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SCHOOL OF BIO AND CHEMICAL ENGINEERING

DEPARTMENT OF BIOTECHNOLOGY

UNIT – I – ENVIRONMENTAL SCIENCE – SBT1001

Unit-I Environment and Natural resources

Introduction

The word environment is coined form the French word "Environ" meaning" surround or surroundings" i.e., each and everything surrounding us. **E.g.** Lion in a forest surrounded by living and non-living things like air, water, trees, other animals etc.

DEFINITIONS

1. Environment

Environment is defined as "the sum of total of all the living and the non-living things around us influencing one another." **E.g.** Lion in a jungle surrounded by living and non-living things like air, water, trees, other animals etc.

2. Environmental Science

The study of the environment, its biotic (living) and abiotic (non-living) components and their interrelationship is called environmental science. It includes the basic concepts of physics, chemistry, geography, geology etc., which is used in understanding the structure, function and physical characteristics of environment.

3. Environmental Engineering

Environmental engineering is the application of engineering principles, science, education, ethics and law in the protection and enhancement of the quality of environment, public health and welfare.

4. Environmental Studies

Environmental studies are the process of educating the people for preserving quality environment. It is the multidisciplinary studies of science, engineering, technology and management which shows the impact of human activities on the environment.

TYPES OF ENVIRONMENT

Environment is divided into 2 types:

1. **Natural Environment:** Natural environment consists of natural

components including all biotic (biological) and abiotic (physical) components created through a natural process without any human support.
E.g. Soil, water, air, trees, radiations, noise etc.

2. Man- made environment: Man is most powerful agent who modifies the environment using modern technologies, according to his needs for survival and well-being.
E.g. Houses, parks, hospitals, schools, roads etc.

SCOPE OF ENVIRONMENTAL STUDIES

Environmental Studies is the tool for educating people to preserve environment. Main scope includes:

1. To get awareness and sensitivity of environment and its related problems.

2. To motivate the active participation of individuals in the protection and improvement of environment.
3. To develop skills for identifying and solving environmental problems.
4. To know the necessity of conservation of natural resources.
5. To conduct environmental programmes in terms of social, economic, ecological and aesthetic factors.

IMPORTANCE/ SIGNIFICANCE/ NEED OF ENVIRONEMNTAL STUDIES

The air we breathe, water we drink, food we eat and the land we live are all polluted. There is no zero pollution.

To solve the above problems, knowledge of environment and its studies are very important.

1. To understand the concept of "need of development without destruction of environment".
2. To gain knowledge of different types of environment their various resources and the effects of different environmental hazards.
3. To inform people about their effective role in protecting the environment by demanding changes in laws and enforcement systems.
4. To develop a concern and respect for the environment.

NEED FOR PUBLIC AWARENESS

1. Necessity to maintain a natural balance, sensible planning of development in order to save humanity from extinction.
2. To check nominal use of natural resources as watch dogs informing government about the degradation of environment.
3. To educate and create awareness through mass media like tv, radio, short films, internet, mobile phones, etc.,
4. To motivate and active participation of individuals in protecting the environment from various types of pollution.

Unit I - NATURAL RESOURCES

Natural resources (economically referred to as land or raw materials) occur naturally within environment existing relatively undisturbed by mankind, in the natural form.

1.1.FOREST RESOURCES: It is one of the most important renewable natural resources on this earth. About one-third of the world‟s land surface is covered with forest.

Commercial uses

(i) Man depends heavily on a larger number of plant and animal products from forests for his daily needs.

(ii) The chief product that forests supply is wood, which is used as fuel, raw material for various industries as pulp, paper, newsprint, board, timber for furniture items, other uses as in packing articles, matches, sports goods etc.

(iii) Indian forests also supply minor products like gums, resins, dyes, tannins, fibers, etc.

Many of the plants are utilized in preparing medicines and drugs; Total worth of which is estimated to be more than $300 billion per year.

(iv) Many forests lands are used for mining, agriculture, grazing, and recreation and for development of dams.

Depending upon the climate conditions, forest may be classified as:

1. Tropical Rain Forests: They are evergreen broadleaf forests found near the equator. They are characterized by high temperature, high humidity and high rainfall, all of which favor the growth of trees.
2. Tropical deciduous forests: They are found a little away from the equator and are characterized by a warm climate the year round. Rain occurs only during monsoon.
3. Tropical scrub forests: They are found in areas where the day season is even longer.
4. Temperate rain forests: They are found in temperate areas with adequate rainfall. These are dominated by trees like pines, firs, redwoods etc.
5. Temperate deciduous forests: They are found in areas with moderate temperatures.
6. Evergreen coniferous forests (Boreal Forests): They are found just south of arctic tundra. Here winters are long, cold and dry. Sunlight is available for a few hours only.

Ecological uses:

The ecological services provided by our forests may be summed up as follows:

(i) Production of Oxygen: The main greenhouse gas carbon dioxide is absorbed by the forests as a raw material for photo synthesis. Thus forest canopy acts as a sink for carbon dioxide thereby reducing the problem of global warming caused by greenhouse gas CO_2

(ii) Wild life habitat: Forests are the homes of millions of wild animals and plants. About 7 million species are found in the tropical forests alone.

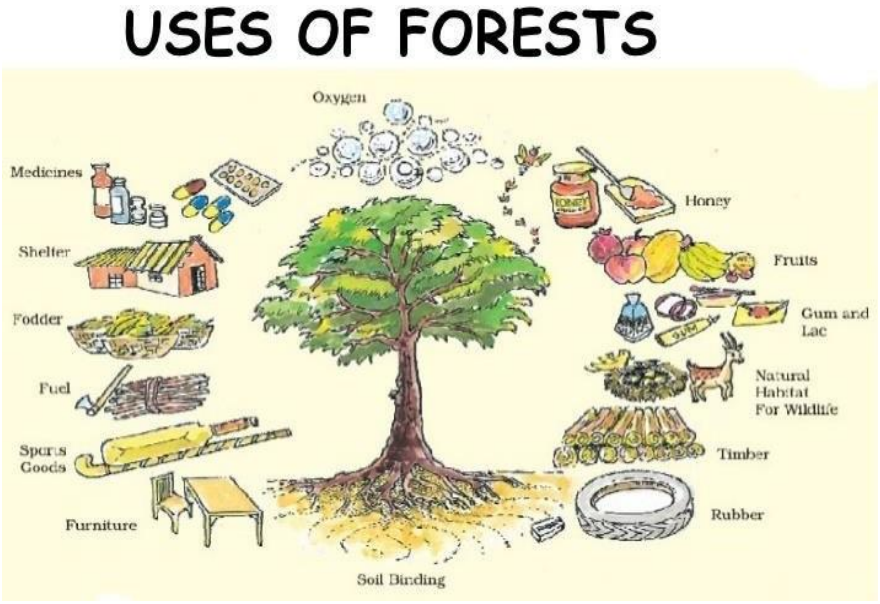
(iii) Regulation of hydrological Cycle: Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff. They control climate through transpiration of water and seed clouding.

(iv) Soil Conservation: Forests bind the soil particles tightly in their roots and prevent soil erosion. They also act as wind breakers.
(v) Pollution moderators: Forests can absorb many toxic gases and can help in keeping the air pure and in preventing noise pollution.

Aesthetic values: Forests also have aesthetic values and serve as generates of important species. Ex;
1. Tribal utilize bamboo and wild grass for making other products like mats, baskets, cots etc.,
2. There are varieties of daily plants fruits, leaves, seeds, roots are used as food by tribal and poor people.
3. Many kinds of alcoholic drinks and medicines are derived.
4. Aromatic oils and other oils used for lighting and cooking, are also derived from forests.

Touristic value: Ecotourism provides a growing income for those who have facilitated it.

Uses of Forests:



Over Exploitation of Forests: Due to over-population the materials supplied by the forest like food, medicine, shelter, wood and fuel are not sufficient to meet the people‟s demand. Hence exploitation of forest materials is going to increasing day by day. Causes for over exploitations are.

Especially with growing civilization, the demand for raw materials like timber, pulp, minerals, fuel wood, etc., increases resulting in large scale logging, mining, building and cleaning forests.

The international timber trade alone is worth over US $ 40 billion per year.
The devastating effects of deforestation in India include soil, water and wind erosion, estimated to cost over 16,400 cores every year.

Effects of over exploitation:

1. Leads to migration of the *farmers.*
2. Environmental damage caused by *over exploitation.*
3. Tropical forests are destroyed at *very fast rate.*
4. Countless *plant species and animals* at very fast rate.
5. Marine pollution will go into extinction.
6. Dumping of wastes into *land, water and air* has become a severe problem.

Deforestation: It is the process of removal of forest resources due to many natural or man-made activities. In general deforestation means destruction of forests.

The total forests area of the world in 1900 was estimated to be 7,000 million hectares which was reduced to 2890 million ha in 1975 fell down to just 2,300 million ha by 2000.

Deforestation rate is relatively less in temperature countries, but it is very alarming in tropical countries. Deforestation is a continuous process in India where about 1.3 hectares of forest land has been lost. The per capita availability of forest in India is 0.08 hectares per person which is much lower than the world average of 0.8 hectares. The presence of waste land is a sign of deforestation in India.

Causes of Deforestation: Major causes of deforestation are listed below:

1. Development projects
2. Shifting cultivation
3. Fuel requirements cutting and burning
4. Construction of dams
5. Growing food needs.
6. Forest fire

Consequences of deforestation: Some of the effects of deforestation are listed below:

a) Effect on climate: Global warming, Less rainfall, Hot climate etc.,

b) Effect on biodiversity: Loss of medicinal plants, Loss of timber and fuel wood.

c) Effect on resources: Loss of land resource, Loss of soil fertility, Soil erosion and Drastic changes in biogeochemical cycles

d) Effect on economy: Increase in medicinal values, Demand of industrial products etc.,

e) Effect on food: Loss of fruit production, Loss of root based foods.

Preventive measures or avoid of deforestation:

1. Planting of new trees.
2. Use of wood for fuel should be discouraged.
3. Forests pests can be controlled by spraying pesticides.
4. Forest fire must be controlled by modern techniques.
5. Over grazing by cattle must be controlled.
6. Steps should be taken by government to discourage the migration of people.
7. Education and awareness programmes must be conducted.
8. Strict implementation of law of forest conservation act.

Case Studies:

(i) Desertification in hilly regions of the Himalayas:

Desertification in Himalayas, involving clearance of natural forests and plantation of monocultures like Pinus roxburghi, Eucalyptus camadulensis etc., have upset the ecosystem by changing various soil and biological properties.

The area is invaded by exotic weeds. These areas are not able to recover and are losing their fertility.

(ii) Disappearing Tea gardens in Chhota Nagpur:

Following the destruction of forest rain fall declined in Chhota Nagpur to such an extent that tea-gardens also disappeared from the region.

(iii) Waning rain fall in Udhagamandalam:

The rainfall pattern was found to fluctuate with wooded land area in the hills. When the Nilgiri mountains had luxuriant forest cover annual rainfall used to be much higher.

TIMBER EXTRACTION: Logging for valuable timber such as teak and mahogany not only involves a few large trees per hectare but about a dozen more trees since they are strongly interlocked with each other by vines etc.

Uses: 1. Industries like pulp and paper, composite wood, furniture etc.,
2. Developmental activities like railways, boats, road construction etc.,

Effects:
1. Large scale timber extraction causes deforestation.
2. It is leads to soil erosion, loss of fertility, landslides, loss of biodiversity etc.,
3. It is also leads to loss of tribal culture and extinction of tribal people.
4. Thickness of forest also reduced.

Also road construction for making approach to the trees causes further damage to the forests. In India, firewood demand would continue to rise in future mostly consumed in rural areas, where alternative sources of energy, are yet to reach.

MINING: It is the process of extracting minerals resources and fossil fuels like coal from the earth.
Types of mining: It is generally divided into two types.
1. Surface mining: shallow deposits.
2. Underground mining: deep deposits.
Steps involved in mining: It involves the following five steps.
Step 1: Exploration (investigation and searching of minerals)
Step 2: Development
Step 3: Exploitation (extraction of minerals)
Step 4: Ore processing (Separation of ores)
Step 5: Extraction and purification of minerals.

More than 80,000 ha of land of the country are presently under the stress of mining activities.

Effects of mining:

- ✓ Mining activity not only destroys trees, but also affects soil, water and air.
- ✓ Destruction of natural habitat.
- ✓ Due to continuous removal of minerals, forest covers, trenches are mixed with ground water.
- ✓ Vibration are developed, which leads to earthquake.
- ✓ When materials are disturbed in significant quantities during mining process.
- ✓ Noise pollution is another problem from mining operations.
- ✓ It also reduces the shape and size of the forest areas.
- ✓ Sometimes landslides may also occur.

- ✓ Migration of people from mining areas to other areas for searching land and food.
- ✓ Indiscriminate mining in Goa since 1961 has destroyed more than 50,000 ha of forest land.
- ✓ Mining of radioactive mineral in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation.

DAMS AND THEIR EFFECTS ON FORESTS AND TRIBAL PEOPLE:

Dams are the massive artificial structures built across the river to create a reservoir in order to store water for many beneficial purposes. However, it‟s also responsible for the destruction of vast areas of forest and displacement of local people.

India scenario: India has more than 1600 large dams.

States	Number of dams
Maharashtra	More than 600 dams
Gujarat	More than 250 dams
Madhya Pradesh	More than 130 dams

Tehri dam is the highest built across the river in the state of Uttaranchal.

Effects of dams:

- ✓ *Thousands of hectares* of forest have been cleared for executing river.
- ✓ The forest also cleared for residential accommodation, storing materials, laying roads etc.,
- ✓ *Hydroelectric projects* also have led to loss of forest.
- ✓ Construction of dams under these projects led to *killing of wild animals & aquatic life.*
- ✓ The big river valley projects also cause water logging which leads to *salinity and fertility of the land.*

Ex: 1. Narmada sagar project: (it has submerged 3.5 lakes hectares of forest in teak and bamboo trees).

2. Tehri dam: 1000 hectares of forest affecting about 430 species of plants.

Effects of dam on tribal people:

- ✓ Tribal people are ill-treated by modern society.
- ✓ Many of the displaced people were not recognized and resettled or compensated.
- ✓ Tribal people and their culture cannot be questioned and destroyed.
- ✓ Displacement and cultural change affects the tribal people for both mentally and physically.
- ✓ Tribal people will not suit with the new areas and hence they will be affected by many diseases.
- ✓ The greatest social cost of big dam is the widespread displacement of tribal people; such a biodiversity cannot be tolerated.

1.2.WATER RESOURCES:

Water is an important component of all living beings. Nearly 80% of earth‟s surface is covered by water.

Ex: 1. A tree is made up of 60% by weight of water
2. Animals are made up of 50-65% of water

Forms of water: Water exists in three phases, solid, liquid and gas. It is circulated in accordance with the hydrological cycle.

1.9.2 Hydrological cycle

1. Evaporation
2. Precipitation
3. Transpiration

1. **Evaporation** : The transformation of water from liquid to gas phases as it moves from the ground or bodies of water into the overlying atmosphere. The source of energy for evaporation is primarily solar radiation. Evaporation often implicitly includes transpiration from plants, though together they are specifically referred to as evapotranspiration. Total annual evaporation amounts to approximately 505,000 km^3 (121,000 cu mi) of water, 434,000 km^3 (104,000 cu mi) of which evaporates from the oceans.

2. **Precipitation:** Condensed water vapor that falls to the Earth's surface .Most precipitation occurs as rain, but also includes snow, hail, fog drip, graupel, and sleet. Approximately 505,000 km^3 (121,000 cu mi) of water falls as precipitation each year, 398,000 km^3 (95,000 cu mi) of it over the oceans.

3. **Condensation:** The transformation of water vapor to liquid water droplets in the air, creating clouds and fog.

4. **Transpiration:** The release of water vapor from plants and soil into the air. Water vapor is a gas that cannot be seen.

Snowmelt :The runoff produced by melting snow.

Runoff : The variety of ways by which water moves across the land. This includes both surface runoff and channel runoff. As it flows, the water may seep into the ground, evaporate into the air, become stored in lakes or reservoirs, or be extracted for agricultural or other human uses.

Infiltration: The flow of water from the ground surface into the ground. Once infiltrated, the water becomes soil moisture or groundwater.

Subsurface Flow: The flow of water underground, in the vadose zone and aquifers. Subsurface water may return to the surface (e.g. as a spring or by being pumped) or eventually seep into the oceans. Water returns to the land surface at lower elevation than where it infiltrated, under the

force of gravity or gravity induced pressures. Groundwater tends to move slowly, and is replenished slowly, so it can remain in aquifers for thousands of years.
Sublimation: The state change directly from solid water (snow or ice) to water vapor.

Flow chart

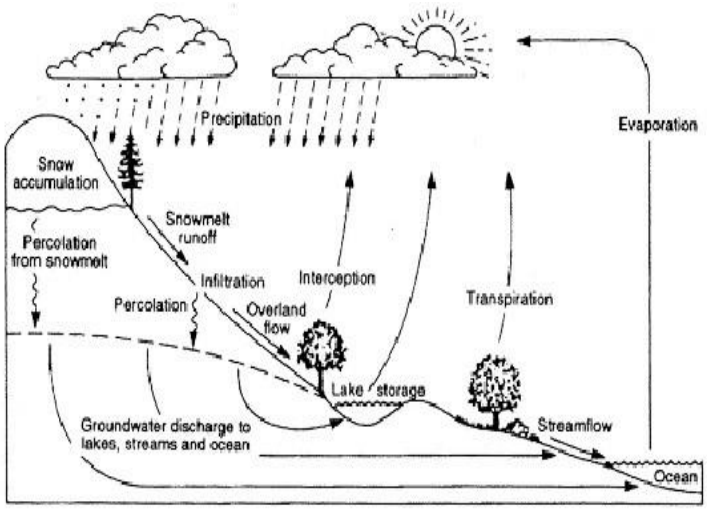


Fig. Water Cycle

Uses of water Resources-Different Types: (Mainly two types)
1. Consumptive Use: Water is completely utilized and is not reused: (in domestic application, industry and irrigation).
2. Non-Consumptive Use: Water is not completely utilized and is reused: (Hydro power plant).
3. Other important Use of Water:
(i) Mainly used for domestic purposes- drinking, cooking, washing, bathing etc.,
(ii) Due to its unique properties, water is of multiple uses for all living organisms.
(iii) Water is absolutely essential for life.
(iv) Most of the life processes take place in water contained in the body.
(v) Uptake of nutrients, their distribution in the body, regulation of temperature, and removal of wastes are all mediated through water.
(vi) Human beings depend on water for almost every developmental activity.
(vii) Water is used for drinking, irrigation, and transportation, washing and waste disposal for industries and used as a coolant for thermal power plants.
(viii) Water shaped the earth's surface and regulates our climate.

OVER UTILIZATION OF SURFACE AND GROUND WATER: With increasing human population and rapid development, the world water withdrawal demands have increased many folds and a large proportion of the water withdrawn is polluted due to anthropogenic activities.

Out of the total water reserves of the world, about 97% is salty water and only 3% is fresh water. Even this small fraction of fresh water is not available to us as most of it is locked up in polar ice caps and just 0.003% is readily available to us in the form of ground water and surface water.

Effects of over exploitation of water:

1. Decrease of Ground Water - Due to increased usage of ground water, the ground water level decreases.

Reason: a) The erratic and inadequate rainfall.

b) The building construction activities are sealing the permeable soil zone, reduce the area for percolation of rain water and increase in surface runoff.

2. Ground subsidence: When the ground water withdrawal is more than its recharge rate, the sediments in the aquifer get compacted, which results in sinking of overlaying land surface (Ground subsidence).

Problems:

1. Structural damage in buildings
2. Fracture in Pipes
3. Reversing the flow of canals and tidal flooding.

3. Lowering of water table: Over utilization of ground water disturb the hydrological cycle.

1. Lowering of water table
2. Decreased pressure in the aquifers and change in the speed and direction of water flow.

4. Intrusion of salt water: In coastal area, over exploitation of ground water would lead to rapid intrusion of salt water from the sea.

Problems: Water cannot be used for drinking and agriculture

5. Earthquake and landslides: Over utilization of ground water leads to decrease in water level, which cause earthquake, landslides and famine.

6. Earthquake and Landslides - As a result of over utilization of ground water, the level of ground water getting depleted.

7. Pollution of water - When ground water level near the agricultural land decrease. water containing the nitrogen as nitrate fertilizer, percolates rapidly into the ground and pollute the ground water.

Problems: Water becomes unsuitable for potable use by infants, when nitrate concentration exceeds 45 mgs/ lit**.**

FLOODS AND DROUGHT:

1. Heavy rainfall often causes floods in the low-lying coastal areas.
2. Prolonged downpour can also cause the over-flowing of lakes and rivers resulting into floods.
3. When annual rainfall is below normal and less than evaporation, drought conditions are created.

Fig. Drought

Causes of flood and drought:

(i) Deforestation, overgrazing, mining, rapid industrialization, global warming etc., have contributed largely to a sharp rise in the incidence of floods.

(ii) Deforestation leads to desertification and drought too. When the trees are cut, the soil is subject to erosion by heavy rains, winds and sun.

(iii) The removal of thin top layer of soil takes away the nutrients and the soil becomes useless. The eroded soils exhibit droughty tendency.

Preventive measures:

1. Clear knowledge in control of drought and desertification can be very useful for dealing with the problem.
2. Carefully selected mixed cropping helps to optimize production and minimize the risks of crop failures.
3. Social forestry and Wasteland development can prove quite effective to fight the problem, but it should be based on proper understanding of ecological requirement and natural process.

CONFLICTS OVER WATER: Indispensability of water and its unequal distribution has often led to inter-state or international disputes. Issues related to sharing of river water have been largely affecting our farmers and also shaking our governments. Many countries are engaged in bitter rivalries over this precious resource.

For instance,

(i) Argentina and Brazil, dispute each other's claims to the La Plata river,
(ii) India and Pakistan fight over the rights to water from the Indus,
(iii) Mexico and USA have come in conflict over the Colorado river,
(iv) India and Bangladesh are fighting for Bhrahmaputra river, and
(v) Iran and Iraq contest for the water from Shatt-Al- Arab River.

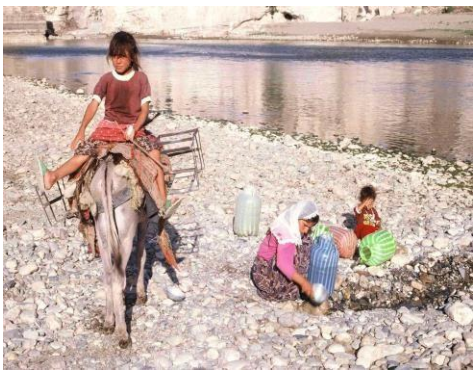


Fig. Conflicts of water

Within India, water conflicts are still being continues between the states.

For Eg.,

1. Sharing of Krishna water between Karnataka and Andhra Pradesh,
2. Sharing of Siruvani water between Tamilnadu and Kerala, and others.
3. Sharing of Cauvery between Karnataka and Tamilnadu
4. On June 2,1990, the Cauvery Water dispute Tribunal was set up which through an interim award directed Karnataka to ensure that 205 TMCF of water was made available in Tamil Nadu's Mettur dam every year, till a settlement was reached.

5. In 1991-1992 due to good monsoon, there was no dispute. In 1995, the situation turned into a crisis due to delayed rains and an expert Committee was set up to look into the matter which found that there was a complex cropping pattern in Cauvery basin.
6. Samba paddy in winter, Kuravai paddy in summer and some cash crops demanded intensive water; thus aggravating the water crisis.
7. Proper selection of crop varieties, optimum use of water, better rationing are suggested as some measures to solve the problem

1.13 BIG-DAMS –BENEFITS AND PROBLEMS

Dams are built across the river in order to store water for drinking, agricultural, industrial purpose. Now days they are mainly used for the hydropower production.
Benefits:
1. Dams are built to control flood and store flood water.
2. Used for diverting the water from river into a channel.
3. Used mainly for drinking and agricultural purposes.
4. Dams are built for generating electricity.
5. Dams are used for recreational purposes
6. Navigation and fishery can be developed in the dam area.
Problems: Problems of constructing dams:
Upstream problems:

- Displacement of tribal people.
- Loss of non-forest land.
- Loss of forests, flora and fauna.
- Landslips, sedimentation and siltation occurs.
- Stagnation and water logging around reservoirs retards plant growth.
- Breeding of vectors and spread of vector-borne diseases.
- Reservoir induced seismicity causes earthquakes.
- Navigation and aquaculture activities can be developed in the dam area.

Downstream problems:

- ✓ Water logging and salinity due to over irrigation.
- ✓ Reduce water flow and slit deposition in rivers.
- ✓ Salt water intrusion at river mouth.
- ✓ Sediments carrying nutrients get deposited in the reservoir, the fertility of the land along the river gets reduced.
- ✓ Due to structural defects the dam may collapse suddenly and destroy many living organisms.
- ✓ Salt water intrusion at river mouth.

1.3. MINERAL RESOURCES:

Minerals are naturally occurring substances with definite chemical and physical properties.

Formation of mineral deposits: „Concentration of minerals at a particular spot, which can be extracted profitably, gives rise to a mineral deposit. Formation of these deposits is a very slow biological process-it takes millions of years.

Various Biological Processes

- ✓ Minerals formed, due to the biological decomposition of dead animals and organic matters

- ✓ Minerals formed, due to the concentration of minerals during cooling of molten rock.
- ✓ Formed due to evaporation of sea water
- ✓ Formed due to oxidation-Reduction reaction inside the earth
- ✓ Minerals also formed, due to concentration of minerals during weathering, transport and sedimentation.

Classification of Mineral Resources:

1. Identified Resources - The location, existence, quantity and quality of these mineral resources are known by direct geological evidences and measurements.
2. Undiscovered Resources - To exist on the basis of geological knowledge and theory but their specific locations, quantity, and quality are unknown
3. Reserves-identified resources - From which a usable minerals can be extracted profitably.

Uses of minerals:

- Development of industrial plants and machinery – *Fe, Al, Cu* etc.,
- Construction, housing, settlements - *Fe, Al, Ni* etc.,
- Generation of energy - Coal, Lignite, Uranium etc.,
- Designing defence equipments, weapons, ornaments.
- Agricultural purposes, as fertilizers, seed dressings and fungicides - Ex: zineb (Zn), Maneb (Mn)
- Jewellery - Au, Ag, Pt, and Diamond.
- Making of alloys for various purposes - Phosphorites.
- Communication purposes - Telephone wires, cables, electronic devices.
- Medicinal purposes (Ayurvedic) - Sulphur pyrites.

Table 1 Distribution and uses of major reserves and metals

Metals	Major world reserves	Major uses
Aluminum	Australia, Jamaica	Packing food items, transportation, utensils, electronics
Chromium	CIS(The common wealth of Independent states), South Africa	For making high strength steel alloys, in textiles and tanning industries
Copper	U.S.A, Canada, CIS	Electronic and electrical goods, building, construction, vessels
Iron	CIS, Canada, U.S.A	Heavy machinery, steel production transportation means.
Manganese	South Africa, CIS	For making high strength heat resistant steel alloys
Platinum	South Africa, CIS	Use in automobiles, catalytic converters, electronics, medical uses.
Gold	South Africa, CIS, Canada	Ornaments, medical use, electronic use, in aerospace

Silver	Canada, South Africa	Photography, electronic jewellery.
Nickel	CIS, Canada	Chemical industry, steel alloys

Table 2 Major uses of some of the nonmetallic minerals

Non-metal mineral	Major uses
Silicate minerals	Sand and grovel for construction, bricks, paving etc.
Limestone	Used for concrete, building stone, used in agriculture for neutralizing acid soils, used in cement industry
Gypsum	Used in plaster wall-board, in agriculture
Potash, phosphorite	Used as fertilizers
Sulphur pyrites	Used in medicine, car battery, industry

Environmental impacts of mineral extraction:

Mining: „Mining is the process of extraction of metals from a mineral deposits"

Types of Mining:

1. Surface Mining: Process of extraction of raw materials from the near-surface deposits.
2. Underground Mining: Process of extraction of raw materials below the earth"s surface.

Open-pit Mining - Machines dig holes and remove the ores. Ex: Fe, Cu, Limestone, sand stone, marble etc.,

Dredging: Chained buckets and draglines used, which scrap up the minerals from under water mineral deposit.

Strip Mining: the ore is stripped off by using bulldozers, stripping wheels.

Environmental Damage: - (Caused by Mining activities)

1. Devegetation and defacing of landscape
2. Groundwater contamination
3. Underground Mining
4. Surface water pollution
5. Air pollution
6. Subsidence of land
7. Occupational Health Hazards:

Effects of over exploitation of mineral resources:

1. Rapid depletion of mineral deposits
2. Wastage and dissemination of mineral deposits
3. Causes environmental pollution

Remedial measures:

1. Adopting eco-friendly mining technology
2. Utilization of low grade ores by using microbial – leaching technique. In this method, the ores are inoculated with the desired strains of bacteria like Thiobacillus ferroxidans, which remove the impurities and leave the pure mineral.
3. Re-vegetating mined areas with appropriate plants
4. Gradual restoration of flora
5. Prevention of toxic drainage discharge.
6. Modernization of the mining industries

7. Search for new deposit
8. Reuse and Recycling of the metals

Case studies:

1. Mining and quarrying in Udaipur:

Soap stones, building stone, and dolomite mines spread over 15,000 hectares in Udaipur have caused many adverse impacts on environment. About 150 tons of explosives are used per month in blasting. The Maton mines have badly polluted the Ahar river. The hills around the mines are suffering from acute soil erosion.

The waste water flows towards a big tank of “Bag Dara".

Due to scarcity of water people are compelled to use this effluent for irrigation purpose.

The animals like tiger, lion, deer, and birds have disappeared from the mining area.

2. Mining in Sariska and Tiger Reserve in Aravallis:

The Aravalli range is spread over about 692 Km in the North-west India covering Gujrat, Rajasthan, Haryana, and Delhi. The hill is rich in mineral resources. Mining operations within and around the Sariska Tiger reserve has left many areas permanently infertile and barren.

The precious wild life is under serious threat.

1.4.FOOD RESOURCES:

Food is an essential requirement for survival of life. Main components are carbohydrates, fats, proteins, minerals and vitamins.

1. Croplands: Produces Grains and provides 76% of the earth‟s food. (Rice, wheat, maize, barley, sugarcane, potato, etc.,)

2. Rangelands: From the grazing livestock and provides 17% of the world‟s food. (Meat, Milk, fruits etc.,)

3. Oceans: Oceanic fisheries supply about 7% of the world‟s food. (Fish, prawn, crab)

Major food sources:

- ✓ Earth is provided with more than thousands of edible plants and animals.
- ✓ Only 15 plants and 8 terrestrial animal species supply 90% of our global intake of calories.

Ex: Rice, wheat, maize, barley, sugarcane, potato, pulses, fruits, vegetables, milk, meat, fish and sea food. Rice, wheat and maize are the major grains, provide more than 50% of the calories people consume.

World Food Problems:

1. Arises due the would population increases and cultivable land area decreases.
2. Environmental degradation like soil erosion, water logging, water pollution, salinity, affect agricultural lands.
3. Urbanization-deteriorates the affect agricultural lands.
4. Food grains are the major food for the people all over the world, the food problem raises.

5. Human activity-which degrade most of the earth‟s net primary productivity which supports all life.

Effects:

1. Every 40 million people die of undernourishment and malnutrition.
2. This means that every year our food problem is killing as many people as were killed by the atomic bomb dropped on Hiroshima during World War II.
3. This statistic emphasizes the need to increase our food production, and also to control population growth.
4. It is estimated that 300 million are still undernourished.

Under nutrition and Malnutrition:

1. Nutrition or nourished: The minimum calorie intake on a global scale-2,500 calories/ day.
2. Under nutrition or under nourished: People who cannot buy enough food to meet their basic energy needs suffer from under nutrition. They receive less than 90% of these minimum dietary calories. Effects- Mental retardation and infectious diseases such as measeles and diarrohea.
3. Malnutrition or malnourished - Deficiency or lack of nutrition often leads to malnutrition resulting in several diseases. Growth, Anemia, Goitre, Cretinism, Blindness etc.,

Impacts of overgrazing and agriculture

Overgrazing: Overgrazing can limit livestock production. Over grazing occurs when too many animals graze for too long and exceed the carrying capacity of a grass land area.

Impact of overgrazing

1. Land degradation: Overgrazing removes the grass cover. The humus content of the soil is decreased and it leads to poor, dry, compacted soil.
2. Soil erosion: The soil roots are very good binders of soil. When the grasses are removed, the soil becomes loose and susceptible to the action of wind and water.
3. Loss of useful species: Due to overgrazing the nutritious species like cenchrus, panicum etc. are replaced by thorny plants like Parthenium, Xanthium etc. These species do not have a good capacity of binding the soil particles and, therefore, the soil becomes more prone to soil erosion.

Agriculture: „Agriculture is an art, science and industry of managing the growth of plants and animals for human use‟. It includes cultivation of the soil, growing and harvesting crops, breeding and raising livestock, dairying and forestry.

Types of Agriculture:

1. Traditional agriculture
2. Modern or Industrialized agriculture

Traditional Agriculture: It involves a small plot, simple tools, surface water, organic fertilizers and a mix of crops. They produce enough food to feed their families and to sell it for their income.

Effects or Impacts of traditional agriculture:

a) Deforestation: cutting and burning of trees
b) Soil erosion: clearing of forest cover exposes the soil to wind and rainfall.
c) Loss of nutrients: organic matter in the soil gets destroyed and most of the nutrients are taken up by the crops within a short period. Thus soil becomes poor in nutrient, which makes the farmers shift to another area.

Modern Agriculture: It makes use of hybrid seeds of single crop variety, high-tech equipment's, lot of fertilizers, pesticides, and water to produce large amount of single crops.

Effects or Impacts of Modern agriculture:

1. Problems in using fertilizer:
   - ✓ Micronutrient imbalance: (excess N, P, K-causes micronutrient imbalance).
   - ✓ Blue baby syndrome: (Nitrate exceeds 25 mg/lit, it causes serious health problem).
   - ✓ Eutrophication: (A large Proportion of N & P fertilizer used in crop yield, is washed off by the run off) (affect the aquatic life).

2. Problems in using Pesticides:

First generation pesticides (As, S, Pb, Hg)
Second generation pesticides (DDT)
(i) Death of non-Target organisms
(ii) Bio-magnification (Non bio-degradable-harmful to the human beings).
(iii) Risk of cancer

3. Desired quality of an ideal pesticide:
   1. Kill only the target species
   2. It must be a bio-degradable
   3. It‟s should not produce new pests
   4. It‟s should not produce any toxic pesticide vapors.
   5. Excessive synthetic pesticide should not be used.
   6. Chlorinated or Organophosphate pesticides are hazardous-should not be used.

4. Water logging: „Is the land where water stand for most of the year‟.

Problems: Mechanical strength of the soil decrease sand crop yield falls.
Causes: Excessive water supply to the croplands, Heavy rain, Poor drainage
Remedy: Preventing excessive irrigation, Sub-surface drainage technology and bio-drainage by trees like Eucalyptus

5. Salinity: (pH of the water-exceeds 8.0): The water, not absorbed by the soil, undergo evaporation leaving behind a thin layer of dissolved salts in the topsoil. This process of accumulation of salts is called salinity of the soil (NaCl, $CaCl_2$, $MgCl_2$, Na_2SO_4, Na_2CO_3, $NaHCO_3$).

Problems: Due to salinity, the soil becomes alkaline and crop yield decreases.
Remedy: The salt deposit is removed by flushing, Sub-surface drainage system the salt water is flushed out slowly.

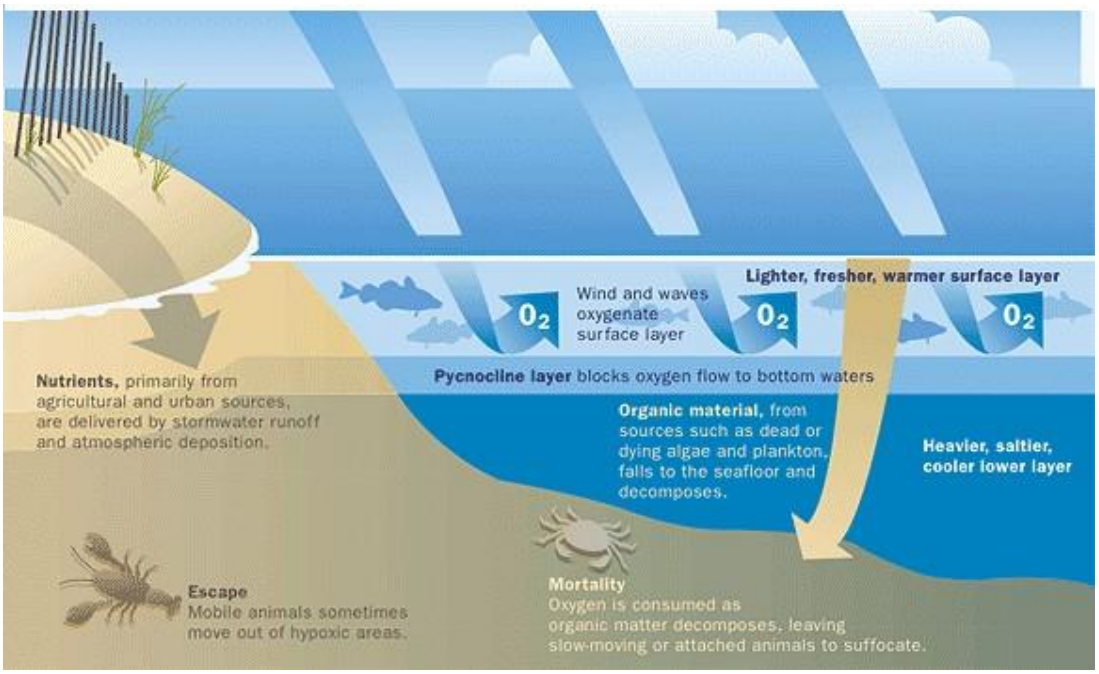


Fig. Eutrophication

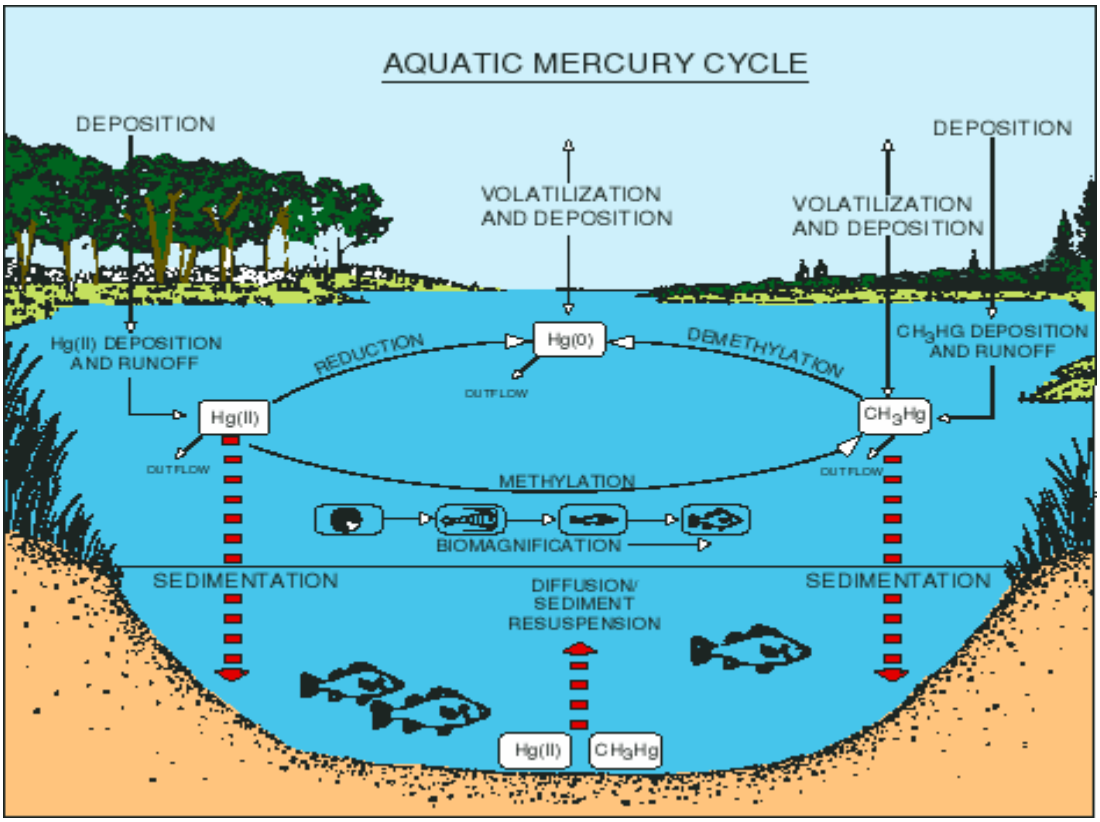


Fig. Biomagnification

Case studies:

1. Salinity and water logging in Punjab, Haryana and Rajasthan:

The first alarming report of salt-affected wasteland formation due to irrigation practices came from Haryana in 1858.

2. Several villages in Panipat, and Delhi lying in Western Yamuna Canal were suffering from salinity problems.

3. The floods of 1947, 1950, 1952, 1954-55 in Punjab resulted in aggravated water logging with serious drainage problems.

4. Rajasthan too has suffered badly in this regard following the biggest irrigation project "Indhra Gandhi Canal Project".

1.5.ENERGY RESOURCES:

Definition: Energy may be defined as, "any property, which can be converted into work."

(or)

Energy is defined as, "the capacity to do work."

Forms of energy, some of immediately used to do work; others require some process of transformation. Life is unthinkable without energy.
All the developmental activities in the world are directly or indirectly dependent upon energy. Energy production and energy utilization are the indicators of a country"s progress.

Development of energy:

1. The first form of energy is the fire.
2. The early man discovered fire and used it for cooking and heating purposes
3. Wood is the main source of energy, which is later replaced by coal.
4. Coal is now being replaced by the oil and gas.
5. Now due to insufficient availability and price hike, people started of thinking and using several alternative sources of energy.

Wood → coal → oil → alternate energy (solar, wind, tidal energy)

Growing energy Needs:

(i) Energy is essential to all human societies.
(ii) All industrial process like, mining, transport, living, heating and cooling in buildings, all require energy.
(iii) With the demands of growing population, the world is facing further energy deficit,
Our life style is also changing from al simple way of life to luxurious life style. At present 95% of the commercial energy is available only from the fossil fuels like coal, oil and natural gas, and are not going to last for many years. It would be really ironic if fuel becomes more expensive than food.

Energy Distribution –World Scenario

U.S.A and Canada 5% of the world"s population- consume 25% of the available world"s energy resources.
It has been observed, that in U.S.A and Canada an average person consumes 300 GJ (Giga Joules; equal to 60 barrels of oil) per year.

But in poor countries like Bhutan, Nepal and Ethiopia, an average person consumes less than 1 GJ per year. So a person in a developed country consumes almost as much energy in a single day as one person consumes in a whole year in a poor country. From the above scenario it is clear that our life style and standard of living are closely related to energy needs.

1. Renewable energy resources (or) non-conventional energy resources:

Natural resources can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner.

Example: Wood, solar energy, wind energy, hydropower energy, etc.,

Merits of renewable energy resources:

1. Unlimited supply.
2. Provides energy security.
3. Fits into sustainable development concept.
4. Reliable and the devices are modular in size.
5. Decentralized energy production.

2. Non- Renewable energy resources (or) Conventional energy resources:

Natural resources which cannot be regenerated once they are exhausted. They cannot be used again.

Example: Coal, petroleum, natural gas, and nuclear fuels.

Even our renewable resources can become non-renewable if we exploit them to such extent their rate of consumption exceeds their rate of regeneration.

Wood is renewable resources but not coal-why?

Wood is renewable resources because we can get new wood by growing sapling into a tree within 15-20 years. But the formation of coal from trees has taken millions of years and cannot be regenerated in our life time.

RENEWABLE ENERGY RESOURCES: Renewable resources are parts of our natural environment and form our eco-system

1. SOLAR ENERGY:

The energy that we get directly from the sun is called solar energy.

The nuclear fusion reactions occurring inside the sun release enormous amount of energy in the form of heat and light.

The solar energy received by the near earth space is approximately1.4 $kJ/s/m^2$ known as solar constant.

Methods of Harvesting Solar Energy:

(i) Solar cells (or) photovoltaic cells (or) PV cells:

Solar cells consist of a p-type semiconductor (such as Si doped with B) and n-type semi- conductor (Si doped with P). They are in close contact with each other. When the solar rays fall on the top layer of p-type semi-conductor, the electrons from the valence band get promoted to the conduction band and cross the p-n junction into n-type semi-conductor.

There by potential difference between two layers is created, which causes flow of electrons (ie.,an electric current)

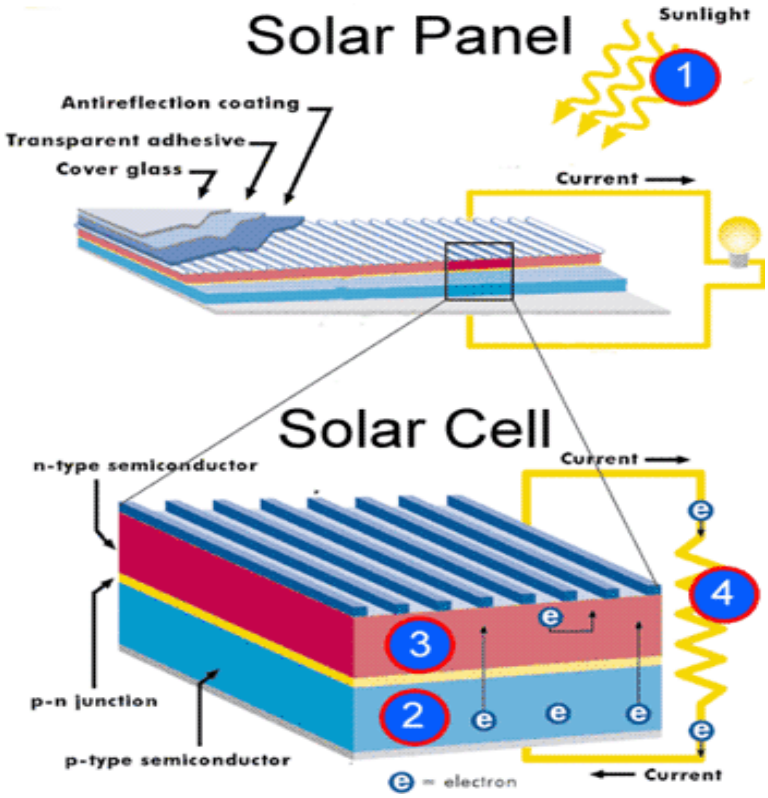


Fig. Solar cell

Uses:

Used in calculators, electronic watches. Street lights, water pumps to run radios and TVs.

(ii) Solar Battery: When a large number of solar cells are connected in series it forms a solar battery. Solar battery produces more electricity which is enough to run water pump, to run street-light, etc., They are used in remote areas where conventional electricity supply is a problem.

(iii) Solar heat collectors: Solar heat collectors consist of natural materials like stones, bricks, (or) materials like glass, which can absorb heat during the day time and release it slowly at night.

Uses:
Used in cold places, where houses are kept in hot condition using solar heat collectors.

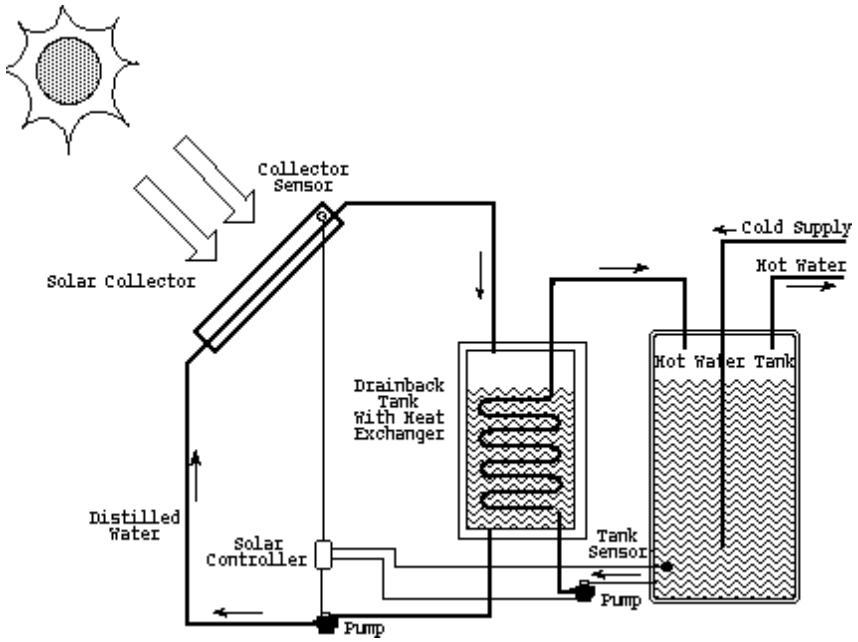


Fig. Solar heat collector

(iv) Solar water heater: It consists of an insulated box inside of which is painted with black paint. Provided with a glass lid to receive and store solar heat. Inside the box it has black painted copper coil, through which cold water is allowed to flow in, which gets heated up and flows out into a storage tank. From the storage tank water is then supplied through pipes.

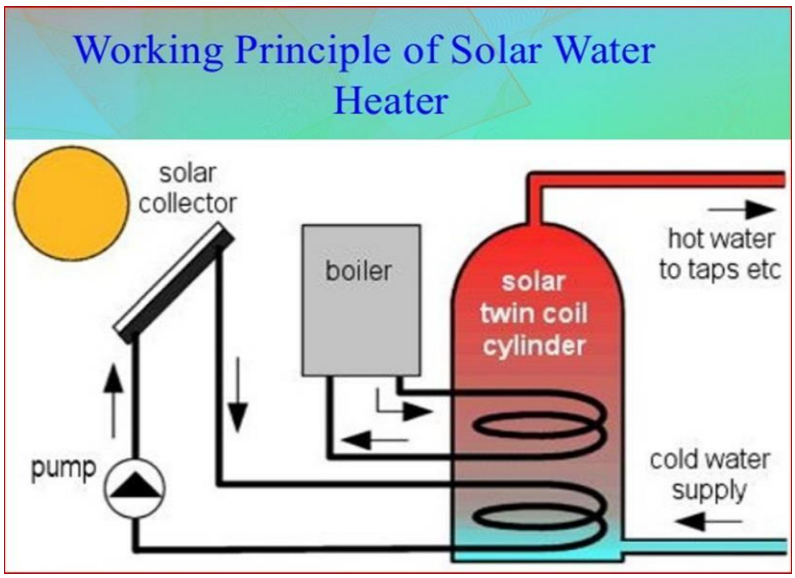


Fig. Solar water heater

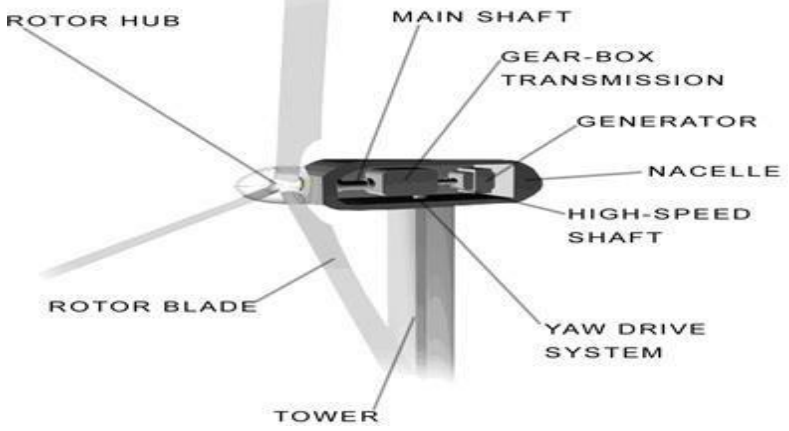
2. WIND ENERGY:

Definition: Moving air is called wind. Energy recovered from the force of the wind is called wind energy. The energy possessed by wind is because of its high speed. The wind energy is harnessed by making use of wind mills.

Harvesting of wind energy:

(i) Wind Mills: The strike of blowing wind on the blades of the wind mill makes it rotating continuously. The rotational motion of the blade drives a number of machines like water pump, flour mills and electric generators.

Fig. 1.9 Wind mill



(ii) Wind farms: When a large number of wind mills are installed and joined together in a definite pattern it forms a wind farm. The wind farms produce a large amount of electricity.

Conditions:

The minimum speed required for satisfactory working of a wind generator is 15 km/hr.

Advantages:

It does not cause any air pollution

It is very cheap.

3. OCEAN ENERGY:

It can be generated by following ways.

(i) Tidal energy (or) Tidal power: Ocean tides, produced by gravitational forces of sun and moon, contain enormous amount of energy. The "high tide" and "low tide" refer to the rise and fall of water in the oceans. The tidal energy can be harnessed by constructing a tidal barrage.

During high tide, the sea-water is allowed to flow into the reservoir of the barrage and rotates the turbine, which intern produces electricity by rotating the generators.

During low tide, when the sea level is low, the sea water stored in the barrage reservoir is allowed to flow into the sea and again rotates the turbine.

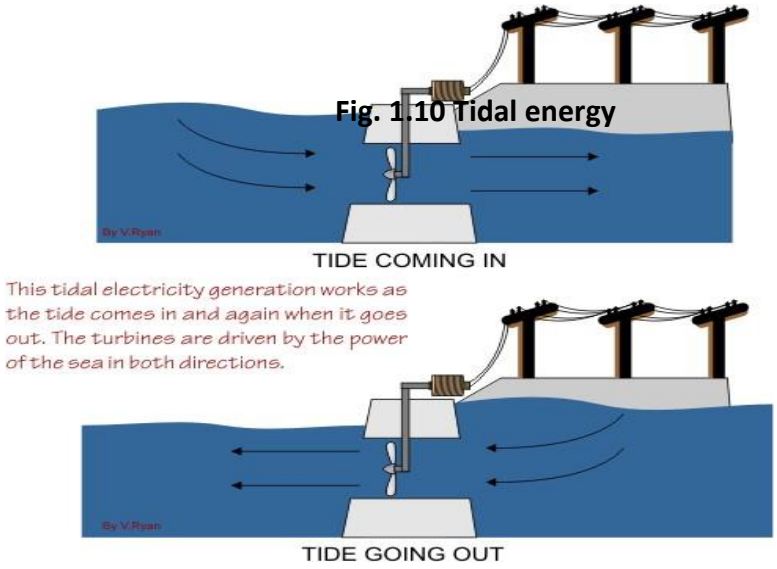


Fig. 1.10 Tidal energy

Significance of Tidal energy:

- ✓ Tidal power plants do not require large areas.
- ✓ As the sea water is inexhaustible, it is completely independent of the uncertainty of precipitation.
- ✓ It is pollution free energy sources, it does not use any energy fuel and also produced any wastes.

(ii) Ocean thermal energy (OTE): There is often large temperature difference between the surface level and deeper level of the tropical oceans. This temperature difference can be utilized to generate electricity. The energy available due to the difference in temperature of water is called ocean thermal energy.

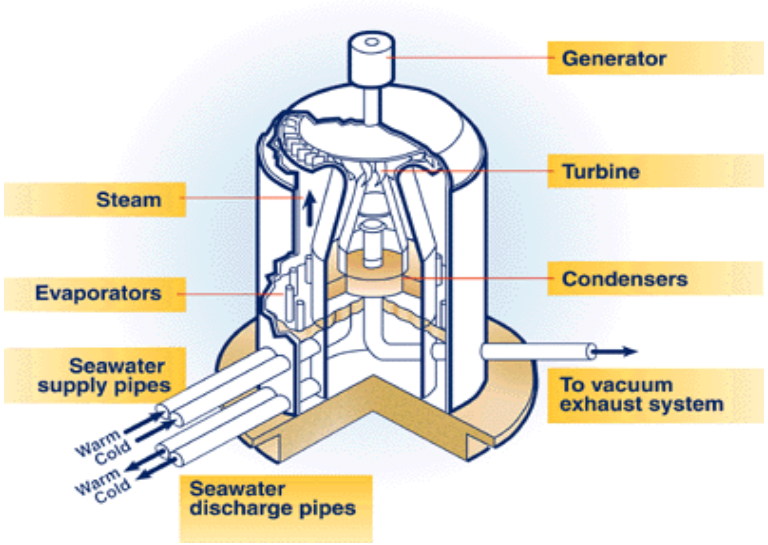


Fig. Ocean thermal energy

Condition:
The temperature difference should be of 20^0C or more is required between surface water and deeper water.

Process:
The warm surface water of ocean is used to boil a low boiling liquid like ammonia.
The high vapour pressure of the liquid, formed by boiling is then to turn the turbine of the generator and generates electricity.
The cold water from the deeper ocean is pumped to cool and condense the vapour into liquid.
Significance:

- ✓ OTE is continuous, renewable and pollution free.
- ✓ The use of cold deep water, as the chiller fluid in AC.
- ✓ Electric power generator by OTE can be used to produce hydrogen.

(iii) Geo-thermal Energy:
1. Temperature of the earth increases at a rate of 20-75^0C per km, when we move down the earth surface.
2. High temperature and high pressure steam fields exists below the earth‟s surface in many places.
3. The energy harnessed from the high temperature present inside the earth is called geothermal energy.

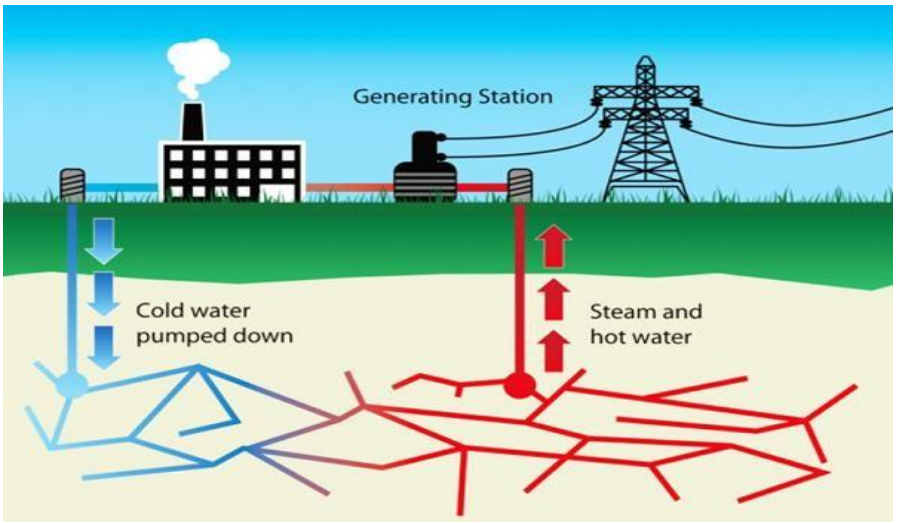


Fig. Geothermal energy

a) Natural geysers:
In some places, the hot water (or) steam comes out of the ground through cracks naturally in the form
b) Artificial geysers:
In some places, we can artificially drill a hole up to the hot region and by sending a pipe in it, we can make the hot water or steam to rush out through the pipe with very high pressure. Thus, the hot water (or) steam coming out from the natural (or) artificial geysers is allowed to rotate the turbine of a generator to produce electricity.

BIOMASS ENERGY: Biomass is the organic matter, produced by plants or animals, used as sources of energy. Most of the biomass is burned directly for heating, cooling and industrial purposes. Eg: Wood, crop residues, seeds, cattle dung, sewage, agricultural wastes.

Biogas: Mixture of methane, carbondioxide, hydrogen sulphide, etc., It contains about 65% of methane gas as a major constituent

Biogas is obtained by the anaerobic fermentation of animal dung or plant wastes in the presence of water.

(i) Bio fuels:

Biofuels are the fuels, obtained by the fermentation of biomass. Eg: Ethanol, Methanol

(a) Ethanol:

Ethanol can be easily produced from the sugarcane. Its calorific value is less when compared to petrol, and produces much less heat than petrol.

(b) Methanol:

Methanol can be easily obtained from ethanol or sugar-containing plants.

Its calorific value is also too low when compared to gasoline and diesel.

(c) Gasohol:

Gasohol is a mixture of ethanol+gasoline.

In India trial is being carried out to use Gasohol in cars and buses.

i. Gasohol is common fuel in Brazil and Zimbabwe for running cars and buses.
ii. Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Due to its high calorific value, hydrogen can serve as an excellent fuel.
iii. Moreover it is non-polluting and can be easily produced.
iv. Presently H_2 is used in the form of liquid hydrogen as a fuel in spaceships.

(ii) **Hydrogen Fuel:** Hydrogen can be produced by thermal dissociation or photolysis or electrolysis of water. It possesses high calorific value, it is non-polluting, because the combustion product is water.

$$2H_2 + O_2 \text{-----} > 2H_2O + 150KJ$$

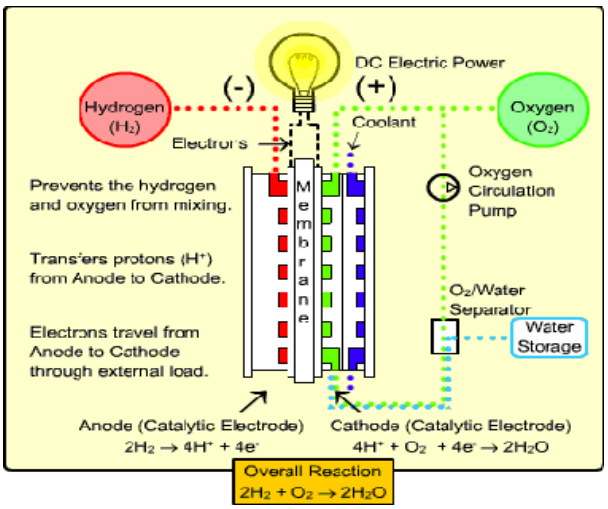


Fig. Hydrogen fuel cell

Disadvantages of hydrogen fuel:
1. Hydrogen is highly inflammable and explosive in nature
2. Safe handling is required
3. It is difficult to store and transport.

NON-RENEABLE ENERGY SOURCES:
1. Coal: Coal is a solid fossil fuel formed in several stages as buried remains of land plants that lived 300-400 million years ago were subjected to intense heat and pressure over millions of years.
Various stages of coal
Wood ⟶ Peat ⟶ Lignite ⟶ Bituminous coal ⟶ Anthracite

1. The carbon content of Anthracite is 90% and its calorific value is 8700 k.cal.
2. The carbon content of bituminous, lignite and peat are 80, 70 and 60% respectively
3. India has about 5% of world‟s coal. Indian coal is not good because of poor heat capacity.

Disadvantages
1. When coal is burnt it produces CO_2 causes global warming
2. Since coal contains impurities like S and N, it produces toxic gases during burning.

2. Petroleum: Petroleum or crude oil = hydrocarbons +small amount S, O, N.
Occurrence
The fossil fuel formed by the decomposition of dead animals and plants that were buried under lake and ocean at high temperature and pressure for million years
Fractional distillation
Hydrocarbons are separated by fractioning the crude oil.
Petroleum World Scenario
1. 67% oil reserves.
2. 25% of the oil reserves in Saudi Arabia.

At the present rate of usage, the world‟s crude oil reserves are expected to get exhausted in just 40 years.

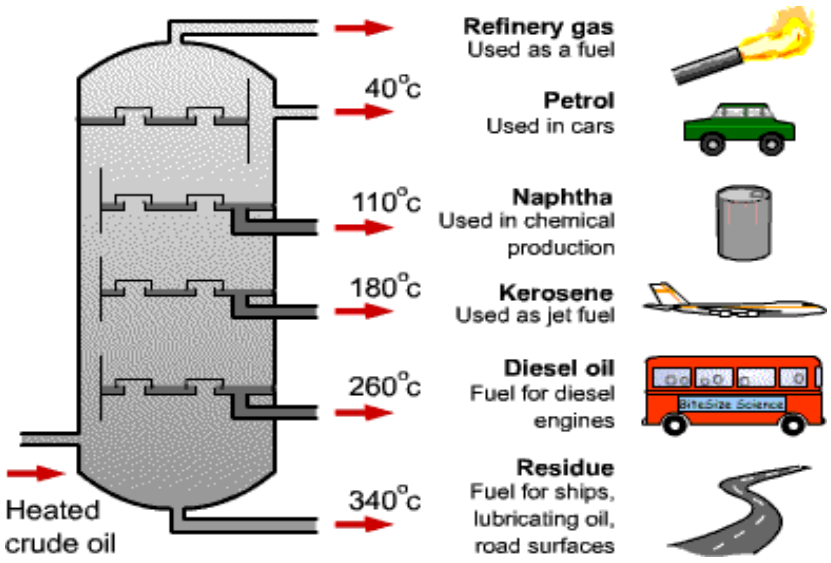


Fig. Fractionating column

3. LPG (Liquefied Petroleum Gas):

1. The petroleum gas, converted into liquid under high pressure as LPG
2. LPG is colorless and odorless gas.
3. During bottling some mercaptans is added, to detect leakage of LPG from the cylinder.

4. Natural Gas:

1. Mixture of 50-90% methane and small amount of other hydrocarbons.
2. Its calorific value ranges from 12,000-14,000 k-cal/$m^{3.}$

(i) Dry gas: If the natural gas contains lower hydrocarbons like methane and ethane, it is called dry gas.

(ii)Wet gas: If the natural gas contains higher hydrocarbons like propane, butane along with methane it is called wet gas.

Occurrence: Formed by the decomposition of dead animals and plants, those were buried under lake and ocean, at high temperature and pressure for millions of years.

5. **NUCLEAR ENERGY:**

Dr. H. Bhabha –father. India has 10 nuclear reactors, which produce 2% of India‟s electricity.

(i) Nuclear Fission: Heavier nucleus is split into lighter nuclei, on bombardment by fast moving neutrons, and a large amount of energy is released.

Eg: Fission of U^{235} When U^{235} nucleus is hit by a thermal neutron, it undergoes the following reaction with the release of 3 neutrons.

$$U^{235} + n^{1} \rightarrow Ba^{139} + Kr^{94} + 3n^{1} + \text{Energy}$$

92 0 56 36 0

Each of the above 3 neutrons strikes another U^{235} nucleus causing (3x3) 9 subsequent reactions. These 9 reactions further give rise to (3x9) 27 reactions.

This process of propagation of the reaction by multiplication in threes at each fission is called chain reaction:

Fission reaction of U^{235} is given below.

$$_{92}U^{235} + {}_{0}n1 \rightarrow {}_{36}Kr^{92} + {}_{56}Ba^{141} + 3\ {}_{0}n^{1} + \text{energy}$$

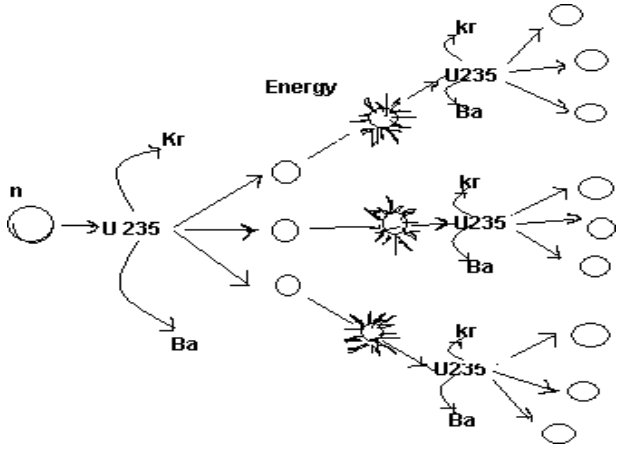


Fig. Nuclear fission-chain reaction

(ii) Nuclear fusion:

Lighter nucleuses are combined together at extremely high temperatures to form heavier nucleus and a large amount of energy is released.

Eg: Fusion of H^2 ₁Two hydrogen-2 (Deuterium) atoms may fuse to form helium at 1 billion^{0}C with the release of large amount of energy

$$_1H^2 + _1H^2 \rightarrow {}_3He^2 + {}_0n^1 + \text{energy}$$

Nuclear power of India:

Tarapur(Maharashtra),
Ranapratap Sagar (Rajasthan)
Kalpakkam (Tamilnadu)
Narora (U.P).

USES OF ALTERNATE (RENEWABLE) ENERGY SOURCES:

1. Why Alternate (Renewable) Energy Sources are required?

The importance of solar energy can be emphasized particularly in view of the fact that fossil fuels and other conventional sources are not free from environmental implications.

2. least pollution, safety and security snags and are universally available have the best enhance of large scale utilization in future

3. Hydro-electric power generation is expected to upset the ecological balance existing on earth Besides space heating, hydel power plants critically pollute the aquatic and terrestrial biota.

4. Radioactive pollutants released from nuclear power plants are chronically hazardous.

The commissioning of boiling water power reactors (BWRS) have resulted in the critical accumulation of large number of long lived radionuclides in water. The dangerous radiowaste cannot be buried in land without the risk of polluting soil and underground water.

5. The burning of coal, oil, wood, dung cakes and petroleum products has well debated environmental problems. The smoke so produced causes respiratory and digestive problems leading to lungs, stomach and eye diseases.

6. The disposal of fly ash requires large ash ponds and may pose a severe problem considering the limited availability of land. Thus the non-conventional sources of energy are needed.

Objectives:

To provide more energy to meet the requirements of increasing population.
To reduce environmental pollution
To reduce safety and security risks associated with the use of nuclear energy.

1.6.LAND RESOURCES:

It provides food, fibre, wood, medicine and other biological materials Soil is the mixture of inorganic materials (rocks and minerals) and organic materials (dead animals and plants).

Top soil is classified as renewable resources.

Uses of land resources:

1. Land provide, food, wood, minerals, etc., for us
2. Land nurtures the plants and animals that provide our food and shelter.
3. Land is used as watershed or reservoir
4. Land acts as a dust bin for most of the wastes, created by the modern society.
5. Land is used for construction of buildings, industries.

1.7.LAND DEGRADATION: Process of degradation of soil or loss of fertility of the soil.

Harmful effects of land degradation:
(i) The soil texture and soil structure are deteriorated
(ii) Loss of soil fertility, due to loss of invaluable nutrients
(iii) Increase in water logging, salinity, and alkalinity and acidity problems.
(iv) Loss of economic social and biodiversity.

Causes of land degradation:
1. Population - Land resources degraded by over population &over exploitation.
2. Urbanization - Urbanization leads to deforestation, reduces the land
3. Fertilizers and pesticides -Increased applications of fertilizers and pesticides leads to pollution of land and water and soil degradation.
4. Damage of top soil - Increase in food production generally leads to damage to top soil through nutrient depletion.
5. Water-logging - Soil erosion, salination and contamination of the soil with industrial wastes all cause land degradation.
6. Soil erosion - Soil erosion is the process of removal of superficial layer of the soil from one place to another.
Harmful effects of soil erosion:
(i) Soil fertility is lost because of loss of top soil layer.
(ii) Loss of its ability to hold water and sediment.
(iii) Sediment runoff can pollute water and kill aquatic life.
Types of soil erosion:
(i) **Normal erosion:** Gradual removal of top soil by the natural process.
The rate of erosion is slower.
(ii) **Accelerated erosion:** Caused by man-made activities. The rate of erosion is much faster than the rate of formation of soil.
Causes of soil erosion:
(i) Water: Affects soil erosion in the form of rain, run-off, rapid flow, wave action.
Sheet erosion: When there is uniform removal of a thin layer of soil from a large surface area, it is called sheet erosion.
Rill erosion: when there is rainfall and rapidly running water produces finger-shaped grooves or rills over the area, it is called rill erosion.
Gully erosion: When the rainfall is very heavy, deeper cavities or gullies are formed, which may be U or V shaped.
Slip erosion: This occurs due to heavy rainfall on slopes of hills and mountains.
Stream bank erosion: During the rainy season, when fast running streams take a turn in some other direction, they cut the soil and make caves in the bank.
(ii) Wind: Wind is the important climatic agent, who carry away the fine particles of soil and creates soil erosion.
Saltation: This occurs under the influence of direct pressure of stormy wind and the soil particles of 1-1.5 mm diameter move up in vertical direction.
Suspension: Here fine soil particles (less than 1mm diameter) which are suspended on the air are kicked up and taken away to distant places.

Surface creep: Here the large particles (5-10 mm diameter) creep over the soil surface along with wind.

(iii) Biotic agents: Overgrazing, mining and deforestation are the major biotic agents, cause soil erosion. Deforestation without reforestation, overgrazing by cattle, surface mining without land reclamation, irrigation techniques that lead to salt build- up, water logged soil, make the top soil vulnerable to erosion. 35% of world soil erosion is due to overgrazing. 30% of world soil erosion is due to deforestation.

(iv) Landslides: Causes soil erosion.

(v)Construction: Construction of dams, buildings, roads removes the protective vegetal cover and leads to soil erosion.

Control of soil erosion (or) soil conservation practices:

1. Conservational till farming (or) no-till-farming:

In tradition method, the land is ploughed and soil is broken up and leveled to make a planting surface. This disturbs the soil and makes it susceptible to erosion. However, no-till-farming causes minimum disturbance to the top soil. Here the tilling machines make slits in the unploughed soil and inject seeds, fertilizers and water in the slit. So the seed germinates and the crop grows.

Fig. Conservational till farming

2. Contour farming: It involves planting crops in rows across the contour of gently sloped land. Each row acts as a small dam to hold soil and to slow water runoff.

Fig. Contour farming

3. Terracing: It involves conversion of steep slopes into broad terraces, which run across the contour. This retains water for crops and reduces soil erosion by controlling runoff.

Fig. Terracing

4. Alley cropping (or) Agro forestry: It involves planting crops in strips or alleys between rows of trees of shrubs that can provide fruits and fuel wood. Even when the crop is harvested, the soil will not be eroded because trees and shrubs still remain on the soil and hold the soil particles.

Fig. Alley cropping

4. **Wind breaks or shelter belts:** The trees are planted in long rows along the boundary of cultivated lands, which block the wind and reduce soil erosion. Wind breaks help in retaining soil moisture, supply of some wood for fuel and provide habitats for birds.

Fig. Wind breaks

DESERTIFICATION: Progressive destruction or degradation of arid or semiarid lands to desert. Desertification leads to the conversion of range lands or irrigated croplands to desert. Desertification is characterized by devegetation, depletion of ground water, salination and soil erosion.

Harmful effect of desertification: Around 80% of the productive land in the arid and semi-regions are converted into desert. Almost 600 million people are threatened by desertification.

Causes of Desertification:

(a) Deforestation: The process of denuding and degrading a forest land initiates a desert. If there is no vegetation to hold back the rain water, soil cannot soak and groundwater level do not increase. This also increases, soil erosion, loss of fertility.

(b) Over grazing: The increase in cattle population heavily grazes the grass land or forests and as a result denudes the land area.

The denuded land becomes dry, loose and more prone to soil erosion and leads to desert.

(c) Water management: Over utilization of ground water, particularly in the coastal regions, is resulting in saline water intrusion into aquifers which is unfit for irrigation.

(d) Mining and quarrying: These activities are also responsible for loss of vegetal cover and denudation of extensive land area leading to desertification.

(e) Climate change: Formation of deserts may also take place due to climate change, ie., failure of monsoon, frequent droughts.

(f) Pollution: Excessive use of fertilizers and pesticides and disposal of toxic water into the land also leads to desertification.

LANDSLIDES: Landslides are the downward and outward movement of a slope composed of earth materials such as rock, soil, artificial fills. Other names of landslides are rockslide, debris slide, slump, earth flow and soil creep.

Man induced landslides

During construction of roads and mining activities huge portions of fragile mountainous areas are cut and thrown into adjacent areas and streams. These land masses weaken the already fragile mountain slopes and lead to landslides called man induced landslides.

Causes of landslides:

1. Removal of vegetation: In the sloppy area creates soil erosion, which leads to landslides.

2. Underground mining: Cause subsidence of the ground.
3. Transport: Due to the movement of buses and trains in the unstable sloppy region cause landslides.
4. Addition of weight: Addition of extra weight (or) construction on the slope areas leads to landslide.
5. Ground water level: Over exploitation of ground water also leads to landslides.

Harmful effect of landslides:

1. Landslide increases the turbidity of nearby streams, thereby reducing their productivity.
2. Destruction of communication links.
3. Loss of habitat and biodiversity.
4. Loss of infrastructure and economic loss.

CONSERVATION OF NATURAL RESOURCES - ROLE OF AN INDIVIDUAL:

Different natural resources like forests, water, soil, food, mineral and energy resources play a vital role in the development of a nation. While conservation efforts are underway at National as well as International level, the individual efforts for conservation of natural resources can go a long way.

I. Conserve Water:

- Use minimum water for all domestic purposes.
- Check for water leaks in pipes.
- Use drip irrigation method and reduce evaporation.
- The wasted water, coming out from domestic usages, it can be used for watering the plants.
- Building rainwater harvesting system.

II. Conserve energy:

- Switch off lights, fan, and other appliances when not in use.
- Use solar water heater for cooking food.
- Grow trees near the house and get a cool breeze and shade.
- Use always pressure cooker.
- Ride bicycle or just walk instead of car & scooter.
- Dry the clothes in sunlight instead of driers.

III. Protect the soil:

- Grow different types of plants in garden and open places, which bind the soil reduce erosion.
- While constructing the house don‟t uproot the trees as far as possible.
- Don‟t irrigate the plants using strong flow of water, which will wash off the top of soil.
- Soil erosion prevented by sprinkling irrigation.
- Use green manure in the garden.

IV. Conservation of Food Resources:

- Eat only minimum amount food.
- Don‟t waste the food.
- Cooke only required amount of the food.
- Don‟t cook food unnecessarily.
- Don‟t store large amounts of food grains and protect them from damaging insects.

V. Promote Sustainable Agriculture:

- Do not waste food. Take as much as you can eat.
- Reduce the use of pesticides.
- Fertilize your crop primarily with organic fertilizers.
- Eat local and seasonal vegetables. This saves lot of energy on transport, storage and preservation.
- Control pests by a combination of cultivation and biological control methods.

EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFE STYLE:

Sustainable development: It is the development of healthy environment without damaging the natural resources.

Unsustainable development: It is the degradation of the environment due to over utilization and over exploitation of natural resources.

Life style in different countries: Life style in world can be explained in two ways.

Most developed countries:

22% of world‟s population,
88% natural resources,
85% total global income

Less developed countries:

78% world‟s population,
12% natural resources,
15% total global income

(They are still struggling hard with their large population, poverty and also consume too low natural resources leading to unsustainability).

Causes of Unsustainable:

- ✓ Over population in poor countries, consume too low resources with low income.
- ✓ Rich countries consume more resources with more income. Conditions for sustainable life style:
  - ➢ To achieve a more balanced and equitable distribution of natural resource and income.
  - ➢ Rich countries should lower down their consumption levels, while the minimum needs of the poor people.

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SCHOOL OF BIO AND CHEMICAL ENGINEERING

DEPARTMENT OF BITOECHNOLOGY

UNIT – II – ENVIRONMENTAL SCIENCE – SBT1001

ECOSYSTEM

Ecology is the study of various ecosystems which is the relationship between organisms and their surroundings (living and non-living).

Ecosystem

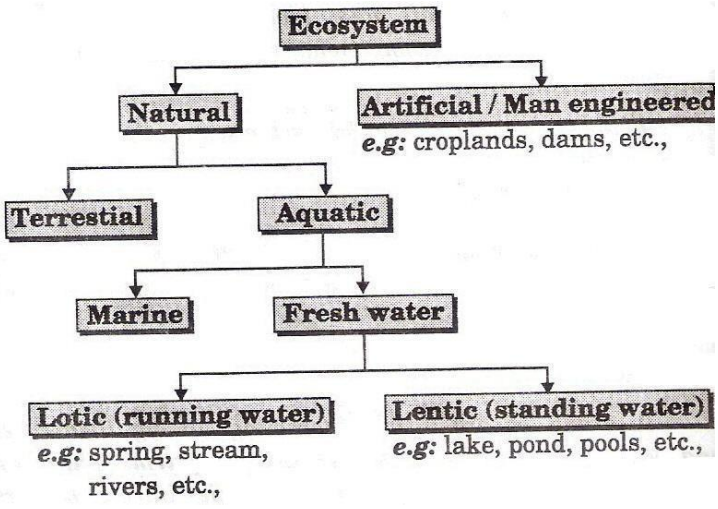
Ecosystem is the basic functional unit of ecology. It is derived from Greek word "study of home". Ecosystem is a group of organisms interacting among themselves and with the environment exchanging its energy and matter.

E.g, forest, desert etc.

Biome

Biome is a small ecosystem within another ecosystem having dominant species with similar lifestyle, climatic conditions and physical structure etc.,

TYPES OF ECOSYSTEM



STRUCTURE OR COMPONENTS OF AN ECOSYSTEM

The ecosystem has two major components (a) abiotic and (b) biotic.

(a) Abiotic Components

Non-living components of ecosystem (physical and chemical) form the abiotic community.

(i) Physical components: It includes energy, climate, raw materials and living space.

E.g. Air, water, soil, sunlight

(ii) Chemical components: They are the sources of nutrients.

(a) Organic substances E.g. proteins, lipids, carbohydrates

(b) Inorganic substances E.g. (C, N, O, P, K, H) and (Al, Co, Cu, Zn).

(b) Biotic Components

Living members in a community form the biotic community.

(i) **Autotrophic/Producers/Self-feeders**: They prepare their own food with the help of chlorophyll, sunlight, water and carbondioxide. E.g. plants, trees.

(ii)**Heterotrophic / Consumers/ other-feeders:** They lack chlorophyll and do not prepare their own food but depends on the producers for their food.

(a) Macro consumers: Herbivores, carnivores and omnivores.

(b) Micro consumers/ Saprotrophs: Decomposers (bacteria, fungi)

Classification/members of biotic components

Based on their source of food

1. **Autotrophs/ Producers**: Prepare their food through photosynthesis using chlorophyll, CO_2 and sunlight.

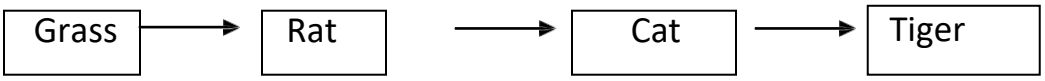
$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

2. **Heterotrophs/Consumers**: They do not make their food but depend on producers for their food.

(A) Primary consumers/Herbivores. Depend on plants for their food. E.g. Insects, rats.

(B) Secondary consumers/Primary carnivores: They feed on primary consumers. E.g. Frogs, cat, snakes.

(C) Tertiary consumers/Secondary carnivores: They feed on secondary consumers e.g. lions, tigers



3. **Decomposers**: They feed on dead plants and animals and decompose them into simpler compounds releasing inorganic nutrients. These are again utilized by plants with other organic substances for the synthesis of food.

e.g. Bacteria, fungi.

FUNCTION OF AN ECOSYSTEM

Its main function is to allow the flow of energy and nutrients.

Types of function

1. Primary function/ production: It is manufacturing of starch by photosynthesis.
2. Secondary function/ production: It is the distribution of energy to all consumers in the form of food which is stored by them.
3. Tertiary function: The dead systems (plants and animals) are decomposed by decomposers thereby initiating the third function called "cycling".

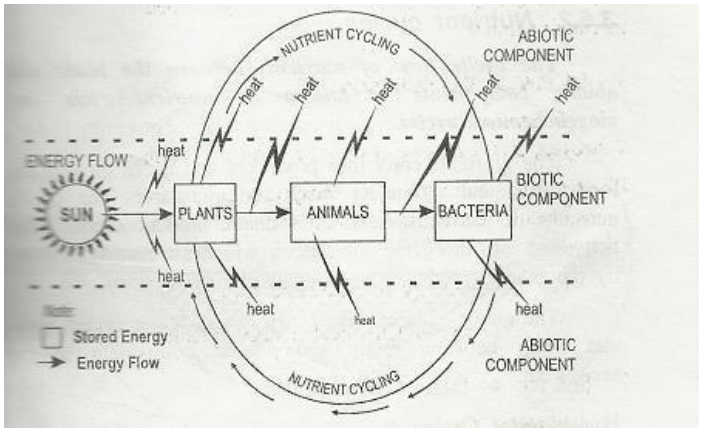
ENERGY FLOW IN THE ECOSYSTEM

Solar energy is the main energy on earth‟s surface. About 1% of this is used by plants for photosynthesis. They convert this into chemical energy part of which is used for their growth and remaining is passed onto consumers.

Thus, energy enters ecosystem through photosynthesis and travels through different feeding or trophic levels at the rate of 10% and the rest 90% is lost in the form of heat. This indicates that the energy flow is greatly reduced at each trophic levels from producers to carnivores. The energy flow is unidirectional i.e energy from sun never return back to sun.

Energy flow through an atmosphere in an ecosystem is governed by laws of thermodynamics **I law of thermodynamics** - Energy can neither be created nor destroyed, but it can only be converted from one form to another.

II law of thermodynamics - Whenever there is transformation of energy, there is loss of energy in the form of heat. The loss of energy takes place through respiration, running, hunting etc. Relationship between structure



and function .ECOLOGICAL SUCCE

ECOLOGICAL SUCCeSSION

The progressive replacement of one community by another till the development of a stable community in a particular area is called ecological succession.

Stages of Ecological succession

1. **Pioneer Community**:

The first group of organisms which establish their community in an area is called pioneer Community.

2. Seres or Seral Stage:

The various developmental stages of a community is called **'seres'**. **Community:** Group of plants or animals living in an area.

Types of ecological succession

1. Primary succession: Involves gradual establishment of biotic communities on a lifeless ground.
2. (a) **Hydrarch**: Establishment starts in watery area (lake, pond)
3. (b) **Xerarch**: Establishment starts in dry land (desert, rocks)
4. Secondary succession: Involves the establishment of biotic communities in an area, where some type of biotic community is already present.

Process of ecological succession

Ecological succession takes place in the following steps:

1. **NUDATION**: It is the development of bare land without any life form.
2. **INVASION**: It is the establishment of one/more species on a bare land through migration followed by establishment.

(a) MIGRATION: Migration of seeds by wind, water and birds.

Types of food chain

1. **Grazing food chain**:

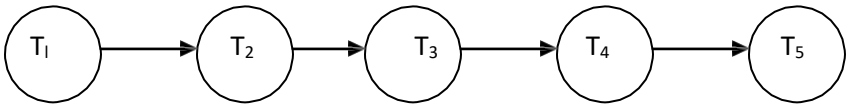
Found in grass land and pond ecosystems. It starts with green plants and goes to the decomposer/detritus food chain through herbivores and carnivores.

2. **Detritus food chain**:

Found in grassland and forest ecosystems. It starts with dead organic matter and goes to decomposer food chain through herbivores and carnivores.

Trophic levels

The various steps through which food energy passes in an ecosystem is called trophic levels.



T_1 - Green plants/producer

T_2 - Herbivores/primary consumers

T_3 - Carnivores/secondary consumers

T_4 - Tertiary consumers

T_5 – Decomposers

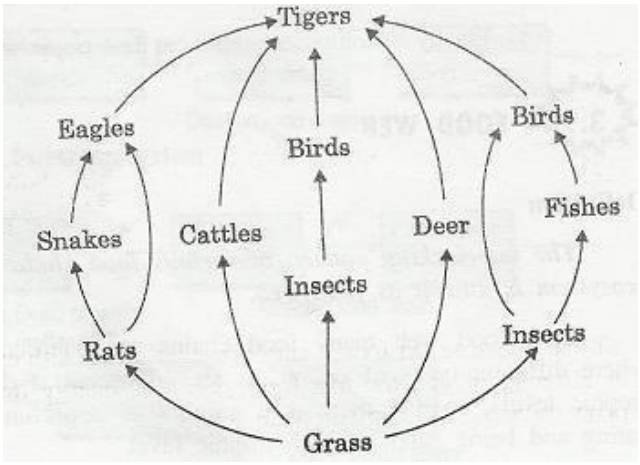
FOOD WEB

Definition: The interlocking pattern of various food chains which are linked together in an ecosystem is called food web. Different types of organisms are connected at different trophic levels so that there are number of opportunities of eating and being eaten at any trophic level.

Functions:

- Maintains the stability of ecosystems.
- Maintains the nutritional balance in an ecosystem.
- Control the population size of species in an ecosystem.
- Provide alternate food source.

Energy flow in a food web



Significance of food chains and food webs

1. Food webs and food chains play an important role in ecosystem as energy and nutrient flow takes place through them.
2. They maintain and regulate the population size of different trophic levels thereby maintaining ecological balance.
3. They have property of biomagnification. The passing of non-biodegradable material from one trophic level to another causing its concentration to increase and this is called biomagnification. E.g.,

Biomagnification of DDT

The concentration of DDT sprayed on plants increases along the food chain through phytoplankton to zooplanktons and then goes to fish, animals and human beings. Thus concentration of DDT is magnified in birds, animals and humans damaging the egg shells in birds and cell tissues in humans. As DDT is fat soluble its accumulation in human body is easier and cannot be removed easily.

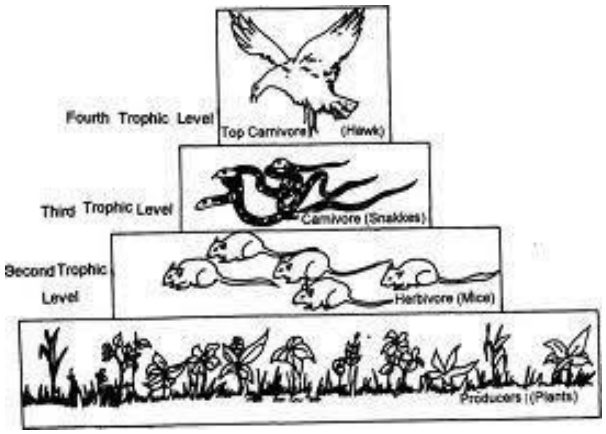
ECOLOGICAL PYRAMIDS

Definition: The graphical representation of structure and function of trophic levels of an ecosystem is called ecological pyramid.

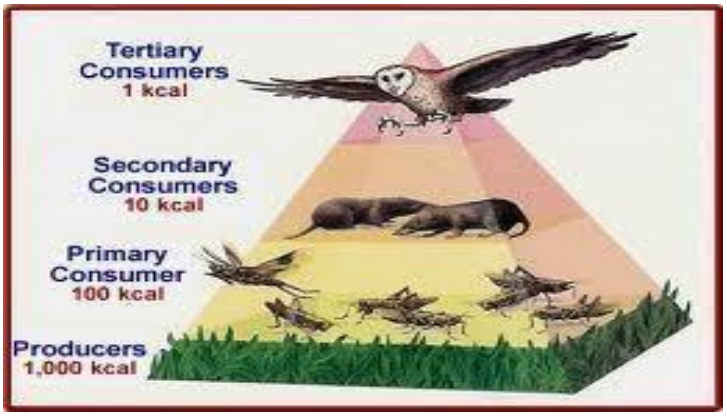
In an ecological pyramid the producers forms the base level and the tertiary consumer occupies the apex level.

It represents the number of individual organisms present in each trophic level. e.g., Grassland ecosystem

Here, the producers are grasses which are small in size and large in numbers. So, they occupy the lower most level of the pyramid. The primary consumers (rats) occupy the second trophic level as its number is lower compared to that of grass. The secondary consumers (snakes) which are even larger in size and smaller in number form the third level. The tertiary consumers (eagles) occupy the top layer as the numbers of it is the least.

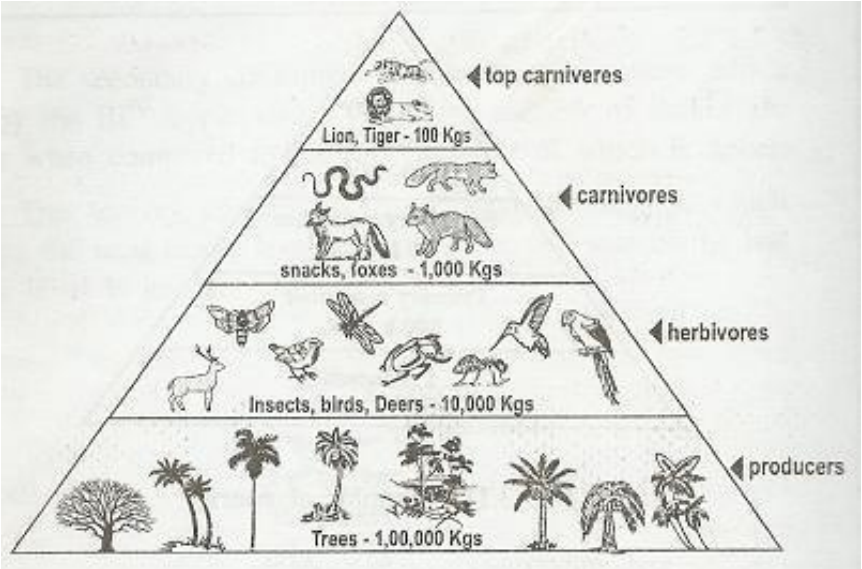


1. Pyramids of energy



It represents the amount of energy present in each trophic level. At every successive tropic level there is a heavy loss of energy (about 90%) in the form of heat. Thus at each next higher tropic level only 10% of energy is transferred.

2. Pyramids of energy



It represents the total amount of biomass (mass or weight of biological material or organism) present in each trophic level.

e.g., Forest ecosystem

The trees in forest ecosystem are the producers and they are maximum in number contributing to a huge biomass. The next tropic levels are the herbivores (insects, birds) and then carnivores (snakes, foxes). The topmost level is the tertiary consumers (tiger, lion) which are few and hence having low biomass.

FOREST ECOSYTEM

Forest consists of densely growing trees which cover 40% of world's land and 19% of Indian land.

Types of forests and their features

Depending on the climatic conditions forests are classified into the following types:

(a) **Tropical rain forest**: They are found near the equator. They are characterized by high temperature. Trees like teak and sandal and animals like lion and tiger are found in these forests.

(b) **Tropical deciduous forest**: They are found a little away from equator. They have warm climate and rain only during monsoon. Trees like maple, oak and animals like deer and fox are found in these forests.

(c) **Tropical shrub forest**: They have dry climate for long time. Have small deciduous trees and shrubs and animals like deer, fox, etc.

(d) **Temperate rain forest**: They are found in temperate areas with adequate rain.Coniferous trees like fir, pines and animals like squirrels, fox are found here.

(e) **Temperate deciduous forest**: These are found in areas with moderate temperatures. Trees like oak, hickory and animals like deer, fox are found in these forests.

Characteristics of forests ecosystem

1. They have warm climate and adequate rainfall, which generates number of ponds, lakes etc.
2. Forests maintain rainfall and climate.
3. Forests support many wild animals and protect biodiversity.
4. Soil is rich in nutrients and organic matter which support the growth of trees.
5. As sunlight penetration is poor, conversion of organic matter into nutrients is very fast.

Structure and function of forest ecosystem

1. **Abiotic components**: e.g., Temperature, light, rain and minerals.

They are the inorganic and organic substances found in soil and atmosphere.

2. **Biotic components**:

(a) **Producers:** Trees, shrubs

(b) Consumers:

(i) Primary consumers: Insects

(ii) Secondary consumers: Birds, snakes

(iii) Tertiary consumers: Tiger, lion

(c) **Decomposers**: Bacteria, fungi. Rate of decomposition of dead matter in tropical and subtropical forest is more than in temperate forest.

GRASSLAND ECOSYSTEM

Grasslands are large areas of grass with scattered trees which occupies about 20% of world's land.

1.19.1 Types and features of grasslands

1. **Tropical Grassland**: they are found near borders of tropical rain forests. They have high temperature and moderate rainfall (40 to 100cm). They are also called Savanna-type. They have tall grasses and shrubs and animals like zebra, giraffe.
2. **Temperate grassland**: They are found in centres of continents, on flat, sloped hills. They have cold winters and hot summers. Intense grazing and summer fires do not allow shrubs or trees to grow in this grassland.
3. **Polar grassland**: They are found in arctic polar region and have severe cold and strong wind with snow and ice. In summers several annual plants grow and animals like arctic wolf, arctic fox is found here.

Characteristics of grassland ecosystem

1. Grassland ecosystem is plain land occupied by grasses.
2. Soil is rich in nutrients and organic matter.
3. Since there are tall grasses, it is an ideal place for grazing animals.
4. It is characterized by low or even rainfall.

Structure and function of grassland ecosystem

1. **Abiotic components**: e.g., Nutrients (C, H, O ,N ,P , S) supplied by CO_2, H_2O, nitrates, phosphates and sulphates.
2. **Biotic components**:

(a) **Producers**: Grasses, shrubs

(b) **Consumers**:

(i) Primary consumers: Cows, deer

(ii) Secondary consumers: Snakes, lizards

(iii) Tertiary consumers: Eagles

(c) **Decomposers:** Fungi and bacteria.

DESERT ECOSYSTEM

Deserts occupy about 35% of world's land. The atmosphere is dry and hence a poor insulator.

Types and features of desert

1. **Tropical desert**: They are found in

(i) Africa: Sahara desert

(ii) India: Thar desert

They have few species and wind-blown sand dunes are common.

2. **Temperate desert**: They are found in South California:

Majave desert

They have very hot summer and very cool winter.

3. Cold desert: They are found in China: Gobi desert They have cold winters and warm summers. **Characteristic features of desert ecosystem**

1. The desert air is dry and climate is hot.
2. Annual rainfall is less than 25cm.
3. The soil is poor in nutrients and organic matter.
4. Vegetation is poor.

Structure and function of desert ecosystem

1. **<u>Abiotic components</u>**: Temperature, rainfall, sunlight

The temperature is very high and rainfall and nutrient cycling are very low.

2. <u>Biotic components:</u>

(a) **Producers**: Shrubs, bushes, some grass

In desert there are succulent plants like cacti which have water inside them and waxy outer coating to protect form sun.

(b) **Consumers**: Squirrels, mice, reptiles.

These animals dig holes in the ground to live and come out at night for food.

Most of the desert animals can extract water from seeds.

(c) **Decomposers**: Fungi and bacteria

Desert has poor vegetation with low amount of dead organic matter. They are decomposed by few bacteria and fungi.

AQUATIC ECOSYSTEM

This deals with water bodies. The major types of organisms found in aquatic environments are determined by water salinity.

Types of aquatic ecosystems: Based on the salinity it is classified into 2 types as

(i) Fresh water ecosystem: Ponds, lakes, rivers, streams

(ii) Marine/ salt water ecosystem: Oceans, estuaries

1. Fresh water ecosystem:

POND ECOSYSTEM

Characteristic features of pond ecosystem

1. Pond is temporary, only seasonal.
2. It is stagnant fresh water body.
3. Pond gets polluted easily due to limited amount of water.

Structure and Function of Pond ecosystem

1. **Abiotic components**: Temperature, light, water, organic and inorganic compounds.
2. **Biotic components**:

(a) **Producers**: They are of 2 types

(i) ***Phytoplankton***: These are microscopic aquatic plants, which freely float on the water surface. e.g., Algae, pandorina.

(ii) ***Microphytes:*** These are large floating plants and submerged plants. e.g., Hydrilla, wolfia.

(b) **Consumers**: (i) **Primary consumers** (Zooplanktons): These are microscopic animals which float freely on the water surface. e.g., Protozoa, very small fish, ciliates.

Zooplanktons are found along with phytoplankton sans they feed on them.

(ii) **Secondary consumers** (Carnivores): Insects like water beetles and small fish.

(iii) **Tertiary consumers:** Large fish like game fish.

(c) **Decomposers**: Fungi, bacteria, flagellates.

LAKE ECOSYSTEM

Lakes are supplied water by rainfall, melting snow and streams.

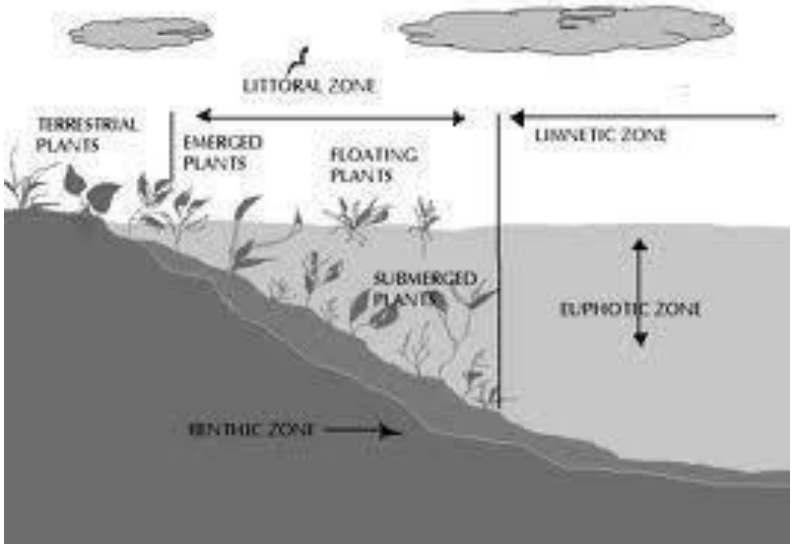
Types of lakes

1. Oligotrophic lakes: They have low nutrient concentrations.
2. Eutrophic lakes: They are over nourished by nutrients like N and P.
3. Dystrophic lakes: They have low pH, high humic content and brown waters.
4. Volcanic lakes: They receive water from magma after volcanic eruptions.
5. Meromictic lakes: They are rich in salts.
6. Artificial lakes: They are created due to construction of dams.

Zones of lake

Depending upon their distance from the shore, a lake consists of 4 distinct zones.

1. **Littoral zone**: It is the top layer of the lake. It has shallow water.
2. **Limnetic zone**: It lies below the littoral zone, where effective penetration of sunlight takes place.
3. **Profundal zone**: This is the deep open water, where it is too dark.
4. **Benthic zone**: This layer is the bottommost layer of the lake.



Characteristic feature of lake ecosystem

1. Lake is shallow fresh water body.
2. It is a permanent water body with large water resources.
3. It is useful for irrigation and drinking purpose.

Structure and function of Lake Ecosystem

1. **Abiotic components**: Temperature, light, proteins and lipids.

2. <u>Biotic components:</u>

(a) **Producers**: These are the green plants which may be submerged, free floating and amphibious plants. e.g., Phytoplankton, algae

(b) Consumers:

(i) Primary consumers (Zooplankton): Ciliates, protozoans.

(ii) Secondary consumers (Carnivores): Insects and small fishes.

(iii) Tertiary consumers: Large fish like game fish.

(c) **Decomposers:** Bacteria and fungi

RIVER/STREAM ECOSYSTEM

The running water of a river or stream is well oxygenated, because it absorbs oxygen from air. The numbers of animals are low in river or stream.

Characteristic features of river or stream ecosystem

1. It is fresh water and free flowing water system.
2. Due to mixing of water, dissolved oxygen content is more.
3. River deposits large amount of nutrients.

Structure and function of river ecosystem

1. **<u>Abiotic components</u>**: Temperature, light, pH, nutrients.
2. **<u>Biotic components</u>**:

(a) **Producers**: Phytoplankton, algae, water grasses.

(b) **Consumers**:

(i) Primary consumers: Water insects, snails

(ii) Secondary consumers: Birds and mammals

(c) **Decomposers**: Bacteria, fungi

MARINE/OCEAN ECOSYSTEM

Oceans cover more than two thirds of earth's surface. It supplies a vast variety of sea products and drugs. It has high concentration of salts and minerals.

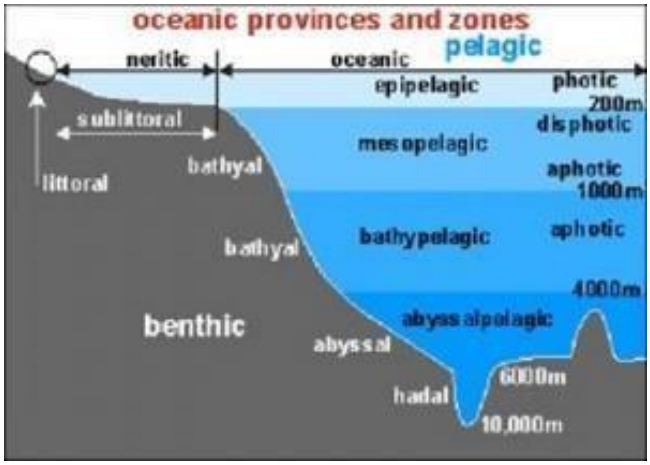
Zones of Oceans

The oceans have two major life zones.

(i) **Coastal zone**: It is relatively nutrient rich, shallow water and has high productivity because of high nutrients and sunlight.

(ii) **Open sea**: It is the deeper part of the ocean and is vertically divided into 3 regions. (a) *Euphotic zone*: It receives abundant light and shows high photosynthetic activity. (b) *Bathyal zone*: It receives dim light and is geologically active.

(c) *Abyssal zone*: It is the dark zone and is very deep (2000 to 5000 m).



Characteristic features of marine ecosystem

1. It occupies a large surface area with saline water.
2. Since, ships, submarines can sail in ocean a large number of commercial activities are carried out.
3. It is rich in biodiversity.
4. It moderates the temperature of earth.

Structure and function of marine ecosystem

1. **Abiotic components**: Temperature, light, NaCl, KCl.
2. **Biotic components**:

(a) **Producers**: Phytoplankton and marine plants

(b) **Consumers**:

(i) Primary consumers (Herbivores): Crustaceans, molluscs (ii) Secondary consumers (Carnivores): Herring, mackerel (iii) Tertiary consumers: Cod

(c) **Decomposers**: Bacteria, fungi.

ESTUARINE ECOSYSTEM

"***An estuary is a partially enclosed coastal area at the mouth of a river which joins the sea***". They are rich in nutrients and have high food potential.

Characteristics of estuarine ecosystem

1. Estuaries are transition zones, which are strongly affected by tides of sea.
2. Water characteristics are periodically changed.
3. The living organisms here have wide tolerance.
4. Salinity in estuaries are highest in summer and lowest in winter.

Structure and function of estuarine ecosystem

1. **Abiotic components**: Temperature, pH, sodium and potassium salts.
2. **Biotic components**:

(a) **Producers**: Marsh grasses, sea weeds, sea grasses.
(b) **Consumers**: Oysters, Crabs, small fishes.
(c) **Decomposers**: Bacteria, fungi.

KEYSTONE SPECIES

Within a habitat each species connects to and depends on other species. But, while each species contribute to habitat functioning, some species do more than others in the overall scheme of things. Without the work of these key species, the habitat changes significantly. These species are called “keystone species". When a keystone species disappears from its habitat, that habitat changes dramatically.

Illustration - 1

Elephants as keystone species in Grasslands

Elephants are keystone species in African grasslands. When elephants are taken away from grasslands, it is converted into forest or shrub areas by overgrowth of woody plants. As keystone species, elephants prevent this conversion.

Illustration - 2

Forest elephants hold keystone status in some woodland (forest) in western Africa

In the above forest elephants are the only species large enough to eat and disperse the seeds of some plant species whose shells are very hard. Thus only elephants can feed on them and disperse the seeds through their dung thereby maintains the forest.

Introduction to biodiversity definition: genetic, species and ecosystem diversity: BIODIVERSITY DEFINITION*:* Bio means „life‟ and diversity means „variety‟, hence Biodiversity refers to variety of life on the earth. Planet earth (biosphere) contains more than 20 million species of organisms. They differ widely from one another. Diversification in the species is influenced by various physical and climatic factors, resulting in the production of new sub-species. Biodiversity is defined as, "the variety and variability among all groups of living organisms and the ecosystem in which they occur".

LEVELS OF BIODIVERSITY:

A. GENETIC BIODIVERSITY

The genes found in organisms can form enormous number of combinations each of which gives rise to some variability. When the genes within the same species show different version due to new combinations, it is called genetic variability. For example rice belongs to the species Oryzasativa which has many varieties that differ in size, shape, aroma etc.

B. SPECIES BIODIVERSITY

This is the variability found within the population of a species or between different species of a community. It broadly represents the species richness and their abundance in a community. Shannon Wiener index and Simpson index are two popular indices of measuring species diversity.

C. ECOSYSTEM BIODIVERSITY

This is the diversity of ecological complexity showing variations in ecological niche, trophic structure, food webs, nutrient cycling etc. The ecosystem also shows variations with respect to physical parameters like moisture, temperature, altitude, precipitation etc.

BIOGEOGRAPHICAL CLASSIFICATION OF INDIA:

Biogeographic zone	Biotic province	Important Flora & Fauna
Trans-Himalayan	**Upper region**	**Pine,deodar- Wild sheep, yak, leopard, wolf**
Himalayan	**North west, west, central and East Himalayas**	**Pine, cork tree, sal, dhaak- Wild bear, sambar, leopard, Sikkim stag, musk deer**
Desert	**Kutch, Thar and Ladkh**	**Acacia, zizyphus, khejri, date palm- Camel, bastard, wild ass, desert cat, fox, rat**

Semi-arid	**Central India, Gujarat**	**Acacia, date palm, peepal -Gir lion, tiger, sariska and Ranthampore tiger**
Western ghats	**Malabar coast Western ghats mountain**	**Sheeshan, peepal, tuna, bahera- Tortoise, frog, lizards, snakes**
Deccan peninsula	**Deccan plateau**	**Acacia, palaash, tuna, pine, castor- Sambar, sloth bear, tiger, cheetal, four horned stag, wild elephant, wild buffalo**
Gangetic plain	**Upper and lower Gangetic plain**	**Sal, acacia, jamun, mango, bael- black chinkara, stag, rhinoceros, gazzel, Aligator, turtle**
North-east India	**Brahmaputra valley**	**Bamboo, sal, jack fruit, tuna, Chestnut cator- Elephnat, Rhinocers, yak, deer, porcupine**
Islands	**Andaman islands, Nicobar islands & Lakshadeep islands**	**Bahera, Harar, jack fruit, cardamom, coconut, cloves- Dolphin, alligator, Molluscs**
Coasts	**West coast East coast**	**Coconut, Banana, cashew Nut – Dugong, Dolphin, Turtle, Alligator, Molluscs**

VALUE OF BIODIVERSITY: (Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values)

1. CONSUMPTIVE USE VALUE

- **Food:** A large number of wild plants are consumed by human beings as food. About 80,000 plants are from wild. About 90% of crops are domesticated from tropical forest.
- **Drugs and medicine**: About 75% of population depends upon plant or plant extracts for medicine. Penicillin antibiotic drug is derived from the fungus penicillium.
- **Fuel:** The fossil fuels coal, petroleum and natural gas are products of fossilized biodiversity.

2. PRODUCTIVE USE VALUE

These are the commercially usable values where the product is marketed and sold. It may include lumber or wild gene resources that can be traded for use by scientist for introducing desirable traits in the crops and domesticated animals. It includes animal products like tusk of elephants, musk deer, silk from silk worm, wool from sheep, fur of many animals etc. Many industries like paper and pulp. Silk, textile, ivory works industry depend on them.

3. SOCIAL VALUE

It is associated with social life, customs, and religion and psycho-spiritual aspects of the people. Many plants are considered holy and sacred in our country like tulsi, peepal, Mango, Lotus, Bael etc. many animals like cow, snake, peacock, bull, owl etc also have significant place in social importance. The tribal people are very closely linked with the wildlife in the forest.

4. ETHICAL VALUE

It is otherwise called existence value. It involves ethical issues like “all life must be preserved” and “live and let live” concept. For the survival of human race, all biodiversity has to be protected because biodiversity is valuable.

5. AESTHETIC VALUE

People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco –tourism. The willingness to pay concept annually generates 12 billion revenue.

6. OPTION VALUE

It is the value of knowing that there are biological resources existing on the biosphere that may one day prove to be an effective option for something important in the future it suggests that any species may prove to be miracle species someday.

BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVEL: BIODIVERSITY AT GLOBAL LEVEL:

It is estimated that there are about 20 million species of plants and animals in earth of which only 1.6 million species have been formally identified with 34 hotspot regions at the global level. There are 12 megadiversity nations which are highly rich in biodiversity which includes India. Most of the world‟s biodiversity are near the equator especially tropical rain forests and coral reefs. South America also has unique species and biodiversity.

BIODIVERSITY AT NATIONAL LEVEL:

India is rich in biodiversity due to its varying climate and topographical features. It occupies only 2.5% of global land of which about 40% is under cultivation. There are 96 national parks, 572 wildlife sanctuaries 14 biosphere reserves and 2 hotspots with 46,000 plant species and 91,000 animal species, 50,000 varieties of rice, 1000 varities of mango, etc.,

1. India ranks 10^{th} among the plant rich countries of the world
2. 11^{th} in terms of Endemic species.
3. 6^{th} among origin of agricultural crops.
4. 12^{th} mega biodiversity country in the world.

BIODIVERSITY AT REGIONAL OR LOCAL LEVEL:

Tamilnadu is rich in biodiversity with natural habitat constituting 4% of country‟s total area which shares the Western Ghats with Kerala, Karnataka, Maharashtra, Goa and, Eastern Ghats with Andhra Pradesh and Odisha accounting for nearly about one third of the total flora of India.

1. **Point Richness**: Refers to number of species at a single point.
2. **Alpha Richness**: Refers to the number of species found in a small homogeneous area.
3. **Beta Richness**: Refers to rate of change in species composition across different habitats.
4. **Gamma Richness**: Refers to the rate of change across large landscape gradients.

INDIA AS A MEGA BIODIVERSITY NATION:

India is one of the 12 mega biodiversity countries in the world. The Ministry of environmental and forests, Government of India (2000) records 47,000 species of plants and 81,000 species of animals which is about 7% and 6.5% respectively of global flora and fauna.

1. **Endemism**: Species which are restricted to only to a particular area

are known as endemic. India shows a good number of endemic species. About 62% of amphibians and 50% of lizards are endemic.

2. **Centre of origin**: A large number of species have known to originate in India. Nearly 5000 flowering species, 166 species of crop plants and 320 species of wild relatives of cultivated crops origin in India.

3. **Marine diversity**: Along 7500 km long coastline of our country in the mangroves, estuaries, coral reefs, back waters etc. there exist a rich biodiversity. More than 340 species of corals of the world are found here.

HOTSPOTS OF BIODIVERSITY

A **biodiversity hotspot** is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot- map, a region must meet two strict criteria:

1. It must contain at least 0.5% or 1,500 species of vascular plants as endemics.
2. It must have lost at least 70% of its primary vegetation.

Around the world, at least 25 areas qualify under this definition, with nine others possible candidates. These sites support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of endemic species.

The importance of biodiversity: Biodiversity is often used to draw attention to issues related to the environment. It can be closely related to:

- The health of ecosystems.

For example, the loss of just one species can have different effects ranging from the disappearance of the species to complete collapse of the ecosystem itself. This is due to every species having a certain role within an ecosystem and being interlinked with other species.

- The health of mankind.

Experiencing nature is of great importance to humans and teaches us different values. It is good to take a walk in the forest, to smell flowers and breathe fresh air. More specifically, natural food and medicine can be linked to biodiversity.

Hot spots of Biodiversity in India:

The hot spots of biodiversity are the geographic areas which possess the high endemic species. At the global level these are the areas of high conservation priority, if these species are lost they can never be replaced or regenerated.

Criteria for recognizing Hotspots: The richness of the endemic species is the primary criterion; they should have a significant percentage of specialized species; the site should be under threat and should contain important gene pools of plants of potential use.

Two hot spots in India are:

1. Eastern Himalayas (Indo-Burma region) and
2. Western Ghats (Srilanka region).

Eastern Himalayas: Comprises of Nepal, Bhutan and neighboring states of Northern India- 35,000 plant species are found here and 30 % are endemic – also rich in wild plants of economic value eg. Rice, banana, citrus, ginger, chilli, jute and sugarcane – Taxal yielding plant also scarcely distributed – 63% mammals are from this region- 60% of Indian Birds- huge wealth of fungi, insects, mammals and birds found in this region

Western Ghats: Comprises of parts of Maharashtra, Karnataka, Tamilnadu and Kerala – nearly 1500 endemic, dicotyledones 62% amphibians and 50% lizards are endemic here- Ternstroemia, Japonica, Rhododendron and Hypericum common plants- Blue Bird and Lizard hawk are common animals.

Biodiversity is the richness & varied species of different organisms contained in a particular ecosystem – Indian biodiversity is highly diverse and rich such that there are various hot spots. However there are numerous threats to our Biodiversity.

THREATS TO BIODIVERSITY :(Habitat loss, Poaching of wildlife & Man-wildlife conflicts) In 2006 many species were formally classified as rare or endangered or threatened; moreover, scientists have estimated that millions more species are at risk which has not been formally recognized. About 40 percent of the 40,177 species assessed using the IUCN Red List criteria are

now listed as threatened with extinction.

LOSS OF HABITAT:

***Habitat destruction*:**

Habitat destruction has played a key role in extinctions, especially related to tropical forest destruction. Factors contributing to habitat loss are: overpopulation, deforestation, pollution (air pollution, water pollution, soil contamination) and global warming or climate change. Habitat size and numbers of species are systematically related. Physically larger species and those living at
lower latitudes or in forests or oceans are more sensitive to reduction in habitat area.

Climate change:

Global warming is also considered to be a major potential threat to global biodiversity in the future. Climate change has seen many claims about potential to affect biodiversity but evidence supporting the statement is tenuous. Increasing atmospheric carbon dioxide certainly affects plant morphology and is acidifying oceans, and temperature affects species ranges, phenology, and weather, but the major impacts that have been predicted are still just *potential* impacts. We have not documented major extinctions yet, even as climate change drastically alters the biology of many species.

POACHING: Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars per year continues. The developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth in wildlife.

Overexploitation:

Overexploitation occurs when a resource is consumed at an unsustainable rate. This occurs on land in the form of overhunting, excessive logging, poor soil conservation in agriculture and the illegal wildlife trade Joe Walston, director of the Wildlife Conservation Society's Asian programs, called the latter the "single largest threat" to biodiversity in Asia. The international trade of endangered species is second in size only to drug trafficking.

MAN-WILDLIFE CONFLICTS:

CAUSES OF MAN WILDLIFE CONFLICT:

1. Dwindling habitats of elephants, Tigers, rhinos and bears due to forest shrinkage compels them to move outside forest.
2. Usually ill, weak, and injured animals have a tendency to attack the humans.
3. Earlier Forest department used to cultivate paddy, sugarcane within the sanctuaries, due to lack of such practices the animals move out of forest food.
4. Villagers put Electric Wiring around their crop field which injures the elephants and turn them violent.
5. Wildlife corridors have been disrupted which makes the animals attack human beings during their migration.

REMEDIAL MEASURES TO CURB THE CONFLICT:

1. Tiger conservation Project (TCP) has made provisions for making available vehicles, tranquillizer guns, binoculars and radio sets etc., to tactfully deal with any imminent danger.
2. Adequate crop compensation and cattle compensation scheme must be started.
3. Solar powered fencing should be provided to prevent animals from
4. straying into fields.
5. Cropping pattern should be changed near the border.
6. Wildlife corridors should be provided.

Introduced and invasive species:

Barriers such as large rivers, seas, oceans, mountains and deserts encourage diversity by enabling independent evolution on either side of the barrier, via the process of allopatric speciation. The term invasive species is applied to species that breach the natural barriers that would normally keep them constrained. Without barriers, such species occupy new territory, often supplanting native species by occupying their niches, or by using resources that would normally sustain native species.

Genetic pollution:

Endemic species can be threatened with extinction through the process of genetic pollution, i.e. uncontrolled hybridization, introgression and genetic swamping. Genetic pollution leads to homogenization or replacement of local genomes as a result of either a numerical and/or fitness advantage of an introduced species. Hybridization and introgression are side-effects of introduction and invasion.

Hybridization, genetic pollution/Erosion and food security

In agriculture and animal husbandry, the Green Revolution popularized the use of conventional hybridization to increase yield. Often hybridized breeds originated in developed countries and were further hybridized with local

varieties in the developing world to create high yield strains resistant to local climate and diseases. Local governments and industry have been pushing hybridization. Formerly huge gene pools of various wild and indigenous breeds have collapsed causing widespread genetic erosion and genetic pollution. This has resulted in loss of genetic diversity and biodiversity as a whole.

ENDANGERED AND ENDEMIC SPECIES OF INDIA:

1. ENDANGERED SPECIES OFINDIA

The international Union for conservation of Nature and Natural Resources (IUCN) publishes the red Data book which includes the list of endangered species of plants and animals.

Species	Names
Reptiles	Gharial, green sea turtle, tortoise,python
Birds	Great Indian bustard, Peacock, Pelican, Great Indian hornbill, Siberian White crane
Carnivors Mammals	Indian Wolf, red fox, sloth bear, red panda, tiger, leopard, Stripped Hyena, Indian lion, Golden cat, desert cat, Dugong
Primates	Hoolock Gibbon, lion tailed Macaque, Nilgiri languor, capped monkey, Golden monkey
Plants	A large number of species of Orchids, Rhododendrons, Medicinal Plants like Rauvolfia serpentine, the sandal wood tree santalum, Cycasbeddonei

2. ENDEMIC SPECIES OFINDIA:

India has two biodiversity hotspots and thus possesses a large number of endemic species. Out of about 47,000 species of plants in our country 7000 species are endemic. Thus, Indian subcontinent has about 62% endemic flora, restricted mainly to Himalayas, Khasi Hills and WesternGhats. Some of the endemic flora includes orchids and species like *Sapria Himalaya*, *Uvarialurdia*

A large number out of total 81,000 species of animals in our country is endemic. The Western Ghats are particularly rich in amphibians and reptiles. About 62% Amphibians and 50% lizards are
endemic to Western Ghats. Different species of Monitor lizards, reticulated python and Indian salamander and viviparous toad are some important endemic species of our country.

CONSERVATION OF BIODIVERSITY (In-situ conservation & Ex-situ conservation)

In-situ and ex-situ conservation along with their merits and limitations:

Conservation of Biodiversity: Biodiversity faces threat of extinction – due human activities – to salvage situation – conservation of biodiversity need of the hour- to preserve biodiversity to prevent their extinction and future flourishing – conservation of Biodiversity required

In-situ conservation: Involves allocating large areas of the land mass for wild life development- such areas can be closed to the public for tourism – wild life can be allowed to flourish in their own environment- promotes genetic diversity- does not stagnate the gene pool

Advantages: cheap and convenient method Species gets adjusted the natural disasters like drought, floods, forest fires.

Limitations: Large surface area of the earth required – shortage of staff and pollution may lead to improper maintenance of the habitat.

Ex-situ conservation: Involves conservation of wild life in zoos, botanical gardens-human supervision- wildlife can grow under controlled conditions - animals would be properly taken care- food, shelter and water- help in the flourishing of endangered species- possible the gene pool could stagnate and result in no genetic diversity taking place.

Advantages: Special care and attention lead to survival of endangered species– In captive breeding, animals are assured food, water, shelter and security - hence longer life span- it is carried out for the endangered species, which do not have any chances of survival in the wild.

Limitations: Expensive method- freedom of wild life is lost – animals cannot survive in such confined places.