8. Ecology & Conservation of Natural resources

8.1. Definition of ecological terms & basic concepts of ecology

Ecology:

- Ecology is the study of the relationship of living organisms among themselves and with the non-living components of the environment.
- Ecology is the scientific study of the interactions between organisms and their environments
- The study of the relationships, distribution, and abundance of organisms, or groups of organisms, in an environment

Ecological terminologies and their definitions

Slide preparation by Kassu T., Bio. Dep't, 2014

1. Abiotic: all non-living components in the biosphere, e.g., air, water, soil, climate.
2. Autotrophic: when an organism is able to produce its own food using abiotic components.
3. Biotic: all the living components in the biosphere: animals, plants, microorganisms, etc.
4. Biosphere: it is the global sum of all ecosystems, and is the zone where all living organisms live on earth.
5. Biome: the biosphere is divided into millions of biomes, based on the specific climate of each region, where the climate determines the unique plant and animal species that live and are adapted to survive in a region.
6. Carnivores: animals that eat only meat. They are generally predators, like lions, cheetahs etc., in a specific environment.
7. Ecosystem: the combined physical and biological components of a specific habitat where animals and plants are interdependent on each other for survival.
8. Herbivores: animals that only eat plants, e.g., buck, cows, goats, sheep, rabbits etc.
9. Heterotrophic: when an organism is unable to produce its own food, and must eat other organisms
10. Omnivores: animals that eat both plant and animal matter, e.g., humans, pigs, baboons.
11. Saprophytic organisms: organisms that live on dead organic matter because they are able to decompose (break down) dead plant and animal matter.
12. Scavengers: animals that eat what is left over by predators. Examples are hyenas, crayfish and vultures.
13. Photosynthesis: a process where plants use sunlight energy, water and CO2 from the air, to produce organic compounds like glucose and inorganic compounds like O2.
14. Vegetation: the plant life that is found in a biome.

Branches of ecology

Ecology can be divided depending on the following concepts:-

1. Hierarchical organization –according to level of organization
2. Taxonomic –according to organisms studied
3. Time/Place -According to time/place

Many other ways to subdivide ecology:

A) Hierarchic: organism, population, community, ecosystem, biosphere
B) Taxonomic: plant ecology, animal ecology, microbial ecology, avian ecology, etc.
C) Time/Place: marine ecology, tropical ecology, freshwater ecology

Hierarchical structure of ecological systems

Organism: fundamental unit of ecology. No smaller unit in biology has an independent life in the environment.

Population: A group of organisms consisting of a number of different populations that live in defined area and interact with each other.

Community: A group of organisms consisting of a number of different species that live in an area and interact with each other

Ecosystem: a biological community plus all of the abiotic factors influencing that community.

Biome: A distinct ecological community of plants and animals living together in a particular climate.

Biosphere: the aggregation of all ecosystems (the sum of all of the organisms of the earth and their environment). Biome is the living zone of the planet.

Ecological branches are:

- Population ecology (or Autecology) o It is concerned with population growth including birth rates and death rates, fluctuation, spread and interactions (scientific study of relationships between organisms of the same species).

- Community ecology (or Synecology) o Community ecology is the scientific study of relationships between organisms of different species.

- Ecosystems ecology, having to do with the structure and function of the entire suite of microbes, plants, and animals, and their abiotic environment, and how the parts interact to generate the whole.

- Evolutionary ecology, which may operate at any of these levels but most commonly at the physiological or population level, is a rich and dynamic area of ecology focusing on attempting to understand how natural selection developed the structure and function of the organisms and ecosystems at any of these levels.

- Conservation ecology: -it deals with methods of proper management of natural resources such as land, water, forests, sea, mines, etc., for the benefit of human beings.

8.1.1. Aquatic & terrestrial ecosystems

There are two main categories of ecosystems:
A) Aquatic ecosystem:
An aquatic ecosystem is an ecosystem in a body of water.
The two main types of aquatic ecosystems are:
1. Marine ecosystems
- cover approximately 71% of the earth's surface and contain approximately 97% of the planet's water. They are distinguished from freshwater ecosystems by the presence of dissolved compounds, especially salts, in the water

2. Freshwater ecosystems
- occupy only about 2% of earth‘s surface).
Example i. Rivers and streams: flowing-water ecosystems
ii. Lakes and ponds: standing-water ecosystems
3. Marshes and swamps: freshwater wetlands
- Grass like plants dominate in marshes, while woody trees and/or shrubs dominate in swamps.

Estuaries: are where fresh and salt water meet.
i. Estuaries are among the most fertile ecosystems in the world
ii. Temperate estuaries usually contain salt marshes which are important in preventing flood damage during storm surges
iii. Mangrove forests are the tropical equivalent of salt marshes; they cover nearly 70% of tropical coastlines.

B. Terrestrial ecosystems

Terrestrial ecosystems include:
(a) Forests (b) Grasslands, (c) Deserts and (d) tundra

(a) Forests: are large areas supporting rich growth of trees. Depending on the climate and type of trees they are generally grouped into:
i. Tropical rain forests
ii. Temperate deciduous forests
iii. Boreal or north coniferous forests include

Grasslands
Distribution: Grasslands are areas dominated by grasses. They occupy about 20% of the land on the earth surface. Grasslands occur in both in tropical and temperate regions where rainfall is not enough to support the growth of trees. Grasslands are known by various names in different parts of the world. For example:
e.g. North America -> Prairies
Eurasia (Europe and Asia) -> Steppes
Africa -> Savanna
South America -> Pampas
India -> Grassland, Savanna

Deserts

Distribution: Deserts are hot and low rain areas suffering from water shortage and high wind velocity. They show extremes of temperature. Globally deserts occupy about 1/7th of the earth‘s surface.

Adaptations:

Desert plants and animals adapt both hot and dry conditions.

(i) These plants conserve water by the following methods:

- They are mostly shrubs.
- Leaves absent or reduced in size.
- Leaves and stem are succulent and water storing.
- In some plants even the stem contains chlorophyll for photosynthesis.
- Root system well developed spread over large area.

(ii) The animals are physiologically and behaviourally adapted to desert conditions.

- They are fast runners.
- They are nocturnal in habit to avoid the sun‘s heat during day time.
- They conserve water by excreting concentrated urine.
- Animals and birds usually have long legs to keep the body away from the hot ground.
- Lizards are mostly insectivorous and can live without drinking water for several days.
- Herbivorous animals get sufficient water from the seeds which they eat. Camel is known as the ship of the desert as it can travel long distances without drinking water for several days.

8.1.2. Energy flow through ecosystems

- The transfer of energy from the source in plants through a series of organisms by eating and being eaten constitutes food chains. At each transfer, a large proportion of energy is lost in the form of heat
- These food chains are not isolated sequences, but are interconnected with each other. This interlocking pattern is known as the food web. Each step of the food web is called a trophic level.

The food chains

- The transfer of food - energy from plants to animals and then to other animals by successive stage of feeding is called a food chain.
- basically two types of food chains are recognized: They are grazing food chain and detritus food chain.

i) Grazing food chain: starts from the living green plants and goes to grazing herbivores and on to the carnivores

- examples of grazing food chain: 1. Aquatic food chain: Phytoplanktons -> zooplanktons-> fish
2. Terrestrial food chain :Grasses-> Rabbit-> fox

ii) Detritus food chain The organic wastes, exudates and dead matter derived from the grazing food chain are generally termed as detritus. The energy contained in this detritus is not lost to the ecosystem as a whole; rather it serves as the source of energy for a group of organisms (detritivores) that are separated from the grazing food chain. The detritus food chain represents an exceedingly important component in the energy flow of an ecosystem.

The food web

In an ecosystem there are a very large number of interlinked chains and forms a food web. Stability of the ecosystem is maintained by food web. If the linkages in the chains that make up the web of life are disrupted due to human activities that lead to the extinction of species, the web will breaks down.

Ecological pyramid

Ecological pyramid is the graphic representation of the number, biomass and energy of the successive trophic levels of an ecosystem.

Ecological pyramids represent the trophic structure (feeding relationships) and trophic function (efficiency of energy transfer through biotic components) of an ecosystem.

Types of ecological pyramid

I) Pyramid of number depicts the number of individual organisms at different trophic levels of food chain.

II) Pyramid of biomass depicts the amount of biomass at different trophic levels of food chain or the total weight of living matter per unit area present in the ecosystem.

III) Pyramid of energy depicts the amount of energy at different trophic levels of food chain. It shows how energy moves throughout an ecosystem. As you move up the pyramid levels, approximately 90% of the food‘s original energy is lost from level to level because animals must use their own energy to consume and digest food.

N.B. Ecological pyramids are always upright; i. e. the apex is pointed upwards. In some ecosystems the number and biomass of producers are less and those of consumers are more. So the apex is directed down wards. This type of pyramid is called inverted pyramid. Inverted pyramid of numbers is found in parasitic food chain. Inverted pyramid of biomass occur in pond and lake ecosystems. However, the pyramid of energy is always upright (never inverted).

8.1.3. Cycling of Materials (Nutrients)

All the functions of the ecosystem are in some way related to the growth and regeneration of its plant and animal species. These linked processes can be depicted as the various cycles. These processes depend on energy from sunlight. During photosynthesis, carbon dioxide is taken up by plants and oxygen is released. Animals depend on this oxygen for their respiration. The water cycle depends on the rainfall, which is necessary for plants and animals to live. The energy cycle recycles nutrients into the soil on which plant life grows. Our own lives are closely linked to the proper functioning of these cycles of life. If human activities go on altering them, humanity cannot survive on our earth.

A. **The Water Cycle**

When it rains, the water runs along the ground and flows into rivers or falls directly into the sea, and part of the rainwater falls on land percolates into the ground. This is stored underground throughout the rest of the year. Water is drawn up from the ground by plants along with the nutrients from the soil. Then, water is transpired from the leaves as water vapour and returned to the atmosphere. As it is lighter than air, the water vapor rises and forms clouds. Winds blow the clouds for long distances and when the clouds rise higher, the vapour condenses and changes into droplets, which fall on the land as rain.

B. **The Carbon cycle**

The carbon, which occurs in organic compounds, is included in both the abiotic and biotic parts of the ecosystem. Carbon is a building block of both plant and animal tissues. In the atmosphere, carbon occurs as carbon dioxide (CO_2). In the presence of sunlight, plants take up carbon dioxide from the atmosphere through their leaves. The plants combine carbon dioxide with water, which is absorbed by their roots from the soil. In the presence of sunlight they are able to form carbohydrates that contain carbon. This process is known as photosynthesis.

C. **Nitrogen cycle**

- 78% of the air is nitrogen
- Plants use nitrogen in their cellular processes
- Nitrogen is present in our DNA and RNA and in amino acids (proteins).
- The food chain largely moves nitrogen around.

Nitrogen Fixation

Nitrogen fixation is the conversion of atmospheric nitrogen (N2) into reactive compounds such as ammonia (NH3) and nitrate (NO3-). The breaking of the bonds between the nitrogen atoms requires a great deal of energy and occurs naturally in two primary ways:

i. Abiotic Fixation: Nitrate is the result of high energy fixation in the atmosphere from lightning and cosmic radiation. In this process, N2 is combined with oxygen to form nitrogen oxides such as NO and NO2, which are carried to the earth‘s surface in rainfall as nitric acid (HNO3). This high energy fixation accounts for approximately 10% of the nitrate entering the nitrogen cycle.

ii. Biological fixation: It is accomplished by a series of soil micro-organisms such as aerobic and anaerobic bacteria. Often, symbiotic bacteria such as Rhizobium are found in the roots of legumes and provide a direct source of ammonia to the plants.

Nitrification – conversion of ammonia in soil to nitrite ions and finally to nitrate ions that are easily used by plants (aerobic bacteria).

Assimilation

Nitrates are the form of nitrogen most commonly assimilated by plants through root hairs. Since heterotrophic organisms cannot readily absorb nitrogen as plants do, they rely on acquiring nitrogen-based compounds through the food they eat

Ammonification

In ammonification, a host of decomposing microorganisms, such as bacteria and fungi, break down nitrogenous wastes and organic matter found in animal waste and dead plants and animals and convert it to inorganic ammonia (NH_3) for absorption by plants as ammonium ions.

Denitrification

It is the process by which nitrates are reduced to gaseous nitrogen (N_2) and lost to the atmosphere. This process occurs by facultative anaerobes in anaerobic environments. Farmers with waterlogged fields and soils that have high clay content are especially vulnerable to nitrogen losses due to denitrification. In short it is conversion of ammonia and ammonium ions to nitrate and nitrite ions and then back into nitrogen gas and nitrous oxide gas.

D. **The Oxygen Cycle**

Oxygen is taken up by plants and animals from the air during respiration. The plants return oxygen to the atmosphere during photosynthesis. This links the oxygen cycle to the carbon cycle.

E. **Phosphorus cycle**

The phosphorus cycle, is the circulation of phosphorous among the rocks, soils, water, and plants and animals of the earth. The phosphorous cycle is the simplest of the cycles that we will examine. For our purposes, phosphorous has only one form, phosphate (PO_4^{-3}), which is a phosphorous atom with four oxygen atoms. This heavy molecule never makes its way into the atmosphere; it is always part of an organism, dissolved in water, or in the form of rock

8.2. **Conservation of natural resources**

8.2.1. Principles of conservation of natural resources

For standard and general criteria for conservation and sustainable use of natural resources, it should be developed at a local level and be adapted to local ecosystems, cultures, values and social and economic conditions. Where necessary, networks of protected areas, corridors and integrated management zones should be established first.

Sustainable use of resources, especially the genetic resources for food and agriculture is vital for the next generation. Greater resource use-efficiency saves land, water and biodiversity, and enhances ecological services underpinning food production. In addition, improved resource-use efficiency can help to reduce pressure on ecosystems, which also subsequently lead to resource depletion and degradation. That is why direct action is needed to conserve, protect and enhance natural resources

According to convention on biodiversity, conservation of biodiversity, forests, fragile ecosystems and other natural resources are the major areas of resource managements. The major strategies of natural resource management techniques are in-situ and ex-situ or both methods. One of among other things, principles of conserving the natural resource is reducing the destruction to biodiversity, which in turn brings about hunger and poverty.

Biodiversity conservation still plays a pivotal role in sustaining and strengthening nutrition. It enhances the resilience of people, communities and ecosystems, especially to climate change and market volatility.

Principles of conservation can be possible through decisions made under various government and public participations, revenue protection policies, an insurance scheme incentivizing to diversify and conserve natural resources, adopt alternative resource utilization strategies, and apply integrated resources management policies among various institutions and individuals. In addition, promoting responsible and effective governance mechanisms are also bet methods for resource management principles.

8.3. **Environmental pollution and public health**

Developmental activities such as construction, transportation and manufacturing not only deplete the natural resources but also produce large amount of wastes that leads to pollution of air, water, soil, and oceans; global warming and acid rains. Untreated or improperly treated waste is a major cause of pollution of rivers and environmental degradation causing ill health and loss of crop productivity

Pollution and pollutants

Pollution may be defined as addition of undesirable material into the environment as a result of human activities. The agents which cause environmental pollution are called pollutants. Pollutants may be defined as a physical, chemical or biological substance unintentionally released into the environment which is directly or indirectly harmful to humans and other living organisms.

Types of pollution

Pollution may be of:

- Air pollution • Noise pollution • Water pollution
- Soil pollution • Thermal pollution • Radiation pollution

Global Warming and Greenhouse Effect

Atmospheric gases like carbon dioxide, methane, nitrous oxide, water vapour, and chlorofluorocarbons are capable of trapping the out-going infrared radiation from the earth. Infra-red radiations trapped by the earth‘s surface cannot pass through these gases and to increase thermal energy or heat in the atmosphere. Thus, the temperature of the global atmosphere is increased.