

# ECOSYSTEM

ANSHIKA

DEPRTEMNT OF ENVIRONMENTAL ENGINEERING

- An 'Ecosystem' is a region with a specific and recognizable landscape form such as forest, grassland, desert, wetland or coastal area. The nature of the ecosystem is based on its geographical features such as hills, mountains, plains, rivers, lakes, coastal areas or islands.
- The living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water, constitute the ecosystem.
- It is also controlled by climatic conditions such as the amount of sunlight, the temperature and the rainfall in the region. The geographical, climatic and soil characteristics form its non-living (abiotic) component. These features create conditions that support a community of plants and animals that evolution has produced to live in these specific conditions. The living part of the ecosystem is referred to as its biotic component.
- Ecosystems are divided into terrestrial or land based ecosystems, and aquatic ecosystems in water. These form the two major habitat conditions for the Earth's living organisms.
- At a global level the thin skin of the earth on the land, the sea and the air, forms the biosphere. At a sub-global level, this is divided into biogeographical realms, eg. Eurasia called the palaearctic realm; South and South-East Asia (of which India forms a major part) is the Oriental realm;

# PRODUCERS, CONSUMERS, DECOMPOSERS

- Plants are the ‘producers’ in the ecosystem as they manufacture their food by using energy from the sun. In the forest these form communities of plant life. In the sea these include tiny algal forms to large seaweed.
- The herbivorous animals are primary consumers as they live on the producers. In a forest, these are the insects, amphibia, reptiles, birds and mammals. The herbivorous animals include for example hare, deer and elephants that live on plant life.
- At a higher trophic level, there are carnivorous animals, or secondary consumers, which live on herbivorous animals.
- Decomposers or detritivores are a group of organisms consisting of small animals like worms, insects, bacteria and fungi, which break down dead organic material into smaller particles and finally into simpler substances that are used by plants as nutrition.

# STRUCTURE AND FUNCTION OF ECOSYSTEM

Structural aspects Components that make up the structural aspects of an ecosystem include:

- 1) Inorganic aspects – C, N, CO<sub>2</sub>, H<sub>2</sub>O.
- 2) Organic compounds – Protein, Carbohydrates, Lipids – link abiotic to biotic aspects.
- 3) Climatic regimes – Temperature, Moisture, Light & Topography.
- 4) Producers – Plants.
- 5) Macro consumers – Phagotrophs – Large animals.
- 6) Micro consumers – Saprotrophs, absorbers, fungi.

Functional aspects:

- 1) Energy cycles.
- 2) Food chains.
- 3) Diversity-interlinkages between organisms.
- 4) Nutrient cycles-biogeochemical cycles.
- 5) Evolution.

# ENERGY FLOW IN THE ECOSYSTEM

- 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.

# ENERGY CYCLE

- The energy cycle is based on the flow of energy through the ecosystem. Energy from sunlight is converted by plants themselves into growing new plant material which includes leaves, flowers, fruit, branches, trunks and roots of plants.
- The different plant and animal species are linked to one another through food chains. Each food chain has three or four links. However as each plant or animal can be linked to several other plants or animals through many different linkages, these inter-linked chains can be depicted as a complex food web. This is thus called the 'web of life' that shows that there are thousands of interrelationships in nature.
- The energy in the ecosystem can be depicted in the form of a food pyramid or energy pyramid. The food pyramid has a large base of plants called 'producers'. The pyramid has a narrower middle section that depicts the number and biomass of herbivorous animals, which are called 'first order consumers'. The apex depicts the small biomass of carnivorous animals called 'second order consumers'.
- Man is one of the animals at the apex of the pyramid.

# ECOLOGICAL SUCCESSION

- Ecological succession is a process through which ecosystems tend to change over a period of time.
- Succession can be related to seasonal environmental changes, which create changes in the community of plants and animals living in the ecosystem.
- Other successional events may take much longer periods of time extending to several decades. If a forest is cleared, it is initially colonized by a certain group of species of plants and animals, which gradually change through an orderly process of community development.
- Developmental stages in the ecosystem thus consist of a pioneer stage, a series of changes known as seral stages, and finally a climax stage. The successive stages are related to the way in which energy flows through the biological system.



# FOOD CHAIN AND FOOD WEB

- 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.
- Hence green plants occupy the first level, herbivores the second level, carnivores the third level and secondary carnivores the fourth level. These trophic levels together form the ecological pyramid.
- Each chain usually has only four to five such links. However a single species may be linked to a large number of species.

## Types of Ecosystems

<i>Terrestrial Ecosystems</i>	<i>Aquatic Ecosystems</i>
<i>Forest</i>	<i>Pond</i>
<i>Grassland</i>	<i>Lake</i>
<i>Semi arid areas</i>	<i>Wetland</i>
<i>Deserts</i>	<i>River</i>
<i>Mountains</i>	<i>Delta</i>
<i>Islands</i>	<i>Marine</i>

# Ecosystem goods and services

- ❖ Direct Values: These are resources that people depend upon directly and are easy to quantify in economic terms.
  - Consumptive Use Value - Non-market value of fruit, fodder, firewood, etc. that are used by people who collect them from their surrounds.
  - Productive Use Value – Commercial value of timber, fish, medicinal plants, etc. that people collect for sale.
- ❖ Indirect Values: These are uses that do not have easy ways to quantify them in terms of a clearly definable price.
  - Non-consumptive use value – scientific research, bird-watching, ecotourism, etc.
  - Option value - maintaining options for the future, so that by preserving them one could reap economic benefits in the future.
  - Existence value - ethical and emotional aspects of the existence of wildlife and nature.

**Direct uses of forest products**

Fruits – mango, jamun, awla

Roots – Dioscoria

Medicine – Gloriosa, Foxglove

Fuelwood – many species of trees and shrubs

Small timber for building huts and houses

Wood for farm implements

Bamboo and cane for baskets

Grass for grazing and stall feeding livestock

**Indirect uses of forest products**

Building material for construction and furniture for the urban sector

Medicinal products collected and processed into drugs

Gums and resins processed into a variety of products

Raw material for industrial products and chemicals

Paper from bamboo and softwoods

# BIODIVERSITY

ANSHIKA

# DEFINITION

- ‘Biological diversity’ or biodiversity is that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locally, in a region, in the country and the world, and various types of ecosystems, both terrestrial and aquatic, within a defined area.
- Biological diversity deals with the degree of nature’s variety in the biosphere. This variety can be observed at three levels; the genetic variability within a species, the variety of species within a community, and the organisation of species in an area into distinctive plant and animal communities constitutes ecosystem diversity.

# DIVERSITY

- Each member of any animal or plant species differs widely from other individuals in its genetic makeup because of the large number of combinations possible in the genes that give every individual specific characteristics.
- This genetic variability is essential for a healthy breeding population of a species. If the number of breeding individuals is reduced, the dissimilarity of genetic makeup is reduced and in-breeding occurs. Eventually this can lead to the extinction of the species. The diversity in wild species forms the 'gene pool' from which our crops and domestic animals have been developed over thousands of years.
- The number of species of plants and animals that are present in a region constitutes its species diversity. This diversity is seen both in natural ecosystems and in agricultural ecosystems. Some areas are more rich in species than others. Natural undisturbed tropical forests have a much greater species richness than plantations developed by the Forest Department for timber production.
- Ecosystem diversity can be described for a specific geographical region, or a political entity such as a country, a State or a taluka. Distinctive ecosystems include landscapes such as forests, grasslands, deserts, mountains, etc., as well as aquatic ecosystems such as rivers, lakes, and the sea. Each region also has man-modified areas such as farmland or grazing pastures.

# India's Biogeographic Zones :

1. The cold mountainous snow covered Trans Himalayan region of Ladakh.
2. The Himalayan ranges and valleys of Kashmir, Himachal Pradesh, Uttarakhand, Assam and other North Eastern States.
3. The Terai, the lowland where the Himalayan rivers flow into the plains.
4. The Gangetic and Brahmaputra plains.
5. The Thar Desert of Rajasthan.
6. The semi arid grassland region of the Deccan plateau Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu.
7. The Northeast States of India,
8. The Western Ghats in Maharashtra, Karnataka and Kerala.
9. The Andaman and Nicobar Islands.
10. The long western and eastern coastal belt with sandy beaches, forests and mangroves.

# VALUE OF BIODIVERSITY

- Environmental services from species and eco- systems are essential at global, regional and local levels. Production of oxygen, reducing carbon dioxide, maintaining the water cycle, protecting soil are important services.
- Biological diversity is also essential for preserving ecological processes, such as fixing and re- cycling of nutrients, soil formation, circulation and cleansing of air and water, global life sup- port (plants absorb CO<sub>2</sub>, give out O<sub>2</sub>), maintaining the water balance within ecosystems, watershed protection, maintaining stream and river flows throughout the year, erosion control and local flood reduction.
- It has become obvious that the preservation of biological resources is essential for the well being and the long-term survival of mankind.



- **CONSUMPTIVE VALUE:** The direct utilisation of timber, food, fuelwood, fodder by local communities.
- The biodiversity held in the ecosystem provides forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products.
- **PRODUCTIVE USE VALUE:** Marketable goods.
- Value of MFP > Timber (which is part of sustainable use)
- The biotechnologist uses bio-rich areas to 'prospect' and search for potential genetic properties in plants or animals that can be used to develop better varieties of crops that are used in farming and plantation programs or to develop better livestock.
- A variety of industries such as pharmaceuticals are highly dependent on identifying compounds of great economic value from the wide variety of wild species of plants located in undisturbed natural forests. This is called biological prospecting.

- Social values: The consumptive and productive value of biodiversity is closely linked to social concerns in traditional communities. 'Ecosystem people' value biodiversity as a part of their livelihood as well as through cultural and religious sentiments.
- Ethical and moral values: Ethical values related to biodiversity conservation are based on the importance of protecting all forms of life. All forms of life have the right to exist on earth.
- We have in our country a large number of sacred groves or 'deorais' preserved by tribal people in several States. These sacred groves around ancient sacred sites and temples act as gene banks of wild plants.
- Aesthetic value: Biodiversity is a beautiful and wonderful aspect of nature. Knowledge and an appreciation of the presence of biodiversity for its own sake is another reason to preserve it.
- Option Value: Keeping future possibilities open for their use is called option value. To continue to improve cultivars and domestic livestock, we need to return to wild relatives of crop plants and animals. Thus the preservation of biodiversity must also include traditionally used strains already in existence in crops and domestic animals.

# BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVELS

- There are at present 1.8 million species known and documented by scientists in the world.
- Most of the world's bio-rich nations are in the South, which are the developing nations. In contrast, the majority of the countries capable of exploiting biodiversity are Northern nations, in the economically developed world. These nations however have low levels of biodiversity.
- Throughout the world, the value of biologically rich natural areas is now being increasingly appreciated as being of unimaginable value. International agreements such as the World Heritage Convention attempt to protect and support such areas. India is a signatory to the convention and has included several protected Areas as World Heritage sites.
- India has also signed the Convention in the Trade of Endangered Species (CITES) which is intended to reduce the utilization of endangered plants and animals by controlling trade in their products and in the pet trade.

- Among the biologically rich nations, India stands among the top 10 or 15 countries for its great variety of plants and animals, many of which are not found elsewhere. India has 350 different mammals (rated eight highest in the world), 1,200 species of birds (eighth in the world), 453 species of reptiles (fifth in the world) and 45,000 plant species, of which most are angiosperms, (fifteenth in the world).
- It is estimated that 18% of Indian plants are endemic to the country and found nowhere else in the world.
- Gene-banks have collected over 34,000 cereals and 22,000 pulses grown in India. India has 27 indigenous breeds of cattle, 40 breeds of sheep, 22 breeds of goats and 8 breeds of buffaloes.

# HOTSPOTS OF BIODIVERSITY

- In order to qualify as a biodiversity hotspot, according to Conservation International, “a region must contain at least 1,500 species of vascular plants ( $>0.5\%$  of the world’s total) as endemics, and it has to have lost at least 70% of its original habitat.”
- Our globally accepted national ‘hot spots’ are in the forests of the North-East and the Western Ghats, which are included in the world’s most bio-rich areas. The Andaman and Nicobar Islands are extremely rich in species and many subspecies of different animals and birds have evolved.

# THREATS TO BIODIVERSITY: HABITAT LOSS, POACHING OF WILDLIFE, MAN-WILD- LIFE CONFLICTS

- Due to this ‘unsustainable’ resource-use, once productive forests and grasslands have been turned into deserts and wasteland have increased all over the world.
- Unfortunately at the present rate of extinction about 25% of the worlds’ species will undergo extinction fairly rapidly. This may occur at the rate of 10 to 20 thousand species per year, a thousand to ten thousand times faster than the expected natural rate! Human actions could well exterminate 25% of the world’s species within the next twenty or thirty years.
- Much of this mega extinction spasm is related to human population growth, industrialization and changes in land-use patterns.

- Repeated fires started by local grazers to increase grass growth ultimately reduces regeneration and lowers the diversity of plant species.
- Another factor that disrupts forest biodiversity is the introduction of exotic weeds which are not a part of the natural vegetation. Common examples in India are lantana bushes, Eupatorium shrubs and 'congress' grass.
- Poaching: Specific threats to certain animals are related to large economic benefits. Skin and bones from tigers, ivory from elephants, horns from rhinos and the perfume from the musk deer are extensively used abroad.

# ENDANGERED AND ENDEMIC SPECIES OF INDIA

- Endangered species can be defined as those species which are under risk or threat of being extinct. Endemic species are plant and animal species that are found in a particular geographical region and nowhere else in the world.
- Among the important endangered animals are charismatic species such as the tiger, the elephant, the rhino, etc. The less well-known major mammals restricted to a single area include the Indian wild ass, the Hangul or Kashmir stag, the Golden langur, the pygmy hog and a host of others. There are also endangered bird species such as the Siberian crane, the Great Indian Bustard, the Florican and several birds of prey.
- To protect endangered species India has created the Wildlife Protection Act.



# CONSERVATION OF BIODIVERSITY: IN- SITU AND EX-SITU

## IN-SITU CONSERVATION:

- Biodiversity at all its levels, genetic species and as intact ecosystems, can be best preserved in- situ by setting aside an adequate representation of wilderness as 'Protected Areas'. These should consist of a network of National Parks and Wildlife Sanctuaries with each distinctive ecosystem included in the network.
- Project Tiger was launched by the Government of India with the support of WWF-International in 1973 and was the first such initiative aimed at protecting this key species and all its habitats.
- A Crocodile Breeding and Conservation Program was initiated in 1975 to protect the remaining population of crocodilians in their natural habitat and by creating breeding centres.
- Project Elephant was launched in 1992 to ensure the long-term survival of a viable population of elephants in their natural habitats in north and north-eastern India and south India.

- There are 589 Protected Areas in India of which 89 are National Parks and 500 are Wild- life Sanctuaries. They include a variety of eco-systems and habitats.
- Protected Areas, to be effective, must be established in every biogeographic region. A relatively larger representation must be included of highly fragile ecosystems, areas of high species diversity or high endemism. Protected Areas must also be integrated with each other by establishing corridors between adjacent areas wherever possible so that wildlife can move between them.
- A major strategy to reduce impacts on the biodiversity of the PAs should be to provide a sustainable source of resources for local people living around them.

# EX- SITU CONSERVATION

- There are situations in which an endangered species is so close to extinction that unless alternate methods are instituted, the species may be rapidly driven to extinction. This strategy is known as ex-situ conservation, i.e. outside its natural habitat in a carefully controlled situation such as a botanical garden for plants or a zoological park for animals, where there is expertise to multiply the species under artificially managed conditions. These breeding programs for rare plants and animals are however more expensive than managing a Protected Area.
- There is also another form of preserving a plant by preserving its germ plasm in a gene bank so that it can be used if needed in future. This is even more expensive.
- Modern breeding programs are done in zoos that provide for all the animal's needs, including enclosures that simulate their wild habitats.