Biodiversity

Introduction

The term **Biodiversity** refers to the variety of life forms, from genes to species to broader scale of ecosystems. In other words, it means variety and variability among living organisms, their genetic differences and the ecosystems in which they live. This living wealth of earth is the outcome of millions of years of evolutionary history. The term biodiversity was coined by **Walter G. Rosen** in 1986, though its longer form "*Biological Diversity*" was used earlier in 1980 by ***Thomas E. Lovejoy***, a US conservation biologist. However, the credit for popularity of this word goes to **E.O. Wilson** who is often called as the **Father of Biodiversity.**

Biodiversity has been viewed in many ways depending upon the perspectives of people from different spheres. In many instances, it has also been referred to "life" or "wilderness". The distribution of biodiversity is uneven on the earth because of the different environmental conditions. Warm humid tropical areas (lying between tropic of Cancer and Capricorn) are rich in biodiversity compared to temperate and polar areas. The countries like Brazil, Columbia, Mexico, Indonesia, Peru, Malaysia, Ecuador, India, Zaire, Madagascar and Australia are known as **Megadiversity countries** because of their rich biodiversity.

Levels of Diversity

Biodiversity is often considered at three fundamental levels - genetic, species and ecosystem level.

1. ***Genetic diversity***: It refers to genetic differences within each species i.e. differences at the level of genes. For example, varieties of crops, strains of microbes or breeds of livestock. According to an estimate there are 10 billion different genes distributed across the world's living organisms. More genetic diversity within a species means greater variability and adaptability of individuals to environmental conditions. Lesser genetic diversity on the other hand leads to uniformity and thus greater susceptibility to environmental changes. Monocultures (genetically similar crops or trees) are known to be more susceptible to environmental changes compared to mix-cultures (genetically different crops or trees) because of little genetic diversity in them. The genetic variations can be measured using a variety of DNA-based and other techniques.

2. ***Species diversity*****:** It refers to the variety of species of animals, plants or microorganisms found on the earth. Biodiversity term is mostly considered as a synonym to species diversity. It is very important level of biodiversity since it is easier to work with it and the species can be seen with the naked eyes unlike genetic diversity that can be worked out only in the laboratories. There is a wide difference in the various estimates for the total number of species found on this earth (this varies from 5 to 100 million). However, so far nearly 1.7 million species have actually been described. Species diversity can be measured in a number of ways. Most of these ways can be classified into three groups of measurements - species richness, species abundance and taxonomic diversity.

3. Ecosystem diversity: It includes various types of ecosystems and the diversity of habitats and ecological processes occurring therein. Examples of various ecosystems are coral reefs, tropical rain forests or temperate rain forests and these are based on the major communities. The measurement of biodiversity within an ecosystem is a difficult task because of their complex nature.

Value of Biodiversity

During the recent times major focus is to assign the value to biodiversity. However, there exists conflict whether to assess it in terms of monetary value or ecological services. In fact, a new discipline that deals with the economical, ecological, environmental and other human services of biological resources has recently come up. It is known as ***Resource or Ecological Economics***. Among the various approaches for assigning values to biodiversity, the most widely used is the one based on the harvested products – whether direct or indirect. Accordingly, these have been called as ***Direct or Use and Indirect or Non-Use values of Biodiversity.*** Direct use values are given to the directly harvested products such as seeds, fruits, etc. In contrast, the indirect use values are given to various ecological and environmental benefits provided by the biodiversity. These include:

Bequest (resource storing for future generations), ***Option*** (as option / security for the future), ***Existence*** (as a source of inspiration to poets, writers etc.) and ***Amenity*** (recreational as zoo) value.

Importance of Biodiversity

Biodiversity is very important as it provides a number of valuable services to us. These are:

Ecological Services

Biodiversity provides us various ecosystem services that sustain our life. Some of these services are as under:

Conservation and Protection of Water: In the water catchments and riparian areas vegetation act as a buffer and helps in maintaining movement and storage of water within biosphere (atmosphere, lithosphere and hydrosphere), and regulates runoff (water that moves on the land especially along a slope, instead of entering into soil).

Protection and Conservation of Soil: Plants protect soil cover by binding the soil particles and also help in its formation. Litter (dead and decaying leaves and other parts of the plants) adds organic matter to soil and hence enhances its fertility.

Climate Moderation: Vegetation stabilizes the climates in the local areas and has a cooling effect on the environment.

Maintenance of Ecosystem Integrity: Biodiversity protects ecosystem integrity by regulating oxygen and carbon dioxide balance, nutrient and mineral cycling.

Biodiversity as a Source of Food

Biodiversity is a direct source of food (cereals, vegetables, fruits, etc.) and contributes substantially to the economy of the country. Though a number of plant species (nearly 5000) can be utilized as a source of food yet only a few of them are nutritionally important and thus managed on commercial scale. Crops like wheat, rice and maize are widely used as staple food. Human existence is greatly dependent upon plants as source of food. Likewise, some animal species are also used as food source

Medicinal Value

People have since long used biological resources as source of medicine. Plants and microbes are the source of a number of drugs used to treat not only common ailments but also some of the serious diseases like cancer. In India, a number of herbs are used in traditional medicine. For example, basil (Tulsi) known as sacred herb is widely used to treat cold and fever, congestion and joint pain in India.

Wood and Non-timber Products

Wood, a primary source of fuel and fibre, is a basic commodity used worldwide. It is harvested from a number of trees like teak, shisham, eucalypts (safeda), deodar, sal, etc. Besides, a number of non-wood products like turpentine oil, dyes, tannins, etc. are also obtained from the forest trees.

Social Benefits

In addition, biodiversity provides a number of social benefits such as: *use in research and education, for recreational and aesthetic purposes, and it is also an important component of our traditional culture as some trees and animals are worshipped.*

Biodiversity Loss

The precious wealth of biodiversity is at risk as a number of species of animal, plants or microbes are shrinking and becoming rare and threatened with extinction (complete loss of species from natural habitats). The extinction rate has substantially increased over the past few decades (currently 1,000 and 10,000 times greater than the natural one) as a result a number of valuable species are at risk of extinction. Looking at the grave situation of world biodiversity, IUCN (**International Union for Conservation of Nature and Natural Resources**) now known as **The World Conservation Union** prepared a list of species (plants or animals) showing various categories of extinction risk in 1988. These documents are known as **Red Data Books** or **Red Data Lists**. In these documents, IUCN has assessed status of world taxa threatened with extinction with a view to promote their conservation. The red data books on animals and plants threatened with extinction were first published in 1988. Since then, a number of species have been evaluated with this motive and given ranks as per their categories and criteria. It has prepared a publication entitled "***2004 IUCN Red List of Threatened Species*****"** that has complete information on threatened and endangered species of the world with risk of extinction. The species have been divided into various categories based on their taxonomy, distribution and conservation status. These categories are:

Extinct (EX)*:* A species is said to be extinct when none of its individual exists either in wild or in cultivation or captivity.

Extinct in Wild (EW)*:* A species is assigned this category when it is known to survive only in cultivation, or in captivity or as a naturalized population well outside its natural range. None of its individual exists under natural condition.

Critically Endangered (CR)*:* When there is 80% reduction in the population of a given species over the last 10 years or three generations, whichever is longer, it is said to be critically endangered.

Endangered (EN): A species is said to be endangered when there is a reduction of about 70% in its population over the last 10 years or three generation, whichever is longer.

Vulnerable (VU): A species is known to be vulnerable when a reduction of 50% of its population is noticed over the last 10 years or the three generations, whichever is longer. Besides, there are a few more categories identified by IUCN. These are:

Near Threatened **(NT):** Species that are neither CR, EN or VU but the reduction in its population is quite high and close to the above categories, it is said to be *near threatened*.

Least Concern **(LC)*:*** A species that is widespread and abundant (not categorized in either of the above categories)

Data Deficient **(DD):** Species for which available information is not complete but it is not under extinction risk.

Not evaluated **(NE):** Not yet evaluated species are placed in this category.

Causes of Biodiversity Loss

Rapid biodiversity loss world wide could be attributed to the following reasons:

Habitat loss, Deterioration and Fragmentation

A number of species have lost their habitat (place where a species lives) because of increased human interference like construction of dams, roads, railway tracts or bridges across natural ecosystems, mining activity or industries. Habitat fragmentation due to deforestation or any other biotic stress has caused much harm to precious biodiversity.

Deforestation rate is increasing due to burgeoning population and this has destroyed the natural homes of species. In fresh water ecosystems, construction of dams has destroyed large habitat of hundreds of aquatic flora and fauna. Likewise, in marine ecosystems, the coastal development has affected the communities, particularly species rich ecosystems like coral reefs.

Exotic Species

Exotic species are those which have been introduced either purposely or entered accidentally in some environmentally distinct zone from the other geographically different areas. These have caused much harm to native plant communities than expected and enhanced the extinction (loss of species) rate. The phenomenon is more common on the islands or isolated ecosystems. A number of example exist world over when an introduced species has become a serious pest or problem. For example, *Lantana camara* introduced as an ornamental hedge in India has now become a serious invader of forests. The example of accidental entry is the Congress grass (*Parthenium hysterophorus*) that is now a major problematic weed in India, Australia and other parts of the world. A number of reasons such as fast growth, rapid colonization, better and efficient resource utilization, wider adaptability and the absence of natural enemies in the invaded areas.

Overexploitation

Some of the species have become threatened and even gone extinct due to their over exploitation by the humans for their food, feed or some other beneficial purpose. In fact, a number of ecosystems have got damaged both in terms of number and variety of species that these are beyond repair in the near future.

Environmental Pollution

Air, water, and soil pollution is one of the major reasons for biodiversity loss in the modern era. Modernization, urbanization, increasing population, and changing life style are some of the prime reasons for the increased levels of pollution in the natural environment. It has not only affected the number of existing species but has also caused the loss of a variety of species that could not tolerate the increased pollutant levels in the atmosphere and have gone extinct. Excessive use of synthetic chemicals as herbicides, pesticides and insecticides has polluted the soil and water environment and greatly threatens the diversity and richness of the species. Due to increased industrialization, the intensity of the acid rain has increased and greatly affected the natural vegetation and the forests in different regions of the world.

Global Warming

Climate change due to global warming is another reason for the depletion of natural biodiversity in the recent times. The increase in the earth's temperature has already shown its impact in terms of depletion of forest resources in many parts of world. For example, temperate or the Taiga forests are reducing in size whereas tropical / sub-tropical forests are slightly increasing. Additionally, the

temperature rise also alters the tolerance limit of the species and greatly changes the structure and ecosystem function. The increased global temperature would result in melting of ice caps and rising of sea levels. It would result in submerging of many islands and inundation of coastal areas thereby greatly affecting the biodiversity of such regions.

Commercialization of Agriculture and Forestry

During the last century there has been a great change in the agricultural practices and the forest operation. Of late, agriculture has shifted from low-input traditional systems involving crop rotations into highly commercialized monocultural practices that utilize high yielding varieties, monocultural operations and use of harmful synthetic chemicals and fertilizers. It has resulted in the depletion of the biodiversity base not only of the plant species in such intensive ecosystems but also affected the animals and other species dependent upon them. Likewise, to meet the increased demand of the timber natural forest has been cut. In order to maintain the forest cover, a number of fast growing tree species have been promoted but in monocultural or pure strands. It has resulted in formation of large areas of plantations / forests that have only one type of species and resulted in loss of other useful species that naturally occurred in the natural forests or exist in the mix-culture type of forests.

How to Check the Loss of Biodiversity?

Biodiversity is vital for our existence. Its depletion at a faster rate is a cause of concern for everyone. It is thus very important to conserve it and in this direction steps have been taken at the local, regional, national and even at the international levels. The conservation of biodiversity can be *in-situ* (in which species are conserved within their natural range) or can be *ex-situ* (where the conservation is done outside the natural range of species).

***Ex-situ* Conservation**

Ex-situ conservation means "off-site" conservation. In this practice the species of plants and animals to be protected are removed from the natural habitats and are placed in the safer areas under the control of man. Botanical gardens, zoos and the arboreta are the traditional methods of ex-situ conservation. Here species of plants and animals are conserved by providing the congenial conditions. ***Germplasm banks or Seed banks*** (also ***Gene banks***) are some other methods of ex-situ conservation. Storing the germplasm in the seed banks helps in conserving rare and endangered species in order to restore genetic diversity. Seeds have a natural tendency to undergo dormancy and hence can be preserved for a longer time. **Orthodox seeds** that can be dried at low humidity or temperature can be stored for a longer time whereas **Recalcitrant seeds** that can not be dried at low humidity and temperature are however, difficult to be stored for a longer time. The plants whose seeds can not be conserved in seed banks their vegetative propagating parts such as corms, cuttings, bulbs, tubers and plants or propagules raised through *in vitro* conditions are stored in the gene banks using cryogenic conditions. Likewise, the important animal germplasm like eggs, sperms or embryos can be preserved in the gene banks. Several international organizations like CGIAR (Consultative Group on International Agricultural Research), IBPGR (International Board for Plant Genetic Resource) IPGRI (International Plant Genetic Resources Institute), and CIFOR (Center for International Forestry Research) are linked with the *ex-situ* conservation through establishment of gene banks and gene libraries.

***In-situ* Conservation**

I*n-situ* conservation means "on-site" conservation i.e. protection of species within the natural habitat of the species of animals and plants. It includes protection in the wildlife sanctuaries, national parks and biosphere reserves etc. that have been formed to protect threatened and even rare species. These methods help to conserve biodiversity without affecting their natural environment. All activities like hunting and poaching are prohibited in the protected areas.

In India we have 608 protected areas. These include:

- National Parks: 95
- Biosphere Reserves: 13
- Wildlife Sanctuaries: 500

Biosphere Reserves

These are the areas of terrestrial and coastal ecosystems that conserve biodiversity in a sustainable way. These are also known as living laboratories for demonstrating integrated management of land, water and biodiversity. The objectives of the biosphere reserves are to conserve biodiversity, to facilitate human and economic development and to provide logistic support to the people to undertake research and education activities and information exchange at international level. These are recognized internationally but are nominated by national Government and remain under sovereign jurisdiction of the country where they are located. The Biosphere Reserves are organized into three inter-related zones namely Core zone, Buffer zone and Transition zone. It is the core area which requires legal protection while some constructive activity may occur in buffer and transition zone.

The origin of concept of Biosphere Reserve goes back to Biosphere Conference - the first inter-governmental conference organized by UNESCO in 1968. The aim of this was to establish terrestrial and coastal ecosystem on earth in which all genetic resources would be protected. Later in 1970, Man and Biosphere (MAB) was officially launched by UNESCO and one of the MAB's projects was to establish world net-work of new protected areas which were designated as Biosphere Reserves. At present, there are now 499 Biosphere reserves recognized in 110 countries world over.

In India, there are four internationally recognized Biosphere Reserves: ***Nilgiri,*** recognized in 2000, ***Gulf of Mannar*** in 2001, ***Sunderbans*** in 2001 and ***Nanda Devi*** in 2004 by MAB (Man and Biosphere Programme of UNESCO). Besides, Sunderbans is also a National Park and a World Heritage Site. In addition, Ministry of Environment and Forests (MoEF), Government of India has also identified 13 biosphere reserves (Nilgiri, Nanda Devi, Nokrek, Great Nicobar Islands, Gulf of Mannar, Manas, Sunderbans, Simlipal, Dibru-Saikhowa, Dehang-Debang, Panchmarhi, Khangchendzonga and Agasthyamalai) at the national level including the four biosphere reserves recognized by MAB.

Biodiversity Hotspot Zones

In order to identify the areas having rich biodiversity and endemic species (those found only in a particular area and not anywhere else), British ecologist Norman Myers gave the concept of '**biodiversity hotspots**' in 1988 and identified 10 such regions in the tropical forests. Later, the concept of hotspots was adopted by Conservation International (CI) and at present this concept has been extended to **34 such areas present world wide**. For an area to be qualified as Hotspot region, it should have at least 1500 species of endemic vascular plants and should have lost about 70% of its

original habitat. In India, three hotspot regions have been recognized. These are: **the Himalayas, Western Ghats (extending up to Sri Lanka) and Indo-Burma region**.

The Himalayan Hotspot has over 10,000 plant species of which 31.6 5 are endemic. These include pines, firs, spruces, rhododendrons and variety of orchids, mosses and ferns. Besides, a number of birds and mammals including vultures, tigers, elephants, rhinos and wild water buffaloes exist in the Himalayas.

Western Ghats and Sri Lanka is one of the richest biodiversity areas with a high rate (52%) of endemism of plants species. A number of unique and rare plants and ferns are present in this hotspot. However, the forests in this region are under tremendous logging pressure. Besides, the region is also home to some of the rare animals like endangered Asian elephant. Unfortunately, there has been excessive human interference in this region resulting in great loss of habitat and biodiversity.

Indo-Burma hotspot region extends from North-east India to Burma and has a rich treasure of biological resources. The region has a remarkable diversity of fresh water turtles and bird species (over 1300 species). A number of dipterocarps, orchids and ginger species are present in this region. However, due to various political and social reasons, the knowledge about the plant diversity of this region is incomplete.

Biodiversity Act of India (2002)

In order to protect precious biodiversity of the country, the Government of India approved biodiversity bill (which seeks to deal with the problem of biodiversity loss and biopiracy by giving tough punishment to the offenders) in December 2002 which became an ACT known as **Biological Diversity Act of 2002**. Later, **Biological Diversity Rules, 2004** were formulated as a step towards conservation of biodiversity. According to this act any one who destroys biodiversity in any way or takes it away for commercial utilization or any other purpose without approval of authorities is liable to be imprisoned for up-to five years or to pay a fine of Rs.10 lakhs. The offences under this act are cognizable and nonbailable. For implementing the provision of the act, National Biodiversity Authority, State Biodiversity Boards and Biodiversity Management Committees at the local level are constituted. The act also lays down procedures for the use of nation's biodiversity by the people. For this one is required to get prior clearance from the National Biodiversity Authority.