UNIT 2 Natural Resources and Biodiversity

Structure

2.0 Objectives

After reading this Unit you will be able to:

- Understand about Natural Resources and its types,
- Understand about renewable and non-renewable natural resources,
- Understand about the problems associated with natural resources and its conservation,
- Develop an understanding about biodiversity, its levels, values and threats,
- Develop an understanding about the conservation of biodiversity.

2.1 Introduction

This unit gives introduction about the natural resources and its types. Through this unit we will come to know about the importance and conservation methods of all natural resources (forest resources, water resources, land resources, food resources and mineral resources). In addition to it we will come to know about impact of over exploitation of natural resources on environmental. The concept of biodiversity will be better understood through this unit. The term biodiversity gained acceptance and popularization by the world media during the Earth Summit in Rio de Janeiro in the year 1992. After reading this unit we will come to know about various biodiversity levels, values, threats, conservation and some terms used in biodiversity. All this knowledge will enable us to find out new ways to conserve natural resources and biodiversity.

2.2 Natural Resources and its Classification

Natural resources occur naturally within environments that exist relatively undisturbed by mankind, in a natural form. Any component of the natural environment that can be utilized by human beings for their benefit are termed as natural resource. The natural resource can be a substance, an energy unit or a natural process or phenomena e.g. water, air, soil, minerals, coal, forests, crops, and wildlife are all examples of natural resources. Some of them are essential for our survival while most are used for satisfying our wants.

There are various methods of categorizing natural resources, these include source of origin, stage of development, and by their renewability, these classifications are described below-

1. On the basis of origin

- Biotic natural resources – Biotic natural resources are obtained from living and organic material, such as forests and animals, and the materials that can be obtained from them. Fossil fuels such as coal and petroleum are also included in this category because they are formed from decayed organic matter.
- Abiotic natural resources – Abiotic natural resources are obtained from non-living, non-organic material. Examples of abiotic resources include land, fresh water, air and metals such as gold, iron, copper, silver, etc.

2. On the basis of development

- Potential resources: these are resources that exist in a region and may be used in the future. For example, if a country has petroleum in sedimentary rocks, it is a potential resource until it is actually drilled out of the rock and put to use.
- Actual resources: these are resources that have been surveyed, their quantity and quality has been determined, and they are currently being used. The development of actual resources is dependent on technology.
- Reserve resources: this is the part of an actual resource that can be developed profitably in the future.
- Stock resources: these are resources that have been surveyed, but cannot be used due to lack of technology. An example of a stock resource is hydrogen.

3. On the basis of renewability

Renewability is a very popular topic and many natural resources can be categorized as either renewable or non-renewable:

- Renewable resources are ones that can be replenished naturally in a short span of time. Some of these resources, like sunlight, air, wind, etc., are continuously available and their quantity is not noticeably affected by human consumption. Though many renewable resources do not have such a rapid recovery rate, these resources are susceptible to depletion by over-use. By the human use perspective, resources are renewable when their rate of replenishment/ recovery exceeds the rate of consumption.
- Non-renewable resources are resources that form extremely slowly. Minerals are the most common resource included in this category. By the human perspective, resources are non-renewable when their rate of consumption exceeds the rate of replenishment/recovery; a good example of this are fossil fuels, which are in this category because their rate of formation is extremely slow (potentially millions of years). Some resources actually naturally deplete in amount without human interference, the most notable of these being radio-active elements such as uranium, which naturally decay into heavy metals. Of these, the metallic minerals can be re-used by recycling them, but coal and petroleum cannot be recycled.

2.3 Types of Natural Resources

Natural Resources are the basis of life on earth. Natural resources are all connected in a way. Therefore if one is taken away, it will affect the supply or quality of all others. Natural resources are of following six types:

1. Energy resources
2. Forest resources
3. Water resources
4. Land resources
5. Mineral resources
6. Food resources

2.3.1 Energy Resources

Sources from where energy can be obtained to provide heat, light, and power are called energy resources. Sources of energy have evolved from human and animal power to fossil fuels, uranium, water power, wind, and the sun. The principal fossil fuels are coal, lignite, peat, petroleum, and natural gas. The demand for energy has increased with the economic development of the world. Energy consumption is an index of advancement of a country.

Energy resources can be classified as renewable/ non-renewable, conventional/ non-conventional, traditional/ alternative.

i. Renewable/ Non-renewable energy resources

- Renewable Energy- energy sources which are in-exhaustive and can be regenerated within a given span of time such as sunlight, wind, rain, tides, and geothermal heat. Renewable energy is an alternative to fossil fuels and therefore commonly called alternative energy.

- Non-renewable Energy- Energy sources which are exhaustible and cannot be regenerated within a given span of time such as fossil fuel like coal, petroleum, minerals etc.

ii. Conventional/ Non-conventional

- Conventional Sources of Energy

(i) The sources of energy which have been in use for a long time, e.g., coal, petroleum, natural gas and water power.
(ii) They are exhaust able except water.
(iii) They cause pollution when used, as they emit smoke and ash.
(iv) They are very expensive to be maintained, stored and transmitted as they are carried over long distance through transmission grid and lines.

- Non-Conventional Sources of Energy

(i) The resources which are yet in the process of development over the past few years. It includes solar, wind, tidal, biogas, and biomass, geothermal.
(ii) They are inexhaustible.
(iii) They are generally pollution free.
(iv) Less expensive due to local use and easy to maintain.

iii. Traditional/ Alternative

- Traditional Sources of Energy is the sources that people have been using for many years. These include coal, petroleum.
- Alternative Sources of Energy are energy sources that are an alternative to fossil fuel. Examples include: wind, solar, biomass, wave and tidal energy.

Renewable energy sources include solar energy, wind energy, hydropower energy, and geothermal energy.

1. Solar Energy- is the sun's rays (solar radiation) that reach the earth. Solar energy can be converted into other forms of energy, such as heat and electricity. It can be used in following ways:

i. Photovoltaic (PV) Energy- is the conversion of sunlight into electricity. A solar cell or PV is the technology used to convert solar energy directly into electrical power. A photovoltaic (PV) cell is a non-mechanical device usually made from silicon alloy. Sunlight is composed of photons, i.e. particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity.

The photovoltaic cell is the building block of a photovoltaic system. One PV cell produces 1 to 3 watts only, which isn't enough power for most applications. To increase power output, cells are electrically connected into a packaged weather-tight module. Modules can be further connected to form an array. The number of modules connected together in an array depends on the amount of power output needed. The performance of a photovoltaic array is dependent upon sunlight. Photovoltaic modules are only about 20% efficient in converting sunlight.

Advantages of photovoltaic system

i. Conversion from sunlight to electricity is direct, so that bulky mechanical generator systems are unnecessary.
ii. PV arrays can be installed quickly and in any size required or allowed.
iii. The environmental impact is minimal, requiring no water for system cooling and generating no by-products.

ii.Solar Thermal Power Plants- uses the sun rays to heat a fluid, from which heat transfer system may be used to produce steam. The steam in turn converted into mechanical energy in a turbine and then into electricity from a generator coupled to the turbine. It works the same as thermal power plant except in place of combustion of coal, steam from the fluid which is heated through sunlight is used.

iii. Solar Thermal Heat- is often used for heating swimming pools, heating water used in homes, and space heating of buildings.

Advantages of solar Energy:

i. It is free of cost.
ii. Its supplies are unlimited.
iii. It does not produce air or water pollution.

Disadvantages of Solar Energy:

i. It has indirect impacts on the environment.
ii. Large solar thermal farms can harm the desert ecosystems if not managed properly.
iii. The amount of sunlight that arrives at the earth's surface is not constant. It depends on the location, time of day, time of year and weather conditions.
iv. Since sun doesn't deliver much energy to a specific place at a specific time, a large surface area is required to collect the energy at a useful rate.

2. **Wind Energy-** is the energy produced through wind. Wind is air in motion. It is caused by the uneven heating of the earth's surface by the sun. Wind energy is mainly used to generate electricity. Wind is a renewable source of energy.

Wind energy is harnessed through wind mill. A windmill is a machine that collects the wind kinetic energy and converts the energy into rotational energy by means of vanes called sails. Originally, windmills were developed for milling grain for food production. An important use of it is to pump water, either for land drainage or to extract groundwater.

The operation speed of wind to produce power is 4-5 m/s, maximum power can be obtained when speed of wind is 15 m/s whereas at a speed of 25 m/s the wind farm has to shut down to reduce damage to wind mills.

A wind farm is a group of wind turbines in the same location used to produce electric power. Large wind farms consist of hundreds of individual wind turbines which are connected to the electric power transmission network. A large wind farm may consist of several hundred individual wind turbines, and cover an extended area of hundreds of square miles, but the land between the turbines may be used for agricultural or other purposes. A wind farm may also be located offshore.

Advantages of Wind Energy are:

i. Wind Energy is an inexhaustible source of energy and is virtually a limitless resource.
ii. Energy is generated without polluting environment.
iii. This source of energy has tremendous potential to generate energy on large scale.
iv. Like solar energy and hydropower, wind power taps a natural physical resource.
v. A windmill generator doesn't emit any emissions that can lead to acid rain or greenhouse effect.
vi. Wind Energy can be used directly as mechanical energy.
vii. In remote areas, wind turbines can be used as great resource to generate energy.
viii. In combination with Solar Energy they can be used to provide reliable as well as steady supply of electricity.
ix. Land around wind turbines can be used for other uses, e.g. Farming.

Disadvantages of Wind Energy

i. Wind energy requires expensive storage during peak production time.
ii. It is unreliable energy source as winds are uncertain and unpredictable.
iii. There is visual and aesthetic impact on region.
iv. Requires large open areas for setting up wind farms.
v. Noise pollution problem is usually associated with wind mills.
vi. Wind energy can be harnessed only in those areas where wind is strong enough and weather is windy for most parts of the year.
vii. Usually places, where wind power set-up is situated, are away from the places where demand of electricity is there. Transmission from such places increases cost of electricity.
viii. The average efficiency of wind turbine is very less as compared to fossil fuel power plants. We might require many wind turbines to produce similar impact.
ix. It can be a threat to wildlife. Birds do get killed or injured when they fly into turbines.
x. Maintenance cost of wind turbines is high as they have mechanical parts which undergo wear and tear over the time.

3. **Hydropower Energy-** Flowing water creates energy that can be captured and turned into electricity. This is called hydroelectric power or hydropower.

   The most common type of hydroelectric power plant uses a dam on a river to store water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which in turn activates a generator to produce electricity.

   Advantages of Dams

   i. Dams generate electricity.
   ii. It helps in irrigation.
   iii. Fuel is not burned so there is minimal pollution.
   iv. Water to run the power plant is provided free by nature.
   v. Hydropower plays a major role in reducing greenhouse gas emissions
   vi. Relatively low operations and maintenance costs
   vii. The technology is reliable and proven over time
   viii. It's renewable - rainfall renews the water in the reservoir, so the fuel is almost always there.
   ix. It generates employment.
   x. It helps in production of inland fisheries.
   xi. It is used for recreation purposes.

   Disadvantages of Dams

   i. High investment costs
   ii. Hydrology dependent (precipitation)
   iii. Inundation of land and wildlife habitat
   iv. Loss or modification of fish habitat
   v. Fish entrainment or passage restriction
   vi. Changes in reservoir and stream water quality
   vii. Displacement of local populations
   viii. Big dams increase the risk of earthquake because the huge amount of standing water puts enormous pressure on land.

But hydroelectric power doesn't necessarily require a large dam. Some hydroelectric power plants just use a small canal to channel the river water through a turbine. Hydropower is the most important and widely-used renewable source of energy.

Large dams produces 30 MW and more of hydro power energy, small hydel projects produces 100 KW- 30 MW, Micro hydel projects produces 5-100 KW of energy and Pico hydel projects produces below 5KW of energy.

4. **Geothermal Energy-** The word geothermal comes from the Greek words geo (earth) and therme (heat). Geothermal energy is heat from within the earth. The steam and hot water produced inside the earth can be used to heat buildings or generate electricity. Geothermal energy is a renewable energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth.

   Temperature hotter than the sun's surface are continuously produced inside the earth by the slow decay of radioactive particles. Most geothermal reservoirs are deep underground with no visible clues showing above ground. Geothermal energy can be on the surface in the form of volcanoes, hot springs, geysers. Naturally occurring large areas of hydrothermal resources (resources where ground water is trapped in porous rock is heated up by magma) are called geothermal reservoirs.

   Use of Geothermal Energy

   - Direct use- hot springs are used for bathing, cooking and heating.
   - Geothermal Power Plants- use hydrothermal resources which have two common ingredients water and heat. They require high temperature (300-700 degree Fahrenheit) These resources can be used by drilling wells into the earth and piping the steam or hot water to the surface. The schematic in **Figure 2.1** shows the production of geothermal power.

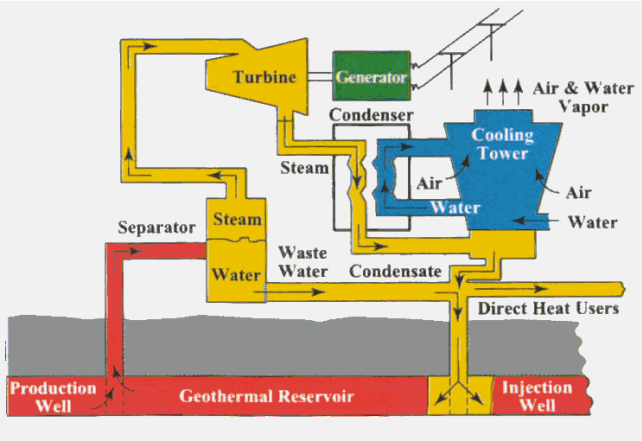


Figure 2.1 Production of Geothermal Energy

Advantages

i. It can be extracted without burning a fossil fuel such as coal, gas, or oil.
ii. Geothermal fields produce only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces. Binary plants release essentially no emissions.
iii. Unlike solar and wind energy, geothermal energy is always available, 365 days a year. It's also relatively inexpensive; savings from direct use can be as much as 80 percent over fossil fuels.

Disadvantages

i. Disposal of some geothermal fluids, which may contain low levels of toxic materials.
ii. Although geothermal sites are capable of providing heat for many decades, eventually specific locations may cool down.
iii. Sometimes hydrogen sulfide gas is released, a gas that smells like rotten egg at low concentrations.

2.3.2 Forest resources- forest are one of the most important natural resources on this earth. Forest is derived from latin word ‘foris’ meaning ‘out of door’.
India is one of the 12 mega biodiverse regions of the world. Forests cover is around 31% of the world's land surface, just over 4 billion hectares. Total forest cover of India is around 21% of the total area of the country.
These forests not only produce innumerable material goods, but also provide several environmental services which are essential for life. Forests are central to all human life because they provide a diverse range of resources: they store carbon, aid in regulating the planetary climate, purify water and mitigate natural hazards such as floods. They also support a variety of ecosystems with diverse flora and fauna. Forests also contain roughly 90% of the world's terrestrial biodiversity.

Forests are vital to the ecological functioning of the planet, producing 60% of the net productivity of all terrestrial ecosystems. They also form the habitat for a large portion of the earth’s plant and animal species, providing the basis for the biodiversity which is essential for the biosphere’s future. The diverse functions of forests can be stated as follows

(i) **Productive Functions** - The forest provide fuel for warmth and cooking, and materials for shelter, tools and transport. One acre of forest provides over 6 tons of oxygen per year. Without forest we would have less oxygen. Some species have shown great importance in the medical field. Forests are the major carbon sink. They use a process called photosynthesis during which they take in carbon dioxide and produce oxygen.
(ii) **Protective Functions-** forests protect our waters and manage our climate. When it rains in the forests, the leaves allow the water to slowly drip to the ground. Without trees the rain pours hard on the unprotected soil. The dirt washes into streams, muddying the water. This is unhealthy for the fish and can cause flooding and soil erosion. Also without trees the moisture in the air evaporates quickly, changing the climate of nearby forests. Plant cover, root systems, and the quality of topsoil enable good infiltration and water retention. Forests also play a role as landscape and recreation areas.
(iii) **Regulative Functions-** forest regulates temperature, humidity, precipitation, shape soil environment and different hydrological cycles.

Forests have been exploited over the centuries as a source of wood and for obtaining land for agricultural, industrial, development and urbanization. The mismanagement of forest lands and forest resources has led to a situation where the forests are decreasing rapidly. Forests cover 31 percent of the world's land surface, just over 4 billion hectares. (One hectare = 2.47 acres.) This is down from the pre-industrial area of 5.9 billion hectares.

According to data from the U.N. Food and Agriculture Organization (**Table 2.1**), forests were overexploited at its highest rate in the 1990s, when each year the world lost on average 16 million hectares of forest.

Table 2.1 Comparison of World Forest Cover from 1990-2010

World Forest Cover, 1990-2010

Region	Total Forest Cover		
	1990	2000	2010
	Million Hectares		
Africa	749	709	674
Asia	576	570	593
Europe	989	998	1,005
North and Central America	708	705	705
Oceania	199	198	191
South America	946	904	864
World	**4,168**	**4,085**	**4,033**

Source: Compiled by Earth Policy Institute from U.N. Food and Agriculture Organization, **Forest Resources Assessment 2010: Global Tables** (Rome, 2010), www.fao.org/forestry/fra/fra2010/en/.

Deforestation is the permanent destruction of indigenous forests and woodlands. It is the complete cleaning of tree formation and their replacement by using land for other purpose.

Factors causing deforestation are:

1. **Natural-** forest fire, soil erosion, drought
2. **Economical-** agriculture (growing food needs), establishment of heavy industries, development projects, urbanization (population growth), mining, quarrying, agribusiness (growing oil palm, rubber, fruit trees, ornamental plants)
3. **Traditional-** shifting cultivation, grazing, fuel wood gathering

Effects of Deforestation

The major effects of deforestation on forests and tribal people include:

1. Soil erosion
2. Expansions of deserts
3. Decrease in rainfall
4. Loss of fertile land
5. Effect of climate
6. Lowering of water table

7. Loss of flora and fauna
8. Environmental changes
9. Lack of fuelwood for tribal people

Effects of Timber Extraction

Unlimited exploitation of timber for commercial use leads to decimation of forests. The major effects of timber extraction on forests and tribal people include:

1. Degradation of forest
2. Loss of biodiversity
3. Sedimentation of irrigation systems
4. Soil erosion
5. Climatic Changes such as low precipitation
6. Permit shifting cultivators and fuel wood gatherers to gain access to logged areas and fell the remaining trees
7. Forest fragmentation
8. Exploitation of tribal people by the contractors

Effects of Mining

The major effects of mining operations on forests and tribal people include:

1. Degradation of lands
2. Loss of top soil due to deforestation
3. Pollution of surface and ground water resources
4. Lowering of ground water table
5. Air pollution due to release of greenhouse gases and other toxic gases
6. Sediment production and discharge
7. Subsidence above and near mine areas can change local hydraulic gradients and create numerous ponds
8. Migration of tribal people from mining areas to other areas in search of land and food
9. Tribal people may be forced into a new way of life for which they are unprepared

Effects of Dams

The major impacts of dams on forests and tribal people are:

1. Degradation of catchment area
2. Reservoir induced seismicity
3. Loss of flora and fauna including gene pool reserves due to submergence
4. Increased incidence of water borne diseases
5. Acute scarcity of fuel wood and other forest products for tribal people
6. Rehabilitation and resettlement of affected people

Case Studies

1. Bishnoi Movement

In 1730, the maharajah (king) of Jodhpur wanted to build a new palace. He sent soldiers to gather wood from the forest region near the village of Khejarli, where Bishnoi villagers had helped foster an abundance of khejri (acacia) trees. When the king's men began to harm the trees, the Bishnois protested in anguish but were ignored by the soldiers, who were under royal orders.

Amrita Devi was a female villager who could not bear to witness the destruction of both her faith and the village's sacred trees. She decided to literally hug the trees, and encouraged others to do so too, proclaiming: “A chopped head is cheaper than a felled tree.” Bishnois from Khejri and nearby villages came to the forest and embraced the trees one by one to protect them from being cut down. As each villager hugged a tree, refusing to let go, they were beheaded by the soldiers. This voluntary martyrdom continued until 363 Bishnoi villagers were killed in the name of the sacred Khejarli forest.

Once word got back to the King about this activity he rushed to the village and apologized, ordering the soldiers to cease logging operations. Soon afterwards, the maharajah designated the Bishnoi state as a protected area, forbidding harm to trees and animals. This legislation still exists today in the region. The Bishnoi tree martyrs were influenced by the teachings of Guru Maharaj Jambaji, who founded the Bishnoi faith in 1485 and set forth principles forbidding harm to trees and animals.

2. Chipko Movement

The Chipko movement or Chipko Andolan was a forest conservation movement in India. The movement originated in the Himalayan region of Uttarakhand in 1973 and quickly spread throughout the Indian Himalayas. The first Chipko action took place in April 1973 in the Mandal village in the upper Alaknanda valley. The movement was triggered by the government's decision to allot a plot of forest area in the Alakananda valley to a sports goods company and clear out all the trees. On March 26, 1974, people especially the women in Reni village, Hemwalghati, in Chamoli district, Uttarakhand started a protest against the contractors ordered by the State Forest Department to cut down the trees in the area. This protest inspired many people to come forward and fight for the tree conservation. Soon the movement reached other areas and inspired the people to take similar actions to save the trees.
The Chipko Andolan is a movement that practiced methods of Satyagraha where both male and female activists from Uttarakhand played vital roles, including Gaura Devi, Suraksha Devi, Sudesha Devi, Bachni Devi and Chandi Prasad Bhatt. One of the prominent Chipko leaders, Gandhian Sunderlal Bahuguna, took a 5,000 kilometre trans-Himalaya foot march in 1981–83, spreading the Chipko message to a far greater area. Women's participation in the Chipko agitation was a very novel aspect of the movement.

2.3.3 Water Resources- water resources like oceans, seas, river, pond, ground water (aquifers) are very important for use. Water is essential for survival. Water is recycled in the environment through hydrological cycle (water cycle). Seventy one percent of earth's surface is covered with water. Out of that 97.5% is saline water and 2.5% is fresh water. Out of 2.5% fresh water, 68.6% exists as snow in glaciers and ice caps, 30.1% as ground water and only 1.3% exists as surface and other fresh water. Water resources are very important to us. The various use of water resources are:

1. Water is used for domestic purposes like drinking, bathing, cooking, washing. etc.
2. Water is used in commercial establishments like hotels, theaters, educational institutions, offices, etc.
3. Almost 60-70% of fresh water is used for irrigation
4. 20-30% of water is used for industrial operations by refineries, iron & steel industries, paper & pulp industries, etc.
5. Water plays a key role in sculpting the earth's surface, moderating climate and diluting pollutants.

Over-Utilization of Surface and Ground Water

The rapid increase in population and industrial growth led to severe demand on water resources. After using all available surface water resources to the maximum, human beings began using groundwater to meet their needs.

1. The increased extraction of groundwater far in excess of the natural recharge led to decreased groundwater level. The erratic and inadequate rainfall caused reduction in storage of water in reservoirs. This also led to decrease of groundwater.
2. Building construction activities seal permeable soil zone and reduce the percolation of rainwater to ground and thereby increasing surface runoff.
3. If groundwater withdrawal rate is higher than recharge rate, sediments in aquifers get compacted resulting in sinking of overlaying land surface. This is called land subsidence which leads to structural damage in buildings, fracture in pipes and reverses the flow of canals leading to tidal flooding.
4. Over-utilization of groundwater in arid and semi-arid regions for agriculture disturbs equilibrium of reservoir in the region causing problems like lowering of water table and decreased pressure in aquifers.
5. Over utilization of groundwater in coastal areas leads to rapid intrusion of salt water from the sea thereby rendering it unusable for drinking and agriculture.
6. Over-utilization of groundwater leads to decrease in water level thereby causing earthquake, landslides and famine.
7. Over-utilization of groundwater leads to drying-up of dug wells as well as bore wells.
8. Due to excessive use of groundwater near agricultural fields, agricultural water that contains nitrogen as a fertilizer percolates rapidly and pollutes the groundwater thereby rendering the water unfit for potable use by infants. Nitrate concentration exceeding 45 mg/L causes blue baby syndrome.

Drought and Floods

A drought is a natural disaster of below-average precipitation in a given region; resulting in prolonged shortages in the water supply, whether atmospheric, surface water or ground water. A drought can last for months or years, or may be declared after as few as 15 days. It can have a substantial impact on the ecosystem and agriculture of the affected region and harm the local economy. Annual dry seasons in the tropics significantly increase the chances of a drought developing and subsequent bush fires. Periods of heat can significantly worsen drought conditions by increase in evaporation of water vapour.

A flood is a situation in which water temporarily covers land where it normally doesn't. The growth of number and magnitude of floods is directly connected to rainfall patterns, which affects the volume of water in lakes, rivers, canals, the ocean, and even sewers. Floods can appear in a variety of forms, ranging from small flash floods to large coastal or urban floods. Some main reasons are severe thunderstorms, Tornados, Tropical cyclones, Monsoons, Melting ice/snow, Dam breaks.

Dams

Dams have made significant contributions to human development and the benefits derived from them have been considerable. Large dams are designed to control floods and to help the drought prone areas, with supply of water. But large dams have proved to cause catastrophic environmental damage. Hence an attempt has been made to construct small dams. Multiple small dams have less impact on the environment.

Some benefits of dams are

- They ensure a year round supply of water for domestic use and provide extra water for agriculture, industries and hydropower generation.
- Some of the problems related to dams are mentioned below.
- They alter river flows, change nature's flood control mechanisms such as wetlands and flood plains, and destroy the lives of local people and the habitats of wild plant and animal species, particularly is the case with mega dams
- Dam construction and submersion leads to significant loss of farmland and forest and land submergence
- Siltation of reservoirs, water logging and salinization in surrounding lands reduces agricultural productivity
- Serious impacts on ecosystems - significant and irreversible loss of species and ecosystems, deforestation and loss of biodiversity, affects aquaculture
- Socio economic problems for example, displacement, rehabilitation and resettlement of tribal people.
- Fragmentation and physical transformation of rivers
- Displacement of people - People living in the catchment area, lose property and livelihood
- Impacts on lives, livelihoods, cultures and spiritual existence of indigenous and tribal people
- Dislodging animal populations
- Disruption of fish movement and navigational activities
- Emission of greenhouse gases due to rotting of vegetation
- Large landholders on the canals get the lion's share of water, while poor and small farmers get less and are seriously affected leading to conflicts. Irrigation to support cash crops like sugarcane produces an unequal distribution of water.
- Natural disasters – reservoirs induced seismicity, flash floods etc and biological hazards due to large-scale impounding of water – increase exposure to vectorborne diseases, such as malaria, schistosomiasis, filariasis

Water Conservation

Water conservation is the practice of using water efficiently to reduce unnecessary water usage. According to Fresh Water Watch, water conservation is important because fresh clean water is a limited resource. Water conservation includes all the policies, strategies and activities to sustainably manage the natural resource of fresh water, to protect the hydrosphere, and to meet the current and future human demand. Water consumption is affected by population, household size, growth and affluence. Factors such as climate change have increased pressures on natural water resources especially

in manufacturing and agricultural irrigation. Water can be saved by applying following methods at home:

1. Low-flow shower heads sometimes called energy-efficient shower heads as they also use less energy
2. Low-flush toilets and composting toilets. These have a dramatic impact in the developed world, as conventional Western toilets use large volumes of water
3. Faucet aerators, which break water flow into fine droplets to maintain "wetting effectiveness" while using less water. An additional benefit is that they reduce splashing while washing hands and dishes
4. Rainwater harvesting
5. High-efficiency clothes washers
6. Weather-based irrigation controllers
7. Garden hose nozzles that shut off the water when it is not being used, instead of letting a hose run.
8. Low flow taps in wash basins
9. Automatic faucet is a water conservation faucet that automates the use of faucets without the use of hands.

Rainwater Harvesting

It is the method of utilizing rainwater for domestic and agricultural use by capturing and storing the rainwater above the ground or recharges the ground water for its later use. It is essential because-

- Surface water is inadequate to meet our demand and we have to depend on groundwater.
- Due to rapid urbanization, infiltration of rainwater into the subsoil has decreased drastically and recharging of groundwater has diminished.

Rainwater harvesting has the following objectives:

- To reduce run-off loss
- To avoid flooding of roads
- To meet the increasing demand of water
- To raise the water table by recharging groundwater
- To reduce groundwater contamination
- To supplement groundwater supplies during lean season
- Prevents soil erosion and flooding especially in urban areas

The following methods are adopted for modern and traditional harvesting:

- Storage of rainwater on surface for future use by constructing pits, dug-well, lagoons, trench or check-dams.
- Recharge to groundwater uses pits, trenches, dug wells, recharge wells, recharge shafts, lateral shafts with borewells.

Components of Rainwater harvesting systems

Rainwater harvesting systems (Figure 2.2) have the following 5 basic components:

1. **Catchment** : the surface from which rainwater is collected for storage. This could be a rooftop, a paved flooring surface or a landscaped area. Catchment area is the area of that surface, usually calculated in square metres.
2. **Gutters and Downtake pipes**: lead the water from the catchment surface to the storage tank
3. **Filters and first flush devices**: remove grit, leaves and dirt that the rainwater may transport from the catchment, before the water enters the storage tank. When it rains after a long gap, the rooftops are usually very dirty and the rainwater also carries with it a lot of dissolved air pollutants. A first flush device diverts the water from the first rain so that it does not enter the storage tank.
4. **Storage tanks**: These can be above the ground or below the ground.
5. **Delivery systems**: Piping systems that convey the stored rainwater till the point of end-use.

It is not recommended to use harvested rainwater for drinking, cooking and dishwashing unless water quality issues are verified and necessary treatment or purification systems are installed.

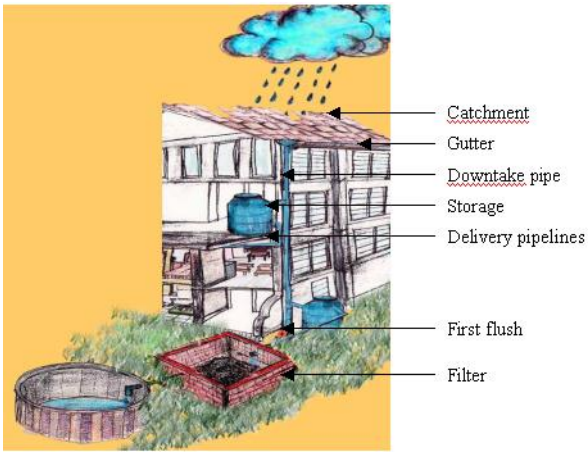


Figure 2.2. Rainwater Harvesting structure

Watershed Management

A watershed describes an area of land that contains a common set of streams and rivers that all drain into a single larger body of water, such as a larger river, a lake or an ocean.
Watershed management is a term used to describe the process of implementing land use practices and water management practices to protect and improve the quality of the water and other natural resources within a watershed by managing the use of those land and water resources in a comprehensive manner.

Runoff from rainwater or snowmelt can contribute significant amounts of pollution into the lake or river. Watershed management helps to control pollution of the water and other natural resources in the watershed by identifying the different kinds of pollution present in the watershed and how those pollutants are transported, and recommending ways to reduce or eliminate those pollution sources.

All activities that occur within a watershed will somehow affect that watershed's natural resources and water quality. New land development, runoff from already-developed areas, agricultural activities, and household activities such as gardening/lawn care, septic system use/maintenance, water diversion and car maintenance all can affect the quality of the resources within a watershed. Watershed management planning comprehensively identifies those activities that affect the health of the watershed and makes recommendations to properly address them so that adverse impacts from pollution are reduced.

2.3.4 Land Resources

Land is finite and valuable resource on which we depend for our housing, food, fiber and fuel wood. Soil, especially the top soil is considered as renewable resources because it is continuously regenerated but the rate of regeneration is a slow process. It takes almost 200-1000 year for the formation of 2.5 cm soil, depending upon climate and soil type. So if the rate of soil degradation is faster than the soil regeneration it can become a non-renewable resource.

Land Degradation: Due to increase in human population there is increased pressure on land resource in term of food growth, land area for the housing purpose, industrial growth. Processes such as soil erosion, water-logging, salinization and contamination of soil with industrial wastes like heavy metals, salt etc. causes degradation of land.

1. **Soil Erosion**: meaning is wearing away of soil. Soil erosion is the deterioration of soil by the physical movement of soil particles from a given site. Wind, water, ice, animals, and the use of tools by man are usually the main causes of soil erosion. One third of world cropland is affected by the problem of soil erosion.
2. **Water logging and induced salinity:** Mainly occurs due to faulty irrigation practice, where farmers applied more irrigation water than actually needed for the crop growth. However due to inadequate drainage water get accumulated and form a continuous column with water table. These types of soil are call waterlogged soil which affects crop production due to inhibition of exchange of gases. Water logging is most often associated with the salinity because irrigation water contain salts which get accumulated on soil during evaporation process.

Soil erosion is of two types:

a) Geological erosion (normal erosion): gradual removal of top soil by natural processes which bring equilibrium between physical, biological and hydrological activities and maintain balance between erosion and renewal.

b) Accelerated erosion: Natural erosion process got faster due to human activities such as deforestation, overgrazing and mining.

Agents of soil erosion: Agents of soil erosion are broadly divided into two types:

a) Climatic agents: water and wind are two major agents responsible for soil erosion.

b) Biotic agents: excessive grazing, mining and deforestation are the major biotic agents responsible for soil erosion.

Climatic Agents

1. **Water erosion** is caused by water and is divided into following category based upon the severity of erosion:
   - **Sheet erosion:** when there is uniform removal of thin layer of soil from a large surface area, it is called sheet erosion. Sheet erosion occurs as runoff travels over the ground, picking up and transporting the particles dislodged by raindrop impacts. The process of sheet erosion is uniform, gradual and difficult to detect until it develops into rill erosion.
   - **Rill erosion:** when there is rainfall rapidly running water produces finger shaped grooves or rills over the area, it is called rill erosion.
   - **Gully erosion:** When rainfall is more heavy rill can convert into deepen cavities or gullies which may be U or V shaped.
   - **Slip erosion:** Especially occurs in mountain areas, where due to heavy rainfall slope of mountain and hill area loose soil. It is also known as landslide defined as an outward and downward movement of the slope-forming material, composed of natural rocks, soil, artificial fills, etc.
   - **Stream bank erosion:** usually occurs during the peak discharge periods, when fast flowing river water cut the soil and make caves in the river bank. This type of erosion is responsible for moving immense quantities of detritus, comprising boulders, shingles, sand and silt, depending upon the geology of the terrain.

2. Wind erosion is a major soil erosion agent in the non-vegetation and dry land area. In case of wind erosion following three type of soil movement takes place:

- **Suspension:** when very fine dirt and dust particles are lifted into the wind. They can be thrown into the air through impact with other particles or by the wind itself. Once in the atmosphere, these particles can be carried very high and be transported over extremely long distances.
- **Saltation:** In saltation, fine soil particles are lifted into the air by the wind and drift horizontally across the surface increasing in velocity as they go. They travel approximately four times longer in distance than in height. When they strike the surface again they either rebound back into the air or knock other particles into the air.
- **Creep:** The large particles which are too heavy to be lifted into the air are moved through a process called surface creep. In this process, the particles are rolled across the surface after coming into contact with the soil particles in saltation.

Methods to reduce soil erosion are:

- **Terracing:** Steep slopes are converted into broad terrace which run across the contour. Terracing retains water for crops at all levels and cut down soil erosion by controlling run-off.

- **Strip cropping:** strip of crops are alternated with strips of soil saving cover crops like grasses or grass legume mixture. So whatsoever run off comes from the cropped soil is retained by strip of cover crop and this reduce soil erosion.
- **Alley cropping:** It is also known as Agro forestry. In this type crops are planted between rows of trees or shrubs. So, when crops are harvested soil is not fallow so reduce the soil erosion.
- **Wind breaks or shelterbelts**: These help in reducing soil erosion by strong winds. The trees are planted in long rows along the cultivated land boundary so that wind is blocked. The wind is substantially reduced which help in preventing wind erosion of soil.

Desertification: is a process whereby the productive potential of arid and semi-arid lands falls by 10% or more**.** It can be categorized as moderate (10-25%), severe (25-50%) and very severe(> 50%) drop in productivity. It leads to the conversion of rangelands or irrigated crop land to desert like condition in which agricultural production fall. It is characterized by devegetation, depletion of ground water, salinization and severe soil erosion.

Causes of Desertification: It can be natural due to change in the climate of any area or due to excess exploitation of land to human pressure. The major anthropogenic activities responsible for desertification are as follows:

- **Deforestation:** The process of denuding and degradation of forested land initiates a desert producing cycles. If there is no vegetation to hold back surface run-off, water drains out quickly before it can soak into the soil to nourish the plant and replenish the ground water.

- **Overgrazing:** Overgrazing areas are more under risk of desertification because it results into denude of the land area. The dry barren land becomes loose and more prone to soil erosion. The top fertile layer is also lost and thus plant growth is badly hampers in such soils.

- **Mining and quarrying:** These activities results into loss of vegetation cover and denudation of extensive land area leading to desertification.

2.3.5 Food Resources

Food is a critical need for survival of living being and is required for growth, physical and mental ability and good health. Any substance containing nutrients, such as carbohydrates, proteins and fats that can be ingested by a living organism and can be metabolized into energy and body tissue comes under food resources.

Different sources of food resource:

- **Plant food:** It includes cereal grains, vegetables, fruits, nuts, sugar, fats and oils. Among cereal grain rice, wheat and maize are the major grains. Rice and wheat are the staple food for the 4 billion people in the developing countries.

- **Animal food:** The most preferred animal food by humans is mutton, beef, pork and poultry as well as their by-products (milk and eggs).

- **Fish and sea foods:** It supports 70 million metric tons of high quality protein to the world diet.

Requirement of food resource:
Average minimum Calories intake on global scale = **2500 calorie/days**
< 90% of this value = undernourished < 80% of this value = serious undernourished

World Food Problem: Every year 40 million people (50% of which are young children in the age group of 1 to 5 years) die of undernourishment and malnutrition. As per estimates of Food and Agriculture Organization (FAO), about 840 million people remain chronically hungry and out of this 800 million are living in the developing world. In last decade, it is decreasing at the rate of 2.5 million per year, but at the same time world's population is increasing. If the present trend continues, due to inadequate purchasing power to buy food, it is difficult to fulfil minimum calorific requirement of human body per day. Large number of people are in India are poor which can be attribute to equitable

distribution of income. India is home to 40 percent of the world's malnourished children and 35 percent of the developing world's low-birth-weight infants. Food insufficiency can be divided into two categories into under-nourishment and malnourishment. Both of these insufficiencies are global problems. A Food Ministry report reveals that India wastes food worth over Rs 500,000 million in a year, even as one fifth of its population is underfed.

Environmental problem associated with food resources

Environmental problem associated with food resources are associated with the production of food resources either from agriculture, cattle and poultry breeding and harvesting of fish and other aquatic products.

1. **Agricultura**l: Initially agricultural practice were less energy intensive with lower chemical inputs in form of fertilizers and pesticides. However with growing needs of food production agriculture become more energy intensive with more chemical inputs leading to degradation of water and land environment. Main problem associated with the modern agricultural are:
    - Monoculture: most of the high yielding variety (HYV) encourage monoculture i.e. use of same genotype over vast area, so if there is an attack of pathogen, large tract of agricultural crop is going to affected.
    - Fertilizer related problem: Application of fertilizer into agricultural land has variety of unwanted environmental affects such as:
        - Micronutrient imbalance: Most of the applied fertilizer have micronutrient (N,P,K), which promote the growth of crop however during crop growth it also required micronutrient such as zinc which is not replenish resulting into the imbalance of soil nutrient.
        - Nitrate pollution: nitrogen applied in the agricultural field find its ways to ground water and surface water in the form of nitrate which is a water pollutant. High concentration of nitrate results into methaemoglobinemia (Blue baby syndrome).
        - Eutrophication of the inland and coastal ecosystem: Excessive supply of phosphate and nitrate from the agricultural land to water bodies result into the favorable growth of non-siliceous alga which are unpalatable resulting into their bloom which eventually consume all the oxygen present in the water bodies resulting into death of other aquatic species and destruction of whole ecosystem.
    - Pesticides related problems: different types of pesticides are applied to control crop from pest such as DDT (Dichlorodiphenyl trichloroethane), however their application also had some adverse effects:

        - Pest resistance and origin of new pest variety: After the time course resistance variety of pest started to arrived which make the application of pesticides unfruitful.

        - Death of non-target organisms: some of the insecticides are poisonous and not only kill the target pest but also other non-target species which are useful.

        - Biological magnification: some of the applied pesticides are non-biodegraded and keep on accumulating in the food chain a process known as biological magnification. It create problem for the species which are present on the higher level of food cahin.

    - Water logging: mainly occurs due to faulty irrigation practice, where land is flooded with water, however inadequate drainage leads to accumulation of water and rise in the water table which results into problem in root respiration and resulted crop yield loss.
    - Salinity problem: land salinity is the major problem and in total 1/3 of the total cultivated land is affected by salinity. Salinity arises due to accumulation of soluble salts such as NaCl, Na2SO4, CaCl2 etc. The main reason behind the salinity is use of ground water for the irrigation purpose, which has high TDS compare to rain water.

2. **Livestock farming:** Livestock provide food resource in form of meat, milk and eggs. However livestock farming also create problem such as:

- Overgrazing: livestock population graze over the community land, degraded forest land for their food supply which resulted into increase risk of soil erosion, land degradation and loss of useful species.

- Emission of greenhouse gases: Livestock sector is responsible for 9% of CO2, 65% of N20 and 37% of methane production due to human induced activity.

- Water pollution: waste emerging out of cattle farm are rich in organic waste, nitrogen and phosphate resulted into increase risk of eutrophication of inland water bodies.

3. **Fisheries**: It is a major food resource however it is suffering from the overexploitation which resulted into decrease in the fish catch amount and total productivity.

2.3.6 Mineral resources

Any mineral, element, and rock that can be extracted from the ground and it has a potential value. Minerals are naturally-occurring inorganic substances with a definite and predictable chemical composition and physical properties.

Usefulness of mining resources:

- Building Materials: sand, gravel, stone, cement, steel, aluminum, asphalt, glass.
- Plumbing and Wiring: iron and steel, copper, brass, lead, cement, asbestos
- Appliances: iron, copper, many rare metals
- Defense equipments
- Agricultural: fertilizers, machinery
- Transportation means
- Jewellary: gold, silver, platinum, diamond etc.

Types of Mineral resources:

(1) Non- metallic minerals: e.g. graphite, diamond, quartz, feldspar
(2) Metallic minerals: bauxite, laterite, haematite etc.
(3) Fossil fuels (also known as mineral fuels): the organic mineral substances that can be utilized as fuels, such as coal, petroleum, natural gas etc.

The minerals and their ores need to be extracted from the earth's interior and the process of mineral extraction is known as mining process. The **mining process** involves following stages:

1) Prospecting: This is done for the searching of minerals. The searching methods include direct analysis of minerals outcrops combined with the aerial photography, geologic maps, and structural assessment of an area. In case of indirect analysis use of geophysical methods such as gravitational, seismic, magnetic, electrical, electromagnetic, and radiometric variables of the earth.

2) Exploration: determines as accurately as possible the size and value of a mineral deposit, utilizing techniques similar to but more refined than those used in prospecting.

3) Development: It involves work of preparing access to the deposit so that the minerals can be extracted. This process involves acquiring water and mineral rights, buying surface lands, arranging for financing, and preparing permit applications and an environmental impact statement (EIS).

4) Exploitation: It involves actual extraction of minerals from the mines.

5) Reclamation: the process of closing a mine and recontouring, revegetating, and restoring the water and land values.

Depending upon the **ways of exploitation** mines are divided into two parts:

1. **Surface mining:** Open pit or open cast mining is usually employed to exploit a near-surface deposit ore. . It often necessitates a large capital investment but generally results in high productivity, low operating cost, and good safety conditions.

2. **Sub-surface mining:** mainly involves unsupported, supported, and caving type of mine used for mining deep minerals deposits. It is most destructive, dangerous, expensive including risks of occupational hazards and accidents.

Environmental problem associated with Mining:

1) **Devegetation and defacing of landscape:** Top soil along with vegetation has to be removed for reaching to the mineral resource, this results into removal of forest and vegetation present in the area also results into loss of biodiversity.

2) **Subsidence of land:** mainly related to the underground mining often leading to destruction of property and displacement of local habitants.

3) **Watershed disturbance:** Mining activity disturb the natural hydrological process and pollute the ground water due to leaching of heavy metals and acids.

4) **Acid-mine drainage:** Acid mine drainage is most serious problem associated with the mining sectors. This is normally associated with the metal ore mines and coal mines having high concentration of sulphides in ores which react with air and water to produce acidity.

5) **Air Pollution:** Mining activity is also a major source of SPM, some of the coal mines release methane through cracks and opening. Mine fire also results into formation of NOx and SOx and some secondary pollutant such as ozone.

6) **Noise pollution:** Mining activity involves lot of heavy machinery related to extraction and transportation of mineral ores resulting into increase noise level in the mining zones.

7) **Displacement of tribal and local population:** Mining activity in forested and hilly region mostly resulted into the displacement of tribal and marginalized population resulted into their rehabilitation issue.

8) **Occupational hazards:** Mining activity especially underground mining is associated with greater risk for the worker due to occurring of mine accidents involving collapse of mine wall, flooding of mines or mine blast associated with methane. Beside accidents longs working in the mine environment results into diseases such as asbestosis, silicosis, black lung disease etc.

Check Your Progress-1

1) Define Natural Resources. Differentiate between renewable and non-renewable natural resources.
2) Write an essay on energy resources.
3) How conventional energy resources are different than non-conventional natural resources?
4) How anthropogenic activities are causing degradation of land resources?

2.4 Role of an individual in conservation of natural resources

Natural resources like forest, water, soil, food, mineral, energy and land plays a key role in the development of a nation. However these resources are facing risk of depletion due to increased exploitation for human need and required to conserve for future utilization. Conservation efforts are underway at national and international level however **individual efforts** are also necessary for the resource conservation. Some of the examples of individual conservation efforts are:

Water resource:

- Don't waste water by keeping water taps running during brushing, shaving, washing and bathing.
- Check water pipelines and taps for water leakage as a small pin shape hole can waste 640 liters of water in a month.
- Install water shaving toilets that not use much water for flushing purposes (not more than 6 liters).
- Install small system of rain water harvesting, which can be used for watering the plants and washing the vehicles.

Energy resources:

- Turn off light, fan, and other electric appliances when not in use.
- Use solar water heater during winter seasons for domestic use.
- Use of CFL bulbs conserves energy.
- Use public transport system as much you can.

Land resources:

- Do not over-irrigate your agricultural land; provide proper drainage facility to reduce the salinity effect.
- Grow different type of ornamental plants, herbs and trees in your garden.
- Don't throw solid wastes like plastic or metal can on open land.
- Promote sustainable agriculture by buying products produced by organic farming, don't waste food material.

Equitable use of resources for sustainable life style

The big divide of north and south, the more developed country (MDC's) and less developed country (LDC's) is one major reason for unequal use of natural resources. The MCD's have only 22% of world's population but they use 88% of its natural resources, 73% of its energy and command 85% of its income. They are the real exploiter of natural resources and pollution generator. These countries include USA, Canada, Japan, CIS, Australia, New Zealand and western European countries.
The LDC's have 78% of world population; they use 12% of natural resources and 27% of energy. Their income is merely 15% of world economy.

Two basic causes of inequitable use of resources are:

- Overpopulation in poor countries who have under consumption of natural resource.
- Over consumption of resources by rich countries.

So for sustainable future of world population rich countries will have to lower down their consumption levels while the bare minimum needs of the poor have to be fulfilled by providing them the resource. International organization such as United nation and World Bank are primarily responsible for doing this job.

2.5 Biodiversity

Biodiversity refers to the **variety and variability** among all groups of living organisms and the ecosystem complex in which they occur.
In the Convention of Biological Diversity (1992), Biodiversity has been defined as the **variability among living organism from all sources** including terrestrial, marine and other aquatic ecosystem and the ecological complexes of which they are a part.
The term biodiversity was first coined by Walter G. Rosen in 1986.

Level of Biodiversity: There are three level of biodiversity:

- **Genetic Biodiversity:** It is diversity within the species due to difference in its genetic structure. The gene found in organism can form enormous number of combination each of which give rise to some variability.

- **Species Diversity:** The number of species of plants and animals that are present in a region constitutes its species diversity. It represents the species richness and their abundance in a community. There are two popular indices of measuring species diversity known as Shannon-Wiener index and Simpson index.
- **Ecosystem Diversity:** There are a large variety of different ecosystems on earth, which have their own complement of distinctive inter linked species based on the differences in the habitat. 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.

Biodiversity value:

The value of biodiversity in term of its commercial utility, ecological services social and aesthetic value is enormous. The multiple uses of biodiversity or biodiversity value has been classified by Mc.Neely et al in 1990 as follows:

1) **Consumptive use value:** these are direct use value where the biodiversity product can be harvested and consumed directly. Example: food, drugs fuel, fibre etc.
    - Food: A large number of wild plants are consumed by human being as food. About 80,000 edible plant species have been reported from wild. About 90% of present day food crops have been domesticated from wild tropical plants.
    - Drugs and Medicines: About 75% of the world population depends upon plant or plant extracts for medicine. Example:
    - Fuel: forests has been used for fuel wood. The fossil fuel coal, petroleum and natural gas are also products of fossilized biodiversity.

2) **Productive use values:** The biotechnologist uses **biorich 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. Animal products like **tusks** of elephant, **musk** from musk deer, **silk** from silk –worm, **wool** from sheep, **fur** from many animals, **lac** from lac insects etc. Many industries are dependent upon the productive use values of biodiversity such as paper and pulp industry, plywood industry, railway sleeper industry, silk industry, textile industry, ivory –works, leather industry, pearl industry etc.

3) **Social value:** These are the value associated with the social life, customs, religion and psycho-spiritual aspects of the people. Many plants are considered **holy and sacred** in our country such as Tulsi, Peepal, Mango, Lotus, Bael etc. Many animals like cow, snake, bull, peacock, owl etc. also significant place in our psyco-spiritual arena and thus hold special social importance.

4) **Ethical values:** Ethical values related to biodiversity conservation are based on the importance of **protecting all forms of life**. It involves ethical issues like ' all life must be preserved'. Indian civilization has over several generations preserved nature through local traditions. This has been an important part of the ancient philosophy of many of our cultures. We have in our country a large number of **sacred groves** or **'deorais'** preserved by tribal people in several States.

5) **Aesthetic value:** Great aesthetic value is attached to biodiversity. The **eco-tourism** is estimated to generate about 12 billion dollars of revenue annually and is a growing area.

6) **Optional Value:** Keeping future possibilities open for their use is called option value. It is impossible to predict which of our species or traditional varieties of crops and domestic animals will be of great use in the future. Thus option value is the **value of knowing that** there are biological resources existing on this biosphere that may one day prove to be an effective option for something important in the future.

7) **Ecosystem service value:** It refers to the services provided by ecosystem like prevention of soil erosion, prevention of floods, maintenance of soil fertility cycling of nutrient, fixation of nitrogen, water cycle, carbon sinks, pollutant absorption and reduction of the threat of global warming etc.

Major Threats to Biodiversity:

Extinction or elimination of a species is a natural process of evolution, however during recent years of human civilization the process of extinction become fast. According to the estimates made by noted

ecologist E.O.Wilson puts the figure of extinction at 10,000 species per year or 27 per day which is a very high rate. Few major threat to biodiversity are as follows:

1) Loss of Habitat: Destruction and loss of natural habitat is one of the major cause of biodiversity loss throughout the world. Due to land use changes billions of hectare of forests and grassland have been converted to into agricultural land, pasture, settlement area or development project during last century.

Loss of habitat can also occur in patches which are small and scattered, a phenomenon known as habitat fragmentation also threaten the wild life.

2) Poaching: Illegal trade of wildlife products such as furs, hides, horns, tusks etc by killing prohibited endangered animals also results into loss of biodiversity. Despite International ban on trade in production from endangered species Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which came into force in July 1975 illegal poaching is going on rampant in many part of world including India due to high value associated with these product.

The cost of elephant tusks can go up to $ 100 per kg; the leopard fur cost is sold at $ 100,000 in Japan while bird catchers can fetch up to $ 10,000 for a rare hyacinth macaw, a beautiful colored bird, from Brazil.

This illegal poaching is responsible for the loss of many keystone species form ecosystem.

3) Invasive species: Invasion is considered as the second most important threat to biodiversity after habitat destruction. Alien species, which locally become dominant and invade natural communities, are referred to as invasive species. Further, IUCN also defines alien invasive species, as a species that becomes established in natural or semi-natural ecosystem or habitat, is an agent of change and threatens biological diversity.

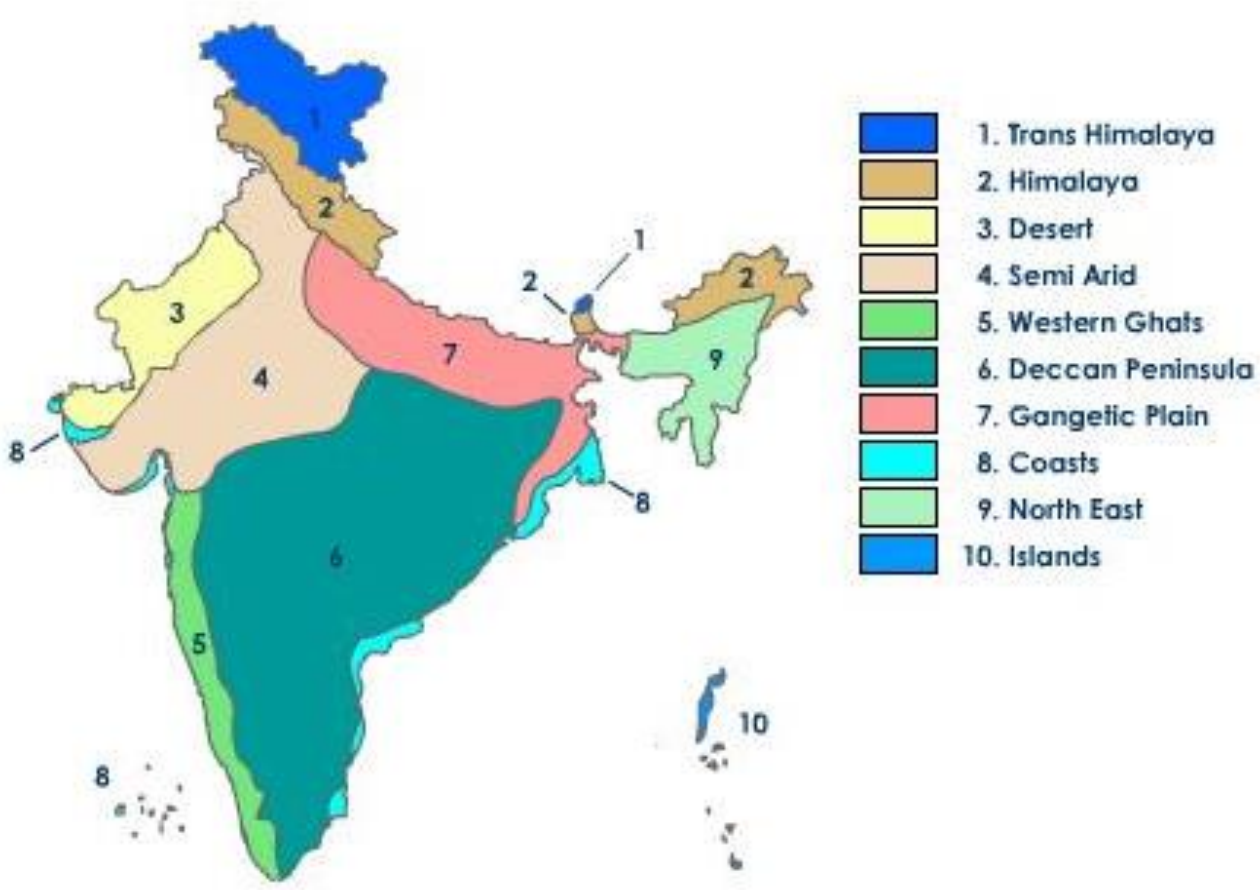
4) Climate change: A changing global climate threatens species and ecosystems. The distribution of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes). Climate change may simply shift these distributions but, for a number of reasons, plants and animals may not be able to adjust.

5) Man- Wildlife conflict: Recent years there are increasing news of wild animal intruding the human settlement areas are coming. For example: In Odissa 195 human being were killed by wild elephant in past 5 year, in retaliation total 98 elephants were also killed by people. In Mysore several instances of elephant killing were reported in Kote-Chamarajanagar area, mainly due to damage of crop done by elephants. The major reason behind this conflict is due to loss of wild life habitat and also due to fragmentation of natural habitat.

BIOGEOGRAPHIC CLASSIFICATION OF INDIA:

Our country can be conveniently divided into **ten major regions**, based on the geography, climate and pattern of vegetation seen and the communities of mammals, birds, reptiles, amphibians, insects and other invertebrates that live in them:

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) **Desert** area of Kutch, Thar region.
4) The **semi arid** grassland region of the central india, Gujarat.
5) The **Western Ghats** in Maharashtra, Karnataka and Kerala.
6) **Deccan Peninsula** consisting of Deccan Plateau south, Central, Eastern, Chhota Nagpur, Central Highlands.
7) The **Gangetic and Bhramaputra** plains.
8) The long **western and eastern coastal belt** with sandy beaches, forests and mangroves.
9) The **Northeast States** of India,
10) The Andaman and Nicobar **Islands**.



2.6 Biodiversity at Global, National and Local Levels

There are at present **1.8 million species** known and documented by scientists in the world. However, scientists have estimated that the number of species of plants and animals on earth could vary from 1.5 to 20 billion! Thus the majority of species are yet to be discovered.
Terrestrial biodiversity of the earth is best described as **biomes,** which are the largest ecological units present in different geographic areas and are named after the dominant vegetation e.g. the tropical rainforests, tall grass prairies, savannas, desert, tundra etc.
About **50 to 80%** of global biodiversity lies in tropical rain forest. However these forest are not well documented yet. Temperate forest have much less diversity however there is much better documentation of the species.

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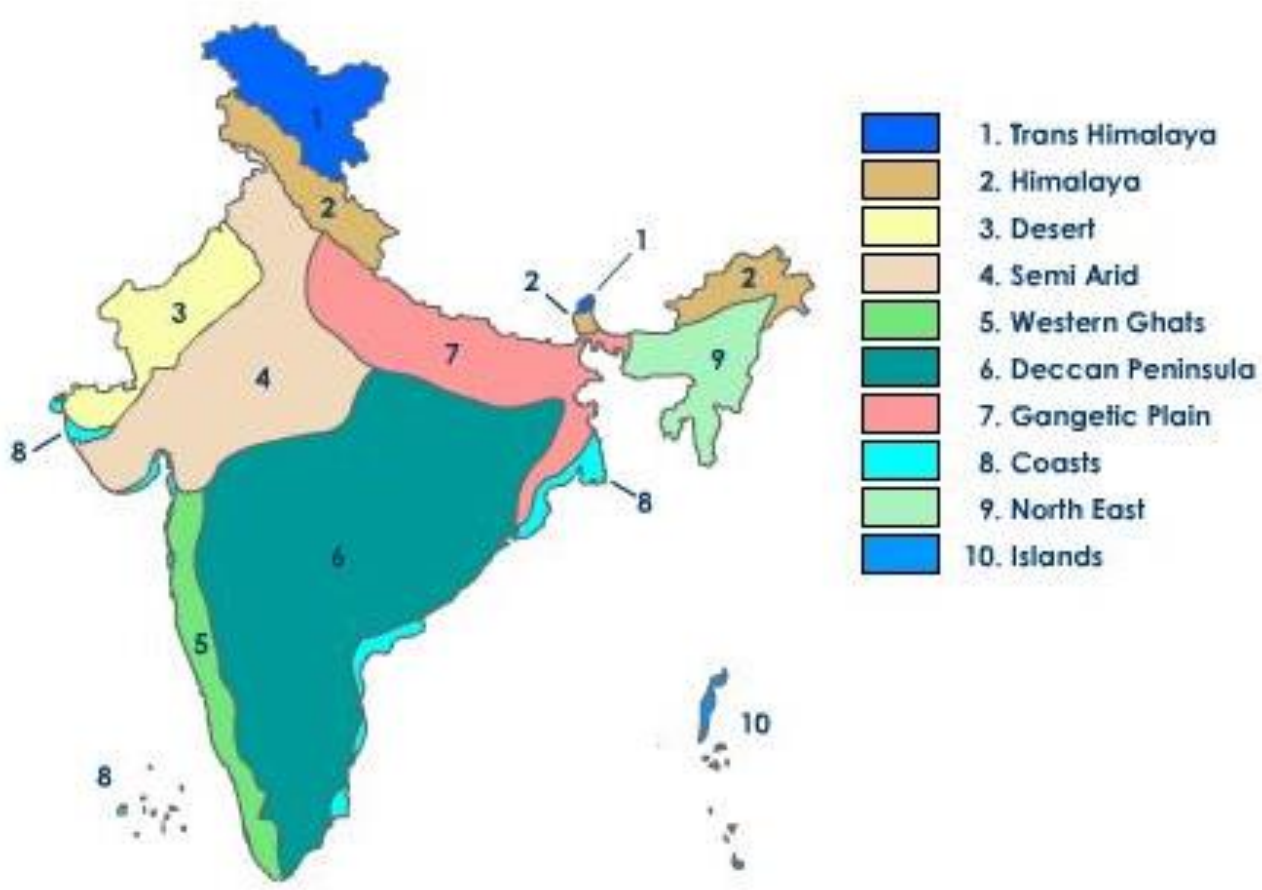


INDIA AS A MEGA DIVERSITY NATION (Biodiversity at National level)

India is one of the 12 mega-diversity countries in the world. It host about 7% of global flora(47,000 plant species) and 6.5% of fauna (81,000 species of animal). Some of the biodiversity criteria are as follows:

1) **Endemism:** India shows a good number of **endemic species**. About 62% of amphibians and 50% of lizards are endemic to India. Western ghats are the site of maximum endemism.
2) **Centre of origin**: A large number of species are known to have originated in India. Nearly 5000 species of flowering plants had their origin in India

Regional or Local Biodiversity: Biodiversity at regional level is better understood by categorizing species richness into four types. **Whittaker (1972)** described three terms for measuring biodiversity over spatial scales: **alpha, beta, and gamma diversity**. Alpha diversity refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., *species richness*) in that ecosystem.

- **Point richness:** it refers to the number of species that can be found at a single point in a given space.

- **Alpha (ά-) richness:** It refers to the number of species found in a small homogeneous area. It is strongly correlated with physical environmental variables. This can be measured by **counting the number** of taxa (distinct groups of organisms) within the ecosystem.
- **Beta(β-) richness:** It is also known as **ecosystem diversity.** Beta diversity measures the present and changes of species diversity between ecosystems; this involves comparing the number of taxa that are unique to each of the ecosystems. In simpler terms, it calculates the **number of species that are not the same in two different environments**.

- **Taxonomic diversity of a region with several ecosystems (Gamma diversity):**
  Gamma diversity (γ-diversity) is a measure of total biodiversity of several ecosystems within an entire region. It refers to the total species richness over a large area or region.

Hotspot of Biodiversity

The term hotspot was introduced by Myers(1988). These are areas which exhibit high **species richness** as well as **high species endemism** are termed as hot spots of biodiversity.

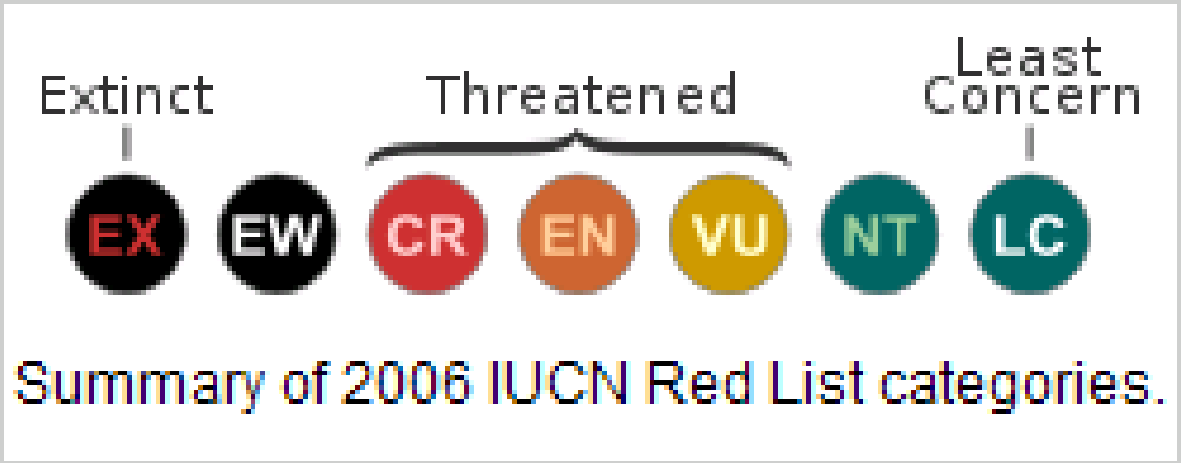
To qualify as a hotspot, a region must meet two strict criteria:

- It must contain at least 1,500 species of vascular plants (> 0.5 percent of the world's total) as endemics, and
- It has to have lost at least 70 percent of its original habitat.

There are 34 such hotspot of biodiversity on a global level out of which two are present in India, namely the **Eastern Himalayas and western Ghats**.

- **Eastern Himalayas**: There are numerous deep and semi-isolated valleys in Sikkim which are extremely rich in endemic plant species. In an area of 7298 Km2 of Sikkim about 4250 plant species are found of which 60% are endemic.
- **Western Ghats**: It extends along a 17,000 km2 strip of forests in Maharashtra, Karnataka, Tamil Nadu and Kerala and has 40% of the total endemic plant species, 62% amphibians and 50% lizards are endemic to Western Ghats.

International Union for Conservation of Nature (IUCN) Red List



- **Least Concern (LC):** is an IUCN category assigned to extant taxon or lower taxa which have been evaluated but do not qualify for any other category such as threatened, Near Threatened, or (prior to 2001) Conservation Dependent. Many common species such as the Rock Pigeon, Honeybee, Asian Tiger, Mosquito, Common Juniper, Snail Kite, Sacred Kingfisher and House Mouse, as well as humans, are assigned the Least Concern category.
- **Near Threatened(NT):** species evaluated from 2001 onwards may also be ones which are dependent on conservation efforts to prevent their becoming threatened. Example: European Otter, Maned Wolf.
- **Vulnerable species:** is one which has been categorized by the International Union for Conservation of Nature (IUCN) as likely to become Endangered unless the circumstances threatening its survival and reproduction improve. A species is said to be vulnerable category if its population is facing continuous decline due to overexploitation or habitat destruction. Example: African Elephant,
- **Endangered (EN):** considered to be facing a very high risk of extinction in the wild. Its number has been reduced to a critical level or whose habitat, have been drastically reduced. Example: Sumatran orangutan, Cross River gorilla.
- **Critically Endangered (CR):** facing an extremely high risk of extinction in the wild. Example: Mountain Gorilla, Red Wolf
- **Extinct in the Wild (EW):** known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. Example: Hawaiian Crow (extinct in the wild since 2002), Wyoming Toad (extinct in the wild since 1991).
- **Extinct (EX):** there is no reasonable doubt that the last individual has died. A species is said to be extinct when it is not seen in the wild for 50 years at a stretch example: Dodo, passenger pigeon.
- **Rare Species:** Species which are not endangered or vulnerable at present but are at risk are categorized as rare species. These taxa are usually localized within restricted areas i.e. they are usually endemic.

Example of some endangered species:

- Reptiles: Gharial, green sea turtle, tortoise, python
- Birds : Great Indian Bustard, Peacock, Great Indian Hornbill, Siberian White Crane.
- Carnivorous Mammals : Indian Wolf, red fox, red panda, tiger, leopard, Indian Lion, golden cat, desert cat, striped hyena
- Primates: Hoolock gibbon, lion-tailed macaque, Nilgiri langur, capped monkey
- Plants: A large number of species of orchids, rhododendrons, medicinal plants like Rauvolfia serpentina,

Conservation of Biodiversity: Due to the immense important associated with the biodiversity it is important to maintain and conserve biodiversity on the earth system. A number of measures are now being taken the world over to conserve biodiversity including plants and wild life. Two types of conservation practices are present:

1. In Situ Conservation (within habitat): It means conservation of biodiversity in its natural habitat and mainly done by designated the natural habitat as protected area such as Biosphere reserve, National Park, Wild life Sanctuary, Reserve Forest etc. At present we have 18 major Biosphere reserves, 93 National Park, 512 Wild life Sanctuary in our country.

- **Biosphere Reserve**

  The idea of `Biosphere Reserves' was initiated by UNESCO in 1973-74 under its Man and Biosphere (MAB) Programme. The Indian National Man and Biosphere (MAB) Committee identifies and recommends potential sites for designation as Biosphere Reserves, following the UNESCO's guidelines and criteria. By 25th October 2007, fourteen Biosphere reserves have been established in India and some additional sites are under consideration.

  Biosphere Reserve (BR) is an international designation by UNESCO for representative parts of natural and cultural landscapes extending over large area of terrestrial or coastal/marine ecosystems or a combination thereof. BRs are thus special environments for both people and the nature and are living examples of how human beings and nature can co-exist while respecting each others' needs.

  As on 12th September, 2007 there were 507 Biosphere Reserves on World Network in 102 countries recognized by UNESCO which include Nilgiri, Sunderbans, Gulf of Mannar and Nanda Devi BRs from India.

  Structure and Design of Biosphere Reserves: In order to undertake complementary activities of biodiversity conservation and development of sustainable management aspects, Biosphere Reserves are demarcated into three inter-related zones:

  - **The Core Zone**: The core zone is kept absolutely undisturbed. It must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism. A core zone secures legal protection and management and research activities that do not affect natural processes and wildlife are allowed.
  - **The Buffer Zone**: These uses and activities include restoration, demonstration sites for enhancing value addition to the resources, limited recreation, tourism, fishing and grazing, which are permitted to reduce its effect on core zone.
  - **The Transition Zone**: The Transition Zone is the outermost part of a Biosphere Reserve. The activities in this zone include settlements, crop lands, managed forests and area for intensive recreation, and other economic uses characteristic of the region.

- **National Park**

  A national park is an area dedicated for the conservation of some particular species of wildlife along with its environment. Grazing of domestic animals, all private rights and forestry activities are prohibited within a national park. As of April 2007, there are 93 national parks. All national park lands encompass a combined 38,029.18 km², 1.16% of India's total surface area.

- **Wild life Sanctuaries**

  These are also protected areas where killing, hunting, shooting or capturing of wildlife is prohibited except under the control of highest authority. However private ownership rights are permissible and forestry operations are also permitted to an extent that they do not affect the wild life adversely.

For the protection and conservation of certain animals there have been specific projects in our country. Example: Project Tiger, Gir Lion Project, Crocodile Breeding Project, Project Elephant, Snow Leopard project etc.

2. **Ex Situ conservation** (Outside Habitat) : This is done by establishment of Zoos, botanical garden, gene banks, seed banks, culture collection etc. This conservation strategy involve conserving the species outside its natural habitat in a controlled environment such as botanical garden for plants or a zoological park for animals, where there is expertise to multiply the species under artificially –managed conditions. Other majors are creating gene bank/ seed bank and using tissue culture methods to preserve important plant variety. In India, we have following important gene bank/ seed bank facilities:

    - **National Bureau of Plant Genetic Resources** (NBPGR): It is located in New Delhi. In this Institution agriculture and horticultural crops and their wild relatives are preserved by cryo-preservation of seeds, pollen etc. by using liquid nitrogen at a temperature as low as -196°C. Crop variety of rice, pearl millet, Brassica, turnip, radish, tomato, onion, carrot, chilli, tobacco etc are preserved using this technique.
    - **National Bureau of Animal Genetic Resources** (NBAGR): located at Karnal, Haryana. It preserves the genetic material of domesticated bovine animals.
    - **National Facility for Plant Tissue Culture Repository** (NFPTCR): It is for the development of a facility of conservation of varieties of crop plant/trees by tissue culture. It is a part of NBPGR.

Check Your Progress-2

1) Define Biodiversity. Discuss various levels of biodiversity.
2) Discuss values and threats are related in a biodiversity?
3) Discuss methods of conservation of biodiversity.
4) Discuss biodiversity hotspot. Discuss hotspots of diversity present in India.