INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE LECTURE NOTES

Course Name	**ENVIRONMENTAL SCIENCE**
Course Code	AHSB07
Programme	B.Tech
Semester	IV
Course Coordinator	Mr. M Praveen, Assistant Professor
Course Faculty	Dr. V. Anitha Rani, Professor Dr. Venkateshwar Rao, Professor Mr. B Raju, Assistant Professor Ms. T Mallika, Assistant Professor Ms. M Malathi, Assistant Professor Mr. G Mahesh Kumar, Assistant Professor
Lecture Numbers	0
Topic Covered	All

COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze the interrelationship between living organism and environment.
II	Understand the importance of environment by assessing its impact on the human world.
III	Enrich the knowledge on themes of biodiversity, natural resources, pollution control and waste management.

COURSE LEARNING OUTCOMES (CLOs):

Students, who complete the course, will have demonstrated the ability to do the following:

S. No	Description
AHSB07.01	Summarize about environment and its importance and Discuss environment and importance of ecosystems.
AHSB07.02	Provides the information regarding ecosystem and applicability. Acquire knowledge of how all the animals are competing with their food

	requirements and also understand the various trophic levels in the food chain.
AHSB07.03	Describe the flow of energy through the various components of ecosystem. Examine the importance a of nutrients and flow of nutrients in ecosystem
AHSB07.04	Summarize about the toxicity of heavy metals on the biotic and a biotic components.
AHSB07.05	Distinguish about different types of natural resources and their applicability and illustrate the utility of renewable resources efficiency.
AHSB07.06	Describe the impact of over utilization of underground and surface water. Discuss the disaster manage mental plans.
AHSB07.07	Describe the benefits and property of dams. Illustrate the uses of mineral resources.
AHSB07.08	Enumerate the applications of the solar energy and wind energy in modern days.
AHSB07.09	Illustrate the definition and importance of biodiversity. Acquire the genetic diversity, species and ecosystem diversity.
AHSB07.10	Describe the ecological values and consumptive use of ecosystem. Recall India is mega diversity nation. Discuss the hot spot center in and around.
AHSB07.11	Analyze the information regarding different causes for loss of biodiversity. Analyze various reasons for conflict of species. Illustrate different methods to protect the biodiversity. Correlate national biodiversity act.
AHSB07.12	Explain the meaning of environmental pollution and classification. Analyze the important pollutants in air pollutants.
AHSB07.13	Enumerate the sources types and effects of water pollution. Correlate the sources types and effects of soil pollution. Analyze the noise quality and permissible levels
AHSB07.14	Describe the various methods commonly employed for the disposal of solid waste.
AHSB07.15	Identify To understand the recent trends in e- waste management practices.
AHSB07.16	Understand concept of climate change and impacts.
AHSB07.17	Summarize the remedial measures of ozone depletion.
AHSB07.18	Evolve strategies to environmental issues. Describe the role of government and legal aspects in environmental protection
AHSB07.19	Discuss the silent features of the hazardous waste management rules. Understand the importance of EIA for developmental activities
AHSB07.20	State the aim and objectives of sustainable development. Enumerate population and its explosion.
AHSB07.21	State the aim and objectives of sustainable development. Acquire knowledge of environmental education. Summarize the environmental ethics and objectives of green buildings

SYLLABUS

MODULE-I	ENVIRONMENT AND ECOSYSTEMS
Environment: Definition, scope and importance of environment, need for public awareness; Ecosystem: Definition, scope and importance of ecosystem, classification, structure and function of an ecosystem, food chains, food web and ecological pyramids, flow of energy; Biogeochemical cycles Hydrological cycle, Phosphorous cycle, Nitrogen cycle. Biomagnifications.	
MODULE-II	**NATURAL RESOURCES**
Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Mineral resources: Use and exploitation; Land resources; Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy source, case studies.	
MODULE-III	**BIODIVERSITY AND BIOTIC RESOURCES**
Biodiversity and biotic resources: Introduction, definition, genetic, species and ecosystem diversity; Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and optional values; India as a mega diversity nation; Endangered and Endemic species, Hot spots of biodiversity. Threats to biodiversity: Habitat loss, poaching of wildlife, human-wildlife conflicts; Conservation of biodiversity: In situ and ex situ conservation; National biodiversity act.	
MODULE-IV	**ENVIRONMENTAL POLLUTION, POLLUTION CONTROL TECHNOLOGIES AND GLOBAL ENVIRONMENTAL PROBLEMS**
Environmental pollution: Definition, causes and effects of air pollution, water pollution, soil pollution, noise pollution; Solid waste: Municipal solid waste management, composition and characteristics of e-waste and its management; Pollution control technologies: Waste water treatment methods, primary, secondary and tertiary; Concepts of bioremediation; Global environmental problems and global efforts: Global Warming, Climate change, Sea level rise, ozone depletion, ozone depleting substances, deforestation and desertification; International conventions / protocols: Earth summit, Kyoto protocol and Montreal protocol.	
MODULE-V	**ENVIRONMENTAL LEGISLATIONS AND SUSTAINABLE DEVELOPMENT**
Environmental legislations: Environmental protection act, air act1981, water act, forest act. municipal solid waste management and handling rules, biomedical waste management and handling rules2016, hazardous waste management and handling rules, Environmental impact assessment(EIA); Towards sustainable future: Concept of sustainable development, population and its explosion, crazy consumerism, environmental education, urban sprawl, concept of green building.	

Text Books:

1. Benny Joseph, "Environmental Studies", Tata Mc Graw Hill Publishing Co. Ltd, New Delhi,
2. 1st Edition, 2006.
3. Erach Bharucha, "Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition, 2013.

Reference Books:

1. Tyler Miller, Scott Spoolman, "Environmental Science", Cengage Learning, 14th Edition, 2012.
2. Anubha Kaushik, "Perspectives in Environmental Science", New Age International, New Delhi,
3. 4th Edition, 2006.
4. Gilbert M. Masters, Wendell P. Ela, "Introduction to Environmental Engineering and Science, Pearson, 3rd Edition, 2007

MODULE-I
ENVIRONMENT AND ECOSYSTEMS

Introduction of Ecology:

The term "Ecology" was derived from Greek words viz., Oikes means house or place and logs means a discussion or study.

So, ecology is the scientific study of the distribution and the interactions between organisms and their natural environment. The environment (surroundings) consists of: living organisms (biotic) and non-living things (abiotic) such as physical components of wind, temperature, rainfall, water, humidity , light, soil etc and chemical components of C,H,N,K,P,S etc..

(in-organic components) and carbohydrates, proteins (organic components).

Hence, Ecology involves studying the ecosystems. According to George Jackson, an Ecosystem is a natural unit consisting of all plants, animals and micro-organisms in an area functioning together with all of the non-living things. An ecosystem is the smallest unit of biosphere that has all the characteristics to support life. Pond ecosystem, forest ecosystem, desert ecosystem, marine ecosystem, urban ecosystem are some of the examples for ecosystems. An ecosystem varies in sizes from a few square kms to hundreds of square kms. Similarly an ecosystem may be temporary like a fresh pool / agriculture field or permanent like a forest / ocean.

Scope of ecosystem:

Ecology plays an important role in agriculture crop rotation, weed control (unwanted land); management of grasslands, forestry etc., biological surveys, fishery surveys, conservation of soil, wild life, surveys of water bodies like rivers, lakes; ponds etc...

Concept of ecosystem:

In an ecosystem, the interaction of life with its environment takes place at many levels. A single bacteria in the soil interacts with water, air around it within a small space while a fish in a river interacts with water and other animals, rivals in a large space. Considering the operational point of view; the biotic and biotic components of an ecosystem are so interlinked such that their separation from each other is practically difficult. So, in an ecosystem both organisms (biotic communities) and a biotic environment (rainfall, temperature, humidity) each influence the properties with other for maintenance of life.

Kinds of Ecosystems: Ecosystem may be natural or artificial.

Artificial Ecosystem: These are maintained or created artificially by man. The man tries to control biotic community as well as physico chemical environment.

Eg: Artificial pond, urban area development.

Natural Ecosystem: It consists of Terrestrial and Aquatic Ecosystems which are maintained naturally.

Terrestrial Ecosystem:

This ecosystem relates to biotic components living on the land. Vegetation dominates the community and the types of vegetation affect the climate, soil structure & a rapid exchange of O2, water & CO2

Aquatic Ecosystem:

This ecosystem relates to biotic community living in water. The types of water (fresh water, saline water, polluted water) dominate and affect the pH of water, depth of water, temperature of water etc. Aquatic ecosystem has been sub-divided into **fresh water** and **saline water** based on the quality of water.

Sturcture & Function of Ecosystem

The two major aspects of an ecosystem are: (1) Structure and (2) Function together they illustrate the organization of an ecosystem.

The Structure of an ecosystem consists of:

Abiotic structure includes the non-living things of the ecosystem such as physical factors (soil, temperature, light & water) and chemical factors consisting the inorganic compounds (N, C, H, K, P,S) & organic compounds (carbohydrates, proteins).

Biotic structure includes plants, animals & microorganisms present in an ecosystem form the biotic component. These organisms have different nutritional behavior and status in the ecosystem and are known as Autotrophs Producers), Heterotrophy (Consumers) & Micro- consumers (Decomposers) based on how they get their food. Hence, the structure of an ecosystem comprises:

(a) The composition of biological community species (plants, animals, microorganisms), their population, life cycles, distribution in space etc.

(b) The quantity and distribution of non-living things such as soil; water etc.

(c) The range or intensity of conditions like temperature, light, rainfall, humidity, wind & topography plays a major role in the structure of ecosystem.

Function of ecosystem means how an ecosystem works/ operates under natural conditions. The rate of biological energy flow ; the rate of nutrient cycles ie Bio- Geo-Chemical cycles and Ecological regulation (means regulation of organisms by Environment and regulation of Environment by organisms) plays a major role in the function of an ecosystem

1. Autotrophic components (Producers):

Autotrophic means self nourishing. Since these organisms are self nourishing, they are also called producers. Eg: Algae, Green plants, Bacteria of photo synthetic. Green plants prepare their food themselves by making use of CO2 present in the air & water in the presence of sunlight through the process of photosynthesis.

$CO_2 + 2H_2O \rightarrow CH_2O + O_2 + H_2O$

(Carbon dioxide)(Water) (Carbohydrates) (Oxygen) (Water)

A few micro-organisms which can produce organic matter (nutrients) to some extent through oxidation of certain chemicals in the absence of sunlight known as chemo autotrophs.

Eg: In the Ocean depths, where there is no sunlight, chemo-autotrophic bacteria make use of the heat generated by the decay of radioactive elements for preparation of their food.

2. Hetero-trophic components (Consumers):

Hetero-trophic means dependent on others for nourishment directly or indirectly upon the utotrophs (producers) for their food. These are of the following types:

a. Herbivores (Primary consumers): These animals feed directly on living plants or remains of plants. Eg: Rabbits, Deer's, Insects.

b. Carnivores (secondary consumers): These carnivores (flesh eating) feed on the herbivores. Eg: Snakes, birds, Lizards, fox.

c. Tertiary consumers (or) Tertiary carnivores: These feed on the primary & secondary consumers. Eg: Lions, Tigers.

d. Omnivores: These consumers feed on both plants & animals. Eg Human beings, Birds (hawk)

3. Decomposers or Micro consumers: They feed on organic compounds of dead or living plants and animals for their food and energy. They absorb some of the products from decomposed material and release organic compounds (nutrients) making them available to producers.

Eg: Bacteria, Fungi, and Flagellates. The decomposers are also called as "Saprotrophs".

Food Chain:

The transfer of food energy from the producers (plants) through a series of organisms (Herbivores, Carnivores) successively with the repeated activities of eating and being eaten is known as food chain. In an ecosystem(s), one organism is eaten by the second who in turn is eaten by the third and so on... This kind of feeding relationship is called food chain.

Examples of food chain:

1. Grass→ Grasshopper→ Frog→ Snake→ Hawk.
2. Grass→ Mouse→ Snake →Hawk.

3. Grass→ Rabbit→ Man.
4. Grass→ Mouse→ Hawk.
5. Plant leaf →Caterpillar →Sparrow →Hawk.

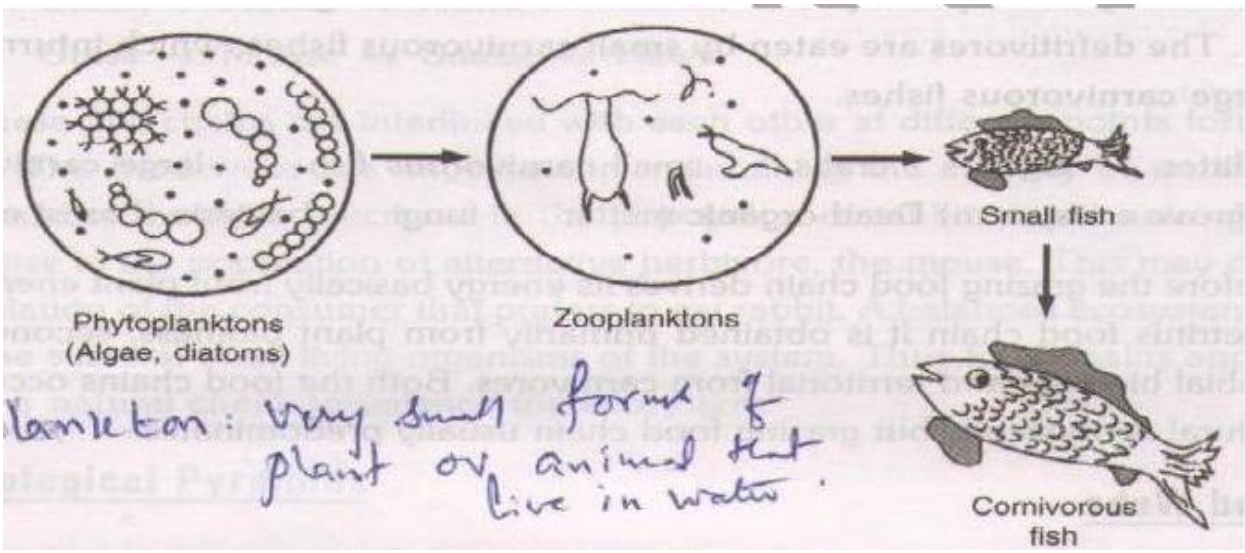
Explanation: A caterpillar eats a plant leaf, a sparrow eats the caterpillar, and a hawk eats the sparrow. When they all die, they are all consumed by micro organisms like bacteria (or) fungi which break down the organic matter and convert it into simple inorganic substances that can again be used by the plants.

In nature, there are two basic types of food chains viz:

1. Grazing food chain and (2) Detritus food chain

Grazing food chain: This food chain starts with green plants (primary producers) and goes to herbivores and on to carnivores.

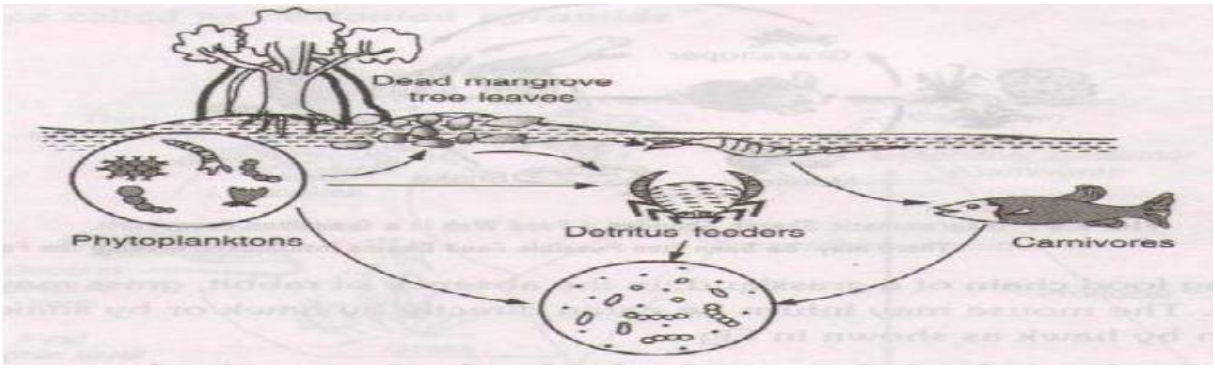
1. Phytoplankton's→ Zooplanktons →Small fish→ Tuna.
2. Phytoplankton's→ Zooplanktons→ Fish→ Man.
3. Grass→ Rabbit→ Fox→ Tiger.



Detritus food chain: This food chain starts from dead organic matter (dead leaves/ plants / animals) and goes to Herbivores and on to Carnivores and so on…..

Leaves or dead plants→ Soil mites→ Insects→ Birds. Dead organic matter→ Bacteria → Insects.

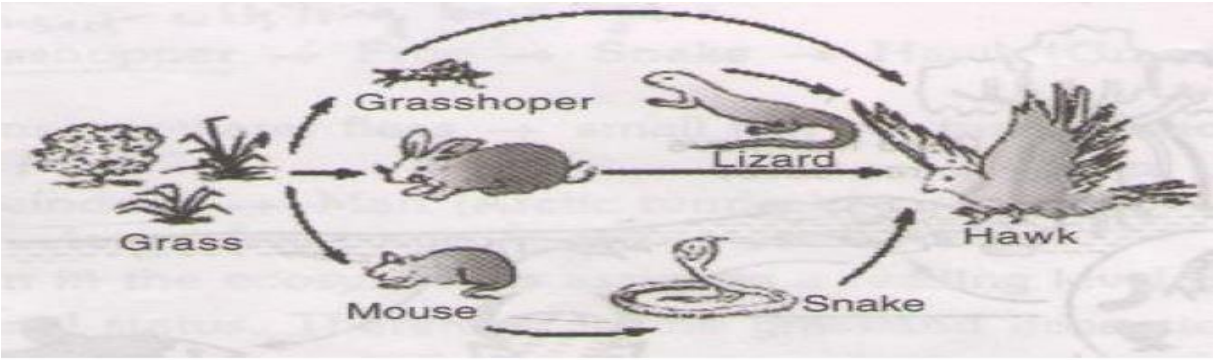
Dead leaves → Algae→ Fish→ Man.



FOOD WEB:

Food web is a net work of food chains where different types of organisms are connected at different trophic levels so that there are a number of options of eating and being eaten at each trophic level. (A trophic level refers to an organism's position in the food chain).

1. Grass→ Grasshopper→ Hawk
2. Grass→ Grasshopper→ Lizard→ Hawk
3. Grass→ Rabbit→ Hawk
4. Grass→ Mouse→ Hawk
5. Grass→ Mouse→ Snake→ Hawk



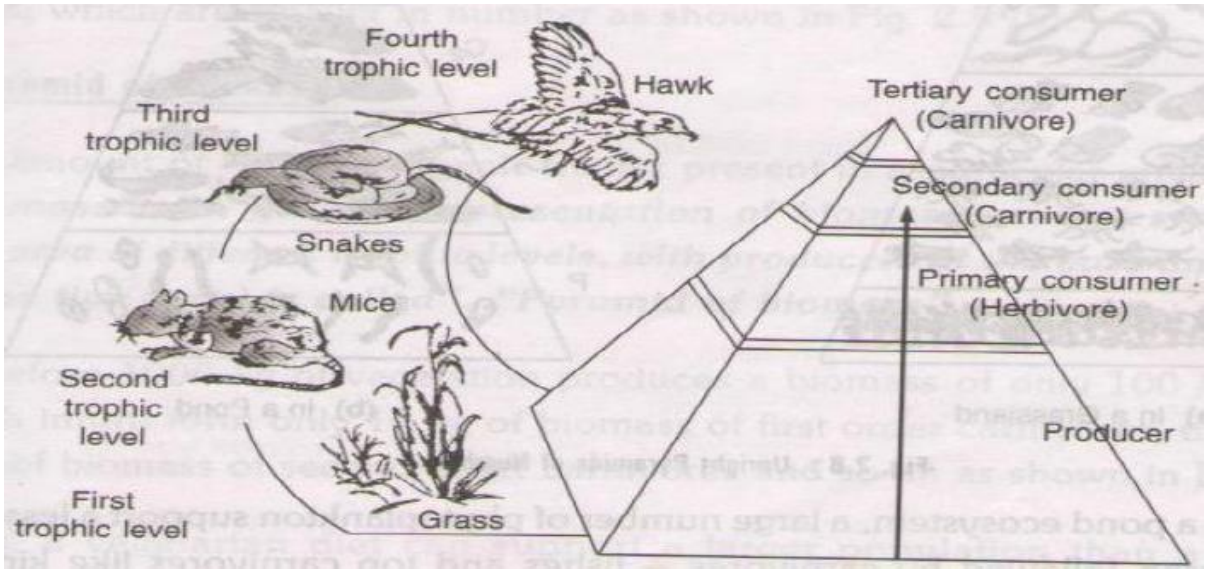
ECOLOGICAL PYRAMID:

Ecological pyramids were first studied by a British ecologist Charles Eltan (1927). An Ecological Pyramid is a graphical representation consisting varioustrophic levels with producers forming the base and top occupy the carnivores. In an ecological pyramid the huge number of tiny individuals form at the base and a few large individuals occupy the top / apex . This formation is known as ecological pyramid. Hence, all producers (micro & macro plants) belong to the *I trophic level*; all primary consumers belong to *II trophic level* and organisms feeding on these consumers belong to the *III trophic level* and so on.

The ecological pyramids are of three types. They are:

1. The pyramid of Numbers (showing population).
2. The pyramid of Biomass (showing total mass of organisms).

3. The pyramid of energy (showing energy flow).



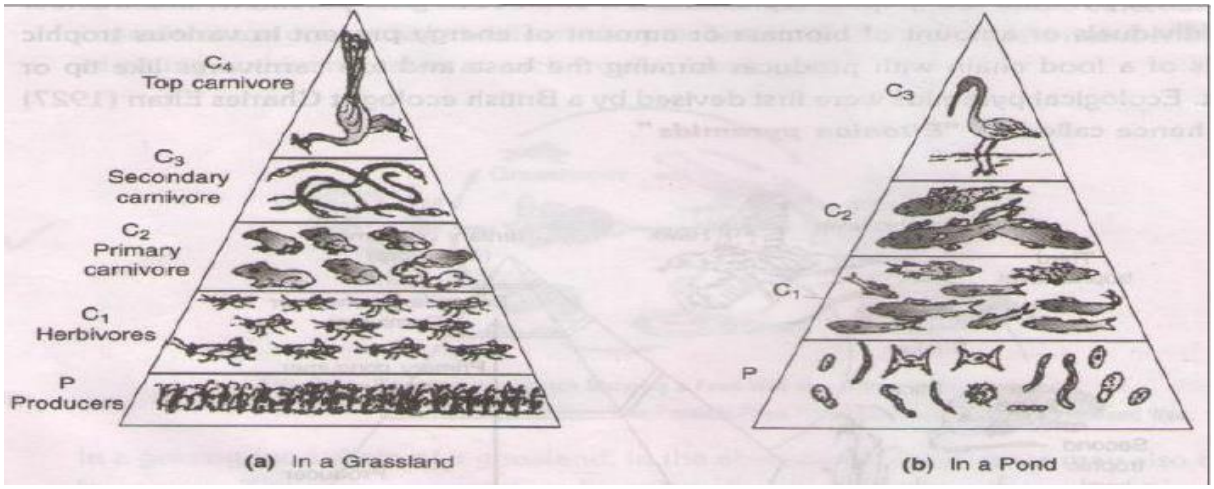
1. The pyramid of Number:

It shows the relationships among the producers, herbivores and carnivores at successive trophic levels in terms of their number. Mostly the pyramid of number is straight (or) upright with number of individuals in successive higher trophic levels goes on decreasing from base to apex. The maximum number of individuals occurs at the producers' level. They support a small number of herbivores. The herbivores, in turn, support a fewer number of primary carnivores and so on….. Top carnivores are very few in number.

For Example:

(1) In a grass land ecosystem: Grass→ Grasshoppers→ Frogs→ Snakes→ Peacock / Hawk.

(2) In a pond ecosystem: Phytoplankton→ Zooplankton→ Fish→ Crane

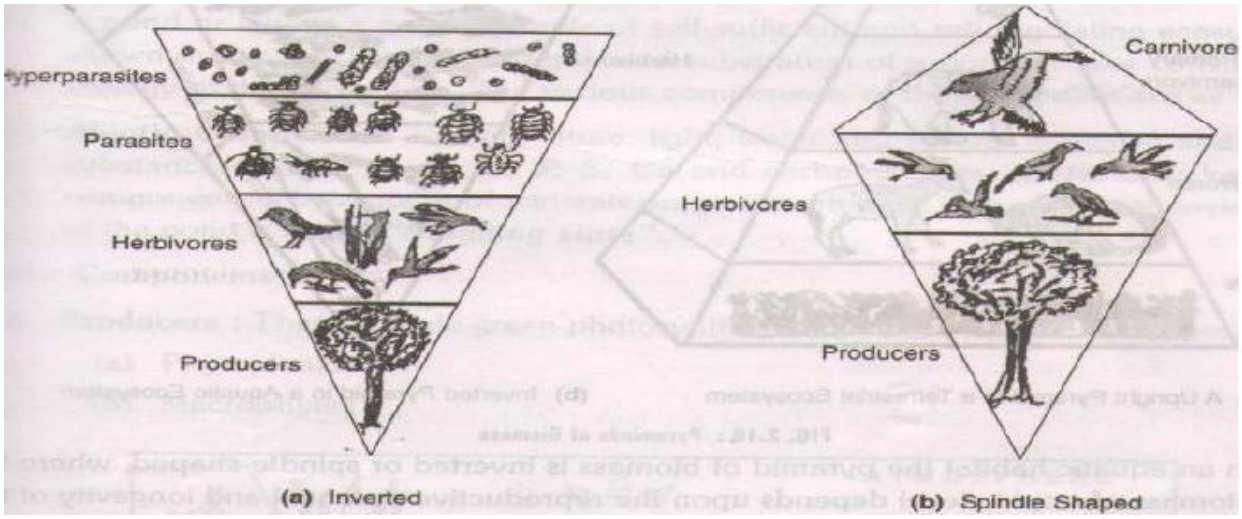


The pyramids may be **inverted** in a few cases:

A single plant may support the growth of many herbivores and each herbivore in turn provides nutrition to

several parasites which support many hyper-parasites. Thus, from the producer towards consumers, there is a reverse position i.e., the number of organisms gradually shows an increase making the pyramid inverted in shape.

(3) In a Forest ecosystem: Tree→ Birds / deer →Parasites→ hyper parasites Tree→ Birds→ eagle

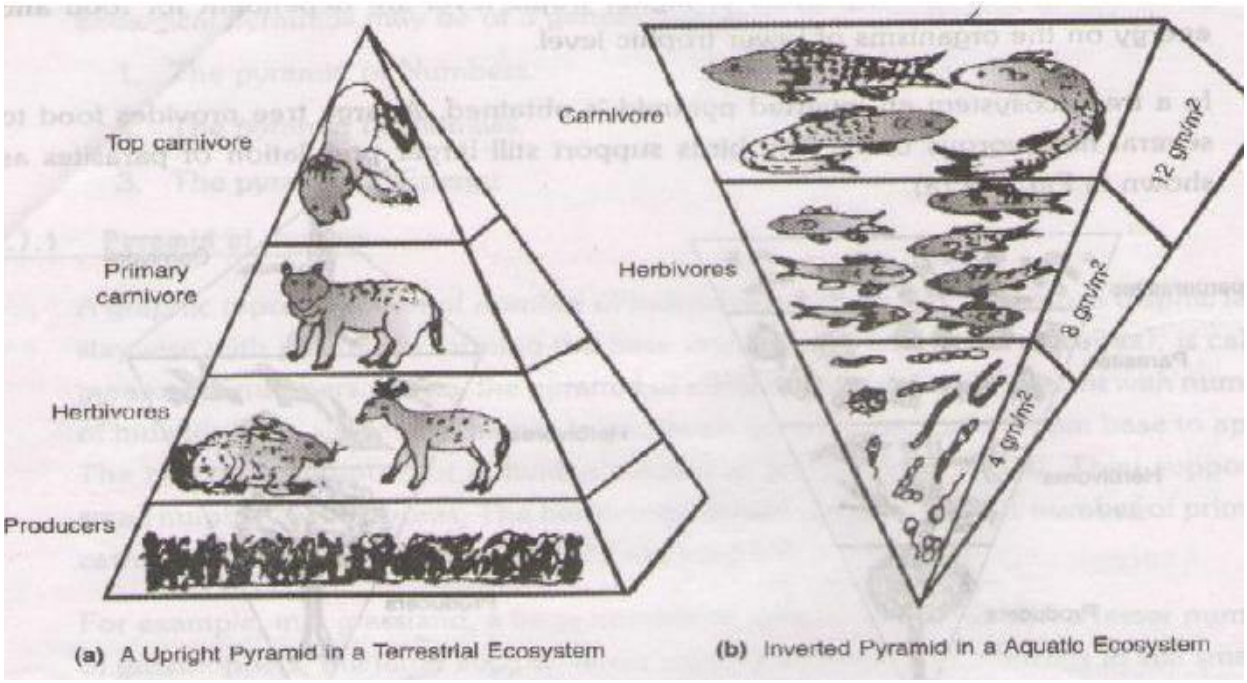


2. **The Pyramid of Biomass:** The amount of organic matter present in environment is called biomass. In pyramids of biomass, the relationship between different trophic levels is mentioned in terms of weight of organisms**.** The pyramid may be upright for grassland ecosystem and inverted for pond ecosystem.

Example: Vegetation produces a biomass of 1000 kg. Out of this 100 kgs of biomass for herbivores, which in turn only 10 kg of biomass for primary carnivores that gives rise 1 kg of biomass for second order carnivores and so on…

1000 kgs	100 kgs	10 kgs	1 kg
Vegetation	Herbivores	primary carnivores	Secondary carnivores

Hence, a vegetarian diet can support a larger population than a Non – vegetation diet.



3. **The pyramid of energy**: The amount of energy trapped per unit time and area at different trophic levels of a food chain with producers forming the base and the top carnivores at the apex is called pyramid of energy. The energy content is generally expressed as K cal /m2 / year or KJ / m2 / year.

Large Fish ---126 KJ / m2 / year

Small Fish 840 – 126 KJ / m2 / year

Zooplankton 7980 KJ / m2 / year

Phytoplankton (producers) 31080 KJ / m2 / year

Energy flow /Transformation of energy in Ecosystem

The movement of energy (or) transfer of energy through a series of organisms in an ecosystem from the external environment and back to the external environment again is known as energy flow.In the universe, the main source of energy is SUN that produces energy in the form of light or solar radiation. Different ecosystems in the world receive variable quantities of solar energy

depending upon their location on the globe. The other chief factors that control the amount of solar energy received by an ecosystem are Latitude and Longitude ; Slope; Cloud formation; Pollutants in the atmosphere

The transformation of energy in an ecosystem begin first with the input of energy from the sun by the process of photosynthesis. Carbon dioxide is combined with Hydrogen (derived from the splitting of water molecules) to produce carbohydrates (CH2O) and the energy is stored in the high energy bonds of Adenosine Tri Phosphate (ATP).

Herbivores obtain their energy by consuming plants or plant products,

Carnivores eat herbivores and **micro-organisms** consume the droppings and carcasses (dead bodies). In an ecosystem, the utility of energy is taken place in the following manner:

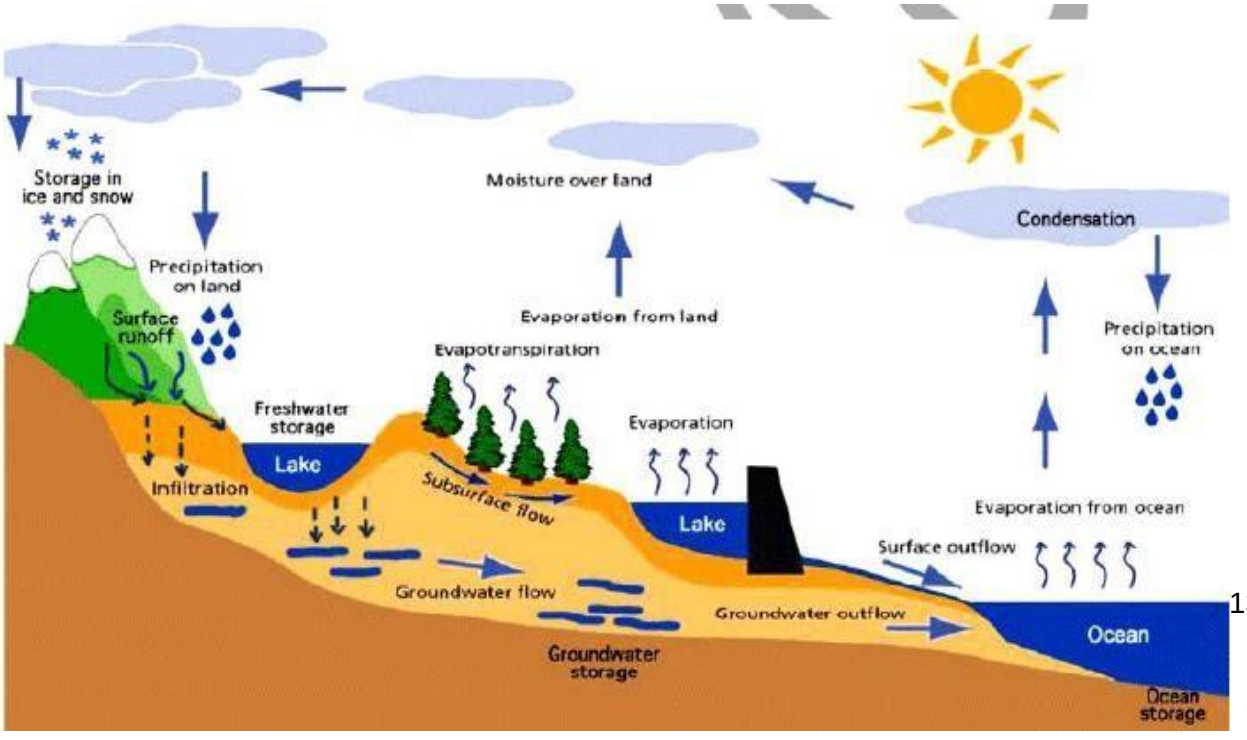
The sun provides heat to maintain the required temperature in which proper Physical and chemical processes can take place. Certain bacteria obtain useful energy by oxidation of a few elements such as sulphur and iron.

Bio – Geo-Chemical Cycles: In every ecosystem sunlight or solar radiant energy is accepted by producers (green plants) and the energy doesn't recycle through an ecosystem. But nutrients like Carbon; Nitrogen; Oxygen, Hydrogen; Water, Sulphur, Phosphorous etc move in circular paths through biotic and abiotic components and they are known as Bio-geochemical cycles.

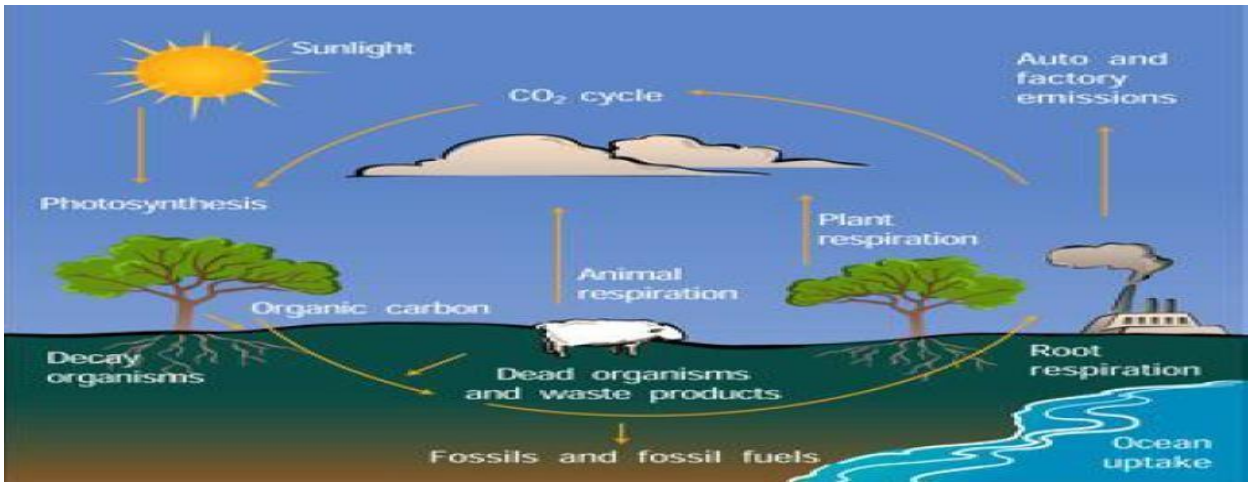
About forty chemical elements are considered to be essential for living organisms. They are macronutrients of C, H, O, P, K, I, N, S , Mg, Ca etc.. and micro nutrients of Cu, Fe, Co……While all inorganic nutrients have cycles, we focus on the following:

WATER CYCLE CARBON CYCLE OXYGEN CYCLE NITROGEN CYCLE POTASSIUM CYCLE PHOSPHOROUS CYCLE

The Water Cycle Or Hydrologic Cycle: Due to the solar heat, water evaporates or water is lost to the atmosphere as vapour from the seas / oceans which is then precipitated back in the form of rain, snow, frost etc.. The evaporation and precipitation continues for ever, and thereby a balance is maintained between the two. This process is known as Hydrologic cycle.



Carbon Cycle: All life is based on the element carbon and hence carbon is the main constituent of living organisms.. Carbon may be present in most organic matter from fossil fuels to the complex molecules (DNA & RNA). In fact, the lithosphere is only 0.032% carbon by weight. In comparison, oxygen and silicon make up 45.2% and 29.4% respectively of the earth's surface rocks. Plants absorb CO2 during photosynthesis whereas animals emit CO2 during respiration. Animals obtain all their carbon through their food and thus, all carbon in biological systems ultimately comes from plants (autotrophs). The dead bodies of plants and animals as well as the body wastes are decomposed by micro-organisms which release carbon in the form of CO2. Even plant debris if buried a longer time cause for the formation of coal, oil, natural gas and these releases carbon when they burned. Otherwise, the carbon in limestone or other sediments released to the atmosphere when they are subducted (using forces) or undergo chemical reactions. The weathering of rocks also contribute CO2 into the environment.



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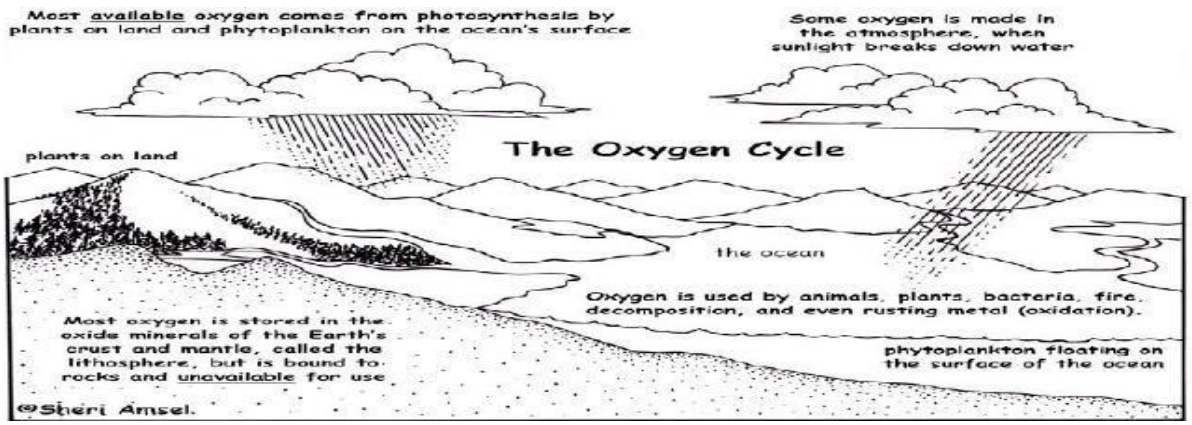
OXYGEN CYCLE: Oxygen is present in CO2, CH2O (carbohydrates) and H2O. Oxygen is released into the atmosphere by plants during photosynthesis and taken up both autotrophs and Heterotrophs during respiration. All the oxygen in the atmosphere is biogenic ie., it was released from water through the process of photosynthesis. Because of the vast amounts of oxygen in the atmosphere, even if all photosynthesis cease it would take 5000 million years to strip out more or less all oxygen.



NITROGEN CYCLE: Nitrogen is used by living organisms to produce a number of complex organic molecules like Amino acids; Proteins ; Nucleic acids ; Enzymes; Chlorophyll etc.. The largest reservoir of nitrogen is the atmosphere where it exists as a gas mainly N2. But atmospheric nitrogen is not utilized directly. However, nitrogen gas undergoes many changes in the nitrogen cycle like: Nitrogen Fixation, Ammonification, Nitrification.

Nitrogen fixation or conversion of free nitrogen into biologically acceptable form is referred to as Nitrogen Fixation.

$N2 + 2(O) \xrightarrow{-\text{electric discharge}} 2\,NO$

Nitrogen gas oxygen radical nitrogen oxide In physico chemical process; nitrogen combines with oxygen during lightning or electrical discharges in the clouds and produces different nitrogen oxides (N2O5). These nitrogen oxides get dissolved in rain water and react with mineral compounds to form Nitrates and Nitrogenous compounds on the earth.

$N2O5 + H2O \rightarrow 2HNO3$

$2HNO3 + CaCO3 \rightarrow Ca(NO3)2 + CO2 + H2O$

Nitrogen fixation is also carried out by biological process by means of blue – green algae in the oceans. Examples: Rhizobium bacteria fix nitrogen in the roots of Leguminous plants Blue – green algae (Nostoc, Anabena) fix Nitrogen.

Ammonification: when plants or animals die or release waste, the nitrogen is returned to the soil as ammonia. The bacteria (nitrite bacteria) in the soil and in the water which take up ammonia and convert it to Nitrite (NO2). Another bacteria (Nitrate bacteria) take nitrite and convert it to Nitrate (NO3) which can be taken up by plants to continue the cycle.

Nitrification means conversion of ammonia into nitrite by some of the bacteri as such as Nitrosmonas, Nitrococcus in oceans and soils.

AQUATIC ECOSYSTEM:

Eco system that exists in water is known as aquatic ecosystem. Water is the primary requirement for life in biological community. The aquatic ecosystems range from a small pond to a large ocean. Varying quantities of nutrients are carried from terristrial (land) ecosystem by the movement of water and deposited in aquatic ecosystems. The life in aquatic communities is influenced mostly by physical factors like**:**

Water depth Amount of light

Temperature Salinity of water

Amount of oxygen and Carbondioxide.

Aquatic ecosystems are broadly classified into ***fresh water*** and ***marine water*** ecosystems. In some regions, the marine and fresh water environments overlaps creating "***Estuaries***".

Fresh Water: Eg: lakes, ponds streams, rivers water Marine: Eg: salt lakes, seas, oceans

Estuaries: Eg: water bodies mix of fresh & sea

I. **Ponds & Lake Ecosystems*:*** A pond is a small area of still water, especially is artificial whereas a lake is a large area of water body and the water is natural. The life span of ponds range from a few weeks or months and whereas the life span for lakes depend upon their location, size and depth. Depending upon temperature, the upper part of the lake becomes warm and is called ***eplimnion*** and the lower part of the lake becomes cold which is called as ***hypolimnion.*** These two zones are separated by **thermocline zone** which acts as a barrier to exchange of material / nutrients within the pond. During rainy season, entire water body gets same temperature due to mixing of water while in non-rainy season very small amount of mixing occurs by surface waves due to wind blow.

The ***non-living (abiotic) components*** of a pond include Heat; light, pH value of water; organic compounds (water, CO2, O2, Ca, N, P) and ***living (biotic) component***s of Autotrophs or producers (green plants, bacteria, rooted plants of Trapa, Typha, Sagi Haria), Consumers (Herbivores, insects and large fish) and micro cosumers (bacteria, fungi).

2. **Stream & River Ecosystems*:*** Rivers and streams are flowing fresh water bodies. Out of all natural ecosystems, rivers are the most intensively used ecosystems by man. The organization of river and stream ecosystem include:

Abiotic Components: include volume of water, speed of water flow, dissolved oxygen content, temperature etc. The energy flow usually the organic matter which is being imported from adjacent terrestrial ecosystems.

Biotic Components: include Producers (algae, grass, amphibians); consumers (leaches, water insects, snails, fishes, crocodiles, reptiles) and Decomposers (bacteria, fungi, protozoa).

3. **Ocean or Marine Ecosystems:** The marine environment is characterized by its high concentration of salts and minerals. The major oceans of the world are Atlantic; Pacific; Indian, Arctic and Antarctic. These are deep and life extends to all its depths. The sea water contains salt content in the form of NaCl and rest are Mg, Ca, K . Temperature ranges from 0o to 30o C and pressure of 1 ATM at surface and 1000 ATM at bottom of oceans. The ocean ecosystem consists of the following;

Biotic components of Producers (phytoplanktons, marine plants, Ruppia, Zostera, Halophile are true marine angiospers), Consumers of Molluscas, fishes and Decomposers of bacteria and Fungi.

Abiotic components include Na, Cl, Mg, Ca, Sulphur, Dissolved oxygen content, light, temperature, pressure variations etc.

4. **Estuarine Ecosystem**: Estuary is the area at the mouth of the river joins the sea and continents. It has a free connection with the open sea and is thus strongly affected by tidal action. Estuaries are mixed with fresh water from land drainages. River mouth, coastal bay etc are the examples for estuarine ecosystem. Estuaries are one among the naturally fertile in the world. The components of estuarine ecosystem are given below:

Abiotic components: Estuaries have their own ecological characteristics. Physical factors such as salinity, temperature, tidal activity etc are variable in estuaries when compared to the sea or ocean.

Biotic components include Producers, consumers and Decomposers. Producers: Three major life forms of Autotrophs play a significant role in grass production. They are

(a) macrophytes (sea weeds, sea grass, spartina,Thalassia, marsh grass, nagrove trees)

(b) Phytoplankton and

(c) Benthic flora (algae).

Consumers include a number of zooplankton, oysters, crabs and some species of fishes capable of surviving in estuarine conditions form primary, secondary, tertiary consumers of the estuarine ecosystem. Decomposers include bacteria and fungi which actively take part in the breaking down the complex and dead organic matter (Fungi of actinomycites).

FOREST ECOSYSTEM

Introduction: Forest is a type of terrestrial (land) ecosystem. It consists of trees, shrubs or woody vegetation occupying an extensive area of land. Forests are important renewable resources. A different types of forests are seen on this earth. The type of forest depend upon its

geographical location and environment factors (Temperature and moisture) that influence the kind of vegetation that occur in an area.

Types of forests:

1. **Savannas:** These forests develop where a seasonal rainfall occurs. The grass lands of North Africa are known as savannas.

Eg: North Africa, America, Burma & India.

2. **Tropical forests:** These exits in areas of good rainfall (>200cm per year) with uniform warm temperature. The Soils found in there forests are old, acidic in nature & poor in nutrients.

Eg: Amazon rain forest (South America, India).

3. **Deciduous forests (or) Temperate forests:** Deciduous forests consists of broad leaved trees & occur where rainfall is plenty (750 - 1000 cms per year).

Eg: Europe & North-East America.

4. **Coniferous forest:** These occur in areas with long winters with heavy snowfall. In other words, where moisture is limited & rainfall is low. Herbivores (animals eating plants) & insects exist in these forests.

Eg: Moscow.

(5) Tundras: These are the large flat Arctic regions of Northern Europe, Asia and North America where no trees grow and where the soil below the surface of the ground is always frozen. The growing season is short and plants grow very slowly.

Following are the types of forests present in India:

1. Tropical, forests present in Western Ghats of Maharashtra, Karnataka, Kerala.
2. Deciduous forests present at Dehradun, Eastern Ghats of Andhra Pradesh, Tamil Nadu, M.P.
3. Littoral and swamp forests present at Sunderbans in West Bengal and Andaman islands.
4. Tropical Thorn forests present in New Delhi, Punjab and Gujarat.
5. Mountain wet temperature forests present at Nilgiri and Palani hills.
6. Alpine scrub forests present at Ladakh and Sikkim.

The characteristic features of a forest ecosystem are as follows:

Abiotic components include inorganic and organic compounds and dead organic debris. Further, the natural light conditions are different in forests due to complex stratification in the vegetation. Biotic components include Producers, consumers and Decomposers. Producers: These are plants and trees and produce the food through photosynthesis. The dominant species of trees are Quercus, Acer, Betula, Thuja, Picea, Abies, Pinus, Cedrus etc.

Consumers: The primary consumers are Ants, beetles, leaf hoppers, bugs, spiders, deers, squirrels etc. The secondary

consumers are Snakes, birds, lizards, foxes etc are the examples. The tertiary consumers are lion, tiger, hawk etc. Decomposers include micro organisms like bacteria, fungi etc. Consume the dead or decayed bodies.

Tropical rain forests are found in the hot and humid regions near the equator: These regions have abundant rainfall (2000 – 4500 mm per year) that occurs almost daily. These forests are found in South and Central America, Western and Central Africa , SE Asia and some islands of the Indian & Pacific Oceans. These rain forests are marked by a variety of tall trees and a dense canopy. The soils are thin and acidic with poor nutrients. A team of Brazilian scientists conducted a research and found that a forest could return as much as 75% of the moisture it received back into atmosphere. Hence, more trees are meant for more rain.

Temperate forests are very cold in winter and warm or humid in summer. These forests grow where the annual rainfall is about 750 – 2000 mm per year and are found in Western and Central Europe, Eastern Asia, Eastern America. Soil is rich in temperate forest areas. oaks, maples, beech, pine trees, ferns, lichens, mosses etc are found in these forests. Temperate forests contain abundant micro – organisms and mammals (squirrels, porcupines, chipmunks, raccoons, hares, deer, foxes, coyotes, bears. Birds like warblers, wood peckers, owls, hawks are seen. Snakes, frogs are also common these forests.

Coniferous forests derive the name from the abundance of coniferous trees like spruce, fir, pine, hemlock etc. Coniferous tree produces dry fruits called cones. In coniferous forests, winters are usually long and cold. The soil in these forests is acidic and humus rich. The main animals found in these forests are deer, moose, elk, caribon, mice, hares, squirrels, foxes, bears and birds. **Status of Forests in India:**

Forest Survey of India (FSI) , Dehradun estimated, the country's forest cover as 6,76,000 sq km Of this 6,76,000 sq km; 259000 sq km is open forest, 417000 sq km is covered by dense forest and mangroves occupied 4490 sq kms. Madhya Pradesh accounts for the largest forest cover of the country with 77265 sq km followed by Arunachal Pradesh 68045 sq km and Chhattisgarh with 56448 sq km.

DESERT ECOSYSTEM:

Deserts occur in regions when the annual rainfall is in the range of 250 to 500 mm and **evaporation rate is high.** Deserts occupy about 30% of land area on the globe. Deserts are found 30 above north and below south of the equator. Deserts are characterized by extremely hot days and cold nights. The largest deserts are found in the interiors of continents where moisture bearing winds do not reach. The desert soils has very little organic matter but rich in minerals. The desert plants have adapted to the dry conditions and conserve water by having few or no leaves.

Examples:

(1) A plant namely Saguaro cactus has a stem that can expand to store water

(2) Many desert plants have thorns or toxins to protect themselves from being grazed by animals.

(3) Some desert plants have wax – coated leaves that minimize the loss of moisture.

(4) Some desert plants have deep roots that reach the ground water.

(5) A few desert plants have shallow roots that collect water after any rain and store it in spongy tissues. Desert ecosystem is characterized by scanty flora and fauna. The organisms which with stand the extreme temperatures can survive here. Desert animals are usually small in size and come out during the nights for food.

Human impact on deserts:

Slow rate of growth of vegetation if topsoil is eroded due to heavy vehicle transportation across the desert. Desert cities, depletion of ground water, land disturbance, pollution from mining, storage of toxic wastes are some of the human activities that cause damage.

Abiotic components include temperature, rainfall, soil, water etc plays a major role to control the desert ecosystem. Biotic components include **producers** (shrubs, bushes, grasses, a few trees and plants namely Cacti, Acacias, Euphorbias). **Consumers** of insects, reptiles, rodents of rats & rabbits; birds, camels which are capable of living under desert conditions. **Decomposers** include Bacteria, Fungi due to poor vegetation and the less quantity of dead organic matter.

A Case study of Desert ecosystem:

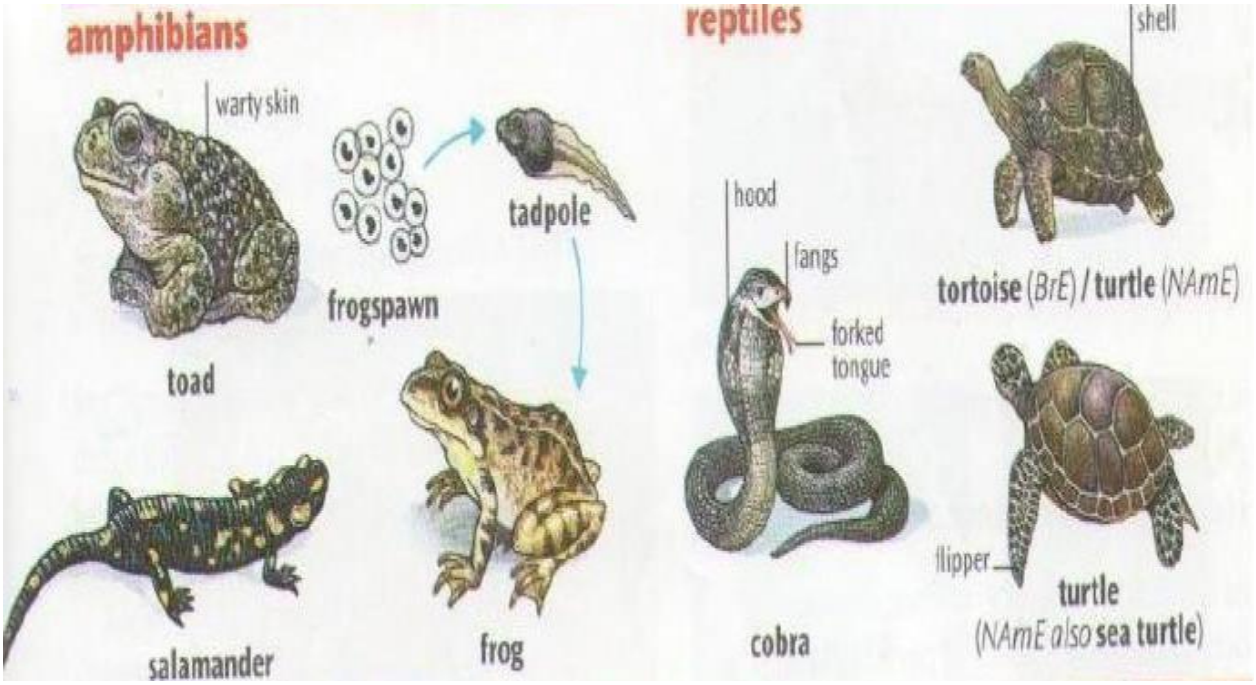
The Thar desert (the Great Indian Desert) is spread over four states in India Punjab; Haryana; Rajasthan and Gujarat and two states in Pakistan. Thar desert covers an area of about 4,46,000 sq kms. Though the Thar desert is smaller than the Sahara desert in Africa and the Gobi desert in Russia, the Thar desert is most populated in the world with about 13 million people. The average rainfall is between 100 mm and 500 mm. The only river in the region is the **Ghaggar** which enters Rajasthan from Punjab and dries up in the forest. The Thar desert has no Oasis. Flowering plants like shrubs, grasses, trees (Khejra, Babul, Rohida); fruit trees (Ber; Pilu) are found in Thar desert. Sheep, goats, camels are the common animals found in the Thar desert. In addition, wild ass, black buck deer, hare, red lynx, Jackal, Wild dog etc.. About 23 species of Lizard and 25 species of snakes are found in Thar desert region. part, is gleaning insects. The community provides the habitat—the place where particular plants or animals live. Within the habitat, organisms occupy different niches.

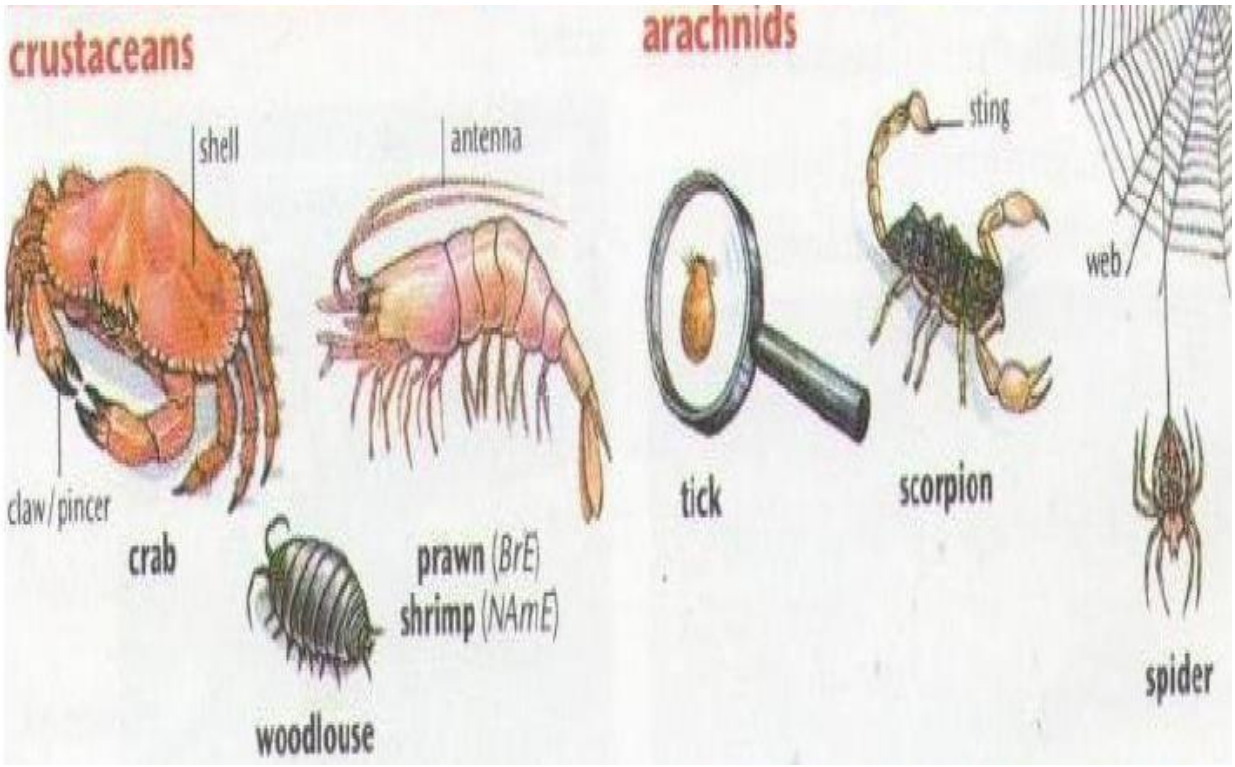
DIFFERENCE BETWEEN HABITAT AND NICHE

In ecology, a **niche** is a term describing the relational position of a species in its ecosystem to each other. A definition of niche is how an organism makes living. A niche is the totality of all biological and environmental factors that affect a population. It encompasses everything one can think of that allows populations to live, grow, and reproduce. The niche of an animal is all the conditions it can tolerate and where it lives. There are two types of niches. A broad and narrow niche. An animal that has a

broad niche can tolerate more conditions rather than an animal that has a narrow niche. An example of an animal that has a broad niche is an opposum. An example of an animal that has a narrow niche is a panda bear. The ecological niche describes how an organism or population responds to the distribution of resources and competitors. A niche is the functional role of a species in a community—that is, its occupation, or its living. For example, the tanager lives in a deciduous forest habitat. Its niche, its part, is gleaning insects. The community provides the habitat—the place where particular plants or animals live. Within the habitat, organisms occupy different niches.

Different species of organisms may appear to have the same habitat but each has a different niche so that they can survive in that habitat. A frog generally tends to have a broad niche. It can live in areas that have little water sources to areas that have a vast region as water sources.

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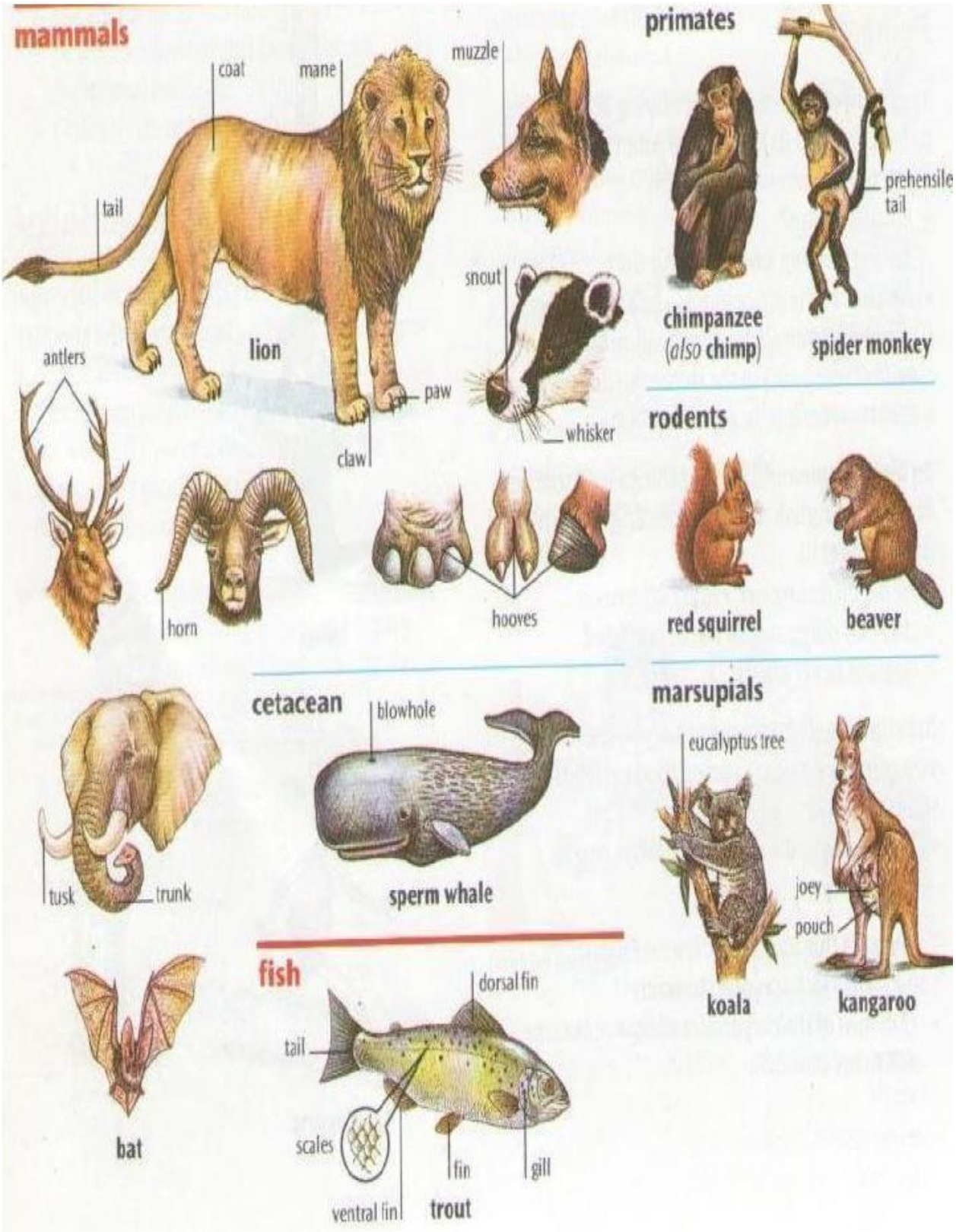
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cetacean
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sperm whale
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trunk
bat
fish
dorsal fin
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scales
fin
gill
ventral fin
trout

MODULE- II
NATURAL RESOURCES

The word resource means a source of supply. The natural resources include water, air, soil, minerals, coal, forests, crops and wildlife are examples. All the resources are classified based on quantity, quality, re-usability, men's activity and availability.

Classification of Resource

Exhaustible Resources: These resources have limited supply on the earth and liable to be exhausted if used indiscriminately. These resources are of two types.

(1) *Renewable resources*: These resources have the capacity to reappear themselves by quick recycling with a reasonable span of time.

Eg: forests, wildlife.

(2) *Non-renewable resources*: Resources that exist in a fixed quantity in earth's crust are called non–renewable resources. These resources lack the ability of recycling and replacement. Eg: minerals, fossil fuels etc..

A few mineral resources which occur in the earth's crust namely copper, aluminum, mercury, gold etc.., minerals of asbestos, clay and mica are considered as non-renewable resources. Fossil fuels are derived from organic matter that accumulated during hundreds of millions of years of early bio-geological history. There is no way of recycling the energy in fossil fuels.

Inexhaustible Resources: These resources are present in unlimited quantity in the nature and they are not likely to be exhausted by human activities.

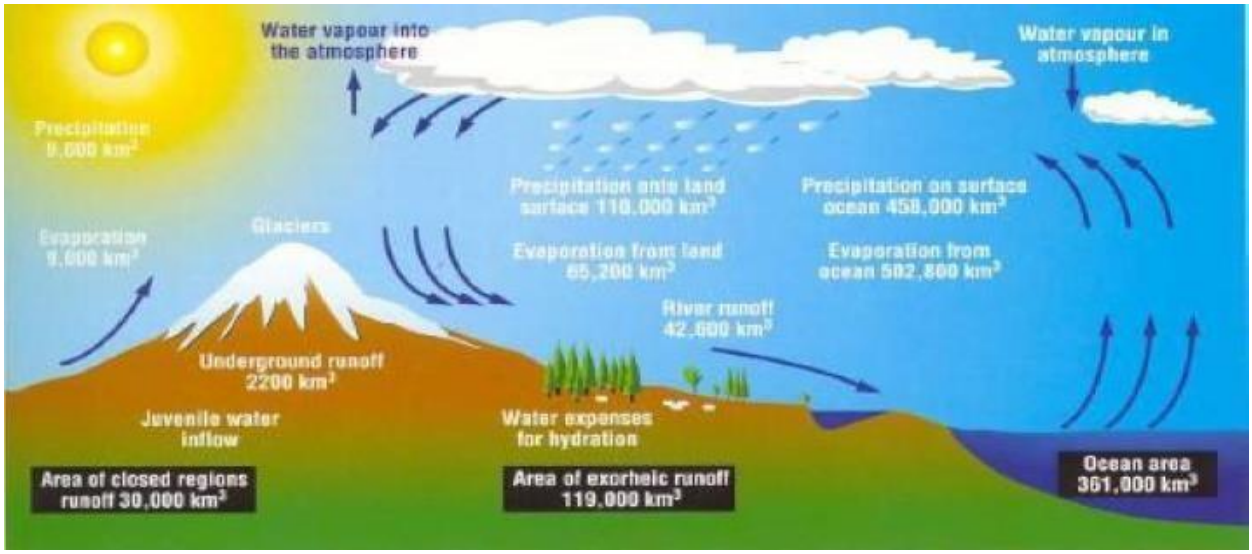
Eg: solar energy, wind power, tidal power, rain fall, atomic energy etc…

It is very important to protect and conserve, the natural resources. Natural resources are to be used in a judicious manner so that they cannot be exhausted. It doesn't mean that we should stop using them. Natural resources are to be used in such a way that we can make use for future generations. Among the natural resources, Water resources; Mineral resources; Energy resources; Land resources are the major ones to discuss.

WATER RESOURCES

Hydrologic Cycle: The continuous circulation of water from land, water bodies etc., which joins the atmosphere and finally condenses into the form of precipitation. A part of water is lost by evapo-transpiration and certain portion percolates into the ground to form ground water reservoir and the remaining water flows on the ground as runoff and joins the streams, rivers and finally into sea. This cycle is continuously repeated. Water is the main constituent of hydrosphere & is renewable resource. Water is next to air that man requires for his survival and existence. Water is needed for daily use by organisms, for irrigation, industrial electricity production and domestic

use. Hence, water is an important resource in all economic activities ranging from agriculture to industry. The distribution of water resources is not uniform over the earth's surface. About 97% of it is salt water in the seas & oceans, 2.6% is trapped in polar ice caps & glaciers. Only 0.4% is available as fresh water.



Fresh water occurs mainly in two forms as .

1. Ground water
2. Surface water

The distribution of fresh water is geographically uneven varying greatly from country to country & even one region to another region.

Uses of water:

1. Domestic use: Water used in the houses for the purposes of drinking, bathing, washing clothes, cooking, sanitary & other needs. The recommended value according to Indian standard specification for domestic use is 135 liters/day
2. Industrial use: Water is required for various industries such as cement, mining, textile, leather industries.
3. Public use: This includes water used for public utility purpose such as watering parks, flushing streets; jails etc.
4. Fire use: Water is used in case of accidents and to prevent the fire issues.
5. Irrigation: To grow crops this is the main sources for food.
6. Other uses: Hydro electric power generation requires water.

Effects of over use of ground water:

Over use of groundwater has following effects.

1. Lowering of water table: Excessive use of ground water for drinking, irrigation and domestic purposes has resulted in rapid depletion of ground water in various regions leading to lowering of water table & drying of wells.

The reasons for shortage of water are:

1. Increase in population,
2. Increasing demand of water for various purposes.
3. Unequal distribution of fresh water.
4. Increasing pollution of water sources cause over exploitation.

2. Ground subsidence: When ground water withdrawal is greater than its recharge rate, the sediments in the aquifer become compacted. This is called ground subsidence which may cause damage of buildings, destroy water supply systems etc.

Floods: A Large area of land with water for several days in continuation is called flood. Floods have been regular features of some parts of India & Bangladesh. Floods are caused by both natural as well as human factors. The (i) anthropogenic activities such as deforestation, construction activities, and diversion of river channels cause floods (ii) over-grazing also cause floods. Floods are also caused by various factors such as, climatologically (due to rain), failure of dams (i.e., excessive release of water) and floods could get intensified because of basin characters. Flooding also takes place when the river channels are unable to contain the discharge.

Drought: The condition of dryness for prolonged period is called drought due to drop of average rainfall. Drought cause famine and starvation of human & animal population of region concerned. Drought is the most serious physical hazard to agriculture. Shortage of water for even the basic needs is the main problem in the drought areas. Shallow rooted plants don't grow. Infiltration wells, construction of dams, water sheds are being taken up in drought prone areas. Clouds seeding techniques, artificial rains etc., are to be implemented.

Conflicts over water: Conflict means a situation in which people, groups, countries are involved in a serious argument. Water is an essential resource for sustaining life and environment. The available water resources are under tremendous pressure due to increased demands. Conflicts over sharing of river water between neighboring countries or different states of a country have now become quite common. The conflicts over water are continuing phenomena and leads to wars.

Some examples of such conflicts in past & at present are listed below:

1. During Second World War many water dams were bombed.
2. Central dams over YALU River were attacked during Korean War.
3. Water supply systems in North Vietnam were bombed by US in1960's during Vietnam War.
4. The construction of Farakka Barrage across Ganga has become a dispute between India and Bangladesh. The Barrage is intended to divert water into river Hoogly to protect Calcutta port.
5. The Cauvery water dispute is between the states of Tamil Nadu and Karnataka. Tamil Nadu is occupying the downstream region of the river wants to use of upstream water whereas the upstream state Karnataka refused to do so.
6. The Sutlej –Yamuna link is the dispute between Punjab & Haryana.
7. The river basin of Fordan and the Nile are the shared water resources for Middle East Countries (Asia; Africa; Europe). Ethiopia controls 80% of Nile River water whereas Sudan (South Africa) too is trying to divert more water. The sufferer is Egypt.

The following statuses have disputes:

Rivers	**Disputing states**

1. Yamuna	Delhi, Haryana, Rajasthan, Himachal Pradesh, Uttar Pradesh.
2. Narmada	Maharashtra, Gujarat, Rajasthan, Madhya Pradesh
3. Krishna	Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka.
4. Godavari	Andhra Pradesh, Maharashtra, Orissa, Madhya Pradesh.
5. Cauvery	Tamil Nadu, Karnataka

Dams benefits & problems : The construction of dams has their own benefits & drawbacks. Excess amount of water flowing in rivers which otherwise Join Sea can be stored as reservoirs by constructing the dams across the rivers. The dam's viz., Bhakra-Nangal, Heerakud, Nagarjuna sagar; srisailam etc generate electricity, to supply drinking water. Pandit Jawahar Lal Nehru called these dams as "THE TEMPLES OF MODERN INDIA".

Uses:

1. More land can be brought under irrigation.
2. Hydro-Electric power can be generated.
3. Water can be supplied to towns & cities. Disadvantages:
1. Causes change in a climate of region at micro level.
2. Loss of vegetation & soil erosion.
3. Generation of seismic activities due to heavy pressure of water.
4. Blasting operations during construction of dams cause landslides.
5. Sedimentation & silting of reservoirs.

MINERAL RESOURCES

Minerals are naturally occuring inorganic, crystalline, solid having a definite chemical composition with a certain physical properties or a substance that is naturally present in the earth and is not formed from animal or vegetable matter. In any country, the growth and development of industry depends on the availability and quality of deposits of minerals of economic importance. Mineral resources can be classified under three main types. They are metallic, nonmetallic and atomic minerals. Metallic minerals include native elements such as gold and silver ; haematite and magnetite (iron) ; Cuprite (copper) ; Laterite (aluminum) and non- metallic minerals include sand (quartz), garnet ; steatite (talc); muscovite (mica) whereas atomic minerals include Pitchblende (Uranium, Thorium). The geological processes are caused for the formation of the minerals over million of years ago in the earth's crust. Minerals are generally localized in occurrence and the deposits are very sporadic in distribution. Mineral resources are non renewable and the mineral /ore is extracted by the process of mining. Much risk is involved in mining process because of high temperature, pressure variations, fire hazards and lack of ventilation in mines. Minerals are used in a large number of ways for domestic, industrial, commercial sectors etc… Generation of energy by using coal (lignite / anthracite) ; uranium, gold, silver, platinum, diamond are used in jewellery. Copper, aluminum etc are used as cables for transmission of power. Some of the minerals are used in ayurvedam as medicine. Gold is reputed to strengthen the heart muscle and increase energy and stamina. By placing a piece of gold (devoid of stones) into 1000 ml of water and boiling it until reduced to 500 ml. Historical dose used gold ash of 10 mcg/day or gold water of 1 tsp 3x/day. Silver is a very important healing substance due to its cooling and antiseptic properties. It is most useful for treating Vata

and Pitta especially conditions involving weakness, and some of chronic fevers. It is also used for gastritis, inflammatory of the intestines. Historical dose used silver ash of 10-30 mcg/day or silver water of 1 tsp 3x/day. Copper was used to treat conditions of excess kapha (primarily) and vata (secondarily). Historical dose used: copper ash: 10-30 mcg/day or copper water: 1 tsp 3x/day
Environmental effects: Mineral extraction and processing in mines involves a negative impact on environment. Mining process involves removal of over burden of soil, ore extraction & transportation, crushing & grinding of ore, water treatment of ore, storage of waste material As a result of these activities cause air pollution, noise pollution, water pollution, loss of habitat of wildlife, concentration of toxic substances in tailing ponds and spreading of dust. People working in mines often suffer from serious respiratory system and skin diseases. Mining often causes ground subsidence which results in tilting of buildings, cracks in houses, buckling of roads, bending of rail tracks etc. Exploration process before a mining involves, geochemical, geophysical surveys drilling activities which causes for air pollution, noise pollution etc.. In addition, disturbance of all vegetation (flora) and fauna (animals) from that a region.

Remedial measures: Atmospheric pollution due to mining and associated activities can be minimized by planning and using dust extractors, by optimizing the blast design, maintenance of roads and sprinkling of water for easy movement of dumpers, by using eco generators (sound proof), proper maintenance of equipment and the machines not only minimize the air pollution but also the noise generation.
case studies of mineral resources
1) *Aravalli hills in Rajasthan*: The Aravallis hills spread across Haryana, Rajasthan and Gujarat and control the climate and drainage system of the region. Mining activity is being taken in this region due to immense mineral wealth (Talc, marble, granite).
Rajasthan state alone has 9700 industrial units connected with mining and 90% of forest has been depleted over the past 20 years. When the mining activity reached below the under ground water level, a cone of depression was formed in the surrounding areas and ultimately bore wells, dug wells, dried up and affected agriculture in a massive level. Several studies have pointed out that the natural drainage system and the ground water table of the entire region have been badly affected. Pollution levels have also increased. Lung diseases, silicosis were attacked by the laborers. In November 2002, the Supreme Court imposed a blanket ban on mining activities in the Aravalli hills. The court ruling closed all 9700 units. The environmentalists have alleged that mining has affected the water, forest and the land.
2) *Uranium mining in Nalgonda*: The Uranium Corporation of India proposed to mine Uranium from the deposits of Lambapur and Peddagattu villages of Nalgonda dist. Processing unit was proposed at Mallapur village in Nalgonda dist by offering employment opportunities. But experts didn't propose mining activity because of possible contamination of water. The proposed mines are just 1 km away from human habitation and 10 km from Nagarjuna sagar dam and 4 km away from Akkampalli reservoir, which is a source for drinking water.
3) Gold mining in Europe: Potassium Cyanide is used during the process of gold treatment. In 2000, the *Baia Mare Gold mine* in Romania (Europe), released 80 million litres of less concentrated cyanide into the Tisza river. The cyanide flowed 500 km via Hungary and Serbia cities caused for diseases.

4) A *Gold and Copper project of Tedi Island in New Guinea* released 1000 cubic meters of less concentrated cyanide into a river and affected the cultureand lifestyle of Guinea people.

LAND RESOURCES

Land is the major part of the lithosphere. Land is made up of soils / rocks and are considered as very important resources of earth. Land plays a major role for growth of crops, vegetation, forests etc., Soils are formed due to disintegration of rocks by various physical processes like change in temperature, pressure, blowing wind and flow of water. The top layer of soil consists of mixtures of Humus (dead leaves & plants), some of the living organisms and Inorganic components which supply nutrients to the soil. Soil fertility depends on inorganic matter, organic matter, water, air and a variety of micro-organisms viz., bacteria, fungi, which help in the decomposition of organic matter and regeneration of nutrients.

Distribution of land resources

The utilization of land distribution in India as under:

Agriculture land	43.60 %
Pastures	14.60 %
Waste lands but cultivable	12.20 %
Forests	10.70 %
Barren land	8.40 %
Urban land	5.30 %
Unavailable information on lands	5.20 %
Total	100.00 %

Types of Indian Soils

Different types of soils are identified by taking into account the geographical extent, physical and chemical properties for the purpose of agriculture, nutritional factors.

(a) *Alluvial soils*: This is generally alkaline and best soil for agricuture. Alluvial soils are derived from debris brought by the floods or rivers or by tidal waves. Eg: North Indian Plains; Indo–Gangetic Plain; Ganga and Brahmaputra Plains …

(b) *Black soils*: Black soils are predominantly with clay and sandy loams. These soils are found in the regions of AP (Krishna and Tungabhadra basins) , Maharashtra (Deccan Traps) and Madhya Pradesh.

(c) *Red soils*: The red colour is due to the presence of high proportion of iron component and characterized by low water retention capacity. Red soils are found in Andhra Pradesh, Tamil Nadu and parts of Bihar, Orissa and Western Ghats of Karnataka..

(d) *Laterite soils*: These soils are rich in hydroxides of Ferrous and aluminum. At low elevation areas, the laterite soils are suitable for paddy cultivation whereas at higher elevations, they are suitable for coffee, tea, rubber etc., Western Ghats, Northern part of Eastern Ghats, North of Bangalore and West of Hyderabad are examples for laterite soils.

(e) *Mountain soils*: These are stony. Mountain soils are formed due to dislodgement of rocks due to landslides and occur over altitudes between 2000 to 3000 mts. Eg: Aravallis and East of Himalayas. Mountain soils are favour for growth of vegetation / forest .

(f) *Desert soils*: These soils cover the parts of areas of Rajasthan and Kutch where the annual rainfall is less than 50 cms per annum.
(g) *Saline soils*: Presence of salt and water retention make the soils unsuitable for agriculture. Eg: Arid (no rain) and Semi arid (partly rain) regions of northern plains and Maharashtra.
Soil erosion and causes for soil erosion
The top layer of the earth is called as soil. Soil erosion occurs due to deforestation, overgrazing, industrialization; desertification etc.
Deforestation: Mining, industrial, urban development etc causes deforestation and leads to exposure of the land to wind and rains causing soil erosion. Cutting trees leads to deforestation which in turn loss of organic matter in the soils.
Overgrazing: When sufficient amount of grass is available for the organisms usually the entire land /area may be subjected to exhaust and the land is exposed without grass and ultimately the land expose to wind/rain causing soil erosion. .
Industrialization: Different processes carried out by industries and mining operations cause soil pollution which leads to degradation of land.
Desertification: The process of conversion of productive lands to unproductive lands is called desertification. This occurs due to loss of top layer of soil by erosion. Erosion of top layer results in loss of water holding capacity and finally converted in to unproductive areas .

Land degradation and control of land degradation
Land degradation can be defined as any change in the land that alter its conditions or reduces its quality. Land degradation occurs due to both natural disasters like volcanic eruptions, earthquakes, heavy rains, fire etc or human induced activities. The other causes of land degradation consists of wind blow, salinity of water, water logging, soil acidity, loss of flora and fauna. Desertification is land degradation occurring in the arid, semi-arid regions of the world. These dry lands cover about 40% of the earth's surface and puts at risk more than 1 billion people who are dependent on these lands for survival. Land clearing and deforestation; Mining activity in forest areas; urban conversion; bringing more land under cultivation; soil pollution ; loss of organic matter in the soils; alkalinization of soils; salinity of water etc leads to land degradation. Severe land degradation affects in decreasing the mineral wealth and economic development of nations. The methods that are followed for the prevention of land degradation are called soil conservation methods. Some of the popular methods are;
(a) *Contour farming*: The land is prepared with alternate furrows (a long narrow cut in the ground) and ridges at the same level . The water is caught and held in furrows and stores which reduces run off and erosion.
(b) *Mulching*: Stems of maize, cotton, tobacco etc are used as a mulch (decay of leaves) to reduce soil moisture, evaporation.
(c) *Crop rotation*: Growing same crop year after year depletes the nutrients and land becomes unproductive. This is overcome by changing the crops and cultivating legumes (plants like peas, beans) after a regular crop.
(d) *Strip cropping*: It consists of planting crops in rows or strips along contours to check flow of water.
(e) *Agrostological methods*: Korean grass, Mexican grasses are grown as erosion – resisting plants.

(f) *Miscellaneous methods*: Construction of bunds, drains, widening of gullies, Afforestation methods prevent the soil erosion.

Landslides and man induced land slides

Landslides are always exist on this planet and the term land slide is used to describe a wide variety of process that result a downward movement of rocks under gravitational forces. In other words, mass movement of rocks, debris and soil down a slope of land. Landslides are primarily associated with steep slopes . Surface run-off and changes in drainage also cause for landslides. Landslides can also be initiated by rainfall; earthquakes; volcanic activity, changes in groundwater movement or any combination these factors. Debris-flows can travel down a hillside of speeds upto 200 miles per hour (more commonly, 30 – 50 miles per hour) depending on the slope angle, water content, and type of earth and debris in the flow. While landslides are a naturally occurring environmental hazard they have recently increased in frequency in certain areas due to human activities. Building excavations, collapses in mining (eg : coal mine) causes landslides. However, landslides can be triggered by the human beings by induced changes in the environment.

Simply landslides can be explained in three ways:

(a) Inherent of rocks (weakness in the structure of a rock)
(b) due to heavy seismic or volcanic activity and
(c) due to various environmental conditions.

ENERGY RESOURCES

The term energy means capacity to do work . Energy can neither be created nor destroyed but transformed from one form to other . Energy is closely related to force. When a force causes an object to move, energy is being transferred from the force to kinetic energy. Energy is present in a number of forms such as mechanical, thermal, chemical, biological energy etc.. Energy production and utilization have become essential to carry out many activities in modern life. Energy is one of the important requirements that a country needs for its economic growth. At the same time, energy production has its impact on environment due to pollution and finally affects the quality of life of people. The energy is used for the following purposes:

a) Cooking, heating and lighting
b) Transporting people and goods by means of vehicles.
c) Manufacturing consumer goods and equipment
d) Conversion of fuels into other forms of energy for various use.. For Example:
(1) Burning coal to produce electrical energy or mechanical energy
(2) Chemical to electrical by dry cell batteries
(3) Using water in dams to produce electricity through mechanical energy.

The power generation capacity in the country has increased from 1400 MW at the end of 1947 to 92,894 MW at the end of 1999 from various sectors comprising as under:

Hydro sector	22,438 MW
Thermal sector	67,618 MW
Nuclear sector	1,870 MW
Wind sector	968 MW
From all sectors	92,894 MW

There are two types of energy sources namely:
(1) Renewable energy sources and (2) Non – renewable energy sources. The important renewable energy resources are described below:
Solar energy: The energy which is derived from the sun is known as solar energy. It can be used for direct heating or sun's heat is converted into electricity. Photo voltaic cells convert direct solar energy into electricity. A number of solar equipments have been developed to utilize sun rays to heat water, to cook food, to pump water and to run certain machines and used for street lighting, railway signals etc. But the major problem with solar energy is that during cloudy weather it is available in less quantity than on sunny days.
Hydro-Power energy: Electrical power is generated by hydro-electric projects in which dams are constructed across the river. The kinetic energy of water is converted into mechanical energy by means of turbines and in turn, the mechanical energy is transferred into electrical energy by generators. Hydro power projects lead to several environmental problems like destruction of animal habitats, deforestation , migration of people etc..
Geothermal energy: Geothermal energy found within rock formations. Inside the earth the temperature rises with depth .The temperature in earth's crust is around 4000oC. Geysers (a natural spring that emits hot water) and hot springs are examples for geothermal energy where the steam and hot water come to the surface, in areas where the steam is tapped by drilling. The obtained steam is then used to generate power. Air pollution results in case of geothermal energy where the gases like H2S, NH3, CO2 present in the steam coming out of the geothermal sources. The overall efficiency for power production is low (15%) as compared to fossil fuels (40%). Wind energy: Wind energy is the kinetic energy associated with the movement of atmospheric air. Wind mills convert the wind energy into electrical energy. On an average wind mills can convert 30 – 40 % of available wind energy into electrical energy at a steady wind speed of 8.5 mts / sec. The efficiency of wind mill is increased with the speed of wind and length of rotor blade. The total wind energy potential in India's estimate is 25,000 MW of this about 6000 MW is located in Tamil Nadu; 5000 MW in Gujarat and contribute the states of Andhra Pradesh, Maharashtra, Uttar Pradesh and Rajasthan for balance quantity.
Merits & demerits of wind energy:
1. It is a non – polluting and environment friendly source of energy.
2. It is a renewable energy available at free of cost
3. Power generation is cheaper with nil recurring expenses.
4. Wind mills are suitable to erect at on shore, remote and rural areas where wind blows with required intensity.
5. Favorable in geographic locations which are away from cities.
6. Wind turbine design, manufacturing, installation is complex due to varying atmospheric conditions.
7. Wind power doesn't suitable for large scale generation.

Ocean energy: Seas and oceans are large water bodies. Seas absorb solar radiation and a large amount of solar energy is stored in the tides and waves of the ocean. Ocean energy is non – polluting in nature and suitable at a few places only. Energy from seas or oceans is obtained from the following:
(1) *Ocean Thermal Energy Conversion*: The oceans collect and store huge quantities of solar on the surface of the water while the temperature of deep waters is very low. Using this temperature difference it is possible to convert heat into electricity.

(2) *Tidal energy*: Tidal waves of the sea can be used to turn turbine and generate electricity. Asia's first tidal power plant of 800 - 1000 MW capacity is proposed to be set up at Kandla in Gulf of Kutch.

(3) *Wave energy*: The wind blowing over water generates waves. A unique property of ocean waves is their ability to travel vast oceanic distances with negligible loss of energy and ultimately arrives the continental margin of that basin. India's first wave energy power plant of 150 KW capacity has been commissioned in Thiruvananthapuram, Tamil Nadu. 1 MW wave energy plant is being set up in Andaman and Nicobar islands.

(4) *Current energy*: Theoretically, the ocean water used to generate energy by allowing the water to pass through a series of turbines installed under water. The turbines are to be sealed and are kept at a depth of 10 to 20 mts. A propeller with a dia of 5 mts can generate about 150 MW of power.

Bio mass energy: Bio-mass is an organic material from living beings or its residues. It is a renewable source of energy derived from the waste of various human and natural activities. The bio-mass energy sources include Wood, animal manure, sugarcane waste, agriculture crops, house hold waste, roots of plants, garbage etc. The simplest way of using bio-mass energy sources is to allow them to dry out in the sun and burn them.

Bio-gas: Bio-gas is a sustainable source of energy by virtue of its production from available natural organic wastes of cattle dung, human excreta, poultry waste, plant leaves, paddy husk etc…. Bio-gas is a mixture of methane (68%), CO2 (31%) and N2 (1%). Methane gas (CH4) is produced by bio-gas plants and this gas is utilized as cooking gas whose calorific value varies from 4400 – 6200 Kilo Calories / cum. Heat value of bio gas can be improved by reducing its CO2 content. Bio-gas production is carried out in an enclosed bio-gas plant made of bricks or steel. Slurry of waste organic matter is fed into the plant through an inlet and gas formed is tapped by an inverted drum. As gas is produced the drum rises and the gas may be drawn through an outlet. Bio-gas is commonly produced from cattle dung in a bio gas plant known as Gobar Gas plant. Bio-gas is a clean, cheap fuel that can be used for lighting purpose, lifting water through small pumps.

Non – renewable energy resources include (a) fossil fuels such as coal, crude oil, natural gas and (b) nuclear energy.

(a) Fossil fuels: Fossil means the remains of an animal or a plant which have become hard and turned into rock. All these found in earth's crust which has been formed in the past by the geological processes. Fossil fuels are solid coal (lignite), liquid (crude oil / petroleum) and gases (natural gas).

Coal: Huge quantity of plant materials buried under earth's crust and altered by geological process and converted into carbon rich fuel. It is a non – renewable source because it takes a very long period (million of years) for its formation. Coal is extracted by the process of mining and involves accidents due to mine collapse, ground water pollution, accumulation of poisonous material, explosive gases etc cause diseases. CO2 pollution leads to green house effect (global warming).

Crude oil: It is obtained in the form of liquid. The crude oil is heated upto 600oC in the oil refinery and condense the vapours of hydro – carbons. Petrol and other petroleum products are refined fuels from crude oil. Petroleum products are used in large quantities in the manufacture of detergents, plastics, fertilizers, pharmaceuticals, synthetic rubber etc. The transport sector

consumes about 40% of diesel; 25% industries and 19% household and rest 16% agriculture and other sectors. .

Natural Gas: Gas deposits are trapped from the sedimentary formations by means drilling holes into the rock formations. While burning of natural gas, the emission of CO2 is less and thus reduces green house effect and global warming. A total of 734 billion cubic mts of gas is estimated as proven reserves.

(b) Nuclear Energy or Atomic power: It is the energy which is trapped inside the atom. It is non–renewable source of energy which is released during fission or fusion of certain radioactive elements. The most important advantage of atomic power is the production of an enormous amount of energy from a small quantity of radioactive element. For eg: 1 kg of Uranium liberates energy equivalent to 30000 kgs of coal. Energy released during nuclear reaction (mass – energy equation as per Albert Einstein's formula E = mc2). Nuclear Energy is produced by two Processes namely

(1) Nuclear Fission (2) Nuclear Fusion.

(1) Nuclear Fission: The nucleus in atoms is split by fast moving neutrons and in turn a tremendous amount of energy in the form of heat, light etc is released by a chain of reactions. Uranium is used as fuel. The energy released slowly in this process is utilized to generate electricity or else released suddenly all at once, results a tremendous explosion as in the case of Atom bomb.

(2) Nuclear Fusion: Nuclear energy can be generated by fusion process which involves two hydrogen atoms combine to produce one helium atom. Eg: hydrogen bomb. The disposal of nuclear wastes during mining, fuel production and reactor operation for a long time period resulting in adverse effects on environment. Disposable of nuclear waste is a national and global problem.

FOOD RESOURCES

The main sources of human food are plants and animals. Human beings consume almost all parts of plants in the form of

Cereals (wheat, barley, millet, rye, oats, maize, corn, rice)

Pulses (peas, red grams, green grams) Vegetables (carrot, cauliflower, beans) Fruits (banana, orange, grapes,pineapple)

Spices (pepper, cloves). Also a number of products such as milk, butter, egg and meat supplement the requirements. To carry out the physiological metabolism of human system successfully, a continuous supply of energy in the form of food is required. Usually food comes from three sources.

Meat from grazing livestock (cows, sheep eat grass that is growing in a field) accounting for 17%

Agriculture activity is the major source for food production which provides 76% of the total, mostly as good grains.

Fisheries that supply the remaining 7%. Enough food in the world is available to provide at least 2 kg per person a day including grains, beans, nuts, fruits, vegetables, meat, milk and eggs but the problem is that many people are too poor to buy readily available food. At least 700

million people do not have enough to eat. Every year hunger kills 12 million children worldwide. India now produces 180 – 210 MT of food grains, 5 MT of meat products and 6 MT of fish annually. Since world's population is growing every year and the demand of food is also increasing continuously. Although world's food production has increased almost three times during the last 50 years, but at the same time rapid population growth outstripped the food production. So, the world food problem is a complex one depending on food production, population increase, the prevalence of poverty and environmental impacts. Famines are due to lack of access to food but not lack of food. Modern agriculture is largely based upon technological factors like the use of improved seeds, chemical fertilizers, synthetic pesticides etc…

Green revolution however changed traditional agricultural practices with a rapid increase in food production in developing countries. An American agricultural scientist, Norman Borlaug developed a high yielding variety of wheat through new concepts in plant breeding. By the mid 1960's, the green revolution was fully adopted in India. There are two types of agricultural systems :(1) Traditional system (2) Modern and Industrialized system

(1) The Traditional system is again subdivided into two types namely:

(a) Traditional Subsistence Agriculture (TSA): In this system, only enough crops or livestock are produced for the use of family and a little surplus to sell to meet the needs.

(b) Traditional Intensive Agriculture (TIA): Farmers increase their inputs of human labour, water fertilizers to get higher yields for the use of their families and to sell small quantities for getting income.

(2) Modern and industrialized agriculture a large extent of land will be brought under agriculture and huge quantities of fuel, energy, water, chemical fertilizers, pesticides used to produce large quantities of single crops purely for sale. This system is spreading in India in the name of Green revolution. But this modern agricultural system has its own adverse effects on environment.

→ Excessive use of chemical fertilizers to boost up the crop yield, contaminate groundwater with nitrate. The presence of excess of nitrate in drinking water is dangerous for human health. Excess Nitrate reacts with hemoglobin and causes for "Blue Baby Syndrome" which kill the infants.

→ The excessive N P K fertilizers in agriculture fields are often washed off with water and leads to algal blooming and Eutrophication. Phosphates have been accumulating in soils, lake sediments for decades change the ecology Increased levels of phosphates in water bodies cause Eutrophication (growth of unwanted plants).

→ The excessive use of pesticides enter the food chain and become hazardous to human life.

→ A large area of fertile land have become saline in recent years due to excessive irrigation.

→ Consumption of fuel energy is more when shifting of human and animal labour to agriculture machinery. Use of fuel leads to air pollution.

→ Continuing to increase input of fertilizers, water and pesticides eventually produces no additional increase in crop yield but slows down the productivity of the crop.

→ Due to increased irrigation, the underground aquifers are slowly and constantly become dry. The rate at which they are being depleted is much faster than its recharge.

→ Excessive application of chemical fertilizers can increase soil salt content. The percolation of domestic and industrial sewage also increase the salinity of soil.

→ The stagnation of water in the soil in the upper layers causes for water logging which causes for less oxygen availability for respiration of plants.

Fertilizers are defined as materials having definite chemical composition that supply nutrients to plants. Most of the chemical fertilizers are inorganic in nature. Plants need water, sunshine, CO2 and nutrients for their successful growth and production.

The nutrients are of two types.

(1) Macro Nutrients (N, P, K)

(2) Micro Nutrients (Ca, Mg, S, Fe, Zn, Ba).

Farmers are tempted to use fertilizers in excessive quantities to get more yields by ignoring the presence of nutrients in the soil naturally. The excessive fertilizers percolate along with water into the soil and pollute the ground water.

Nitrates contaminate the water and leads to health problem to the animals and people who use such water. Nitrates in excess over 50 mg / litre in ground water causes 'Blue Baby disease' Phosphates have been accumulating in soils, lake sediments for decades change the ecology. Increased levels of phosphates in water bodies cause Eutrophication (growth of unwanted plants). The alternate methods to prevent chemical fertilizer problems are the use of organic manure, crop residues, green manure, crop rotation, high yield crop varieties.

Pesticides are used in order to prevent the damage caused by several types of insects, weeds and micro-organisms. Pesticides are of 3 types.

(a) Insecticides (insect killers)

(b) Nematocides (worm killers)

(c) Rodenticides (rat and mouse killers):

Worldwide about 2.3 million MT of pesticides are used yearly. Some of the examples of pesticides are DDT, Aldrin dieldrin, Toxaphene, Lindane, Chlorodane, Methoxychlor, Malathian, Pyrethrum, Aldicarb, Carbaryl, Rotenone, atrazine etc. Entire agriculture suffers from Pests. Pests are undesirable parasites or predators. The major agriculture pests are insects that feed on leaves and stems of plants. Eg: Nematodes are small worms that feed on roots. Pesticides are applied in the form of dry powders, solutions, emulsifiable concentrates. Soil micro organisms (earthworms); pollinating insects (butterflies), Natural predators (birds) that consume the poisoned dead pets are killed by the pesticides causing considerable environmental damage. Short term effect include illness caused by pesticide food grains, fruits etc whereas long term include cancer, immunological, chronic diseases

Case studies:

(1) Salinity in Haryana and Punjab: Thousands of hectares of land area in Haryana and Punjab are affected by soil salinity and alkalinity.

(2) Water logging in Punjab, Haryana, Rajasthan: About 1.2 million hectares of land in Haryana resulted in rise in water table followed by water logging and salinity due to canal irrigation.

(3) The soil water containing salts seep into the pipes slowly and is drained out of the fields. The Central soil Salinity Research Institute (CSSRI) in Karnal dist of Haryana converted the barren lands into productive lands.

FOREST RESOURCES

Forests are one of the most important natural resources on this earth predominantly composed of trees, shrubs, woody vegetation etc… Approximately 1/3rd of the earth's total land area is covered by forests.

Functions of forests: Forests have three types of functions

1. Productive functions: This includes the production of timber, bamboos & a variety of compounds such as resins, alkaloids (poisonous substance in plants), oil and pharmaceuticals.
2. Protective functions: It includes conservation of soil and water, prevention of drought, protection against wind, cold, radiation, noise, odours etc…
3. Regulative functions: This includes absorption, storage and release of gases like CO2 & O2. Droughts & particularly CO2 is regulated by forests. The regulative functions of forests improve atmospheric & temperature conditions.

Types of forests: Forests are important ecologically and economically. Forests are the important renewable resources which contribute sustainability to the economic development of a country.

1. Savannas: These forests develop where a seasonal rainfall occurs. The grass lands of North Africa are known as savannas.

Eg: North Africa, America, Burma & India.

2. Tropical forests: These exits in areas of good rainfall (>200cm per year) with uniform warm temperature. The Soils found in there forests are old, acidic in nature & poor in nutrients.

Eg: Amazon rain forest (South America, India).

3. Deciduous forests (or) Temperate forests: Deciduous forests also known as temperate forests with a broad leaved trees & occur where rainfall is plenty (750 - 1000 cms per year). Destruction of these forests results in soil erosion & loss of biodiversity in the eco system.

Eg: Europe & North-East America.

4. Coniferous forest: These occur in areas with long winters with heavy snowfall. In other words, where moisture is limited & rainfall is low. Herbivores (animals eating plants) & insects exist in these forests.

Eg: moscow.

Uses of Forests: The uses of forests can be broadly classified as follows (a) Commercial uses and (b) Ecological uses.

a. Commercial Uses:

i. Forests provide a large number of commercial goods which include timber, firewood, pulp wood, food items, gums, resins, non-edible oils, rubber, bamboos, medicines etc…

ii. Half of the timber cut each year is used as fuel for cooking.

iii. 1/3rd of the wood harvest is used for building materials as plywood, hardwood etc...

iv. 1/6th of the wood harvest is converted into pulp & used for paper industry.

b. Ecological uses:

i. Production of O2: Trees produce O2 by photosynthesis.

ii. Reducing global warming: CO2 is absorbed by the forest as a raw material for photosynthesis. These forests reduce the problem of global warming caused by green house effect.

iii. Wild life habitat: Forests are the homes for millions of wild animals & plants. About 7 million species are found in the forests alone.

iv. Soil conservation: Forests bind the soil particles tightly in their roots & prevent soil erosion.
v. Pollution moderators: Forests can absorb many toxic gases & help in keeping the air pure & fresh. In addition to the above, forests protect people from drought & floods; protect from radiation etc…

Over exploitation of forests: Forests come under renewable resources which are replenished through natural cycles. The highest rate at which the forest resources can be used indefinitely without reducing their available supply is called sustainable yield. If the utilization rate exceeds the natural replacement rate, the available supply begins to shrink and leads to rapid environmental degradation.

Reasons for over exploitation:

1. For instant profit without realizing the longer term.
2. When the forest resources are over exploited the supply of wood & other products diminish & ultimately the price of wood & other products increases. This leads to further over exploitation of forests.
3. To meet basic needs, people are forced to over exploit the forest resources.
4. Ignorance & lake of awareness also causes for over exploitation.

Deforestation and causes of Deforestation

Deforestation is defined as the removal of trees in the forests. The removal of trees leads to adverse effects as it leaves soil exposed & results in soil erosion, rapid water run-off, loss of wildlife. Forest ecosystems are extremely good & hold a good quantity of water. About 80% of the original forests on the earth has already been cleared. Only 20% of forest area (63 million hectares) is seen based on satellite date as per National Forest Policy.

Disadvantages of deforestation:

1. A variety of food products such as coffee, tea, spices, nuts, fruits etc will be reduced.
2. Various living beings may come down resulting in imbalance of forest ecosystem.
3. Soil erosion increases to a great extent.
4. Rainfall decreases to a great extent.
5. Climatic conditions are changed.
6. Wildlife is diminished.
7. Historical values are lost.

Case studies

1. Sardar Sarovar dam: The dam is situated on river Narmada & is spread over three states of Gujarat, Maharashtra & Madhya Pradesh. The aim of the project was to provide irrigation water, drinking water & electricity for 3 states. A total of 1,44,731 hectares (or) 3,57,638 acres of land was submerged by the dam. A total of 573 villages were submerged. Submerged area was rich in wildlife. Ex: Tigers, Panthers, Bears, Wolves, Hyenas, Jackals, Crocodiles, Turtles etc. Thus the massive loss of wildlife species was apprehended. Displacing of 80,000 tribal people of oldest civilization. Hence the project management & Govt. to pay maximum attention for proper rehabilitation.
2. Tribal people:

a. The lives of millions of tribal peoples of the world (5% world population) are the worst affected due to deforestation.
b. They get their food by hunting, gathering, trapping animals.
c. Many tribal's of Kaunas of PANAMA, Kenya's in Indonesia, Yanomami in Brazil were dispersed by leaving their places due to deforestation & construction of dams.
3. Dams & their effects on forests and people: Construction of large dams in forests & in sensitive areas cause ecological problems & destruction of ecosystem in the long run. The construction of large dams and reservoirs have their own benefits and drawbacks. Excess amount of water flowing in rivers, which, otherwise joins the sea, can be stored in reservoirs formed by constructing dams across the rivers. The stored water can be utilized for various purposes like water supply, irrigation, hydroelectric power generation at the desired rate.
a. Tehri dam on river Bhagirathi in Uttaranchal state.
b. Bhakra dam on river satlej in H.P.
c. Silent valley hydro electric project in Western Ghats.
d. The crusade against the ecological damage & deforestation caused due to Tehri dam was led by sri Sunderlal Bahuguna, the leader of Chipko movement.
e. Disappearing tea gardens in chhota Nagpur: Chhota Nagpur is a place favouring tea plantation, which is located in hilly region. Following destruction of forests, rainfall declined in Chhota agpur causing that the tea gardens were also disappeared from region. Anthropogenic Related to human activities Over-grazing Damaged by many animals feeding on it intensified more serious starvation To suffer due to lack of food

Anthropogenic	Related to human activities
Over-grazing	Damaged by many animals feeding on it
Intensified	More serious
starvation	To suffer due to lack of food

MODULE-III

BIODIVERSITY AND BIOTIC RESOURCES

The word biodiversity is a combination of two words: "biological and diversity" and refers to the variety of life on the Earth which includes a large number of living things that exist in a certain area (in the air, on land or in water). The area may be considered as small as heap or as big as whole planet. Hence, Biodiversity means **"the existence of a large number of different kinds of animals and plants which make a balanced environment"** is called as biodiversity. Biodiversity deals with a large variety of flora and fauna on this earth. ***Ex:*** a wide variety of plants and animals are finding in a part of forest. The plant life range from a small herb to a large tree and the animal life vary from a tiny insect to a large mammal in addition to micro-organisms (algae, bacteria and fungi).

Biodiversity is usually considered at three different levels:

Genetic diversity means the variation of genes within the species.

Ex: In human species, genetic variation between an Indian and African and genetic variations within a population. (Ex: Within the Indian population) can be seen. In simple terms, genetic matter dictates whether the persons have blue or brown eyes, brown or black hair and tall or short. Genetic diversity can be identified by using a variety of DNA based and other techniques.

One estimate is that there are 1000 crores of different genes distributed across the worlds biota though they do not all make an identical contribution to overall genetic diversity.

1. **Species diversity** means the richness of species in all ecosystems. It is measured on the basis of number of species in a region. So far 1.75 million species have been described worldwide. Warmer areas tend to support more species than colder ones and wetter areas contain more species than drier ones. Topography and climate of the areas support and control the species of a region.

2. **Ecosystem diversity** means the study of difference between ecosystem types. Ecosystem diversity is difficult to measure since the boundaries of various sub ecosystems are overlap each other. ***Ex:*** for ecosystem diversity is Godavari – Delta ecosystem which consists of grassland ecosystem, river ecosystem, estuarine ecosystem, fresh water aquatic ecosystem, marine water aquatic ecosystem.

Importance of biodiversity: Biodiversity performs a number of ecological series for human kind that have economic and aesthetic values. As an example, the contribution of biodiversity to human health is given below: One out of 125 plant species produce a major drug as per Herb Research Foundation. Of the 118 drugs in the US, 74% are based on plants; 18% on fungi; 05% on bacteria and 03% on vertebrates. 80% of the world population relies on traditional plant medicine.

Value of biodiversity: The value of biodiversity (in terms of its commercial utility, ecological services, social and aesthetic values) is enormous. There are several ways that biodiversity and its various forms are valuable to humans. We get benefits from organisms in an innumerable ways. Sometimes, one realizes the value of the organism only after it is lost from this Earth. Every year numerous species are lost before we have a chance know anything about them.

The biodiversity value may be classified as follows:

1. **Consumptive Value*:*** Biodiversity is an essential requirement for the maintenance of global food supply. The main sources of human food include animals, fish and plant produces. A large number of plants are consumed by human beings as food. A few animal species are consumed by people who come from cattle, pigs, sheep, goats, buffaloes, chickens, ducks, geese and turkey species.

Fish: Many fresh water fish can be grown in ponds. Israel and China already get about half of their fish from aqua culture.

Drugs & medicines: About 75% of the world's population depends upon plants or plant extracts for medicines. The drug Penicillin used as an antibiotic is derived from a fungus called Penicillium. Likewise,

Tetracycline from bacteria which is used to cure malaria is obtained from the bark of cinchona tree.
Fuel: The fossil fuels like coal, petroleum products and natural gas are the products of biodiversity.

2. **Productive Value:** Some of the organisms are commercially usable where the product is marketed and sold. The animal products like tusks of elephants; musk from deer, silk from

silkworm, wool from sheep or goats; fur of many animals etc all of which are traded in the market.
→ **Calabar bean** was tradionally used as a poison in West Africa.
→**Daisy plants** were first used as a lice remedy in the Middle East and this led to the discovery of **Pyrethrum**. Mosquito coils made from Pyrethrum are sold in the market.
→ The bacterium **Bacillus thuringiensis** produces toxic proteins that kill certain insects.
→ The **neem** *tree* has been using in birth control such as parts of neem tree that cause abortion.

3. **Social Value**: These are the values associated with the social life, religion and spiritual aspects of the people. Many of the plants are considered to be sacred in our country like Tulasi, Mango leaves, Banana leaves. The leaves, fruits, flowers of some of the plants are used in worship. Many animals like cow, snake, bull, peacock also have significant place in spiritual and thus hold special importance. Thus, biodiversity has distinct social value, attached with different societies.

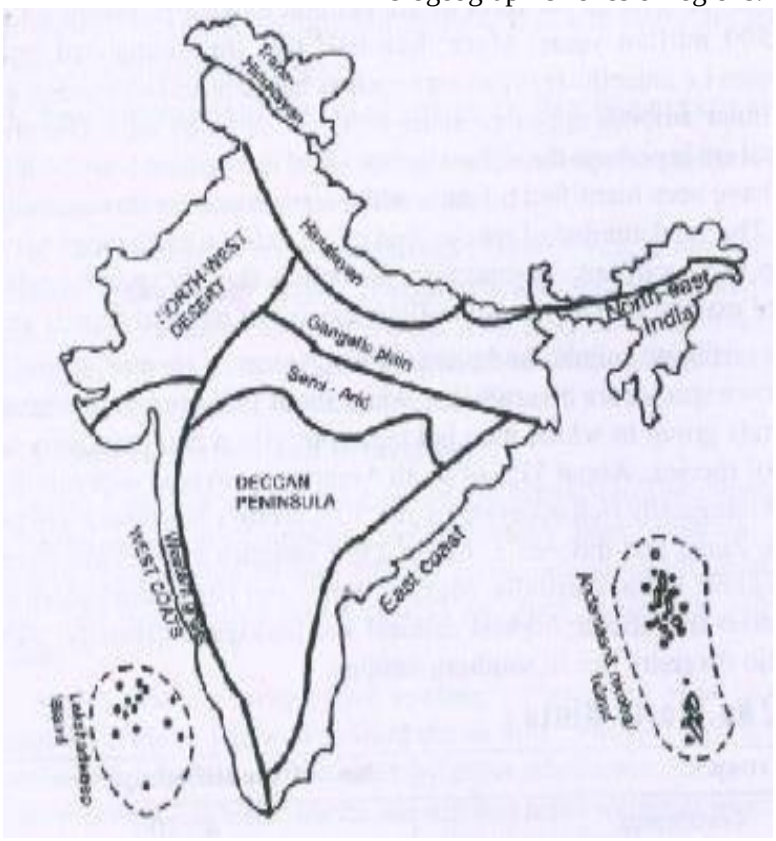
4. **Ethical Value**: The ethical value means that human beings may or may not use a certain species but knowing the very fact that this species exists in nature gives pleasure.
Ex: a peculiar species of Pigeon, grey / white bird with short legs is no more on this earth. Similarly, Dodo species is also no more. Human beings are not deriving anything direct from Kangaroo, giraffe but strongly feel that these species should exist in nature.

5. **Aesthetic Value**: Every one of us would like to visit vast stretches of lands to enjoy the visible life. People from farther areas, spend a lot of time and money to visit wild life areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco tourism. Eco-tourism is estimated to generate 12 billion dollars of revenue annually that roughly gives the aesthetic value of biodiversity. A study of the impact of environment on the psyche was undertaken by Kaplan and Kaplan (1989) in whom they found that being near nature relieved working stresses while people who worked in closed environment or human made structures experienced much more job stresses and illnesses.

India as a mega diversity Nation:
India contains a great wealth of biodiversity in the forests, wet lands and marine areas. Hence biodiversity can be observed at all levels ie locally, nationally and globally. India, as a subcontinent representing a major part of South Asia is rich in flora and fauna and hence it is one of the world's "MEGADIVERSITY NATIONS". It is estimated that over 75000 species of animals and over 45000 species of plants are found in India. The identified biodiversity in India and world is:

Group	No of Species in India	No of Species in World
Mammals	350	4629
Birds	1224	9702
Reptiles	408	6550
Amphibians	197	4522
Fishes	2546	21730
Flowering plants	15000	250000

Biogeographic regions of India: According to wild life Institute of India, the country has 10 distinct biogeographic zones or regions. They are:



1. Trans – Himalayan Zone
2. Himalayan Zone
3. Desert Zone
4. Semi – arid Zone
5. Western Ghats
6. Deccan Zone
7. Gangetic plain Zone
8. NE Indian Zone
9. Coastal Zone
10. Islands around the country.

Endangered and Endemic species:

Endangered species A species whose numbers are reduced to the point. That means endangered species are in immediate danger of extinction. The International Union Conservation of Nature (IUCN) classified the species of plants and animals as:

(a) Endangered species

(b) Vulnerable species means depleted species.

(c) Threatened species: Species (including animals, plants, fungi, etc.) which are vulnerable to endangerment in the near future)

(d) Rare species

Among the important endangered animal species, Indian wild ass; the Kashmir stag, the Golden Langur are considered highly endangered. There are also endangered bird species like Siberian crane; the great Indian Bustard; the florican. The IUCN published the data on endangered species of both plants and animals of India. The data symbolizes the working signal for those species which are endangered and if not protected are likely to become extinct in near future. India contains 172 species of animal are considered to be endangered; vulnerable; rare and threatened. These include:

Taxonomic Group	Endangered species	Vulnerable species	Rare species	Threatened species	Un known	Total

MAMMALS(Tiger; Leopard; Indian Lion; Golden cat; Desert cat; Sloth bear; Red fox; Indian wolf; golden monkey; Lion tailed Macaque)	13	20	2	5	13	53
BIRDS (Siberian white crane; Vultures; Great Indian Bustard; peacock; pelican)	6	20	25	13	5	69
REPTILES (Gharial; green sea turtle; star tortoise; python)	6	6	4	5	2	23
AMPHIBIANS	0	0	0	3	0	3
FISHES	0	0	2	0	0	2
NVERTIBRATES (crab; beetle; spider; snail)	1	3	12	2	4	22
	26	49	45	28	24	172

During the recent past, Vultures which were common have suddenly disappeared. Several species of Reptiles (lizard; snakes; star tortoise; crocodiles); ; Amphibians (frog); Invertebrates (crab, beetle; spider; snail) are also threatened due to human anthropogenic activities. India contains some of Asia's rarest animals such as: The Bengal Fox; Asiatic Cheetah; Marbled Cat; Asiatic Lion; Indian Elephant; Asiatic wild Ass; Indian Rhinoceros; Markhor; Gaur; Wild Asiatic Water Buffalo etc… **Description of the Asiatic Lion (Panthera Leo Persica**):

The Asiatic Lion is very similar to the African Lion. The lion is yellowish brown in color. The male lion is distinguished by the presence of the **mane**. The lion on an average grow to about 9 feet in length. The young cubs (young lions) are often spotted or striped. Though the Asiatic lions are once widespread throughout SW Asia (Northern Greece to Central India) their numbers declined with the disappearance of grasslands. Today the Asiatic Lion is restricted to GIR National Park, Gujarat, India and the total population of the Asiatic Lion is around 250 only the effort to conserve this species was initiated as long ago as 1910 by the Nawab of Junagadh who banned the hunting of lions within his province. Emperor Ashoka used the Lion as a symbol of Power & Strength.

Endemic Species is a species that confined to a certain region and are restricted to particular areas.

Ex: Penguins usually found on a single ice-land or glaciers. About 33% of the country's flora (plants) are endemic and are concentrated mainly in : NE part of India (Rhinoceros is restricted to Assam but was once found throughout the Gangetic plain) Western Ghats (Lion – tailed macaque & Nilgiri leaf monkey and bull frog; tree frog) NW and Eastern Himalayas (Oak tree; Pine tree; Hangul deer of Kashmir ; snow leopard; jackal; wild dog; Himalayan wolf) Andaman and Nicobar islands and South India (Nilgiri Tahr is found in Nilgiri & Annamalai hills in south

India) The Gangetic plains are generally poor in endemics while the Andaman & Nicobar islands are rich.

Hot spots of biodiversity: Biologically hot spots are areas that are extremely rich in endemic species of both plant and animals. The world is identified with 25 biodiversity hot spots containing 44% of all plant species and 35% of vertebrates & 21% of invertebrates and others of all animal species in land area. The following is the list of identified bio-diversity hot spots of the world:

S.No.	Location	S.No	Location
1	**Tropical Andes** (venezula; Columbia; peru; argentina)	14	Mediterranean Basin (surroundings of Europe, Asia; Africa; Algeria; Libya; Egypt)
2	Meso America (central Mexico)	15	Caucasus
3	Caribbean (West Indies)	16	Sunda land
4	Brazil forest	17	Wallacea
5	Western Ecudor (NW of S.America)	18	Philliphines
6	Brazil's Cerrado	19	Indo-Burma region
7	Central Chile	20	South Central China
8	California Province	21	Western ghats – Sri Lanka
9	Madagascar	22	SW Australia
10	Coastal Forest of Kenya (S Africa)	23	New Caledonia
11	Western African Forests	24	New Zealand
12	Cape Province (S. Africa)	25	Polynesia / Micronesia
13	Karoo (Australia)		

Hot spots in India: Among 25 hot spots of world two found in India extending into neighbouring countries viz., 1) The Western Ghats – Sri Lanka region and 2) The Indo – Burma region covering Eastern Himalayas (The Eastern Himalayas form a distinct region which comprises Nepal, Bhutan ; Sikkim and states of Northern India).

Plants of Endemic Species*:* Of India's 45000 plant species, 1600 endemics are found in a 17000 sq kms in the Western Ghats. In Sikkim, in an area of 7298 sq kms, 4250 plant species are endemic while in Nepal, 500 species are believed to be endemic . Bhutan possesses an estimated species of 750 are considered to be endemic. Eg; oak tree; pine tree etc..

Animals of Endemic Species: Eg: Penguins . Rhinoceros (NE of India); Lion – tailed macaque & Nilgiri leaf monkey and bull frog; tree frog (Western Ghats) Hangul deer of Kashmir ; snow leopard; jackal; wild dog; Himalayan wolf (NW and Eastern Himalayas); Nilgiri Tahr (Nilgiri & Annamalai hills in south India).

Major threats to the Biodiversity:

Biodiversity is threatened by anthropogenic activities in many ways (by destruction of forests, over – hunting conversion of wet lands & grass lands into industrialization; mining of minerals / rocks; pollution; constructions of roads; tourism business; exploitation of timber resources etc..) to eliminate millions of species. Habitat loss is the major cause of species extinction. Habitat loss may be qualitative and quantitative losses: Qualitative losses involve a change in the structure, function or composition of the habitat.

Ex: If a paper industry discharging chemicals into a waterway system and polluting / poisoning the water, thus there has been a qualitative loss. Quantitative losses are measured by looking at a previously mapped area and determining how much of the habitat area no longer present is.

Ex: If a wet land is paved over, then there has been a quantitative loss of wet land. Diseases; the spread of non – native species threatens many local species with extinction (Ex: Dodo); climate changes (threatens to force species and ecosystems to migrate towards favorable areas) etc disturb and cause the elimination of species. .

Biogeographical classification of India: India is the 7th largest country in the world and Asia's second largest nation with an area of 32,87,263 sq km. It has a land frontier of 15,200 kms and a coast line of 7516 km. India's northern frontier's are Tibet; China; Nepal and Bhutan. In the North West, India borders on Pakistan; in the Northeast China and in the East, Burma. The southern peninsula extends into Indian Ocean; Bay of Bengal lying to the Southeast and the Arabian Sea to the Southwest. For administrative purposes India is divided into 28 states and 7 union territories. Physically the country is divided into four relatively well defined regions:

a) Himalayan region
b) The Gangetic river plains or Indo-Gangetic plains.
c) The southern (Deccan) Plateau and
d) The islands of Lakshadweep, Andaman and Nicobar. The Himalayas in the North include the highest peaks in the world.

The highest mountains are:

a) Khanchen Junga (8586 mts) which is located in Sikkim;
b) Pir Panjal (3,600 – 4,600 mts) in Kashmir;
c) Dhaula dhar in Himachal Pradesh and
d) Siwaliks (900 – 1500 mts) in the Indo – Gangetic plains.

The northern plains of India stretch from Assam in the East to the Punjab in the West covering a distance of 2400 kms. Some of the largest rivers in India including the Ganges, Ghaghara, Brahmaputra and Yamuna flows across this region. Thar desert which is located at the western extremity of Indian part of the plains in the states of Rajasthan. Observations show that the biodiversity is far richer in NE Himalayan range compared to Northwest range. The following factors play a major role in the classification of biogeographical / biodiversity:

Climate: The climate of India is dominated by the Asiatic monsoon, mostly by southwest rains between June and October and drier winds from the North between December and February. From March to May the climate is dry and hot. .

Wet Lands: India has a rich variety of wetland habitats. The total area of wetlands excluding rivers in India is 5,82,86,000 hectares . Chilka lake (orissa) and Keoladeo National Park (Bhartpur in Rajasthan) have been designated under the convention of wetlands of International importance. The country's wet lands are generally differentiated by region into 8 categories:

1. The reservoirs of the Deccan Plateau in south
2. the vast saline expanses of Rajasthan and Gujarat
3. Fresh water lakes and reservoirs from Gujarat eastwards.

4. The delta wet lands and lagoons of India's east coast.
5. The fresh water marshes of Gangetic plain
6. The Flood plain of Brahmaputra
7. The marshes and swamps in the hills of NE India and Himalayan foot hills and the lakes and rivers of the mountain region of Kashmir and Ladakh and
8. Wet lands of the island areas of Andaman & Nicobars.

Forests: The panorama of Indian forests ranges from evergreen tropical rain forests in the Andaman and Nicobar Islands; the Western Ghats to alpine forests in the Himalayas to the North. The country has also several types of forests viz.,

a) Semi – ever green rain forests
b) Deciduous forests
c) Thorn forests
d) Pine forests
e) Tropical forests (Andaman & Nicobar Islands; the Western Ghats)
f) Rain forests (Orissa)
g) Western Ghats monsoon forests contain rosewood, Malabar, teak.
h) Tropical evergreen rain forests and tropical monsoon forests (Andaman & Nicobar)

Marine Environment: The coastal waters of India are extremely rich in fishing grounds. In 1981, it was estimated that there were approximately 1,80,000 non – mechanized boats carrying out fishing activities in these waters. At the same time, there were about 20,000 mechanized boats operating mainly out of ports in the states of Maharashtra, Kerala, Gujarat, Tamil Nadu and Karnataka. Indian coral reefs have a wide range of resources which are of commercial value. Exploitation of corals, coral debris is widespread on the Gulf of Mannar and Gulf of Kutch. Ornamental shells and pearls are the important reef industry. Other marine areas are including sea grass and prawns. Five species of marine turtle occur in Indian waters.

1. Green turtle
2. Logger head
3. Olive Ridley
4. Hawksbill
5. Leather back.

Conservation of Biodiversity:

In order to maintain and conserve biodiversity, the Ministry of Environment and Forests, Govt of India has already taken several steps to manage wildlife, the objectives of which are:

1. Maintenance of a number of species in protected areas such as National Parks, Sanctuaries.
2. To improve the biosphere reserves
3. Implement strict restrictions of export of rare plants and animals
4. Educate the public on these through the Govt agencies and NGO's. Conservation of biodiversity can be carried out in two ways, as shown:

MODULE - IV

ENVIRONMENTAL POLLUTION, POLLUTION CONTROL TECHNOLOGIES AND GLOBAL ENVIRONMENTAL PROBLEMS

Introduction: According to ODUM (1971), Pollution is "an undesirable change in the characteristics of air, water and land that harmfully affect the life and also create health hazards for all living organisms on the globe".

According to SOUTHWICK (1976), Pollution can be defined as "the unfavorable (or) alteration of environment caused by human activities and causing harm to human beings".

Basically the Pollution is of two types.

(1) Natural Pollution: This type of pollution is limited in its occurrence generally from natural hazards like volcanic eruptions, emissions of natural gas, soil erosion, ultraviolet rays, cosmic rays etc and

(2) Manmade Pollution: Most of the pollution is man made only. However, Pollution is usually categorized as Air Pollution; Water Pollution, Thermal Pollution; Noise Pollution; Land & soil Pollution; Radio Active Pollution and Marine Pollution.

AIR POLLUTION

Air pollution may be described as "the imbalance in quality of air so as to cause adverse effects on the living organisms existing on earth". Pollution is due to the presence of undesirable substance of sufficient quantity which exists in environment. The substance or energy which causes pollution is called pollutant. Pollutants may be classified according to origin and state of matter.

a) According to Origin: Air pollutants are divided into two categories as primary & secondary. Primary air pollutants are those which are emitted directly into the atmosphere.

Eg: C, CO, CO2, SOx ,N, S,H, NOx, CFC's etc .

Secondary air pollutants are those which are produced in the air by the interaction among the primary air pollutants or by reaction with atmospheric constituents.

Eg: Ozone (O3); Smog; Para Acetyl Nitrate (PAN); Acid Rain; Aerosols.

b) According to State of Matter: Air pollutants include fine solids; liquids and gases. Dust, Smoke, Fumes etc are examples for solid particles whereas fog is an example for liquid particles. Benzene (C6H6), Methane (CH4), Butane, Aldehydes, Ketones, inorganic gases etc are gaseous air pollutants.

Listed below are the major air pollutants:

S.No	Compound	Pollutants
1	Carbon oxides	Carbon Monoxide (CO); Carbon dioxide
2	Sulphur oxides	Sulphur dioxide (SO2); Sulphur Trioxide (SO3)
3	Nitrogen oxides	NO2; Nitrous oxide (N2O); Nitrogen Peroxide (N2O5)
4	Organic compounds	Methane; Propane (C3 H8) ; Benzene; Chloro Fluro Carbons (CFC)
5	Photochemical Oxidants	Ozone (O3); PAN; Aldehydes
6	Radioactive substances	Iodine 131; Strontium 90; Plutonium 239

Primary Pollutants:

Carbon Monoxide: It is a colorless, odorless, poisonous gas that is produced by the incomplete burning of carbon based fuels (coal, petrol, diesel and wood) which comes from the automobile industries, exhaust devices, about 70% of CO emissions are from the transport sector. When the air is polluted with CO, human blood is likely to be deprived of oxygen and leads to coma and death. In mild dosages, it leads to headache.

Oxides of Sulphur: SO2 is a gas produced from burning of coal, mainly in thermal power plants. Some industries such as paper mills produce SO2. It is injurious not only to men and plants, but it also attacks rapidly a few rocks such as limestones, marbles, electric contacts etc. It can even dissolve nylon. Paper absorbs SO2 causing the paper to become brittle and fragile. SO2 polluted air leads to corrosion of metals such as Fe, Zn, Cu, steel etc… SO2 is a major contributor to Smog and acid rain.
Sulphur trioxide is more irritant than SO2 because it combines immediately with water to form sulphuric acid.
Oxides of Nitrogen : Combustion of coal, oil, natural gas and gasoline which produces upto 50 ppm of Nitrogen. NOx are also produced when fossil fuels are burned especially in power plants and motor vehicles. NO2 poisoning results SILOFILTER disease. High levels of NO2 exposure causes cough and make the human beings feel short of breath. People who are exposed to NO2 for a long time have a higher chance of getting respiratory infections.
NOx compounds contribute for the formation of Ozone. Similarly, when nitrogen oxide when combine with SOx to form acid rain.
Chloro Fluoro Carbons: CFC's (also known as Freon) are non- toxic. They contain Carbon, Fluorine and Chlorine atoms. The five main CFCs are the following:
→ CFC – 11 (Trichloro Fluoro Methane CFCl3)
→ CFC – 12 (Dichloro Fluoro Methane CF2Cl2)
→ CFC – 113 (Trichloro Trifluoro Ethane C2F3Cl3)
→ CFC – 114 (Dichloro Tetrafluoro Ethane C2F4Cl2)
→ CFC – 115 (Chloropenta Fluoro Ethane C2F5Cl)
The major uses of CFCs are as coolants in refrigerators and in air conditioners; as solvents in cleaners particularly for electronic circuit boards etc. CFCs are the main cause of ozone depletion. CFCs have a lifetime in the atmosphere of about 20 to 100 years, and as a result one free chlorine atom from a CFC molecule can do a lot of damage.
Secondary Pollutants:
Ozone (O3) / Ozone layer Depletion: Ozone consists of oxygen molecules which contain three oxygen atoms. It is not emitted directly into the air but produced in the atmosphere when oxygen combine with oxygen radical (O) in the presence of sunlight. Ozone protects us from ultra violet radiation and other harmful rays. It is observed that over the last few years, many man made processes release gases into atmosphere causing drastic depletion of ozone layer. The chlorine atoms cause depletion of ozone slowly and holes are formed in the ozone layer. Ozone reacts with tissues and cause for breathing and decrease the working ability of the lungs, chest pains and coughing. It lowers the human body resistance power and leads to cold; pneumonia also.
Antarctic Ozone depletion: According to NIMBUS-7 satellite picture which was taken on 5th Oct 1987, the protective ozone layer showed a hole over 50% of the area of the Antarctica continent covering 7 million sq km. On Jan 1st 1989, the country Montreal (Canada) proposed redesigning refrigeration, air conditioning technology replacing the use of CFCs by ozone friendly substitutes.
Smog: Smog is a combination of smoke and fog or various gases when react in the presence of sunlight. The effects of smog on human health cause for respiratory, irritation to the eyes, diseases related to nose, throat, bronchitis, pneumonia, headache, nerves, liver, and kidneys. The first smog related deaths were recorded in London in 1873, when it killed 500 people. In 1892,

December, London had worst experiences causing 1000 deaths. In 1940's severe smog began covering the cities of Los Angeles in USA.

Para Acetyl Nitrate (PAN*):* PAN which is a harmful chemical form in nature and causes irritation of eyes and other human sense organs. It may also cause blisters on the skin.

Acid rain: Acid rain has become one of the most important global environmental problems and poses significant adverse impact on soils, rivers, lakes, forests and monuments. The phenomenon occurs when SOx and NOx from the burning of fossil fuels such as Petrol, Diesel, Coat etc combine with water vapour in atmosphere and fall as rain or snow or fog. Natural sources like volcanoes, forest fires, etc also contribute SOx and NOx. Increased urban and industrial activities cause air pollution resulting in the rise of concentration of SO2 and NOx. Sulphur dioxide and NO2 combines with water vapour in the atmosphere produce Sulphuric acid and Nitric acid respectively and results acid rain.

Some of the examples are:

Europe and parts of W.Asia have experienced rain with water pH range of 4.5 to 5.0 (acidic) in 1958. In 1962, acid rain occurred in Sweden with pH of water ranging from 4.5 to 5.0. Netherlands and Holland also experienced acid rains in the same year. In April 1984, acid rain occurred in Scottland.

Aerosols: These are Suspended Particulate matter. It consists of dust, soot, asbestos particles, Pb, Ni, Nitrate and sulphate salts, fumes, mists, smoke and sulphuric acid particles etc.. These particles measure less than 1 micron in size because of that, they directly enter into respiratory track. Exhaust gases from aero planes, automobile industries are the main sources for releasing aerosols.

Air pollution effects; Prevention & control measures:

Human beings breathe 22000 times a day on the average, inhaling 16 kg of air. Atmosphere constitutes a protective cover of gases surrounding the earth which sustains life and saves it from unfriendly environment. The atmosphere consists of several layers viz. Troposphere, Stratosphere; Mesosphere; Thermosphere & Exosphere. The lower atmosphere i.e., the troposphere contains 70% of gaseous components of major, minor and traces. Table depicts the available components in the atmosphere as:

Component	**Symbol**	**Concentration in Volume%**	**Status**
Nitrogen	N2	78.09	Major
Oxygen	O2	20.94	Major
Argon	Ar	00.93	Minor
Carbon dioxide	CO2	0.0318	Minor
Ne,He,Kr,H2, CO, O3			Traces
NH3; NO2, SO2; H2S, Xenon etc are still in traces.			

Ultra violet radiation from the sun is absorbed by ozone in the stratosphere which is so called ozone layer located between 17 - 26 kms above sea level.

Effects of Air pollution: The effects of pollution may be direct and affect certain organisms. The effects of pollution may possess a hazard or nuisance. Long continued pollution even affects the evolution of a species and eliminates organisms that cannot tolerate certain pollutants and favour others who can eat. Air pollution causes deaths, Impair health, reduce visibility and brings vast economic losses. It can also cause intangible losses to historic monuments such as Taj Mahal. Finally, Air pollution can affect the environment on a global scale.

Prevention and control of Air Pollution:

→ Inputs that do not contain the pollutants.

→ Operating process to minimize generation of the pollutants.

→ Replacing the process with one does not generate the pollutant.

→ Removing the pollutants from the process.

→Substitution of raw materials.

Ex: The substitution of high sulphur coal with low sulphur coal in power plants. Ex: Changing a fossil fuel with nuclear energy can eliminate sulphur emission.

→ By involving the Process Modification:

Ex: Chemical and petroleum industries have changed by implementing automated operations, computerized process control by reducing the oxidation of SO2 to SO3 by reducing excess air.

→ By involving the control technologies: Control equipment viz., Wet Collector (scrubber); Gravity Settling chamber; Cyclone Collectors; Dry Scrubbers; filters are to be used to minimize the air pollution.

WATER POLLUTION

Hydrosphere in the universe contains water in the form of oceans, rivers, lakes, tanks and many other water sources. Water sources in the world are of two types. They are (1) Marine water bodies and (2) Fresh Water bodies. Water is a good solvent for many substances. Because of this property water cannot exist in its pure form at many parts of the world. Water pollution is mainly because of sewage, industrial disposals effluents.

Chemical examination of water (tests): pH; Biological Oxygen Demand, Dissolved Oxygen; Chemical Oxygen Demand etc are some of the chemical tests to find the stage of pollution of water.

pH: The value of pH gives the degree of acidity or alkalinity of polluted water. Determination of pH is important in calculating the coagulant (thick or thin) dose.

Biological Oxygen Demand (BOD): It is defined as the quantity of oxygen utilized by micro organisms at a temperature of 20oC, generally measured for 5 days. When water is polluted by unwanted materials, naturally the O2 content gets reduced and that water become not fit for consumption either by human beings or animals or plants. Living organisms require water with some quantity of sustainable oxygen in it. That oxygen is necessary for living organisms is generally called BOD. If there is reduction in oxygen content of water, it becomes unfit for biological consumption because there is change in BOD.

Dissolved O2: The amount of oxygen in dissolved form in water at a particular temperature and atmospheric pressure is known as dissolved Oxygen. In polluted waters, dissolved oxygen is the factor which determines whether the biological changes are carried by aerobic (needing oxygen) or by anaerobic (oxygen not required) micro-organisms.

Ex: 5 to 8 mg/L of dissolved oxygen is required for most of the species and fishes.

Chemical Oxygen Demand (COD): This test is conducted to determine the pollution strength of the sewage. Potassium dichromate and potassium permanganate are used as oxidizing agents.

Common types of water pollutants:

Disease causing agents: Bacteria, viruses, protozoan's that enter water from domestic sewage and animal wastes.

Water soluble inorganic chemicals: Acids, salts and compounds of toxic metals such as Pb, Hg can make water unfit to drink, harm fishes and other aquatic life. Also Nitrate, Phosphate compounds dissolve in water that can cause excessive growth of algae, which then die and decay, depleting dissolved O2 in water and killing fish.

Water Soluble Organic chemicals: Oil, gasoline (a type of oil is obtained from petroleum), pesticides, detergents and many other water soluble chemicals that threaten human health and harm fish.

Heat: Large quantity of water is heated when it is used in the cooling towers of thermal power plants. When this hot water is discharged into the nearby water bodies, it causes an increase in its temperature.

Sewage: sewage is waste water from municipal area where there is human habitation. Sewage which comes from homes is called

DOMESTIC SEWAGE:

In nature water pollution is classified into three types by Kimball (1975). They are:

1. **Domestic water pollution:** Sewage is a part of domestic water pollution. Domestic sewage not only contains unwanted waste materials, but it is also infested with harmful bacteria, virus etc. These are responsible for causing diseases in animals and human beings, if they drink this polluted water and even plants may die if polluted water is provided. Domestic water pollution leads to Diarrhea, Cholera, and Typhoid etc in human beings.
2. **Agricultural Water Pollution:** Water require for plants for its growth. Major irrigation, minor irrigation, sprinkler irrigation, drip irrigation, lift irrigation carry waste substances and causing water pollution in addition to the utilization of fertilizer and pesticides. Agricultural water pollution leads to Eutrophication & Water Bloom.

Eutrophication is the ecosystem response to the addition of artificial or natural substances, such as nitrates and phosphates, through fertilizers or sewage, to an aquatic system. Eutrophication also occurs when fresh water bodies like ponds, lakes, pools which contain organic waste material. Because of that, the fresh water ponds and lakes get polluted. Eutrophication is a type of water pollution. Eutrophication was recognized as a pollution problem in European and North American lakes and reservoirs in the mid-20th century. Since then, it has become more widespread. Surveys showed that 54% of lakes in Asia are eutrophic; in Europe, 53%; in North America, 48%; in South America, 41%; and in Africa, 28%. Ecological effects: The important troubling ecological impacts are :

→ Excessive nutrients in water bodies promote plant growth which leads to a drop in water quality;
→ Disruption of the natural ecosystem. Ex: lack of oxygen for shellfish and marine life (causing a drop in their population).
→ Decrease in the recreational and aesthetic value of water bodies
→ Health problems when it occurs in drinking water reserves
→ Coral reef decline
→ Decreased biodiversity,
→Changes in species composition and dominance and toxicity effects.
→Toxic phytoplankton species
→Decreases in water transparency (increased turbidity)
→Colour, smell, and water treatment problems
→Dissolved oxygen depletion
→Increased incidences of fish kills
→Loss of desirable fish species

Water Bloom:

It is defined as "A growth of algae at or near the surface of a body of water, such as a pond". This is another kind of water pollution because of the presence of Blue Green Algae (BGA). Blue-green algae are microscopic organisms that can be considered as simple aquatic plants that occur naturally in habitats such as marine waters, rivers, lakes, damp soil, tree trunks, hot springs and snow. They can vary considerably in shape, colour

and size. They usually are present in low numbers. Blue-green algae can become very abundant in warm, shallow, undisturbed surface water that receives a lot of sunlight. When this occurs, they can form blooms that discolor the water or produce floating rafts or scums on the surface of the Because of the presence of B G A, the water turns blue in color or blue green which is unsuitable for drinking. This type of pollution of fresh water bodies by Blue Green Algae is generally called "Water Bloom".

3. **Industrial water pollution:** Many industries discharge waste materials containing harmful chemicals. Such Industrial wastes are called ***effluents***. Rivers get polluted when the river water is polluted by mixing of chemical substances released by the petrochemical industries, paper industries, chemical industries etc. The river Godavari is polluted because of effluents released by the paper industry. It affects the entire water ecosystem causing enormous damage to fishes, prawns and fresh water animals.

Eg: Minimita disease & Fluorosis.

Minamata disease is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms. Minamata disease was first discovered in Minamata city in Japan in 1956. It was caused by the release of methyl mercury from, the Chisso Corporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bio- accumulated in shellfish and fish in Minamata Bay which when eaten by the local populace resulted in mercury poisoning. While cat, dog, pig, and human deaths continued over more than 30 years, the government and company did little to prevent the pollution.

Fluorosis: People suffer from a disease called fluorosis after consuming water containing fluorine for sufficiently a long time. Quantity of fluoride in water is only 1 ppm. Diseases caused by fluorosis are:

→ Back pain and cannot easily bend.

→ Joints get stiffened as so movement of joints is impaired.

→ Teeth are the worst effected and a brown coating appears on the enamel of teeth giving bad appearance.

→Persons with fluorosis cannot erect freely.

Preventions or control measures of water pollution:

Drinking water should be boiled, cooled and then used.

1. Disinfection of drinking water should be done by using chemicals like bleaching powder.
2. Pesticides and insecticides should be prevented from nearby use of water lakes, ponds and pools.
3. Drainage water should not be allowed to mix with drinking water.
4. Drainage system should be maintained properly.
5. Chlorination process is to be adopted for drinking water. For 1 litre of water 30-40 mg of chlorine is to be added to get perfect disinfection. It kills bacteria, fungi, fungal spores and other microbes also.

NOISE POLLUTION

Everyone knows that sound is a form of energy that is capable of causing disturbances in human beings. Ears are the hearing organs in human beings. A thin membrane is called Tympanum (or) ear drum receives the vibrations produced by sound to a limited extent. Human ear is capable of perceiving about 85 decibels of sound. Beyond the limit, the ear drum cannot bear sound. In nature, we hear different types of sounds. Sound is a kind of vibration which travel through air, water, and are sensed by the ear. This is from music, speech, etc from radio / television / computers etc., one thing in this matter is that we can increase the volume of sound or decrease as per our taste whereas, a noise is a sound which cannot be heard clearly and only mixed sounds will be heard.

Ex: In an office one is talking on mobile, phone ringing another side, ring tones in some person's hands, loud conversations with one and another etc., this is called noise. One cannot increase or decrease the volume of noise. In general, a sound is a vibration from a particular machine, place or material which can be heard clearly whereas a noise a mixed vibrations that will come to us from all directions. A sound can be clear and can be able to hear, whereas a noise will not be clear and cannot be heard.

Sources of Noise

Noise is an unwanted sound and noise pollution occurs through different sources:

→ Vehicles produce noise that leads to noise pollution.

→ Automobile industry is another source of noise pollution.

→ Noise pollution is very common in industrial areas where machines are working for factories making more noise. The sources of noise are more in urban and industrial areas, than in rural areas. The sources of noise may be stationary or mobile. The stationary sources include industries, loud speakers, mining operations and

use of machineries, TV, Radio and Grinders etc. The mobile sources include Road Traffic, Highway Noise, Railway Traffic and Air Traffic.

(1) Stationary sources:

Industrial noise: The main categories of industrial activity that are particularly relevant to the study of noise are the following: Product fabrication Product assembly Power generation by means of generators. Combusting process in furnaces. (Burning of gases)

Noise from construction works: Construction noise, a major source of noise pollution is emitted by construction equipment. The sources of noise are dozers, excavators, front end loaders, soil compactors, cranes, air compressors, concrete vibrators, riveting steel structure during the casting, dismantling of construction materials etc...

Noise from other sources: These include sources such as sirens, barking dogs, ambulances, Police vehicles, Fire engines etc.

(2) Mobile sources:

Road traffic: Of all sources of noise pollution, road traffic is the most prevalent and perhaps the most source of noise pollution. More people are exposed to noise from motor vehicles and the noise depends on various factors such as Road location, Road design, Vehicle standards, Driver behaviors, Horns, Traffic density. ,

Noise of common road vehicles

Vehicle type	**Noise(db)**
Medium road traffic (Main roads)	70- 80
Heavy road traffic (High ways)	80- 90
Buses & Trucks upto 3.5 tons	85- 95
Trucks upto 3.5-12 tons	90-100
Motor cycles	90-105

It can be observed that motor cycles with their exposed engines and inadequate silencing arrangements are notorious noise producers, which produce more than 30 times, sound than a small passenger car.

Railway traffic: Noise from railway traffic is not serious nuisance as compared to the road traffic noise. The level of noise associated with rail traffic is related to the type of engine, the speed of the train, track type and condition. The majority of noise emitted by trains is produced by the engine (or) by the interaction of wheels with the tracks, horns, warning signals at crossings etc..,

Air traffic: The noise of air craft is different from that of road traffic in the sense it is intermittent. Noise is maximum during takeoff and landing. Noise made by jet planes is more disturbance than that of propeller driven air craft. Supersonic air craft produce noise at high levels due to its intensity.

Effects of Noise: At 120 decibels the ear registers pain but hearing damage begins about 85 decibels. Apart from hearing loss, noise can cause lack of sleep, irritation, indigestion, ulcers, High B.P., Heart diseases , Stress etc.,.

Annoyance (Feeling slightly angry): One of the most important effects of noise on human is annoyance. Due to this breathing rate affects.

Noise- induced hearing loss: Exposure to noise for long enough duration results in damage to the inner ear and thus decreases one's ability to hear. The louder the noise the less time it takes to cause hearing loss.

Effects on sleep: Noise disturbs sleep. It has been found that the cases related to various levels of noise are associated with sleep disturbances. Sleep disturbance by noise depends on the characteristics of the noise such as frequency, loudness and whether the noise is continuous or intermittent.

Other effects: There are many other effects of noises such involve aggression (ready to attack). People may turn mad and nerves may not function normally, People may be deformed in many ways including increased stress and strain, nonfunctioning of hands, legs etc due to noise pollution if exposed continuously.

Noise pollution control: Noise pollution could be controlled by either reducing the noise at the source or by preventing its transmission. The first step in the prevention of noise pollution is to control the noise at source itself.

Ex: Lubrication of machines reduces the noise produced, Tightening the loose nuts, Reducing the vibrations produced by machines etc.

Failing to control the noise at its source, the second step is to prevent its transmission.
Ex: keeping the noise machine covered in an enclosure so that the sound does not escape and reach the receivers, construction of noise barriers on road sides, sound proof the buildings by using heavy curtains on the windows, acoustical tiles on the ceiling and walls, by sealing the cracks in the walls to reduce the noise coming from outside. If the noise levels are not able to bring down to the desired levels in some cases, the only alternative is to follow:
→ Avoiding horns except in emergency situations.
→ Sound proof or eco-generators and Turning down the volume of stereos.
→ Conducting the awareness programs.

MARINE POLLUTION

Pollution of oceans is damaging the marine environment and is becoming a major problem. Marine environment is interesting for various reasons such as Sea food, Navigation, Adventure, Tourism etc. Marine Pollution is harmful and its danger can be identified in a variety of ways. Sources & causes of marine pollution: Marine pollution originates from one of two sources the land or the sea which are explained below:
Marine Oil Pollution: Oil is basically an important pollutant which destroys marine environment. The various sources of oil pollution are: Run-off oil from streets; disposal of lubricants from machines; Off shore oil and gas exploitation from off-shore drilling; blowouts at off-shore drilling rigs; oil escaping under high pressure from a bore hole in the ocean floor. ; Waste chemicals, mud and accumulation of toxic substances in the ocean in the form of mercury, dioxin, PCBs, PAHs (Poly Aromatic Hydrocarbons), Radioactivity. Benzene; xylene (colorless, flammable liquids) and heavy metals such as lead; copper; nickel, mercury also cause for marine pollution during the off shore drilling activities. Both dumping and exploitation of ocean resources cause ocean pollution also.
PAHs: It is a chemical compound and organic pollutant. These occur in oil, coal and tar deposits and are produced as by products of fuel burning. PAHs are lipophilic meaning they mix more easily in oil than water. Ex: Acenaphthene; Anthracene; Benzopyrene; Chrysene; Coronene; Fluorene; Pyrene.
Effects of Marine Pollution:

S No	Source	Effect
1	Sewage & run- off from Forestry.	Depletes oxygen in water causes killing of fishes.
2	Sediments from mining	Sediments clog in the gills of fishes.
3	Sewage from municipalities, Towns, cities etc…	Contaminate sea food.
4	Industrial discharge; pesticides from farms	Cause disease in coastal marine life.
5	Oil from off horedrilling;industries / automobiles.	Low level contamination kills larvae whereas high level contamination causes death for sea fishes.
6	Litter (rubbish), waste, plastics.	Marine life disturbs.

Other sources from land: The major sources of marine pollution originating from the land vary from country to country. Effluents are discharged either directly into the sea or enters the coastal waters through rivers. Thousands of barrels of oil burn when oil wells were set on fire. Tanker

accidents on land carries oil to the nearby streams / canals and cause for marine pollution. Due to burning of oil, smoke, SO2, NO2, CO are added towards atmospheric contamination. The effects of oil pollution depend mainly on the following factors:
Type of oil and its viscosity; amount / quantity released; distance covered; time; average water temp etc.
Marine Pollution Abatement / Prevention & control measures of Marine pollution: The following are the some of the control measures for marine pollution:
→ Improving existing sewage disposal facilities
→ Ensuring individual houses have sewage disposal systems (such as septic tanks).
→ Large resorts should use and manage their own packaged treatment plants.
→ Marine planning and management should be considered as processes such as land – sea interaction; inter disciplinary co-operation; participation of public & private sector organizations; balance between protection and development public participation
→ Oil tankers are double hulled (two layered bottom) to reduce the chance of oil leakage
→ Recycling facilities for used oil.

THERMAL POLLUTION

Thermal pollution is also known as heat pollution and occurs when heat is released into water or air that produces undesirable effects. Sudden heat release usually due to forest fire or volcanoes or human induced activities. Thermal pollution is also the addition of excess undesirable heat to water that makes it harmful to human, animal or aquatic life.
Sources of Thermal Pollution: Various sources of thermal pollution include Thermal Power Plants; Nuclear Power Plants; Petroleum Refineries; Steel Plants; Metallurgical industries; Paper Mills; Chemical Plants. Coal fired power plants constitute major sources of thermal pollution. Nuclear plants discharge much heat and also traces of toxic radioactive substances. Many industries use water for cooling purpose and thus the heat effluents are
finally discharged into water.
Temperature and its effects*:* Temperature plays an important role in determining the conditions in which living things can survive. Birds and mammals require a narrow range of body temp for survival whereas aquatic species can exist at a certain range of temperatures. Thermal pollution increases water temperature causing a change (lowering) of dissolved oxygen levels. This disrupts and causes decay of plant and animal species.
Ex: the warmer water increases the metabolic rate of fish and other animals in the sea; this decreases the life expectancy of aquatic animals.
Management of Thermal Pollution*:* Thermal Pollution is controlled by the following methods:

1. Cooling Towers are designed to control the temperature of water which transfers some of the heat from the water to the surrounding atmosphere by evaporation. There are two types of cooling towers namely wet cooling towers and dry cooling towers.
2. Cooling ponds are employed for thermal discharges. Heated effluents on the surface of water in cooling ponds maximize dissipation of heat to the atmosphere.
3. Artificial lakes are manmade bodies of water which offer possible alternative. The heating effluents are discharged into lake at one end and the water for cooling purpose may be withdrawn from the other end.

SOLID WASTE MANAGEMENT

Solid Waste is defined as " any garbage, refused materials, sludge from a waste treatment plant and other discarded material including solids, semisolids etc resulting from industrial, commercial, mining, agricultural operations etc."

Solid Waste Management has become very important role in order to minimize the adverse effects of solid wastes. Solid waste (other than liquid or gaseous) can be classified as Municipal Solid Waste (MSW); Industrial Solid Waste; Hazardous Solid Waste; Agriculture Solid Waste; Mining Waste, Sewage Sludge Waste etc..

Solid wastes are being produced since the beginning of civilization. The disposal of Solid Waste has been increased due to the rapid developments in industrialization and urbanization. High population density, intensive land use for residential, commercial and industrial activities led to generation of more solid waste. In Andhra Pradesh, the solid waste generated in medium and small municipalities in the range of 30 – 150 MT / day. The per capita generation of Municipal solid waste in class I cities is in between 100 – 500 gms / day per person.

Sources of Solid Wastes:

1. **Municipal Solid Waste** is commonly known as garbage consists of packing materials, furniture, clothing, bottles, food scraps, newspapers, home appliances; paints, batteries etc. Municipal solid wastes are arise from residential quarters, commercial (markets, hotels, garages); institutions; public places, open areas/streets, parks, play grounds etc. MSW also include the following wastes:

Food Wastes usually generate from domestic houses, hotels, markets and consist of fruits, vegetable residues resulting from the handling, preparation, cooking and eating of foods.

Rubbish waste consists of combustible wastes (papers; cardboards, torn clothes, plastics, wood etc) and non – combustible waste (glass, crockery, aluminum tins, ferrous metals; construction wastes).

Demolition & Construction wastes result from the construction, remodeling and repairing of residential, commercial buildings and industrial factories. These wastes include dust, stones, concrete, bricks, steel pieces etc.

Special Wastes include street sweepings, road side litter, drainage debris; dead animals and abandoned vehicle parts.

2. **Industrial Waste** arise from industrial activities such as chemical industries; metal and mineral processing industries. Radio Active wastes are generated by Nuclear Power Plants. Thermal Power Plants produce fly ash in large quantities. Fly ash is a fine solid particles result from the burning of wood, coal and other combustible wastes.

3. **Hazardous Solid Waste** is any solid waste or combination of wastes that posses a substantial danger, now or in future to human beings and plant / animal life and cannot be handled or disposed. The following is a list of types of hazardous wastes:

→ wastes from specific and non-specific sources. Ex: Disposable synergies from hospitals is a specific source identified as hazardous solid waste.

→ Ignitable materials (easily inflammable below 60oC)

→ Corrosive materials (iron rods / pieces)

→Reactive materials (undergoes rapid reaction with water or other substances and releases toxic gases. Ex: limestone / marble).
→ Toxic materials which consists of Pb, Cl (Toxic to human beings)
Effects of Solid Waste: The improper handling and transfer of the solid wastes results in various health and environmental problems. The main impacts of waste accumulation are:
→ Garbage dumping places are breeding places for diseases.
→ Rats and pigs roam and feed on garbage and transmit diseases like brain fever from pigs to human beings and plague from Rats.
→ Solid wastes may choke the drains and gully pits resulting in water logging which in turn results in breeding of mosquitoes and then cause for Malaria & dengue in human beings.
→ Noxious fumes (harmful gas) may pollute air due to the burning of waste products especially plastic containers.
→ Obnoxious (very unpleasant) odours pollute the air due to decomposition of organic solid wastes.
→ Municipal solid wastes heap up on roads due to improper disposal system. Every year several tones of solid waste is dumped along the high-ways thereby spoiling the landscape (appearance of an area of land).
→ Urban and industrial solid wastes often contain a variety of toxic chemicals which may enter into the food chain and affect both terrestrial and aquatic organisms.

DISASTER MANAGEMENT

Disaster means a terrible event that causes a great damage / loss to the human beings. It is a situation arising from natural forces where large scale disruption of infrastructure, services etc. occurs. It causes a serious impact on human life, economy and environment. Natural disasters are always severe and sudden. Some disasters are:

(A) Geological in nature like the earthquakes.
(B) Landslides (rocks slides down from the side of a hill), volcanic eruptions etc.
(C) Climatic disasters / Natural calamities:

These are of different types affect nations all over the world. Because of the large geographical size of the country, India often faces natural calamities like floods, cyclones and drought occurring frequently in different parts of the country. Natural calamities are of two types:

1. Major calamities: Ex: earthquakes; droughts; floods, tsunamis; cyclones etc
2. Minor calamities: Ex: hailstorms; avalanches; fire accidents

(D) Man induced disasters include wars, battles, riots, rail/road accidents, nuclear explosions. **The disaster Management**: The natural disaster management involves the following steps: **Relief measures**: it include rescue tools; communication equipments; heavy machines to remove debris; water pumps; technicians; drugs, doctors, ambulances..

Disaster predictions: The predictions of natural hazards may be made on the basis of past history of the area with regular monitoring of the environmental changes caused by human activities to assess the genesis of natural disasters.
Education: Disaster education plays a significant role in disaster education. It creates awareness and improves the standards to prevent from the disasters.
Geographic Information Systems: (GIS): GIS is a system that captures, stores, analyzes. Manages and presents data with reference to geographic location of the area. In simple terms, GIS is the merging of cartography, statistical analysis and database technology. GIS may be used

in Archaeology, Geography, Remote Sensing, Land surveying; Natural Resource Management; Urban Planning etc.. GIS programmes help by means of maps available data of the problem areas, to predict the severity of the disaster.

Words	**Meanings**
Aerosol	Atmosphere or gas containing finely divided solids or liquid particles of microscopic size (0.1 – 100 microns).
Avalanche	Large amount of snow falls down.
Battles	Between the persons / enemies.
Contamination	A substance causing pollution is too low to cause harm Dioxin Poisonous chemical.
Disaster	Something that causes a lot of harm (bad situation).
Fly ash	Fine solid particles exist during the burning of coal.
Fog	high concentration of liquid particles formed by the Condensation of vapour (reduction of visibility to < 1 km).
Formaldehyde	A chemical substance.
Fumes	Very fine liquid or solid particles. (0.03 - 0.3 microns).
Garbage	Unwanted things.
Gases	Matter having no independent shape and expands Continuously.
Gasoline	A mixture of volatile hydrocarbons used as a fuel known as petrol.
Hailstorm	Small pieces of frozen rain falls from the sky.
Hazard	Something that is dangerous.
Haze	When the air is not clear because of the presence of heat/smoke.
Herbicides:	A chemical used to kill the unwanted plants.
Impair	To harm something and make it less good.
Intangible	Can’t prove the feelings or quality exits.
Landscape	The appearance of an area of land.

Litter	Pieces of paper left in Public places.
Matter	Physical substance that exist in the universe.
Mists	Liquid particles formed by the condensation of vapor or a chemical Reaction.
Noxious gases	Harmful gases.
Obnoxious	Very unpleasant.
Pollutant	The substance or energy or things which cause pollution. Ex: Aerosol, dust, smoke, fly ash, gases, fumes, smog, fog.
Radon	A type of gas due to poor ventilation. It is confined to inside the house.
Riots	Violent behavior by a crowd of people.
Sludge	Soft, wet soil.
Smog	Mixture of smoke & fog or contain large quantities of different Chemicals.
Smoke	Results from incomplete combustion of fuels(0.001- 1 microns).
Soot	Results from incomplete combustion of carbonaceous material bituminous coal, kerosene lamp. Ex: chimney consists soot
SPM	A mixture of liquid or solid particles and gas under pressure which is released from a container. Ex: Deodorants.
War	Between the nations.

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GLOBAL ENVIRONMENTAL PROBLEMS & GOBAL EFFORTS

The problems caused by pollutants such as NOx, Sox etc are now worldwide issues. Heating of earth surface; poor air quality in urban areas; the formation of acid rains, depletion of ozone layer; emission of gases are of our environmental issues which are to be studied.

Green House Gases (GHG) & Green House Effect: Greenhouse gases are those that can absorb and emit infrared radiation. In order, the most abundant greenhouse gases in Earth's atmosphere are: water vapor; carbon dioxide; methane; nitrous oxide; ozone. In addition to the main greenhouse gases listed above, other greenhouse gases include sulfur hexafluoride, hydrofluorocarbons, CFC’s etc.

Chloro Fluoro Carbons are non – toxic; non-flammable contains fluorine, carbon and chlorine atoms. The five main CFCs are the:

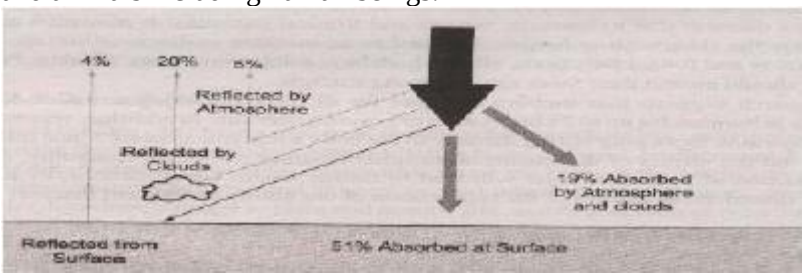
CFC- 11 (Trichloro Fluoro Methane … $CFCl_3$) CFC- 12 (Dichloro Fluoro Methane … CF_2Cl_2) CFC- 113 (Trichloro Tri Fluoro Ethane … $C_2F_3Cl_3$) CFC- 114 (Dichloro Tetra Fluoro ethane $C_2F_4Cl_2$) CFC-11 5 (Chloro Penta Fluoro ethane C_2F_5Cl)

The major uses of CFCs are:
→ As coolants in refrigerators (CFC 11, 12, 113,114,115);
→ In air-conditioners and in fire extinguishers (Halogen + HCFC 123);
→ as solvent in cleaning particularly electronic circuit boards (Methyl chloroform and Carbon Tetrachloride).
→ CFC's are used as sterilization agent in medical field (mixture of CFC12 & ethylene oxide) and propellant in aerosols like deodorants; shaving foam, perfumes etc.
Man made CFC's however, are the main cause of stratospheric ozone depletion. CFCs have a lifetime in the atmosphere of about 20 to 100 years and as a result one free chlorine atom from CFC molecule can do a lot of damage. Methane (CH_4): The major source of methane is extraction from geological deposits known as Natural gas and used as fuel. Since it is a gas at normal conditions, methane is distributed through pipe lines. It is also called as LNG (Liquefied Natural Gas). Methane reacts with halogens and produce Methyl Chloride (CH_3Cl), Chloroform ($CHCl_3$) and Carbon tetrachloride (CCl_4).
Since the beginning of the Industrial Revolution, the burning of fossil fuels has contributed to the increase in carbon dioxide in the atmosphere from 280 ppm to 390 ppm. When these gases are ranked by their direct contribution to the greenhouse effect, the most important are:

Gas	**Formula**	**Contribution (%)**
Water vapor	H_2O	36 – 72 %
Carbon dioxide	CO_2	9 – 26 %
Methane	CH_4	4 – 9 %
Nitrous oxides	NO_x	3 – 7 %
Ozone	O_3	3 – 7 %

Of these gases, CO_2 accounts for about 55% of the earth's Green House effect. Other gases are capable of changing the energy balance and causes for increase of temperature of the earth. A number of changes usually take place in the energy which comes from the sun through the atmosphere. In detail: 26% of the energy is reflected back to the space by clouds and particles whereas about 19% of the energy is absorbed by some of the gases especially ozone in the atmosphere. 4% is reflected from the surface back to space. Of the remaining 51% of the solar energy is then used in a number of process including the heating of the ground surface, evaporation of water.
The main sources of greenhouse gases due to human activity are:
→ Burning of fossil fuels and deforestation leading to higher carbon dioxide concentrations in the air.
→ Use of chlorofluorocarbons (CFCs) in refrigeration systems, and use of CFCs and halogens in fire suppression systems and manufacturing processes. Some halogens are used in fire

extinguishers; they in turn produce CFC's. Hence, CFC emissions increases in the atmosphere and then causing Green House Effect .
→ Agricultural activities, including the use of fertilizers that lead to higher nitrous oxide (N2O) concentrations.
Green House effect is a naturally occurring process that aids the heating of the earth's surface and atmosphere. Green House effect results from the gases such as CO2; CH4 (methane); N2O (Nitrous Oxide); CFC's; Halogens (F, Br, Cl, I) and O3. Ultimately, the Green House effect may lead to the death of both plants and animals including human beings.



Global Warming: Earth has become warmer over the last century. As a result of higher concentrations of gases (especially CO2); the earth's climate become warmer and this is referred to as Global Warming. Reports that the average climate / temperature of the earth has increased during the twentieth century by about 0.6oC (+/- 0.2oC). The IPCC (Inter-government Panel on Climate Change), a group established by the World Meteorological Organization (W M O) and The United Nations Environment Programme (UNEP) revealed the following effects of global warming:
→ Global warming causes, rate of precipitation decreases on land and causes a decrease of rainfall by 40% all over the world.
→ Sea level raises and low lying areas will be inundated (to cover an area of land with water)
→ Global Warming change the direction of wind.
→ CFC's convert O3 into oxygen and oxygen radical and thus ozone depletes in the atmosphere.
→ Global temperature will increase atleast by 4oC.
→ Decrease of earth's albedo (the amount of sun light reflection by the earth's surface to the moon).
→ People suffer from many undiagnosible diseases.
→ CFC-11; 12 and 113 in the atmosphere for a longer period harmful to the human beings.
Solutions for Global Warming:
→ By reducing the emissions of Green House gases.
→ Clean electricity technologies such as wind mills/turbines; solar panels; tidal energy etc are to be used
→ Bio-fuels (Ex: ethanol - a type of alcohol) and Bio-diesel could substantially cut down the CO2 emission.
→ By avoiding the driving of vehicles (walking / bicycling is to be followed)

Climate Change & their impacts on Human Environment:
The weather conditions and seasonal variations in a region over a long period are called the average temperature in many regions has-been increasing in recent decades. Globally, 1990 was the warmest decade on record. Climatologists of the Inter-governmental Panel on Climate

changes (IPCC) have carried out several experiments in order to estimate the changes in climate. Accordingly, First Assessment Report (FAR) was completed in 1990 and Second Assessment Report (SAR) in 1997.

Following are the main points from the climate reports:

→ The concentration of Green House Gases in the atmosphere such as CO2; Methane; Nitrous Oxide have all increased markedly since 1750 and now exceeded the levels.

→ Emissions of Carbon dioxide from fossil fuel has been increased from 1990's onwards. The Third Assessment Report (TAR) on climate change 2001 is the most comprehensive and up-to- date scientific assessment of past, present and future climate change. The report:

→ Analyses an enormous body of observations of all parts of the climate system.

→ Increasing concentrations of atmospheric greenhouse gases.

→ Assesses our understanding of the processes and feedbacks which govern the climate system.

→ Projects related to scenarios of future climate change using a wide range of models of future emissions of greenhouse gases and aerosols. Fourth Assessment Report was released in 2007 and concluded that 90% of human beings are caused for Global Warming.

→ The concentration of the Carbon Dioxide in the atmosphere (379 ppm in 2005) is higher than the past years (180 to 300 ppm) mainly due to fossil fuel usage.

→ The studies have also shown that in the near future the Global surface temperature will rise by 1.4oC to 5.8oC and leads to floods and/or droughts.

→ The Global mean seal level is projected to rise by 9.88 cm by the year 2100.

→ The studies / reports also stated that a few regions such as NILE

Delta: in Egypt and Ganges – Brahmaputra delta in Bangladesh may become vulnerable (liable to be damaged). Finally, it was concluded that continued Green House Gas emissions because further Global warming and induce many changes in the Global climate system during the 21st century.

Impacts on Human Beings:

→ Human environment will be seriously affected by extremes of climate by means of Floods and Droughts.

→ Due to extreme changes in Climate, Human beings suffer from safe drinking water.

→ Changes in climate may affect the distribution of vector species (Ex: mosquitoes) which in turn spread infectious diseases such as Malaria; Filariasis, Dengue, diarrhea; Yellow fever etc.

→ The reduction in food production would lead to starvation.

→ Climate change could lead to migration of humans.

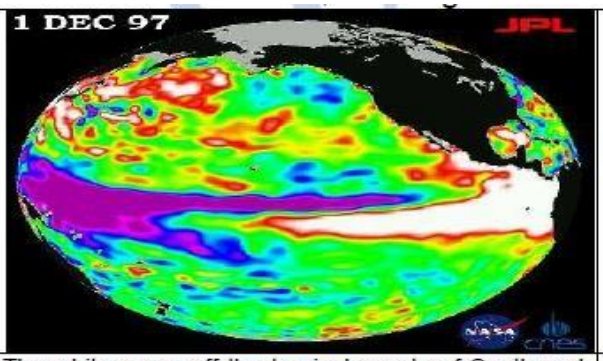
El Nino – LA NINA

Oceans not only control the climate of the areas by absorbing and storing solar energy, but also distribute heat between lower and higher latitudes. The **Pacific Ocean** is the largest of the Earth's oceanic division extends from the Arctic in the north to the South of Antarctica, bounded by Asia and Australia in the west, and the US (Americas) in the east. The equator subdivides it into the **North Pacific Ocean** and **South Pacific Ocean.** Interesting examples of the interaction between the oceans and the atmosphere are the **El Niño and La Niña phenomena** patterns. **El Nino** is defined by prolonged differences in Pacific Ocean surface temperatures. It is also defined as a periodic warming ie variations in the temperature in the Pacific Ocean. The accepted definition is a warming of at least 0.5 °C (0.9 °F) over the east-central Pacific Ocean. Typically, this anomaly

Happens at irregular intervals of 3–7 years. Because of variations in the temperature, the winds create cyclones, which is an another sign of an El Niño. The Pacific Ocean is a heat reservoir (that drives global wind patterns) and the resulting change in its temperature alters weather on a global scale.

A global wind pattern means "the region of Earth receiving the Sun's direct rays is the equator. Here, air is heated and rises, leaving low pressure areas behind. Moving to about thirty degrees north and south of the equator, the warm air from the equator begins to cool and sink. The air movements toward the equator are called **trade winds".**

The European Remote Sensing Satellites ERS-1 and ERS-2 measured sea surface topography continuously since July 1991. One of the areas of interest is the Pacific Ocean where the famous El Niño roars every year. This event is characterized by relatively high sea level (along the coast of Central America) accompanied by with heavy rainfall. At the same time, sea level drops in the Western Pacific ocean, where extreme droughts devastate crop yields. Envisat was launched in 2002 is the largest Earth Observation spacecraft. It carries ten sophisticated optical and radar instruments to provide continuous observation and monitoring of the Earth's land, atmosphere, oceans and ice caps. More advanced imaging radar, radar altimeter and temperature-measuring radiometer instruments extended ERS data. This is supplemented by new instruments including a medium-resolution spectrometer sensitive to both land features and ocean colour. Envisat also carries two atmospheric sensors monitoring trace gases.
The first signs of an El Nino are: Rise in surface pressure over the Indian Ocean, Indonesia and Australia Fall in air pressure in eastern Pacific Ocean Warm air near Peru, causing rain in the northern Peruvian deserts.



The white areas off the tropical coasts of South and North America indicate the pool of warm water

ENVISAT

LA NINA: The results of La Niña are mostly the opposite of those of El Niño. La Niña often causes drought conditions in the western Pacific but flooding in northern South America; mild wet summers in northern North America, and drought in the southeastern United States. During a period of La Niña, the sea surface temperature across the equatorial Eastern Central Pacific Ocean will be lower than normal by 3–5 °C.
Ex: Singapore experienced the driest February in 2010 with 6.3 mm of rain fell in the month and temperatures hitting as high as 35 degrees Celsius. The name La Niña originates from Spanish, meaning "the girl," analogous to El Niño meaning "the boy."

Ozone Layer and Ozone layer depletion:
The earth's atmosphere is composed of several layers.
EXOSPHERE: The outer most layers extended up to 960 ms. THERMOSPHERE: Layer extended up to 400 km from Mesosphere. MESOSPHERE: Another layer extended up to 80km from the surface of the earth. STROTOSPHERE: Next layer extended up to 50 km from the surface of the earth. TROPOSPHERE: Lower layer extended up to 18 km from the surface of the earth.

Ozone Formation: Ozone is a form of oxygen that has three atoms in each molecule (O3). Ozone is bluish colored and highly poisons gas that has a boiling point of 112oC. At atmospheric pressure, ozone can partially dissolve in water. At standard temperature and pressure, the solubility of ozone is thirteen times that of oxygen.

Standard Temperature and Pressure**:** STP is commonly used to define standard conditions for temperature and pressure which is important for the measurements and documentation of chemical and physical processes. *STP is defined by IUPAC (International Union of Pure and Applied Chemistry) as air at 0^{o}C (273.15 K, 32 ^{o}F) and 105 pascals or 100 kPa.*

Ozone is formed by the action of sunlight on oxygen. When normal oxygen absorbs solar ultra violet radiation; splitting oxygen molecules into radical oxygen (O). This atomic oxygen quickly combines with further oxygen molecules to form ozone. This action takes place naturally in the atmosphere.
$O2 + UV \rightarrow O + O$
$O + O2 \rightarrow O3$
Destroy of Ozone Layer: *Two different processes destroy ozone naturally:* The first is when a free oxygen radical combines with an ozone molecule to produce two diatomic oxygen molecules.
$O + O3 \rightarrow 2O2$
The other process when ozone molecules absorb ultraviolet radiation and form one diatomic oxygen molecule and one free oxygen radical.
$O3 + UV \rightarrow O + O2$

Ozone Depleting Substances (ODS)
Ozone Depleting Substances (ODS) are those which deplete the ozone layer. The ODS's Chloro Fluoro Carbons (CFS's) Hydro Chloro Fluoro Carbons (HCFS's)
Methyl Chloroform Carbon Tetrachloride and Halogens (MCCTH's)

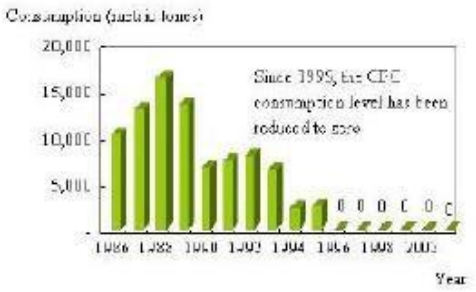
Effects on human beings:
→ Ozone makes human beings eyes itch, burning sensation.
→ It lowers the human body resistance power and leads to cold and pneumonia.
→ Ozone reacts with tissues and cause for breathing and decrease the working ability of the lungs
→ The thinning of the ozone layer may lead to an increase of skin cancers.

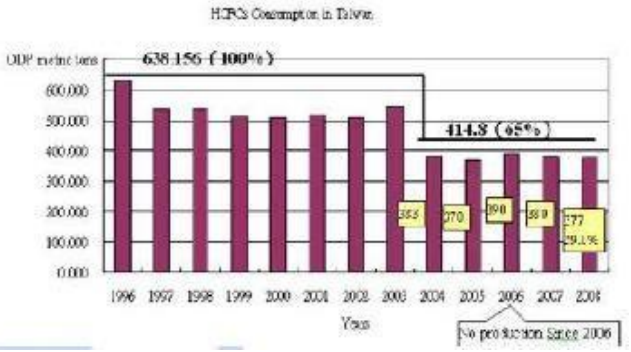
Effects on Global environment:
Certain crops may be damaged if ozone layer is depleted thus affecting natural food chains and food webs so that the ecology system disturbs. The effect of ozone depletion in Antarctica is severe; however, the ozone in the arctic region should not be neglected. Depletion of ozone causes Global warming.

International Conventions / Protocols:
Convention: large formal meeting of people with the same interest or work. Protocol: The rules about what you must do and how you behave in an official situation. The objectives of the International Conventions are to stabilize the Green House Gas concentrations in the atmosphere to certain levels to prevent dangerous human interference with the climate system of the world..

Earth Summit: The **United Nations Conference on Environment and Development** (UNCED), also known as the **Rio Summit**, **Rio Conference**, **Earth Summit** (Portuguese) was a major conference held in Rio de Janeiro from 3 June to 14 June 1992. Totally 172 Governments were participated with their heads and representatives, NGO's accounting 17000 people. The issues included:
→ Systematic scrutiny of patterns of production of Toxic components such as lead in gasoline.
→ Alternative sources of energy to replace the use of fossil fuels which are linked to global climatic changes.
→ By introducing new public transport system in order to reduce vehicle emissions in cities.
→ Alarming the growing scarcity of water and has been decided to come out with proper utilization methodologies.
→ Not to carry out any activities on lands that would cause environment degradation.

Montreal Protocol:
Several meetings have taken place to address the ozone layer depletion problem. The well known meeting was held in Montreal on 16-09-1987 and the agreement signed is called the Montreal Protocol, which set a timetable to phase out of CFCs as well as halogens which contain bromine and 96 harmful chemicals in the Protocol subject the schedules. The Montreal Protocol on substances that deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987, and entered into force on January 1, 1989, followed by a first meeting in Helsinki (Finland), May 1989. Since then, it has undergone seven revisions, in 1990 (London), 1991 (Nairobi capital of Kenya), 1992 (Copenhagen, capital of Denmark), 1993 (Bangkok in Thailand, SE Asia), 1995 (Vienna, capital of Austria), 1997 (Montreal, Canada), and 1999 (Beijing, china). After implementing the schedules, following are the identified advantages:
Montreal protocol:
→ The highest calculated level of consumption of CFCs was 16,255 metric tons in 1988. Substances were used chiefly as refrigerants, cleaning solvent, foam blowing agents and propellants in spray can. In 1996 the consumption level was reduced to zero and maintain at that level since.





→ HCFCs have been used as one of the alternative substances for CFCs since 1996. As a result, consumption of HCFCs was reduced from around 630 ODP (Ozone Depletion Potential) metric tons in 1996 to 383 ODP metric tons in 2004, which indicated a 40% reduction from the baseline level.
→ Without the protocol there would be a doubling effect of Ultra violet – Beta radiations reached the earth in the northern latitudes and also the amount of ozone depleting chemicals in the atmosphere would have been 5 times greater.
→ It also ensured the improved scientific understanding which can be incorporated in decisions quickly.
→ It is believed that if the International agreement is adhered (sticking to) the ozone layer is expected to recover by 2050.

Kyoto Protocol:
The Kyoto Protocol is a legally binding International agreement to reduce Green House Gas (GHG) emissions of 5.2% by the year 2012. The Protocol states that "developed countries are committed, individually or jointly to ensure that the emissions of Green House Gases do not exceed amounts assigned to each country in Annexure A to the Protocol. The agreement specifies that all countries must follow a number of statements and some of which are as follows:
→ Design and implementation of climatic change mitigation (to reduce the harmful effects of something) and adoption programmes.
→ Preparation of a national inventory of emission removal procedures.
→ Promotion of climate friendly technology transfer.
→ Accounting, reporting and review to ensure the integrity (honesty and the ability to do) of the protocol.

Deforestation and Desertification:
Forests are one of the most important natural resources and a part of biosphere since these are natural assets on this earth. Forests predominantly composed of trees, shrubs, woody vegetation. Approximately 1/3rd of the earth's total land area is covered by forests. Forests are important ecologically and economically. Ecologically forests are to be considered as earth's lungs because they consume CO2 and release O2 which is required for sustaining the life on this earth. The poisonous gas CO2 is absorbed by the trees of forests and reduces the global warming; helps to continue hydrological cycle, reduce soil erosion…. Forest ecosystems are extremely good & hold a good quantity of water. Economically forests provide timber, fodder to grazing animals, firewood (conventional fuel), bamboos, rubbers, medicines, gums, resins, food items Deforestation refers to the loss of forest cover (or) the aimless destruction of trees . The clearing

of forests across the earth has been occurring on a large scale basis for many centuries. This process involves the cutting down, burning and damaging of forests. Currently 12 million hectares of forests are cleared annually and the current rate of deforestation continues, the world's forests will vanish within the next 100 years about 80% of the original forests on the earth have already been cleared. Deforestation is taking place in many parts of the world for many reasons such as:

→ For need of money for developing / weak countries (Malaysia cleared 3.5 million hectares of forest for rubber and oil palm plantations)
→ To construct various projects
→ To pay international debts if any
→ To develop industries
→ For making roads to access the interiors of the areas

Effects of Deforestation:

The removal of trees leads to soil exposure & results in soil erosion, rapid water run-off, loss of wildlife. Deforestation cause unknown effects on global climate and eliminating the majority of plant and animal species on this earth. Various living beings (wildlife is diminishing) may come down resulting in imbalance of forest ecosystem.

→ A variety of food products such as coffee, tea, spices, nuts, fruits etc will be reduced.
→ Rainfall decreases to a great extent.
→ Climatic conditions may are change.
→ Historical values are lost.

Case Studies:

Chipko movement related to mining or quarrying opposed by Sundarlal Bahuguna in North India (refer text books for further information) Sardar Sarovar – Narmada project is a multipurpose project in Gujarat (refer text books for further information)

Desertification: The processes by which an area becomes even more barren, less capable of retaining vegetation and is known as a desert. This may become a disaster in long term. Hence, desertification refers to land degradation in arid and semi-arid areas due to anthropogenic activities. Desertification often starts as patchy destruction of productive land. Increased dust particles in atmosphere also lead to desertification. The chief causes of desertification also include: Climatic factors and (ii) human factors (population growth, increased population density According to the United Nations Environmental Programme (UNEP), deforestation is an important factor contributing to desertification. At the time of Independence in India, about 22% of area was under forest cover and today this has been reduced to 19% UNEP estimated that desertification threatened 35% of the world's land surface and

MODULE - V
ENVIRONMENTAL LEGISLATIONS AND SUSTAINABLE DEVELOPMENT

Definition of Impact: An impact can be defined as any change in physical, chemical, biological, cultural or socio-economic environmental system as a result of activities: relating to a project
(or) adverse effects caused by industrial, infrastructural projects OR by the release of a substance into the environment.
Definition of Impact Assessment: Impact assessment is the process of identifying the future consequences (bad results) of a proposed project. Impact Assessment ensures that projects, programmes and policies are economically viable; socially equitable and environmentally sustainable.
Definition of Environmental Impact Assessment: The United Nations of Environmental Programme (UNEP) defined that EIA is a tool used to identify the environmental and economic impacts of a project prior to decision making regarding the project planning, design, adverse impacts, etc.. For all proposed and development projects, whether Government or Private, the Ministry of Environment and Forests (MoEF) requires an Environmental impact assessment report related to the following parameters:
The report must define what impact it would have on water; soil and air including flora and fauna. Affect on the lives of local people. To ensure that no way harm the environment on a short term or long term basis.
Why is EIA important?
By identifying potential alternatives and adverse impacts, Nations can better achieve goals for sustainable development; avoid adverse environmental; social and cultural impacts; reduces cost, provides better plan for infrastructure etc.
CLASSIFICATION OF IMPACTS:
Environment impacts arising from any development projects fall into three categories:
(i) Direct impacts
(ii) Indirect impacts
(iii) Cumulative impacts.
According to their nature, these three groups reveal:
→ Positive and negative impacts
→ Reversible and irreversible impacts
→ Light, moderate and severe impacts
→ Local and widespread impacts
→ Short – term and long – term impacts
Ex: To construct a major project: **Direct impacts are** related to:
(a) aesthetics in the area (understanding of beautiful things)
(b) traffic at nearby junctions,
(c) removal of natural vegetation;
(d) interference with natural water ways;
(e) additional housing or commercial shops to support employees.
Indirect impacts may occur due to delay in time for the proposed project whereas **Cumulative impacts occur** where individual projects when combined with other projects may cause an overall adverse cumulative effect.
Ex: of various types of impacts that occur in a *typical Road Development project:*
Direct impacts are caused by the removal of gravel from a pit for use of surfacing the road. In this case, the land area in which the pit site is located has been directly affected by activities associated with the road project.

Indirect impacts are difficult to measure, however, such as the land degradation, quality of surface water, urban growth near a new road. New roads often lead to the rapid depletion of animals due to poaching (illegal catching and animals).
A cumulative impact might be the de-vegetation and the roadside vegetation is also damaged by vehicle and foot traffic and the soil is left unprotected. The vegetation never has enough time to recover (because of high traffic volume on the road) and the problem is exacerbated (to make something worse) over time.

Significance of Effects: Significant effects are likely to occur where valuable resources are subject to impacts of severity. EIA is recognized by adopting the five levels of significance as described in the draft to good practice and procedures. These five levels of significances are: **Severe:** Sites of national importance and unique resources (to exist in only one place) if lost, cannot be replaced or relocated.
Major: These effects are to be important considerations at a regional or district scale during the decision making process..
Moderate: These effects at a local scale are likely to be key decision making issues.
Minor: These effects may be raised as local issues but are unimportant in the decision making process.
Neutral: No effect, not significant.

Methods of Baseline Data Acquisition:
An Environmental Baseline Study (EBS) is an investigation conducted to establish the level of contaminants in the project areas and to assess the extent of contamination. The information needed to conduct an EBS can be acquired from the available sources:
Land features include topography; climatology (temperature, rainfall)
Geology & Hydrogeology (Lithology of rock formations, drainage pattern, ground water table)
Air environment (Study of SPM, SOx; NOx)
Noise environment
Water Environment (pH; TDS; F; dissolved Oxygen; BOD etc..)
Soil quality Soil analysis reflect the presence of nutrients like N, P, K, Ca, Mg, Fe, Mn and Al
Flora and Fauna of the proposed area
Socio economic study include Population density; Literacy rate; Category of workers viz., cultivators, agriculture laborers, etc); Medical facilities; Main sources of availability of water viz., rivers, canals, hand pumps, taps etc.

Prediction of Impacts and Impact Assessment Systems (Methodologies):
One of the main challenges in today's society is to access to have a relevant and quality environmental data. An impact assessment system must consist of:
→ All aspects of consequence reports (especially a bad result report) about existing and future emissions to air.
→ Projection of pre-situation, accidental situations etc of the site area should be mapped.
→ Screening to determine the effect of impacts in a proposed project require a full or partial impact assessment study
→ To identify the potential impacts to assess the alternative solutions that avoid adverse impacts on biodiversity

E I A Methodologies include:
1. *Adhoc methods:* In this method, each environmental area such as air; water and the nature of impacts (short term or long term ; reversible or irreversible) are considered. This method serves as a preliminary assessment which helps in identifying more important areas like: Wildlife, Endangered species; Natural vegetation; Grazing; Natural drainage; Groundwater; Air Quality; Economic values; Public facilities etc.
2. *Checklist methodologies:* Checklists in general are strong in impact identification. Impact identification is the most fundamental function of an EIA. These are of 4 broad categories used in E I A system. They are:
   (i) Simple Check lists: A list of parameters without guidelines provided on how to interpret.

Examples for simple checklist parameters;
Land Use includes open space, Agricultural land; Residential; commercial; Industrial. Water resources include Quality, irrigation; Groundwater Air Quality include oxides (sulphur, C, N); SPM; Odors; Gases Service Systems include Schools; Police; Fire Protection; Water & Power System. Biological conditions include Wildlife; Trees, Shrubs. Aesthetics include Scenary; Structures.

(ii) Descriptive checklists: A list of environmental parameters with guidelines provided on how to interpret.

(iii) Scaling Checklists: Similar to descriptive checklists with additional information.

(iv) Scaling Weighing Checklists: These are decision making parameters.

(3) Matrix methods: A matrix should be considered as a tool for the purposes of analysis that means the interactions between various activities and environmental parameters. For eg:

Activity Environmental Parameters:

Resource extraction needs Drilling & Blasting affects on Flora/ Fauna, insects; Fishes

(4) Network Matrix: Networks generally consider only adverse impacts on the environment and hence decision making in terms of the cost and benefit of a project to a region.

(5) Overlay methods: These methods involve preparati on of a set of maps, which represent the spatial distribution of certain parameters. For eg: extent of forest area. Geographic Information Systems are now being used for these methods.

(6) Environmental Index: Following some of the codes are considered: L denotes Criteria

P denotes completely satisfied N denotes criteria not satisfied

(7) Cost / benefit analysis: It provides the nature of expenses and benefits of a project. Essential steps to complete an environmental impact assessment include:

- Describe the proposed project as well as options
- Describe the existing environment
- Select the impact indicators to be used
- Predict the nature of environmental effects
- Assess the significance of the impact

Environmental impact statement:

Most development projects such as industries, roads, railways and dams affect the lives of local people. New projects are called “Green Field Projects” where no development has been done.

Projects that already exist but require expansion are called “Brown Field Projects.” Projects can be classified into

(a) Mild Projects

(b) Moderate Projects

(c) Serious Projects

Some projects may have a temporary impact during the construction phase which could be later become less damazing. In other situations the impact may continue and even the affect of impact may increase (for eg: where toxic solid waste will be constantly generated). Environmental Impact Statement is a

- Tool for decision making.
- Document prepared to describe the affect of proposed activity.
- Document that describes the impacts as a result of proposal action.
- Council for Environmental Quality Regulations (CEQ) provide the recommended format and environmental impact statements , generally forwarded to MoEF.

The EIS has Typically four sections

1. An introduction including a statement of the purpose and the need of the proposed action.
2. A range of alternatives to the proposed action.
3. A description of the affected environment
4. An analysis of the environmental impacts of each of the possible alternatives. Hence an Environmental Impact Statement (EIS) which is a summary of the project is kept for the public to read,

- The venue and the time of public hearing is declared.
- Once the hearing is held, opinions have been expressed both for and against the project (positive and negative ideas).
- The recorded minutes of meeting both positive and negative are sent to the MoEF.

Environmental Management Plan:

Environmental Management Plan (EMP) is aimed to maintain the existing environmental quality.

The main objective of EMP is to investigate specific activities which are related to adverse impacts. The impacts can be first minimized by various planning activities. Some more measures can be practiced to minimize the impacts on environment are as follows:

 The debris and unutilized construction material from construction site should be removed immediately.

ll include regular maintenance of machinery and provision of productive equipment to workers where needed.

Green Belt Development

A **green belt** is a policy and used in land use planning to retain areas of largely undeveloped land or agricultural land surrounding or neighbouring urban areas.Green belt development also has a special importance in hydro electric projects asthe project construction process emanates lot of dust due to excavation works,crushing of material and batching of aggregates. In addition, air pollution also takesplace due to vehicular movement during construction and operation phases.

In order to combat different kind of pollutions and avoid land slips from the portion of catchment area, a green belt is usually developed along project site & around thereservoir. The objectives of green belt policy are to:

-natural environments; Protect natural or semi

 Improve air quality within urban areas;

The green belt has many benefits for people:

 Walking, camping, and biking areas close to the cities and towns.

 Contiguous habitat network for wild plants, animals and wildlife.

 Cleaner air and water

 Better land use of areas within the bordering cities.

The general consideration involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height should be planted .
- Planting of trees should be undertaken in appropriate encircling rows around the project site.
- Generally fast growing plant species should be planted.

The effectiveness of Green Belts differs depending on location and country. In the 7th Centuary, Muhammed established a Green Belt around Medina by prohibiting any further removal of trees in a 12 – mile long strip around the city.Although the forest loss due to the reservoir submergence and construction of variousprojects can be compensated if afforestation is implemented . However, it isproposed to develop greenbelt around the perimeter of various project boundaries ,selected stretches along reservoir periphery, etc.

Recommended tree species for Greenbelt Development Botanical name Common name

Dendrocalamus sp. semla Callistemon citrinus Battle Brush Calotropis gigantea Gigantic Swallow Wort Emblica officinalis Omla Ficus benjamina Chilabor Aegle marmelos Bel Fruit and medicinal Albizia lebbeck Siris

Cinnamomum tamala Tej pata Spices, medicinal, fuel

BUDGET: The cost of plantation is estimated at Rs. 40,000 per ha which includes sapling cost, nursery cost, labour cost, cost of manure, weeding etc. It is proposed to afforest about 50 ha of land as a part of Greenbelt Development Plan. The total cost works out to Rs 20,00,000 . The plantation for this purpose will be carried out by Forest Department, state government of Arunachal Pradesh.The plantation will be at a spacing of 2.5 x 2.5 m. About 1600 trees per ha will be planted. The treated wastewater and the components manure generated by solidswaste will be used for the greenbelt development.

Notable green belts can be observed in the following countries: Australia

Brazil: With approximately 17,000 km².

Canada: Ottawa Greenbelt - Surrounds the Capital city of Ottawa; Greenbelt of Golden Horseshoe is 7300 km²

Europe: European Green Belt; Stockholm Eco park; German Green Belt
New Zealand : Dunedin's Town Belt is one of the world's oldest green belts, having been planned at the time of the city's rapid growth during 1860s.
Pakistan: Islamabad, often called the "green city," is known for its green belts found on most roadsides which are often decorated and filled with various flora.
The Philippines : Makati City's green belt is very green yet full of malls and modern structures.
South Korea: Seoul
United Kingdom: There are fourteen green belt areas, in the UK covering 16,716 km² of England, and Scotland;.
United States: The U.S. states of Portland, Oregon; Virginia ; Lexington, Barton Creek Greenbelt, Austin;

WATER CONSERVATION & RAINWATER HARVESTING METHODS

Water conservation means "*saving water for future*". Water is necessary to man for many purposes and also for metabolic activities. Due to growth of population, industrialization and expanding agriculture have pushed up the demand for water.
Efforts have been made to collect water by constructing dams, reservoirs, digging wells, and by implementing water shed management methods. Water shed management means the wet lands should not be flooded with water and water logging should be avoided. Sprinklers (or) drip methods of water supplyshould be used. Ground water recharging by means of harvesting rain water is also should be used. In ancient India, water conservation methods were adopted for eg:

1) Indus Valley Civilization in Western & Northern India especially at both Mohenjodaro and Harappa.
2) Dholavira a village in Rann of Kutch area in Gujarat where a large number of tanks were made in the rural to provide drinking water.
3) In Tamil Nadu, the ancient people stored rain water in places separately one for drinking purpose and another for bathing and the other for domestic purposes and called them as ***Ooranies.***
4) *In* south India, temples are built with a small tank at the centre which is called as Koneru. During the monsoon season, these koneru's get filled with water so that they are used for many purposes .

***Methods for water conservation*:**

A. *Decreasing run-off losses:* Huge water loss occurs due to run-off; which can be reduced by allowing the water to infiltrate into the soil. By adopting
(1) Contour cultivation (Cultivation across the slope without much skill to the benefit of conservation water in any region
(2) Terrace farming (Construction of a series of benches for catching the runoff water where the slope is above 15 degrees)
(3) Water spreading (Water flow is controlled by a series of diversions with vertical intervals and small depressions are dug in the area for temporary storage of water)
(4) Surface residues (Crop residues, animal residues etc help reducing run – off by allowing more time for water to penetrate into the soil).
B. *Reducing evaporation losses*: This is more effective in sandy soil and less effective in loamy sand soils. A chemical called "super Slurper" (starch + Acrylonitrile)

absorbs water if used in sandy soils.

C. *Reducing irrigation losses*: Irrigation in early morning/ late evening reduces the evaporation losses. Sprinkling and drip irrigation methods conserve water by 30%. Growing hybrid crop varieties with less water requirements help conserve water.
D. *Increasing block pricing*: The consumer has to pay a proportionately higher electricity bill with higher use of water. This helps in economic use of water by the consumers.
E. *Preventing wastage of water:* Wastage of water is to be arrested in houses, commercial buildings, public places etc.. Closing taps when not in use; repairing leakages from pipes & using small capacity flush in toilets prevent wastage of water.
F. *Rainwater harvesting Methods***:** Rainwater harvesting means collecting rain water on the roofs of buildings and storing it underground for later use.

Rainwater Harvesting Methods : Rain water harvesting means collecting rain water and storing it underground for later use. Not only this method recharging the groundwater, it also raises the water table and help augment water supply. Town and civic authorities in many cities in India are introducing by laws making rainwater harvesting compulsory in all new structures.Rain water harvesting methods are classified as ., Traditional and Modern methods. Traditional Rainwater Harvesting is still prevalent in rural areas as surface storage bodies like lakes, ponds, tanks etc.. Modern methods of Rainwater harvesting are include Absorption pit method; absorption well method; and recharge trench method and collecting rain water on the roofs of buildings and stored in underground.

Fig depicts rain water harvesting facility for a building. Geographic Information System

A **geographic information system** (GIS) is a computer-based tool for mapping and analyzing geographic features (phenomenon) that exist and events occur on earth. A **GIS** that captures, stores, analyzes, manages, and presents data that are
linked to locations. In the simplest terms, GIS is the merging of cartography , statistical analysis, and database technology .

GIS applications allow users to analyze spatial information, edit data and maps and present the results of all these operations. A GIS has 4 main functional
subsystems. These are:

1. **A data input subsystem**: It allows the user to capture, collect and transform spatial and thematic data into digital form. The data inputs are usually derived from a combination of hard copies of maps, aerial photographs, Remote Sensing images, Reports, Survey documents etc.
2. **A data storage and retrieval subsystem:** It organizes the data and attribute (a quality ie a particular point of thing) and permits quickly retrieved by the user for analysis and accurate updates to be made to the data base.
3. **A data manipulation and analysis subsystem:** It allows the user to define and execute spatial information. This subsystem is known as the “heart of a GIS” and usually distinguishes it from other database information system and computer-aided drafting systems (CAD).
4. **A data output and display subsystem:** It allows the user to generate graphic displays (normally maps) and tabular reports.

USES: GIS may be used in archaeology, geography, remote sensing, land surveying,

public utility management, natural resource management, photogrammetry, urban planning, emergency management, landscape architecture, navigation, aerial video. GIS may allow to easily calculate and the movement of response resources (for logistics) in the case of a natural disaster. GIS might be used to find wetlands that need protection strategies regarding pollution. Most city and transportation systems planning offices have GIS sections.
Therefore, in a general sense, the term describes any information system that integrates, stores, edits, analyzes, shares, and displays geographic information for decision making.

GIS techniques and technology:

Modern GIS technologies use digitization (method of data creation), where a hard copy map or survey plan is transferred into a digital medium through the use of a computer-aided design (CAD) program, and geo-referencing capabilities

CARTOGRAPHY: The art or technique of making maps or charts

GEOGRAPHIC FEATURES are the features of things such as the bodies of waters, and landforms where they are on earth. Mount Everest is a geographic feature . A water fall, an island etc are some more examples.

DATABASE: A **database** is an organized collection of data for one or more purposes, usually in digital form.

SPATIAL INFORMATION: describes the absolute and relative location of geographic features.

THEMATIC DATA: data describing the characteristics of geographic features..

REMOTE SENSING

Remote Sensing is the technique of deriving information about objects on the surface of the earth without physically coming into contact with them. This process involves:

 Making observations using sensors (cameras, scanners, radiometers,
radars etc) mounted on platforms (aircraft and satellites) which are at a considerable height from the earth surface.
n photographic films and video tapes; digital data on CDs, magnetic tapes.

earth, platform attitude, earth curvature, non-uniformity of illumination, variations in sensor characteristics . This can be done either using electro-optical techniques or by using computers.

 Generation of output products in the form of photographic enlargements
with appropriate rectification.

Conventionally Remote Sensing uses electromagnetic radiation. It refers to the identification of earth features by detecting the characteristic electromagnetic radiation that is reflected / emitted by the earth surface.
Just as our eyes need objects to be illuminated by light so that we can see them, sensors also need a source of energy to illuminate the earth's surface. Different forms of electromagnetic (E M) energy are used for this purpose. Whenever E M energy falls on an object, part of it is absorbed, part of it is allowed to pass through and the remaining is either reflected / scattered. The proportion of this distribution is different for different wavelengths of the incident energy and depends on the nature of the object.