

Unit 2**Module 3****Biodiversity****Biodiversity**

Biodiversity describes the richness and variety of life on earth. It is the most complex and important feature of our planet. Without biodiversity, life would not sustain.

The term biodiversity was coined in 1985. It is important in natural as well as artificial ecosystems. It deals with nature's variety, the biosphere. It refers to variabilities among plants, animals and microorganism species.

Biodiversity includes the number of different organisms and their relative frequencies in an ecosystem. It also reflects the organisation of organisms at different levels.

Biodiversity holds ecological and economic significance. It provides us with nourishment, housing, fuel, clothing and several other resources. It also extracts monetary benefits through tourism. Therefore, it is very important to have a good knowledge of biodiversity for a sustainable livelihood.

Types of Biodiversity

- Genetic Biodiversity
- Species Biodiversity
- Ecological Biodiversity

Species diversity

Species diversity refers to the variety of different types of species found in a particular area. It is biodiversity at the most basic level. It includes all the species ranging from plants to different microorganisms.

No two individuals of the same species are exactly similar. For example, humans show a lot of diversity among themselves.

Genetic diversity

It refers to the variations among the genetic resources of the organisms. Every individual of a particular species differs from each other in their genetic constitution. That is why every human looks different from each other. Similarly, there are different varieties in the same species of rice, wheat, maize, barley, etc.

Ecological diversity

An ecosystem is a collection of living and nonliving organisms and their interaction with each other. Ecological biodiversity refers to the variations in the plant and animal species living together and connected by food chains and food webs.

It is the diversity observed among the different ecosystems in a region. Diversity in different ecosystems like deserts, rainforests, mangroves, etc., include ecological diversity.

Importance of Biodiversity

Biodiversity and its maintenance are very important for sustaining life on earth. A few of the reasons explaining the importance of biodiversity are:

Ecological Stability

Every species has a specific role in an ecosystem. They capture and store energy and also produce and decompose organic matter. The ecosystem supports the services without which humans cannot survive. A diverse ecosystem is more productive and can withstand environmental stress.

Economic Importance

- Biodiversity is a reservoir of resources for the manufacture of food, cosmetic products and pharmaceuticals.
- Crops, livestock, fishery, and forests are rich sources of food.
- Wild plants such as Cinchona and Foxglove plants are used for medicinal purposes.
- Wood, fibres, perfumes, lubricants, rubber, resins, poison and cork are all derived from different plant species.
- The national parks and sanctuaries are a source of tourism. They are a source of beauty and joy for many people.

Ethical Importance

All species have a right to exist. Humans should not cause their voluntary extinction. Biodiversity preserves different cultures and spiritual heritage. Therefore, it is very important to conserve biodiversity.

Loss of Biodiversity

Loss of biodiversity is the decrease in the number of a particular species in a certain habitat. Loss of biodiversity also leads to the extinction of the plant and animal species and this loss can be either reversible or permanent.

Human activities have been the major cause of the loss of biodiversity which has led to sudden changes in climate causing a big threat to biodiversity. There has also been an increased demand for natural resources along with the growing population leading to greater waste generation.

Causes of Loss of Biodiversity

Some of the major causes that have resulted in the loss of biodiversity are mentioned below:

- The natural habitat of the ecosystem plays a major role in maintaining the ecological balance. Several trees are cut down every year for the

construction of industries, highways, settlements, and so on to fulfil human demands. As a result, the species becomes the target of predation and eventually dies.

- Hunting of the wild animals for commercialization of their products has been a major reason for the loss of biodiversity. Since the year 2013, more than 90 rhinos were killed by the poachers for their horns and as per the records of 2016, 9 Indian Rhinos have been killed in Kaziranga National Park of Assam.
- The exploitation of the medicinal plants for several laboratory purposes has resulted in the extinction of these species. Also, several animals are sacrificed for various research in science and medicine.
- Natural calamities like floods, earthquakes, forest fires also lead to the loss of biodiversity.
- Air pollution has a major role in the loss of biodiversity. Rapid cutting down of the trees has resulted in the increase of carbon dioxide in the atmosphere leading to climate change. As a result, there has been an increase in the land and ocean temperature leaving an inimical impact on species

MEASUREMENT OF BIODIVERSITY

Measurement of biodiversity was done by Whittaker. Biodiversity can be measured by two major components:

1. Species Richness
2. Species Evenness

Species Richness:

It refers to the measure of a number of species found per unit area of a region or community. It has three components:

- Alpha diversity: It refers to the diversity of species found in a particular area or ecosystem, and is usually expressed by the number of species in that ecosystem.
- Beta diversity: It refers to the comparison of the diversity of species between two or more ecosystems, usually measured as the change in the number of species between the ecosystems.

- **Gamma diversity:** It is the measure of the overall diversity for the different ecosystems in a region. It is highly subjective because of different perceptions about the boundaries of the region.

Species Evenness:

It is the measure of relative abundance of individuals of different species in a given region. Low evenness in general, means that a few species dominate the region or ecosystem.

Biodiversity Hotspots

According to Conservation International, a region must fulfil the following two criteria to qualify as a hotspot:

1. The region should have at least 1500 species of vascular plants i.e., it should have a high degree of endemism.
2. It must contain 30% (or less) of its original habitat, i.e. it must be threatened.

Following the criteria must for an area to be declared as Biodiversity Hotspot, there are major four biodiversity hotspots in India:

- 1. The Himalayas**
- 2. Indo-Burma Region**
- 3. The Western Ghats**
- 4. Sundaland**

The Himalayas

Considered the highest in the world, the Himalayas (overall) comprises North-East India, Bhutan, Central and Eastern parts of Nepal. This region (NE Himalayas) holds a record of having 163 endangered species which includes the Wild Asian Water Buffalo, One-horned Rhino; and as many as 10,000 plant species, of which 3160 are endemic. This mountain range covers nearly 750,000 km².

Indo – Burma Region

The Indo-Burma Region is stretched over a distance of 2,373,000 km². In the last 12 years, 6 large mammal species have been discovered in this region: the Large-antlered Muntjac, the Annamite Muntjac, the Grey-shanked Douc, the Annamite Striped Rabbit, the Leaf Deer, and the Saola.

This hotspot is also known for the endemic freshwater turtle species, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss. There are also 1,300 different bird species, including the threatened White-eared Night-heron, the Grey-crowned Crocias, and the Orange-necked Partridge.

The Western Ghats

The Western Ghats are present along the western edge of peninsular India and covers most of the deciduous forests and rainforests. As per UNESCO, it is home to at least 325 globally threatened flora, fauna, bird, amphibian, reptile and fish species. Originally, the vegetation in this region was spread over 190,000 km² but has been now reduced to 43,000 km². The region is also known for the globally threatened flora and fauna represented by 229 plant species, 31 mammal species, 15 bird species, 43 amphibian species, 5 reptile species and 1 fish species. UNESCO mentions that “Of the total 325 globally threatened species in the Western Ghats, 129 are classified as Vulnerable, 145 as Endangered and 51 as Critically Endangered.”

Sundaland

The Sundaland hotspot lies in South-East Asia and covers Singapore, Thailand, Indonesia, Brunei, and Malaysia. In the year 2013, the Sundaland was declared as a World Biosphere Reserve by the United Nations. This region is famous for its rich terrestrial and marine ecosystem. Sundaland is one of the biologically richest hotspots in the world which comprises 25,000 species of vascular plants, of which 15,000 are found only in this region.

Biodiversity in India – Flora, and Fauna

India is famous for its rich flora and fauna. India houses over 500 species of mammals, more than 200 species of birds, and 30,000 different species of insects. The Zoological Survey of India which is headquartered in Kolkata is responsible for surveying the faunal resources of India.

India has a diverse climate, topology, and habitat are known to have the richest flora in the world with over 18000 species of flowering plants. These plant species constitute 6-7% of the world's plant species. There are 8 main floristic regions in India- the Western and the Eastern Himalayas, Indus and Ganges, Assam, the Deccan, Malabar, and the Andaman Islands which is home to 3000 Indian plant species. The forests in India cover ranges from the tropical rainforest including Andaman, Western Ghats, and northeast India to the coniferous forests of the Himalayas. The deciduous forests can be found in the eastern, central, and southern parts of India.

Endangered Species of India

According to the International Union for Conservation of Nature, "India accounts for 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals. But with the rapid loss of biodiversity, many species are becoming extinct or at risk of becoming critically endangered. The species that are at risk of extinction due to the sudden decrease in their population and habitat are known as endangered species.

Endangered Animal Species

- The Royal Bengal Tiger
- The Great Asiatic Lion
- The Snow Leopard
- Nilgiri Tahr
- Indian Rhino

IUCN Red List

Founded in 1964, the IUCN Red List also known as the Red Data List evaluates the biological species in the world which are at the risk of extinction. IUCN aims to focus on the conservation of the world's species to reduce species extinction. More than 77,300 species have been assessed on the IUCN Red List.

The IUCN Red List can be divided into the following 9 categories:

1. Extinct (EX) – No known individuals remaining.
2. Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalised population outside its historic range.
3. Critically endangered (CR) – Extremely high risk of extinction in the wild.
4. Endangered (EN) – High risk of extinction in the wild.
5. Vulnerable (VU) – High risk of endangerment in the wild.
6. Near threatened (NT) – Likely to become endangered shortly.
7. Least concern (LC) – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.
8. Data deficient (DD) – Not enough data to assess its risk of extinction.
9. Not evaluated (NE) – Has not yet been evaluated against the criteria

VALUES OF BIODIVERSITY

- Values related to biodiversity are three categories:-
 1. Productive use
 2. Consumptive use
 3. Indirect use
- Biological resources contribute to social and economic development through:-
 - i. Products consumed directly such as firewood, fodder and game meat.
 - ii. Products for commercial harvest such as Timber, Fish, and Medicinal Plants.
 - iii. Various ecosystems services and functions e.g. Watershed protection, Photosynthesis, Regulation of climate, Production of soils
 - iv. Intangible values of keeping options open for the future and simply knowing that certain species exist.

- Biodiversity, besides its ecological significance, provides a socio-economic and monetary asset to the nation.
- Biological resources provide us Nourishment, Clothing, Housing, Fuel, Medicine, Livelihood, and Knowledge for Planning.

In situ Conservation

In situ Conservation is one of the methods of the conservation of genetic resources in natural populations of plant or animal species. In other words, it is a set of conservation techniques involving the designation, management, and monitoring of biodiversity in the same area where it is encountered.

Wildlife Sanctuaries or wildlife refuges

- Wildlife Sanctuaries or wildlife refuges are home to various endangered species.
- They are safe from hunting, predation or competition.
- They are safeguarded from extinction in their natural habitat.
- Certain rights of people living inside the Sanctuary could be permitted.
- Grazing, firewood collection by tribals is allowed but strictly regulated.
- Settlements not allowed (few exceptions: tribal settlements do exist constant; efforts are made to relocate them).
- A Sanctuary can be promoted to a National Park.
- There are more than 500 wildlife sanctuaries in India.

National Park

- National parks are areas reserved for wildlife where they can freely use the habitats and natural resources.
- The difference between a Sanctuary and a National Park mainly lies in the vesting of rights of people living inside.
- Unlike a Sanctuary, where certain rights can be allowed, in a National Park, no rights are allowed.

- No grazing of any livestock shall also be permitted inside a National Park while in a Sanctuary, the Chief Wildlife Warden may regulate, control or prohibit it.

Eco-Sensitive Zones

- The National Wildlife Action Plan (2002–2016) of MoEFCC stipulated that state governments should declare land falling within 10 km of the boundaries of national parks and wildlife sanctuaries as eco-fragile zones or ESZs under the Environmental (Protection) Act, 1986.
- The purpose of the ESZ was to provide more protection to the parks by acting as a shock absorber or transition zone.
- Eco-Sensitive Zones would minimise forest depletion and man-animal conflict.
- The protected areas are based on the core and buffer model of management.
- The core area has the legal status of being a national park.
- The buffer area, however, does not have legal status of being a national park and could be a reserved forest, wildlife sanctuary or tiger reserve.

Ex-situ Conservation

Ex-situ conservation is the relocation of endangered or rare species from their natural habitats to protected areas equipped for their protection and preservation.

Botanical garden

- Botanical garden refers to the scientifically planned collection of living trees, shrubs, herbs, climbers and other plants from various parts of the globe.
- Purpose of botanical gardens
 - 1) To study the taxonomy as well as the growth of plants.
 - 2) To study the introduction and acclimatisation process of exotic plants.
 - 3) It augments conserving rare and threatened species.

Zoo

- Zoo is an establishment, whether stationary or mobile, where captive animals are kept for exhibition to the public and includes a circus and rescue centres but does not include an establishment of a licensed dealer in captive animals.
- The initial purpose of zoos was entertainment, over the decades, zoos have got transformed into centres for wildlife conservation and environmental education.
- Apart from saving individual animals, zoos have a role to play in species conservation too (through captive breeding).
- Zoos provide an opportunity to open up a whole new world, and this could be used in sensitising visitors regarding the value and need for conservation of wildlife.

Difference between In situ and Ex-situ Conservation

| In situ Conservation | Ex situ Conservation |
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| It means the conservation of biodiversity in their natural habitats itself. | It means the conservation of biological diversity outside their natural areas |
| Protected areas are the sanctuaries and national parks. | Artificial conditions are created to make their habitat almost like a natural habitat |
| It aims to enable biodiversity to maintain itself within the context of the ecosystem. | It involves the maintenance of genetic variation (Genetic Conservation) away from its original location. |
| Establish a protected area network, with appropriate management practices, corridors to link fragments | Established botanical and zoological gardens, conservation stands; banks |

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| restore degraded habitats within and outside. | of germplasm, pollen, seed, seedling, tissue culture, gene, and DNA, etc. |
| It involves the reduction of biotic pressure rehabilitation | It identifies and rehabilitates threatened species; launches augmentation, reintroduction, or introduction programs. |
| It helps in the multiplication of the species through the process of evolution and adaptation. | This method will enhance the probability of reproductive success for endangered species. |
| It provides greater mobility to the animal species because of the large habitat area. | It provides less mobility to the organism because of the small habitat area. |
| Example- National parks, biosphere reserves, parks, sanctuaries. | Example- Zoo, aquarium, seed banks, botanical gardens, etc. |

Forest Conservation

Forests are a unique gift of nature to man and constitute one of the prized assets of a nation. They are of both direct and indirect use, and hence are aptly termed as an 'index of prosperity of a nation'. Keeping in view the benefits which we derive from forests, it is of utmost importance that strong steps be taken to conserve forests

Forest conservation does not mean the denial of use, but rather the proper use without causing any adverse effect on our economy and environment. It is the practice of planning and maintaining forested areas for the benefit and sustainability of future generations

The following techniques could be used for forest conservation, which could eventually improve forested areas and make the available resources sustainable:

Afforestation

- It is the planting of trees for commercial purposes
- Instead of taking resources from existing natural forests, afforestation is a process used to plant trees and use them as resources instead of naturally existing forests.
- It also creates habitat for wildlife, recreational areas, and commercial use while not causing harm to natural forests
- Van Mahotsava was launched in 1950 to make people aware of the importance of planting trees

Selective logging

- It is a method used to meet the needs of both the forests and humans seeking economical resources
- Selective logging is the removal of trees within a stand based on size limitations
- This technique allows for forest regeneration to occur between and after the selective harvest cycles

Controlling forest fires

- Forest fires are the most common and deadly cause of loss of forests
- They can start due to natural causes or can be accidents caused by man
- Hence, Precautions must be taken for such incidents. Making fire lanes, spreading chemicals to control fire, clearing out dry leaves and trees etc.

Better farming practices

- Slash and burn farming, overgrazing by cattle, shifting agriculture are all farming practices that are harmful to the environment and particularly to forests. Hence, these practices must be kept under control.

Checking forest clearances for urbanisation

- In the era of rapid urbanisation and industrialization, clearing of forests either by encroachment or actual grant of permission is often done
- Hence, strict policies should be in place, so as to avert forest land from urban encroachment

Forest Policy and Law for conservation

Indian Forest Policy, 1952

1. This was a simple extension of colonial forest policy, which became conscious about the need to increase forest cover to one-third of total land area
2. The policy laid stress on
 - Weaning the primitive people by persuasion, from the harmful practice of shifting cultivation
 - Increasing efficiency of forest administration by having adequate forest laws
 - Providing facilities for forest research and for conducting research in forestry and forest products utilisation
 - Controlling grazing in forestry

Forest Conservation Act 1980

- This Act stipulated that the central permission is necessary to practice sustainable agro-forestry in forest areas. Violation or lack of permit was treated as a criminal offence
- It targeted to limit deforestation, conserve biodiversity and save wildlife
- This act provide hope of forest conservation, but wasn't successful

Forest policy of 1988

1. It made a very significant and categorical shift from commercial concerns to focus on the ecological role of the forests and participatory management.
2. It aims were

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- Maintenance of environmental stability through preservation and restoration of ecological balance
- Check on soil erosion and denudation in catchment areas
- Substantive increase in forest cover through massive afforestation and social forestry programmes
- Increase in productivity of forests to meet national needs

Wildlife protection act 1972

- It provides for the establishment of wildlife sanctuaries, national parks, etc.
- The National Board for Wildlife was constituted to offer advice to the central government on issues of wildlife conservation in India

National Green Tribunal Act, 2010

- This was for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto

Compensatory afforestation fund Act, 2016

- It seeks to provide an appropriate institutional mechanism, both at the Centre and in each State and Union Territory, to ensure expeditious utilisation in efficient and transparent manner of amounts released in lieu of forest land diverted for non-forest purpose which would mitigate impact of diversion of such forest land.

Other initiatives/measures can be taken to conserve forests

Support NGOs/movements

- The Chipko Movement is a living examples of how general public action on forests can help conserve them

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- NGOs like the TREE Foundation, the Nature Conservancy, the Sierra Club, Centre for Biological Diversity, and Rainforest Action Network offset deforestation and conserve threatened ecosystems around the world
- In the absence of effective and environmentally-friendly governance in many areas, NGOs provide important organisational and monetary support for a variety of conservation efforts

Buy forest-friendly (or certified) products

- There is a need to use one's purchasing power in a high-impact way to prevent deforestation
- Buying products that are certified sustainable could help in certain manner to conserve forests

Promoting value education on Forests

- Inculcating the principles to value forests through education and promoting forests like a tourist centre could help people realise the crucial role forests play, and eventually make them more responsible

Wildlife Conservation

Importance of wildlife conservation:

- **Important for their medicinal values:** More than one-third of our pharmaceutical needs are catered by wild plants. Forests provide great scope for breakthroughs in the field of medical science and technology along with the requirements for the large-scale manufacture of antibiotics and other medicines for therapeutic uses.
- **Helps keep our environment healthy:** They are responsible for maintaining temperatures globally, thereby fighting against the greenhouse effect and in turn preventing the sea levels to rise sharply.
- **Important to maintain ecological balance:** the interdependence of plants and animals is very essential

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- **Economical importance:** Fossil fuels obtained from forests help in the economic growth of the country, which in turn contributes towards a better standard of living.
- **Helps preserve biodiversity:** There are thousands of species that take shelter in these huge forests.
- Microorganisms in wildlife take part in nitrogen fixation, thus, bringing about an increase in the levels of soil fertility

Sustainable Development

Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Thus, it takes into account both the present and future generations without over-exploitation of natural resources and environmental degradation.

Features of Sustainable Development:

- **Sustained Rise in Real per Capita Income :** There should be a sustained rise in real per capita income and economic welfare on a long-term basis.
- **Rational Use of Natural Resources :** Sustainable development simply means that natural resources should be rationally used in a manner such that they are not overexploited.
- **Preserving the natural resources for future generations :** Sustainable development aims at making use of natural resources and environment for raising the existing standard of living in such a way as not to reduce the ability of the future generations to meet their own needs.

Sustainable Development Goals

- The documentary screened at the Rio+20 conference – “Future We Want” presented the idea of a post 2015 development agenda.
- Sustainable development Goals (SDGs) is an intergovernmental agreement formulated to act as post 2015 Development agenda, its predecessor being Millennium Development Goals.

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- It is a group of 17 goals with 169 targets and 304 indicators, as proposed by the United Nation General Assembly's Open Working Group on Sustainable Development Goals to be achieved by 2030.
- Post negotiations, an agenda titled "Transforming Our World: the 2030 agenda for Sustainable Development" was adopted at the United Nations Sustainable Development Summit.
- SDGs is the outcome of the Rio+20 conference (2012) held in Rio De Janeiro and is a non-binding document.

17 Sustainable Development Goals

- SDG 1: No Poverty
- SDG 2: Zero Hunger
- SDG 3: Good Health and Well-being
- SDG 4: Quality Education
- SDG 5: Gender Equality
- SDG 6: Clean Water and Sanitation
- SDG 7: Affordable and clean energy
- SDG 8: Decent Work and Economic Growth
- SDG 9: Industry, innovation and infrastructure
- SDG 10: Reduced inequalities
- SDG 11: Sustainable cities and communities
- SDG 12: Responsible production and Consumption
- SDG 13: Climate actions
- SDG 14: Conserve life below water
- SDG 15: Protect the life on land
- SDG 16: Peace, justice and strong institutions
- SDG 17: Partnerships for the goals