are radically changing weather patterns and, as a result, the spread and nature of wild habitats.

The primary individual cause of loss of habitat is the clearing of land for agriculture. An estimated 177,000 square kilometres of forests and woodlands are cleared annually to make space for farming or in order to harvest timber for fuel and wood products. Estimates suggest the Earth has lost about half of its forests in 8,000 years of human activity, with much of this occurring in recent decades. About three per cent of forests have been lost since the 1990s alone. And it's not just forest clearing that leads to habitat loss. The loss of wetlands, plains, lakes, and other natural environments all destroy or degrade habitat, as do other human activities such as introducing invasive species, polluting, trading in wildlife, and engaging in wars.

This destruction of habitat also involves marine zones and the ocean, with urbanisation, industrialisation and tourism all affecting habitats in coastal areas. Some 40 per cent of the global population live within 100 kilometres of the coast, placing major strains on wetlands and oceans.

3.3 Impacts of Human Activities

With such significant habitat destruction underway, the effects on ecosystems and wildlife are significant. Figures from the International Union for Conservation of Nature (IUCN) suggest about 2,000 mammals around the globe are affected by habitat loss. It is the primary threat to 85 per cent of species on the union's Red List which lists organisms whose existence is vulnerable, endangered, or critically endangered. The problem is particularly acute in Australia where, thanks to human impacts, more mammal species have been lost in the past 200 years than in all other continents combined. Of the 1,250 plant and 390 terrestrial animal species considered threatened, 964 plants and 286 animals have deforestation and resulting habitat fragmentation or degradation listed as threats. These include Carnaby's cockatoo, the southern cassowary, Bennet's tree kangaroo, the Cape York rock-wallaby, and the black-flanked rock-wallaby, as well as the iconic koala, recently listed as vulnerable to extinction in Queensland and NSW.

Perhaps the most obvious forms of habitat alteration are deforestation, which involves cutting of trees to free forest for agriculture and housing, and conversion of wild grassland to agriculture. Deforestation has led to the loss of about half of Earth's forest over the last three centuries, with destruction being most intense in tropical areas, where pressures to provide food and housing are greatest. Overgrazing and poor farming practices can easily lead to soil erosion, resulting in desertification, where agricultural land is converted to desert.

Extracting materials from land or water can also lead to habitat alteration. Mining for coal and metals strips the land directly and removes everything growing or living there. Additionally, the oceans are overfished, and populations of many larger fish are now stressed, which in turn, has a direct effect upon marine ecosystems and food webs there. Fishing causes habitat alteration in other ways. Bottom trawling is a fishing method used by commercial operators in which large bag-shaped nets are dragged along the sea or ocean floor in the search for shrimp, cod, and other species that dwell on the bottom.

On land, roads are a major contributor to habitat alteration. Most human activities require roads to support them. Therefore, roads are built through habitats as part of a building program, or to support logging, mining, or agriculture. The construction of dirt roads during deforestation and mining often damages habitats through soil erosion and landslides. Paved roads will encourage run off so that polluted water contaminates local land and water supplies. And any new road will bring an increase in traffic which poses a direct threat to any species in that habitat, leading to an increase in "road kill" and damage to plants.

Human activities often impact on aquatic habitats. The need to increase scarce water supplies leads to the diversion of streams and rivers to build dams or for irrigation. Waterways are dredged to make them deeper or to create a harbor area. Recreational activities like Fishing, hiking, sailing, and adventure sports may also lead to habitat alteration.

3.4 Protecting Habitats

While, significant tracts of habitat have been lost, and along with them many species of plant and animal, steps can be taken to slow and even reverse the process. One key measure is the establishment of protected areas where human activity is restricted in order to conserve existing ecosystems and wildlife. Well-planned and well-managed reserves, parks and forests can help to safeguard freshwater and food supplies, reduce poverty, and reduce the impacts of natural disasters.

4.0 CONCLUSION

In this unit, we have examined the meaning of habitat alteration and the causes of habitat loss. We also examined the impacts of human activity and protecting the habitats.

5.0 SUMMARY

In this unit students have learnt that:

- habitat alteration is a change in land use or land cover that has an impact on local ecosystems;
- human activity is by far the biggest cause of habitat loss;
- the primary individual cause of loss of habitat is the clearing of land for agriculture;
- the most obvious forms of habitat alteration are deforestation, which involves cutting of trees to free forest for agriculture and housing, and conversion of wild grassland to agriculture.
- one key measure is the establishment of protected areas where human activity is restricted in order to conserve existing ecosystems and wildlife.

6.0 TUTOR-MARKED ASSIGNMENT

1. Write a short note on habitat alteration.
2. Describe the impacts of human activity on habitats.

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UNIT 6 INTEGRATION OF ECOLOGY AND ENVIRONMENT INTO DEVELOPMENT PLANNING

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
  3.1 Meaning of Ecology and Environmental Planning
  3.2 Concept of Ecology and Environmental Planning
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5.0 Summary
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7.0 References/Further Reading

1.0 INTRODUCTION

The world is becoming increasingly urbanised, and with this accelerating process comes a host of challenges. Urban areas now contain more than 50 per cent of the world's population, occupy just two per cent of the world's terrestrial surface, and consume up to 75 per cent of natural resources.

Growing cities in the world can have an impact on the surrounding sensitive ecosystems such as wetlands, forests, mountain ecosystems and need increasing amounts of resources, which could result in over-exploitation.

Recognising the increasing role of cities, this report builds on the 2007 report *Liveable Cities: the benefits of urban environmental planning4* to explore how a variety of issues have been taken into account in different urban areas, and how a range of activities have been implemented that show the potential for integrating the environment in urban planning and management. Since the launch of the *Liveable Cities report* in 2007, cities have become increasingly prominent in terms of addressing global environmental issues.

2.0 OBJECTIVES

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

- define ecology and environmental planning
- explain the concept of ecology and environmental planning
- explain the importance of ecology and environmental planning

3.0 MAIN CONTENT

3.1 Meaning of Ecology and Environmental Planning

Ecology and environmental planning is a spatial and societal planning activity which includes both the protection of biotic and abiotic resources as the basis of societal use and the protection of landscapes and species. It has the task of the distribution of various land uses (such as agriculture, transport, recreation, nature conservation) in the room and the occurring conflicts in their view, the best possible solution to be supplied (Technische Universität München, 2015). **Ecology and environmental planning** seeks to ensure human development which does not compromise ecological elements in anyway. In this sense, it is the practice of making systematic, well thought and guided decisions to guide the nature and extent of human interaction with his environment and ecosystem.

3.2 Concept of Ecology and Environmental Planning

In relation to implementation, **ecology and environmental planning** advocates for the integration of environmental issues in planning decisions, and ensures that institutions responsible for ecology and environmental planning direct national, local, and sector-specific policies, plans and investment decisions based on considerable consideration for environmental issues. This approach of ecology and environmental planning ensures greater participation and collaboration between environment and stakeholders of development. This strengthens institutions to carefully consider environmental issues by establishing effective linkages of development and environment in practice (EU, 2013). Williams (2000), view ecology and environmental planning is making it possible for people to live in an area governed more by nature than legislation, and resulted in the creation of a sustainable human settlements rooted on principles of ecological balance, community self-reliance, and participatory democracy. Ecology and environmental planning is a multi-dimensional activity.

3.3 Importance of Ecology and Environmental Planning

(i). Today, **ecology and environmental planning** has become a viable strategy or mechanism for sustaining the built environment by meeting human needs while protecting the natural environment (SenStadtUm, 2009).

(ii). Ecological and environmental planning is a purposeful requirement in the creation of sustainable benefits of the built environment.

(iii). Ecological planning ensures human needs are supplied without compromising resources. In this case, natural resources are used in the most effective and sustainable manner.

(iv). Ecological planning also involves maintenance of ecological balance in a sustained way.

(v). Protection of human and environmental health, healthy ecosystems, eliminating environmental pollution and providing green spaces and many others are just few activities associated with ecology and environmental planning (SenStadtUm, 2009).

(vi). It provides a wide range of environmental, economic and social benefits to stakeholders of development.

- (i) In terms of environment, it creates ecologically effective green spaces, reduces ecological risks, and advances the quality of environmental resources.
- (ii) In economic sense, it prevents sprawl of urban areas and reduces traffic congestion as well as providing better utilisation of existing infrastructure.
- (iii) It reduces health risks, enhance the quality of urban life and city services to ensure good social environment (Galifianakis, 2006).

According to UNEP, ecology and environmental planning remains the most effective way of integrating environmental issues in urban planning and development as it provides a platform to incorporate issues on the environment into existing frameworks, and avoids the formulation of independent approaches, which are often costlier. In many cities around the world, integrated solutions to the major environmental challenges are being developed. This is aimed at using ecology and environmental planning to transform them into more sustainable and self-sufficient communities (SenStadtUm, 2009). Manila in the Philippines, which integrated climate change adaptation approaches into its development plan, is one of the successful ecology and environmental planning models.

4.0 CONCLUSION

In this unit, we have examined the meaning of ecology and environmental, planning and its concept. Also, the importance of ecology and environmental planning was also discussed.

5.0 SUMMARY

In this unit students have learnt that:

- human population has reached unprecedented levels and natural resources are being pushed to unsustainable limits;
- it is important for cities to develop new visions to become sustainable entities;
- there is the need to integrate urban planning and environmental conservation;
- environmental factors should be well incorporated into all planning activities; and
- ecology and environmental planning should therefore be used as a useful tool to plan human activities. This will help ensure sustainable development of humans and the environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the concept of ecology and environment planning
2. Mention the importance of ecology and environmental planning

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MODULE 3

Unit 1 Ecological Management
Unit 2 Eco-development and Integrated Development
Unit 3 Environmental Planning Principles: Inter-discipline, Holistic and Comprehensive
Unit 4 Environmental Planning Principles: Participative Coordinated, Integrated and Continuous Planning

UNIT 1 ECOLOGICAL MANAGEMENT

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
 3.1 Ecological Management
 3.2 Adaptive Management
 3.3 Natural Resource Management
 3.4 Strategic Management
 3.5 Command and Control Management
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Public and public policy-makers are increasingly interested in maintaining and managing healthy ecosystems, both in their own right and as they contribute to the health and well-being of people. Intact, functioning ecosystems provide the goods and services that healthy human populations require; not only clean air and water, food and fiber, medicines, other products, and protection from storms and inclement weather, but also recreational opportunities, aesthetic pleasures, cultural and religious experiences and existence values (Harper and Harris, 2008). Maintaining healthy ecosystems requires information derived from evaluating natural resources within a community and ecosystem context, herein defined as ecological evaluation. Maintaining healthy ecosystems is easier for uncontaminated ecosystems than for those that have been exposed to undue physical disruption and high levels of environmental pollution.

2.0 OBJECTIVES

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

- explain the full meaning and concept of ecological management
- explain the adaptive and natural resource management
- discuss the strategic, command and control management.

3.0 MAIN CONTENT

3.1 Ecological Management

Ecological management are well-known disciplines with a wide range of paradigms, approaches, and techniques. Ecological management is simply defined with activities aimed at balancing changes in an ecosystem to bring about optimum survival of organisms. In order to achieve this, organisms go into various biological associations. Ecological management is largely interested in the biological components and with the physical components only as they impact the biota. Ecological management both require baseline information, and temporal and spatial patterns to evaluate the current status of environmental health and well-being (Baird, 2005). Ecological evaluation forms the basis for all forms of environmental and ecological management, including assessment of species abnormalities and reproductive success, population levels and distribution, community and ecosystem structure and dynamics, and landscape changes, among others. With this information, managers can protect, manage, and enhance species and ecosystems, determine remediation levels and types, determine restoration types and restore specific ecosystems, conduct Natural Resource Damage Assessment (NRDA) and design long-term stewardship plans.

Several approaches to effective ecological management engage conservation efforts at both a local or landscape level and involves: adaptive management, natural resource management, strategic management, and command and control management.

3.2 Adaptive Management

Adaptive management is based on the concept that predicting future influences/disturbance to an ecosystem is limited and unclear. Therefore, the goal of adaptive management is to manage the ecosystem so that it maintains the greatest amount of ecological integrity, but also to utilise management practices that have the ability to change based on new experience and insights.

Adaptive management aims to identify uncertainties in the management of an ecosystem while using hypothesis testing to further understand the system. In this regard, adaptive management encourages learning from the outcomes of previously implemented management strategies. Ecosystem managers form hypotheses about the ecosystem and its functionality and then implement different management techniques to test the hypotheses. The implemented techniques are then analysed to evaluate any regressions or improvements in functionality of the ecosystem caused by the technique. Further analysis allows for modification of the technique until it successfully meets the ecological needs of the ecosystem. Thus, adaptive management serves as a "learning by doing" method for ecosystem management.

3.3 Natural Resource Management

The term natural resource management is frequently used when dealing with a particular resource for human use rather than managing the whole ecosystem. The main objective of natural resources management is the sustainability for future generations, which appoints ecosystem managers to balance natural resources exploitation and conservation over long-term time frame. The balanced relationship of each resource in an ecosystem is subject to change at different spatial and temporal scales. Dimensions such as, watersheds, soils, flora and fauna, need to be considered individually and on a landscape level. A variety of natural resources are utilised for food, medicine, energy and shelter.

The ecological management concept is based on the relationship between sustainable resource maintenance and human demand for use of natural resources. Therefore, socioeconomics factors significantly affect natural resource management.

Human populations have been increasing rapidly, introducing new stressors to ecosystems, such as climate change and influxes of invasive species. As a result, the demand for natural resources is unpredictable. Although ecosystem changes may occur gradually, the cumulative changes can have negative effects for humans and wildlife. Geographic Information Systems (GIS) and Remote Sensing Applications can be used to monitor and evaluate natural resources by mapping them in local and global scales. These tools will continue to be highly beneficial in natural resources management.

3.4 Strategic Management

Strategic management encourages the establishment of goals that will benefit the ecosystem while keeping socioeconomic and politically relevant issues in mind. Strategic management differs from other types of ecological management because it keeps stakeholders involved and relies on their input to develop the best management strategy for an ecosystem.

Similarly, to other modes of ecological management, this method places a high level of importance on evaluating and reviewing any changes, progress or negative impacts and prioritises flexibility in adapting management protocols as a result of new information.

3.5 Command and Control Management

Command and control management utilises a linear problem solving approach where a perceived problem is solved through controlling devices such as laws, threats, contracts and/or agreements. This top-down approach is used across many disciplines and works best with problems that are relatively simple, well-defined and work in terms of cause and effect. The application of command and control management has often attempted to control nature in order to improve product extractions, establish predictability and reduce threats. Some obvious examples of command and control management actions include: the use of herbicides and pesticides to safeguard crops in order to harvest more products; the culling of predators in order to obtain larger, more reliable game species; and the safeguarding of timber supply, by suppressing forest fires.

Consequently, there has been a transition away from command and control management due to many undesirable outcomes and a stronger focus has been placed on more holistic approaches that focus on adaptive management and finding solutions through partnerships.

4.0 CONCLUSION

In this unit, we have examined the meaning of ecological management. We also examined the different aspect of ecological management namely; adaptive, natural resource, strategic, command and control management.

5.0 SUMMARY

In this unit students have learnt that:

- ecological management is not a simple task, nor is it one that can be conducted in isolation from other considerations that range from social and cultural, to ecological and physical.
- ecological evaluation is the base for all types of environmental and ecological management.
- there are many different continuums that intersect ecological management.
- in summary, all types of ecological management and long-term stewardship require ecological evaluation as a basis for sound decisions.

- ecological management consist of the following aspects which are: adaptive, natural resource, strategic, command and control management.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the meaning and concept of ecological management.
2. Describe adaptive and natural resource management.

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UNIT 2 ECODEVELOPMENT AND INTEGRATED DEVELOPMENT

CONTENTS

1.0 Introduction
2.0 Objectives
3.0 Main Content
3.1 Meaning of Eco-Development
3.2 Concept of Eco-Development and Integrated Development
3.3 Conditions for Achieving Eco-Development
3.3.1 Social Equity
3.3.2 Economical Equity
3.3.3 Ecological Security
3.4 Objectives of Eco Development
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Development is directly related to the spatial planning (regional and urban). Nowadays, humanity faces multidimensional crisis, socioeconomic crisis, cultural crisis, which is directly related to the environmental one. In the last few decades, the current development model has been questioned by international organizations and scientists of various specializations. Sustainable development or eco-development approaching interdisciplinary the problem explores the exit from the socioeconomic and environmental crisis.

2.0 OBJECTIVES

By the end of this unit, you will be able to;

- explain the meaning of eco-development and its concept
- discuss conditions for achieving eco-development
- explain the objectives of eco-development.

3.0 MAIN CONTENT

3.1 Meaning of Eco-Development

Eco-development refers to development at regional and local levels, consistent with the potentials of the area involved, with attention given to the adequate and rational use of natural resources, technological styles and organisational forms that respect the natural ecosystems and local social and cultural patterns. The term is also used to describe an integrated approach to environment and development.

3.2 Concept of Eco-Development and Integrated Development

The bearing capacity of the ecosystem defines the maximum level for (a) quantitative development of each activity, b) Culture and tradition will sustain, evolve and turn into key-elements for human cultivation, development of special forms of communal organisation and production. The cultural tradition of each country shows off its identity by highlighting its cultural diversity, which is essential to maintain a cultural diversity at a global level.

Agriculture takes advantage of two natural resources: soil and water. Misuse of these resources contributes to soil degradation and pollution of water. For this reason, establishment of ecological agriculture is essential. Moreover, ecological agriculture correlates traditional cultivation of land with scientific knowledge, respects nature and the developed mild technical means and creates new jobs. Ecological methods of cultivation and plant growth ought to be utilised in restructuring of crops. The harmonious co-existence of agriculture and farming is reckoned as a crucial factor. Animal waste could sometimes serve as fertilizer, while the free grazing of animals in selected places will provide countries with healthy livestock.

In energy sector, it is necessary to exploit and use environmentally friendly forms of energy and develop bioclimatic architecture for the protection of the environment and strengthening of the battle against unemployment. Development and dissemination of modern forms and networks of telecommunications, transmission of information and service (telecommuting, telemedicine, distance learning etc.) could keep population at home contributing to balanced development.

Tourism should also be approached with a sustainable point of view. Tourism must be developed within the framework of the tourist bearing capacity of each region, highlighting the local culture and productive economy as well as sparking the robust local development. The ecotourism experiment in the National Park of Abruzzo (Apennines) is worth mentioning as a contemporary example of implementing alternative tourism.

Environmental education plays the key-role in the required ecological transformation of society. Each country should develop, evolve and promote its own material and immaterial culture. A modern example of eco-development is the area of Anavra in the mountainous Magnesia; where resident enjoy high incomes and quality of life, which can be compared with the rich Switzerland.

3.3 Condition for Achieving Eco-Development

3.3.1 Social Equity

There should be an equilibrium condition in the society among the same generation within and between nation (intra-generation equity) and between two different generations (inter-generation equity). We should handover a safe, healthy and resourceful environment to our future generations.

3.3.2 Economical Equity

The technology should address to the problem of the development countries, producing drought tolerant varieties for uncertain climates, vaccines for infectious diseases, clean fuel for domestic and industrial use. This type of technological development will support the economic growth of the poor countries and help in narrowing the wealth gap and lead to sustainability.

3.3.3 Ecological Security

If any development process protects our biodiversity, decreases the rate of soil erosion and increases the forest cover area that brings the ecological security.

3.4 Objectives of Eco-Development

A primary goal of eco-development is to achieve a reasonable and equitably distributed level of economic well-being that can be perpetuated continually for many human generations. It also implies using renewable natural resources in a manner that does not eliminate or degrade them, or otherwise diminish their usefulness for future generations. Eco-development also requires depleting non-renewable energy resources at a slow enough rate so as to ensure the high probability of an orderly society transition to renewable energy sources. Other objectives are listed below:

1. It should protect our biodiversity;
2. It should prevent soil erosion;
3. It should slow down the population growth;
4. It should increase forest cover;

5. It should cutoff the emissions of CFC, SO_2, NO_2 and CO_2;
6. It should reduce waste generation.
7. It should eliminate poverty and deprivation and above all.
8. It should bring benefits to all.

4.0 CONCLUSION

In this unit, we have examined the meaning of eco-development. We looked at the concept of eco-development and integrated development. The conditions for achieving eco-development and its objectives were also examined.

5.0 SUMMARY

In this unit students have learnt that:

- eco-development refers to development at regional and local levels, consistent with the potentials of the area involved and so on;
- the bearing capacity of the ecosystem defines the maximum level for (a) quantitative development of each activity, b) Culture and tradition will sustain, evolve and turn into key-elements for human cultivation, development of special forms of communal organization and production;
- some of the concept of eco-development and integrated development involves agriculture, ecological method of cultivation, animal waste, energy sector, eco-tourism and environmental education;
- the conditions for achieving eco-development are social equity, economical equity and ecological security; and
- a primary goal of eco-development is to achieve a reasonable and equitably distributed level of economic well-being that can be perpetuated continually for many human generations.

6.0 TUTOR MARKED ASSIGNMENT

1. What do you understand by eco-development and describe the concept of eco-development and integrated development?
2. Mention the objectives of eco-development.

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UNIT 3 ENVIRONMENTAL PLANNING PRINCIPLES: INTER DISCIPLINE, HOLISTIC AND COMPREHENSIVE

CONTENTS

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  3.1 Meaning of Environmental Planning
  3.2 Inter-disciplinary Planning
  3.3 Holistic Planning
  3.4 Comprehensive Planning
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1.0 INTRODUCTION

Environmental planning is not a new concept. As early as the 1920s, when planning was used for design purposes, Benton MacKaye sought ways to 'bring together conservation and community planning'. In the late 1960s and 1970s, the modern environmental movement provided a great opportunity to build a nexus of two interdisciplinary areas: environmental studies and planning Since the 1990s, recent technologies, approaches, knowledge, and geographic information systems (GISs) have impacted environmental planning. Thus, environmental planning must be considered as an interdisciplinary field of practice that includes environmental studies, planning, and recent technologies, among others.

2.0 OBJECTIVES

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

- define environmental planning
- explain the inter-disciplinary and holistic planning
- explain the comprehensive planning.

3.0 MAIN CONTENT

3.1 Meaning of Environmental Planning

Environmental planning is defined as 'the process of planning for **environmental protection** and **problem solving'**. Both environmental protection and problem solving involve extensive knowledge, skills, and abilities. Thus, the complex and interdisciplinary nature of environmental planning poses serious challenges to educators.

Also environmental planning can be defined as the process of facilitating decision making to carry out land development with the consideration given to the natural environment, social, political, economic and governance factors and provides a holistic framework to achieve sustainable outcomes. A major goal of environmental planning is to create sustainable communities, which aim to conserve and protect undeveloped land.

Furthermore, the term '**Environmental Planning'**, also well known, was defined by the **International Union for Conservation of Nature as**: "...a process whereby regional, national or subnational resource conservation or development plans are created in ways that consciously seek to minimise long term negative effects on existing levels of **environmental quality** ..." There are, however, views which consider Environmental Planning as all planning, that is, including planning for regions, towns and settlements of various kind.

3.2 Inter-disciplinary Planning

Historical development and the present state of planning imply that its main concerns were always the development processes of settlement and settlement systems at all levels, together with their impact on the natural environment, state of economy and the quality of human life. Development is a multi-complex process and, in its essence, planning has been usually recognised as responsible for its coordination both in space and time. Planning evolved, generally, from architecture but, later, other disciplines became entangled in it because of their interest in various aspects of development and, at present, the prime 73 responsibility of planning cannot be discharged without close affinity with and knowledge of **economic**, **managerial**, **ecological**, **technological** and **social issues**. This is, of course, a very large field and it has compelled planning to evolve as, primarily, a generalist activity that must examine development from a wide range of viewpoints coming from many disciplines, and then try to integrate this very broad spectrum into planning decisions.

3.3 Holistic Planning

The goals of improved equity, eradication of poverty and environmental sustainability which must form the basis of development in the Third World, can only be achieved if basic human necessities are met on a much wider scale than before. It is the contention of this article that development requires a large scale decentralised but coherent effort for the application of science to basic needs and the delivery of goods and services aimed at fulfilling these needs through the government machinery, judicial administrative, social and academic institutions. The environmental impacts of conventional technology are relatively well known today. Air pollution, acid rain, industrial waste disposal, toxic effluent, noise and vibrations, crowding and congestion and many other side effects of urban and industrial activity are now widely recognised as the costly bi-products of activities which otherwise produce useful outputs.

While governments must necessarily play a leadership role through education, creation of awareness, implementation of various Acts, policies and programmes in letter and spirit along with the provision of infrastructure and overall planning, their policies on science and technology must be geared primarily for promotion of creative action at the individual and community levels.

3.4 Comprehensive Planning

Comprehensive planning is a process that determines community goals and aspirations in terms of community development. The result is called a comprehensive plan and both expresses and regulates public policies on transportation, utilities, land use, recreation, and housing. Comprehensive plans typically encompass large geographical areas, a broad range of topics, and cover a long-term time horizon. The term comprehensive planning is most often used by urban planners in the United States.

In Canada, **comprehensive planning** is generally known as strategic planning or visioning. It is usually accompanied by public consultation. When cities and municipalities engage in comprehensive planning the resulting document is known as an **Official Community Plan** or **OCP** for short.

4.0 CONCLUSION

In this unit, we have examined the meaning of environmental planning and the various planning principles as follows: inter-disciplinary, holistic and comprehensive planning

5.0 SUMMARY

In this unit students have learnt that:

- environmental planning is defined as 'the process of planning for environmental protection and problem solving;
- the term 'Environmental Planning', also well known, was defined by the International Union for Conservation of Nature as: "...a process whereby regional, national or subnational resource conservation or development plans are created in ways that consciously seek to minimise long term negative effects on existing levels of environmental quality.
- inter-disciplinary planning evolved, generally, from architecture but, later, other disciplines became entangled in it because of their interest in various aspects of development.
- holistic planning in governments must necessarily play a leadership role through education, creation of awareness, implementation of various Acts, policies and programmes in letter and spirit along with the provision of infrastructure and overall planning.
- comprehensive planning is a process that determines community goals and aspirations in terms of community development.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the different meanings of Environmental Planning.
2. Write short notes on inter-disciplinary, holistic and comprehensive planning principles.

7.0 REFERENCES/FURTHER READING

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UNIT 4 ENVIRONMENTAL PLANNING PRINCIPLES PARTICIPATIVE COORDINATED, INTEGRATED AND CONTINUOUS PLANNING

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1.0 INTRODUCTION

Participative coordinated and integrated approaches to environmental planning and management are being widely advocated in the literature and by management organisations. Terms such as integrated resources management, ecosystem management, and integrated environmental management have emerged from several different fields. But in this unit we are going to discuss on participative coordinated, Integrated and continuous planning.

2.0 OBJECTIVES

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

- explain the meanings of environmental planning
- discuss the participative coordinated planning
- explain the integrated and continuous planning.

3.0 MAIN CONTENT

3.1 Meaning of Environmental Planning

Earlier in this course we defined environmental planning as ‘the process of planning for environmental protection and problem solving’. Both environmental protection and problem solving involve extensive knowledge, skills, and abilities. Thus, the complex and interdisciplinary nature of environmental planning poses serious challenges to educators.

Also environmental planning can be defined as the process of facilitating decision making to carry out land development with the consideration given to the natural environment, social, political, economic and governance factors and provides a holistic framework to achieve sustainable outcomes.

Furthermore, the term ‘Environmental Planning’, also well known, was defined by the International Union for Conservation of Nature as: a process whereby regional, national or subnational resource conservation or development plans are created in ways that consciously seek to minimise long term negative effects on existing levels of environmental quality.

3.2 Participative Coordinated Planning

Participatory planning is an urban planning paradigm that emphasizes involving the local community from the very beginning (preparation of Local Action Plans) of the strategic and management processes of urban planning; or, community-level planning processes. The Participatory Strategic Planning process is a consensus-building approach that helps a community to join together in explaining how they would like their community or organisation to develop over the next few years.

The participatory planning method has its roots in the United States, influencing western European countries in the subsequent years. Participative planning has a long tradition in most western countries also, whereas it’s still in infancy in the “eastern-blocks”, and in some South-European countries where cities are rather focused on carrying planning in a traditional level, based alone on professional expert opinions. Planning methodology based on public participation is rather for harmonising the different viewpoints and knowledge than forcing concrete solutions. It is a democratic process of common solution seeking with the users for the users. The involved professionals and community planners coordinate and support the process without dominating or proclaiming the one and only “right” professional solution.

3.3 Integration Planning

Integration includes the following dimensions: functional – mixed use areas with good infrastructure and services, social – different social and cultural groups, economic – a mix of different income groups and economic activities.

- **Functional integration** or physical integration involves creating development that is not mono-functional or sterile. The aim is to create lively and interactive living and working areas where all dimensions of activity including cultural, educational, and economic and others are catered for. The result of functional integration is the availability and accessibility of a range of services and amenities required for daily life. Functional integration can be achieved through the implementation of mixed use, higher densities, infilling, and the co-location of living, working, service and recreational opportunities.

Benefits include local income generation, accessibility of goods and services, reduced need to travel and transport goods, lower financial and environmental costs, a diverse and dynamic urban environment and a more efficient provision of infrastructure and other services.

- **Social integration**: Social integration involves facilitating a diverse and vibrant population mix in a community where all population groups are catered for. This includes catering for different cultural, age, ability and income groups. Social integration can be achieved through the provision of mixed housing, different land tenure and financing options and variations in available buiding and dwellings. It can also be achieved through multi-purpose community centres and through the strategic location of business centres, markets and institutions. The benefits of social integration include social interaction, co-operation, understanding and tolerance, people from different backgrounds enriching one another, cross-cutting interest groups, overcoming differences and enhanced human resources and capacities available in communities.

- **Economic integration**: Economic integration results in a community that reflects a diversity of income groups. It will also have a range of different scales of economic activities and possibilities and opportunities. This can be achieved through the conscious provision of spaces and opportunities for the full range of economic requirements for a community, such as urban agriculture, small-scale selling, markets, entrepreneurial centres, business support and the more traditional opportunities such as commercial activity areas. The benefits include increased employment opportunities, local buying power and ultimately a more economically successful community.

3.4 Continuous Planning

Continuous planning is an approach to planning where static annual or bi-annual plans are replaced with a continually updated plan, which is revised every time an internal or external event (such as a shift in priorities, an unexpected delay in a given program or a change in the business environment) occurs.

Continuous planning is tightly linked with the implementation of Agile and Lean methodologies, which both advocate short, flexible plans that can be adapted to changing circumstances.

Whilst most studies focus on the team level, continuous planning has benefits at all levels of the organisation, including the strategic, portfolio, and product levels.

3.4.1 Characteristics of Continuous Planning

Planning is no longer triggered by a given date in the calendar, but by internal and external events as they occur. As a result:

- The plan stays more up-to-date: since the plan is updated every time a change occurs in the internal or external environment, the latest version of the plan automatically includes all changes up to that point.
- The plan is more accurate: because the plan can be updated at any time to incorporate new information, organisations do not need to project themselves into the future quite so strongly, and can afford to have a simpler, less detailed plan. Instead, the plan will be quickly updated as projects evolve and more specific and detailed data become available.
- Top management (including financial and business people) get involved in the planning process more regularly and frequently. This in turn allows planning to become a tool that leaders can use to think about changes and the impact these will have on the business.
- From something they get involved in maybe twice a year, to something they must engage with perhaps on a daily basis.

That being said, continuous planning is seldom (if ever) applied at all levels of the organisation. Instead, companies will choose to apply it only to some levels (and most often at the team / operational level).

4.0 CONCLUSION

In this unit, we have examined the meaning of environmental planning and the various planning principles as follows: participative coordinated, integrated and continuous planning.

5.0 SUMMARY

In this unit students have learnt that:

- environmental planning is defined as 'the process of planning for environmental protection and problem solving;
- Participatory planning is an urban planning paradigm that emphasizes involving the local community from the very beginning (preparation of Local Action Plans) of the strategic and management processes of urban planning; or, community-level planning processes;
- Integration includes the following dimensions: functional, social, and economic integration.
- Functional integration or physical integration involves creating development that is not mono-functional or sterile; and
- Continuous planning is an approach to planning where static annual or bi-annual plans are replaced with a continually updated plan and so.

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe participative coordinated planning.
2. Write short notes on functional, social and economic integrated planning.

7.0 REFERENCES/FURTHER READING

Deshmukh, N. (2014). Environmental Education. *Indian Journal of Public Administration, H*60(1):38.

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