Environmental studies and Disaster management

Ecosystem & Concept, Structure, Functions Characterizations and Components Producers, consumers and decomposers

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Ecosystems: Definition, concept, structure and functions

Ecology is the science that deals with the relationships between living organisms with their physical environment and with each other. Ecology can be approached from the viewpoints of (1) the environment and the demands it places on the organisms in it or (2) organisms and how they adapt to their environmental conditions. An ecosystem consists of an assembly of mutually interacting organisms and their environment in which materials are interchanged in a largely cyclical manner. An ecosystem has physical, chemical, and biological components along with energy sources and pathways of energy and materials interchange. The environment in which a particular organism lives is called its habitat. The role of an organism in a habitat is called its niche. For the study of ecology it is often convenient to divide the environment into four broad categories.

- **Terrestrial environment** - The terrestrial environment is based on land and consists of biomes, such as grasslands, one of several kinds of forests, savannas, or deserts.

- **Freshwater environment** - The freshwater environment can be further subdivided between *standing-water habitats (*lakes, reservoirs) and *running-water habitats (*streams, rivers).
- **Oceanic marine environment** - The oceanic marine environment is characterized by saltwater and may be divided broadly into the shallow waters of the continental shelf composing the neritic zone
- **Oceanic region** - The deeper waters of the ocean that constitute the oceanic region.

Two major subdivisions of modern ecology are

- **Ecosystem ecology** - which views ecosystems as large units, and
- **Population ecology** - which attempts to explain ecosystem behavior from the properties of individual units.

In practice, the two approaches are usually merged. Descriptive ecology describes the types and nature of organisms and their environment, emphasizing structures of ecosystems and communities and dispersions and structures of populations. Functional ecology explains how things work in an ecosystem, including how populations respond to environmental alteration and how matter and energy move through ecosystems.

Ecosystems are broadly divided into natural and artificial.

Natural ecosystems are those that are existing in nature; they are further classified into terrestrial and aquatic. Terrestrial includes hot desert, grass land, tropical and temperate rainforest and aquatic includes ponds, river, streams, lakes, estuaries, oceans, mangroves, swamps and bays etc. However these two ecosystems are self regulating, open system with a free exchange of inputs and outputs with other systems. **Artificial ecosystems** are simple, human-made, unstable and subjected to human intervention and manipulation. Usually it is formed by clearing a part of the forest or grassland e.g. crop field, agricultural land.

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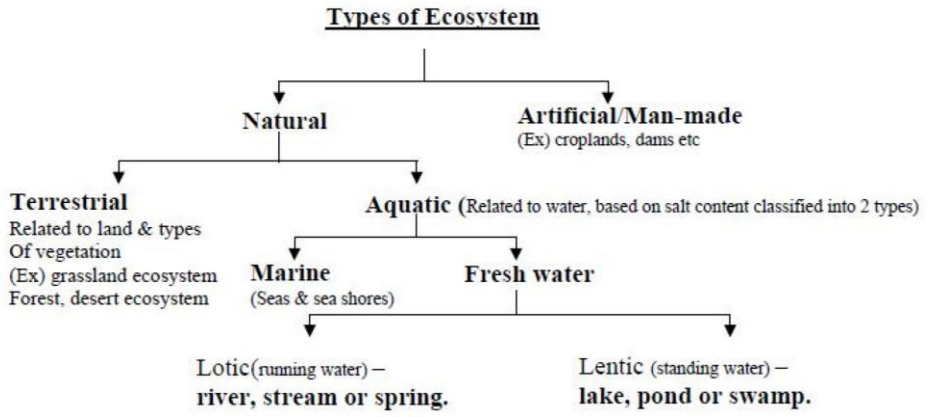
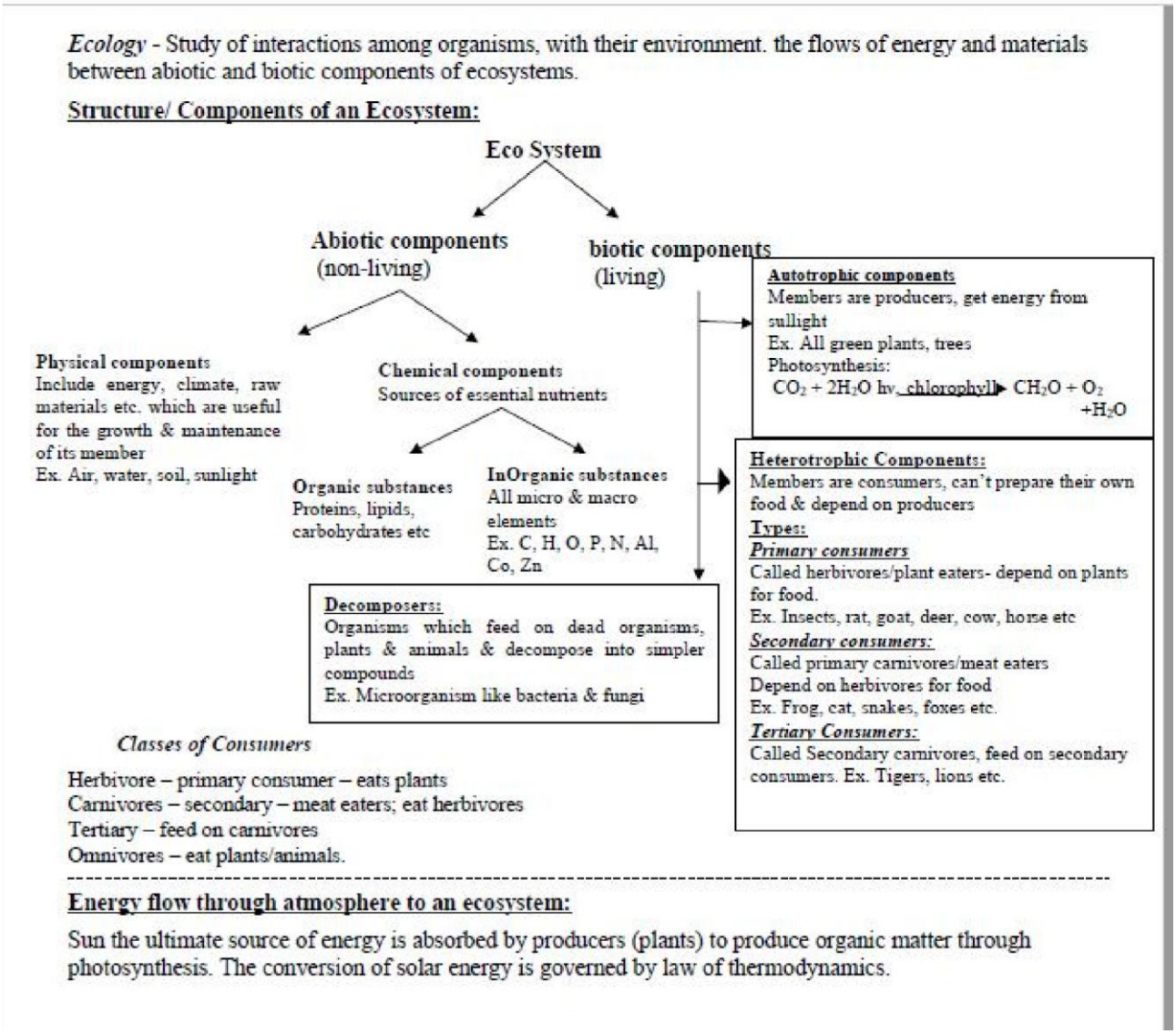
ECOSYSTEMS AND BIODIVERSITY

Ecosystem–A group of organisms interacting among themselves and with environment is known as ecosystem.



Structure and Function of an ecosystem

An ecosystem has two components the biotic components consisting of living things, and the abiotic portion, consisting of elements that are not alive. The non living constituents are said to include the following category, habitat, gases, solar radiation, temperature, moisture and inorganic and organic nutrients. The living organisms may be sub divided into producers, consumers and decomposers. Abiotic Components include basic inorganic and organic components of the environment or habitat of the organism. The inorganic components of an ecosystem are carbon dioxide, water nitrogen, calcium phosphate all of which are involved in matter cycle (biogeochemical cycles). The organic components of an ecosystem are proteins, carbohydrates, lipids and amino acids, all of which are synthesized by the biota (flora and fauna) of an ecosystem and are reached to ecosystem as their wastes, dead remains etc. the climate 'microclimate' temperature, light soil etc. are abiotic components of the ecosystems.



Functions of an Ecosytem

Ecosystem function is the capacity of natural processes and components to provide goods and services that satisfy human needs, either directly or indirectly. Ecosystem functions are subset of ecological processes and ecosystem structures. Each function is the result of the natural processes of the total ecological sub-system of which it is a part. Natural processes, in turn, are the result of complex interactions between biotic (living organisms) and abiotic (chemical and physical) components of ecosystems through the universal driving forces of matter and energy.

There are four primary groups of ecosystem functions

(1) Regulatory Functions, (2) Habitat Functions, (3) Production Functions and (4) Information functions. This grouping concerns all ecosystems, not only for forests.

General characterizations of ecosystem functions are:

(1) Regulatory functions: this group of functions relates to the capacity of natural and seminatural ecosystems to regulate essential ecological processes and life support systems through bio-geochemical cycles and other biospheric processes. In addition to maintaining the ecosystem (and biosphere health), these regulatory functions provide many services that have direct and indirect benefits to humans (i.e., clean air, water and soil, and biological control services).

(2) Habitat functions: natural ecosystems provide refuge and a reproduction habitat to wild plants and animals and thereby contribute to the (in situ) conservation of biological and genetic diversity and the evolutionary process.

(3) Production functions: Photosynthesis and nutrient uptake by autotrophs converts energy, carbon dioxide, water and nutrients into a wide variety of carbohydrate structures which are then used by secondary producers to create an even larger variety of living biomass. This broad diversity in carbohydrate structures provides many ecosystem goods for human consumption, ranging from food and raw materials to energy resources and genetic material.

4) Information functions: Since most of human evolution took place within the context of an undomesticated habitat, natural ecosystems contribute to the maintenance of human health by providing opportunities for reflection, spiritual enrichment, cognitive development, recreation and aesthetic experience.

Components of an ecosystem: Complete ecosystem consists of four basic

components such as producers, consumers, decomposers and abiotic components e.g. Pond. If anyone of these four components are lacking, then it is grouped under incomplete ecosystem e.g. Ocean depth or a cave.

Productivity in the Environment: The productivity of an ecosystem is the rate at which solar energy is fixed by the vegetation of the ecosystem; it is further classified into primary productivity, secondary productivity and net productivity.

Primary productivity refers to the rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producers; it is further distinguished as gross primary productivity (GPP) and net primary productivity (NPP). It is expressed in terms of weight (g/m2/yr) or energy (kcal/m2). Secondary productivity refers to the rates of energy storage at consumer levels. An understanding of ecology is essential in the management of modern industrialized societies in ways that are compatible with environmental preservation and enhancement. The branch of ecology that deals with predicting the impacts of technology and development and making recommendations such that these activities will have minimum adverse impacts, or even positive impacts, on ecosystems may be termed as Applied Ecology. It is a multidisciplinary approach.

Interactions among living organisms are grouped into two major groups *viz*.,

- Positive interactions
- Negative interactions

I. Positive interactions

Here the populations help one another, the interaction being either one way or reciprocal. These include (i) Commensalism, (ii) Proto co-operation and (iii) mutualism.

1 . Commensalism

In this one species derives the benefits while the other is unaffected.

Eg. (i) Cellulolytic fungi produce a number of organic acids from cellulose which serve as carbon sources for non-cellulolytic bacteria and fungi.

(ii) Growth factors are synthesised by certain microorganisms and their excretion permits the proliferation of nutritionally complex soil inhabitants.

2. Proto-cooperation

It is also called as non-obligatory mutualism. It is an association of mutual benefit to the two species but without the co-operation being obligatory for their existence or for their performance of reactions.

Eg. N2 can be fixed by *Azotobacter* with cellulose as energy source provided that a cellulose decomposer is present to convert the cellulose to simple sugars or organic acids.

Mutualism

Mutually beneficial interspecific interactions are more common among organisms. Here both the species derive benefit. In such association there occurs a close and often permanent and obligatory contact more or less essential for survival of each.

Eg. (i) Pollination by animals. Bees, moths, butterflies etc. derive food from hectar, or other plant product and in turn bring about pollination.

(ii) Symbiotic nitrogen fixation:

Legume - *Rhizobium* symbiosis. Bacteria obtain food from legume and in turn fix gaseous nitrogen, making it available to plant.

II. Negative interactions

Member of one population may eat members of the other population, compete for foods, excrete harmful wastes or otherwise interfere with the other population. It includes (i) Competition, (ii) Predation, (iii) Parasitism and (iv) antibiosis.

(i) Competition

It is a condition in which there is a suppression of one organism as the two species struggle for limiting quantities of nutrients O2 space or other requirements.

Eg. Competition between *Fusarium oxysporum* and *Agrobacterium radiobacter*.

(ii) Predation

A predator is free living which catches and kills another species for food. Most of the predatory organisms are animals but there are some plants (carnivorous) also, especially fungi, which feed upon other animals.

a) Grazing and browsing by animals on plants.
b) Carnivorous plants such as *Nepenthes, Darligtoria, Drosera* etc. consume insects and other small animals for food.
c) Protozoans feeding on bacteria.

(iii.) Parasitism

A parasite is the organism living on or in the body of another organisms and deriving its food more or less permanently from its tissues. A typical parasite lives in its host without killing it, whereas the predator kills its upon which it feeds.

Eg. Species of *Cuscuta* (total stem parasite) grow on other plants on which they depend for nourishment. Parasitism may occur even within the species. Hyperparasites which are chiefly fungi growing parasitically on other parasites, (ie) Parasite on a parasite. Eg. *Cicinnobolus cesatii* is found as hyperparasite on a number of powdery mildew fungi.

(iv) Antibiosis

The phenomenon of the production of antibiotic is called as antibiosis. Antibiotic is an organic substance produced by one organism which in low concentration inhibits the growth of other organism. Eg. Streptomycin - *S.griseus* , Penicillin - P. *notatum* , *Trichoderma harzianum* inhibits the growth of *Rhizoctonia* sp.

Producers, consumers and decomposers of an ecosystem.

Our environment consisting of both living and non-living systems, influence each other in form, function and property which is necessary to maintain life. The composition of the living and the nonliving systems are the building blocks of an ecosystem.

Producers

In an ecosystem, producers are those organisms that use photosynthesis to capture energy by using sunlight, water and carbon dioxide to create carbohydrates, and then use that energy to create more complex molecules like proteins, lipids and starches that are crucial to life processes. Producers, which are mostly green plants, are also called autotrophs.

Producers funnel into the ecosystem the energy needed for its biological processes. The carbohydrates and other organic chemicals formed by the producers are utilized by the heterotrophs, or consumers; first by the herbivores who eat the plants--the primary consumers-then by the predators who eat the herbivores--the secondary, tertiary, and so on consumers. But at each step, much energy is lost. Less than 10 percent of the energy stored in plants is converted to herbivore mass. The loss from herbivore to predator is similar. Thus energy needs to be added to the ecosystem continuously.

Producers: Organism which produces its own food by using energy from the sun

Consumers

Consumers are organisms (including humans) that get their energy from producers, regarding the flow of energy through an ecosystem. For example, producers, (such as plants), make their own

food by the process of photosynthesis. An organism ate this plant, than it would be a primary consumer. The animal that eats *this* animal is known as the second order consumer. Scientifically, all consumers are either herbivores, carnivores, omnivores or detrivores (decomposers and other organism that break down organic matter). These 'orders' are known as trophic levels.

Consumers: Organism which doesn‘t make its own food, but gets it from eating plants or other animals.

Decomposers

Decomposers eventually convert all organic matter into carbon dioxide (which they respire) and nutrients. This releases raw nutrients (such as nitrogen, phosphorus, and magnesium) in a form usable to plants and algae, which incorporate the chemicals into their own cells. This process resupplies nutrients to the ecosystem, in turn allowing for greater primary production. Although decomposers are generally located on the bottom of ecosystem diagrams such as food chains, food webs, and energy pyramids, decomposers in the biosphere are crucial to the environment. By breaking down dead material, they provide the nutrients that other organisms need to survive. As decomposers feed on dead organisms, they leave behind nutrients. These nutrients become part of the soil. Therefore, more plants can grow and thrive.