COURSE MATERIAL

ENVIRONMENTAL STUDIES

AND

TECHNOLOGY

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UNIT I
ECOSYSTEMS

Introduction:

Environment is derived from the word *Environner* which mean "encircle or surround" Environmental Studies deals with every issue that affects an organism. So, Environment refers to surroundings which vary from place to place and continent depending upon Physiography, Topography, Climate and the available Natural resources. Since the beginning of the culture, the natural resources such as Soil, Land, Water etc are being over-exploited causing the environment gets polluted or degraded. This has resulted in multi – dimensional environmental crisis like soil erosion, landslides and in turn have created soil pollution, air pollution, water pollution, noise pollution etc.

Importance of Environment:

1. Environment is concerned with day – to – day interaction with the surroundings with which human being is closely associated.
2. Environmental Science is related to many branches of Sciences
3. Environment is concerned with the importance of wild life and its protection.
4. Environmental Science explains the significant role of biodiversity in establishing ecological balance.
5. Environmental Science gives information relating to Population growth, Population explosion and impact on Population growth.
6. Environmental Science also gives information about water conservation, watershed management and the importance of water.

Biodiversity: The existence of a large number of different kinds of animals and plants which make a balanced environment or the totality of all species and ecosystems in a region.

UNIT – I: ECOSYSTEM

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 theecosystems. 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 supportlife. 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 O_2, water & CO_2

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.

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 CO_2 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”.

FUNCTION OF ECOSYSTEM

Means how an ecosystem works/ operates under natural conditions. Major attributes are as follows:

- Food chain ,food webs and trophic structure
- The rate of biological energy flow ;
- the rate of nutrient cycles ie Bio- Geo-Chemical cycles
- primary and secondary production
- Ecological regulation (means regulation of organisms by Environment and regulation of Environment by organisms) plays a major role in the function of an ecosystem

Trophic structure :

The producers and consumers are arranged in the ecosystem in a definite manner and their interaction along with population size are expressed together as Trophic structure. Each food level is known as trophic level

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:

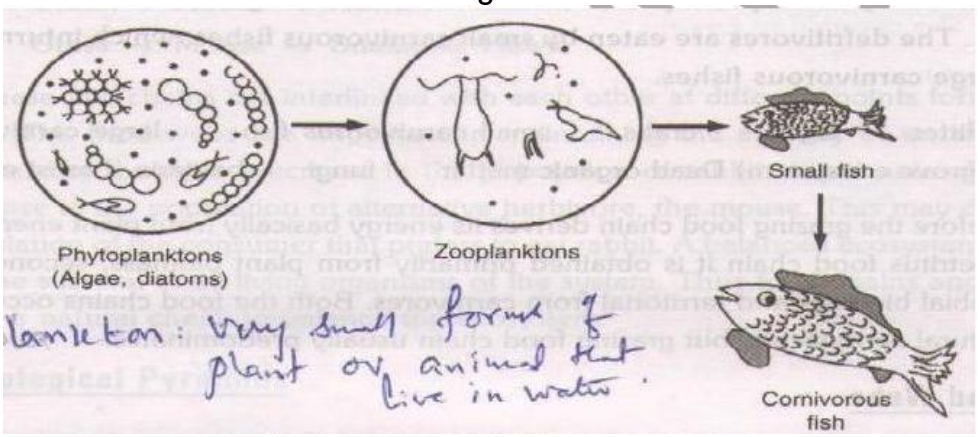
1. Grass→ Grasshopper→ Frog→ Snake→ Hawk.
2. Grass→ Mouse→ Snake →Hawk.
3. Grass→ Rabbit→ Man.
4. Grass→ Mouse→ Hawk.
5. Plant leaf →Caterpillar →Sparrow →Hawk.

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.

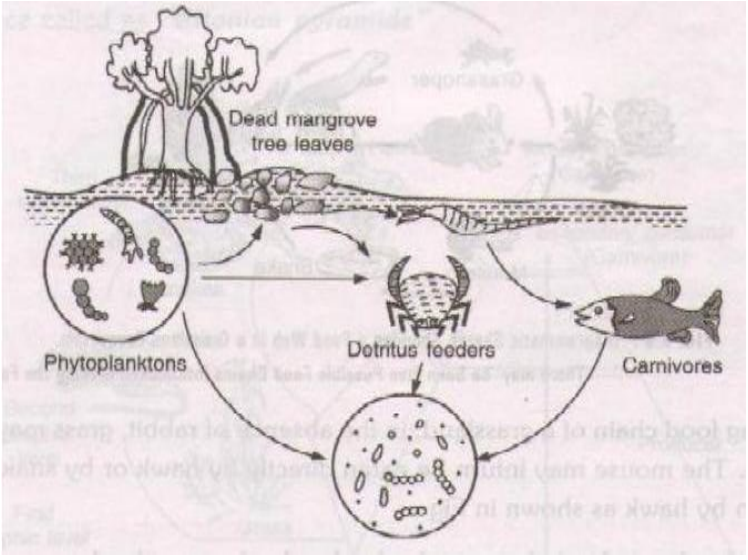
1. Phytoplankton‟s→ Zooplanktons →Small fish→ Tuna.
2. Phytoplankton‟s→ Zooplanktons→ Fish→ Man.
3. Grass→ Rabbit→ Fox→ Tiger.



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.

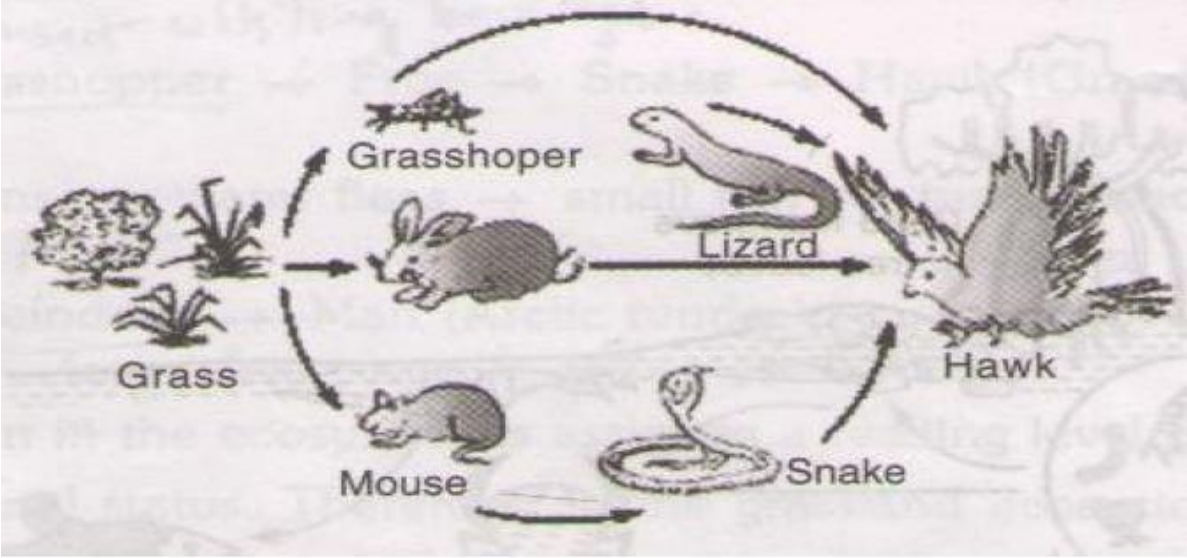
Dead leaves → Algae→ Fish→ Man.



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



BIOMAGNIFICATION: Biomagnification, also known as **bioamplification** or **biological magnification**, is the increase in concentration of a substance that occurs in a food chain as a consequence of:

- Persistence (can't be broken down by environmental processes)
- Food chain energetics
- Low (or nonexistent) rate of internal degradation/excretion of the substance (often due to water-insolubility)

Substances that biomagnify

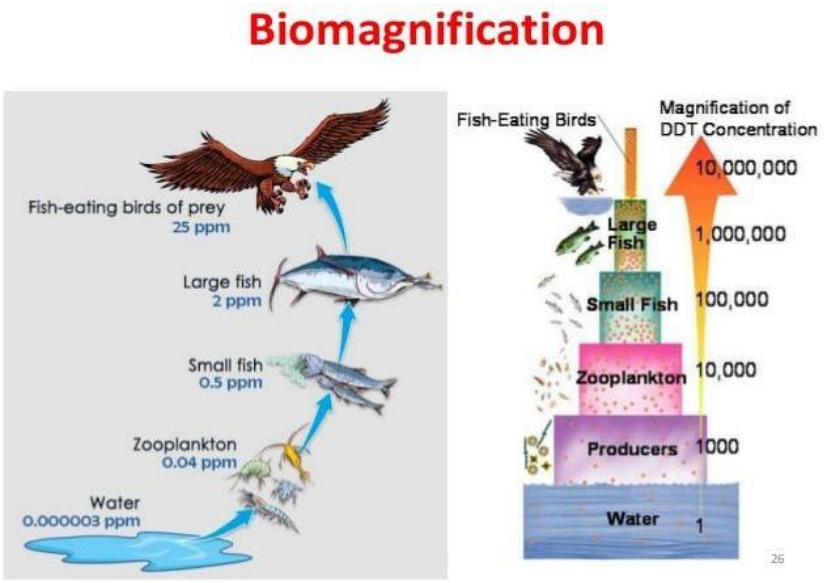
Metals are not degradable because they are elements. Organisms, particularly those subject to naturally high levels of exposure to metals, have mechanisms to sequester and excrete metals. Problems arise when organisms are exposed to higher concentrations than usual,

which they cannot excrete rapidly enough to prevent damage. Some persistent Heavy metals are especially harmful to the organism's reproductive system.

organic substances

: Persistent organic pollutant

- DDT ,HCB s,PCBs ,Toxaphene , Monomethylmercury ,
- **Inorganic substances:** Heavy metal ; Arsenic ,Cadmium ,Mercury ,Selenium



BIOMAGNIFICATION VS BIOACCUMULATION:

Bioaccumulation refers to how pollutants enter a food chain; biomagnification refers to the tendency of pollutants to concentrate as they move from one trophic level to the next. Here are some definitions of these terms:

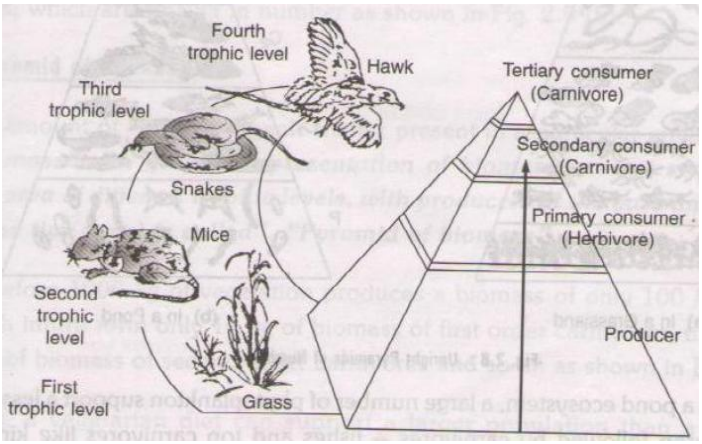
Bioaccumulation: increase in concentration of a pollutant from the environment to the first organism in a food chain
Biomagnification: increase in concentration of a pollutant from one link in a food chain to another

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).



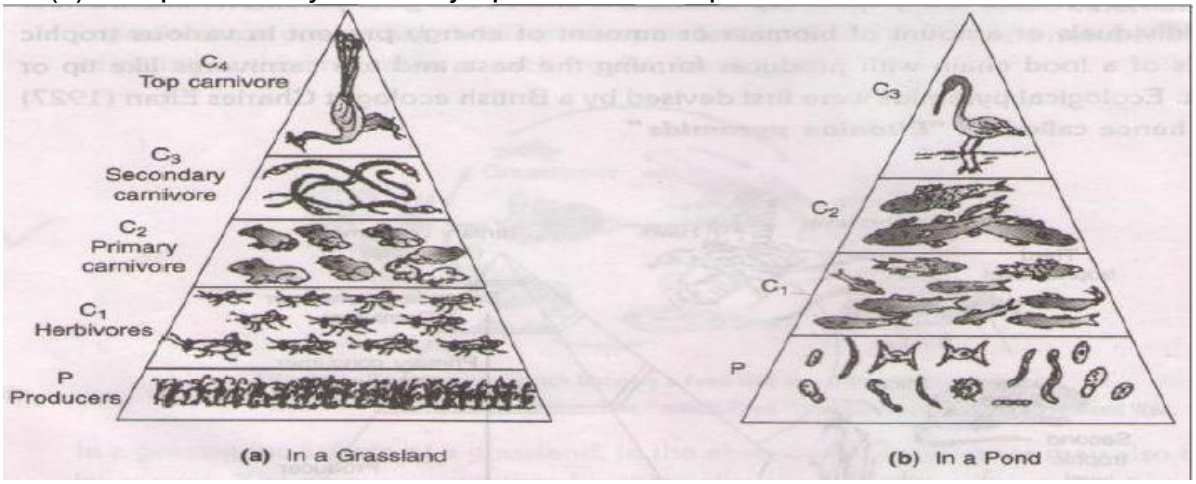
1. The pyramid of Number:

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) uprightwith 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

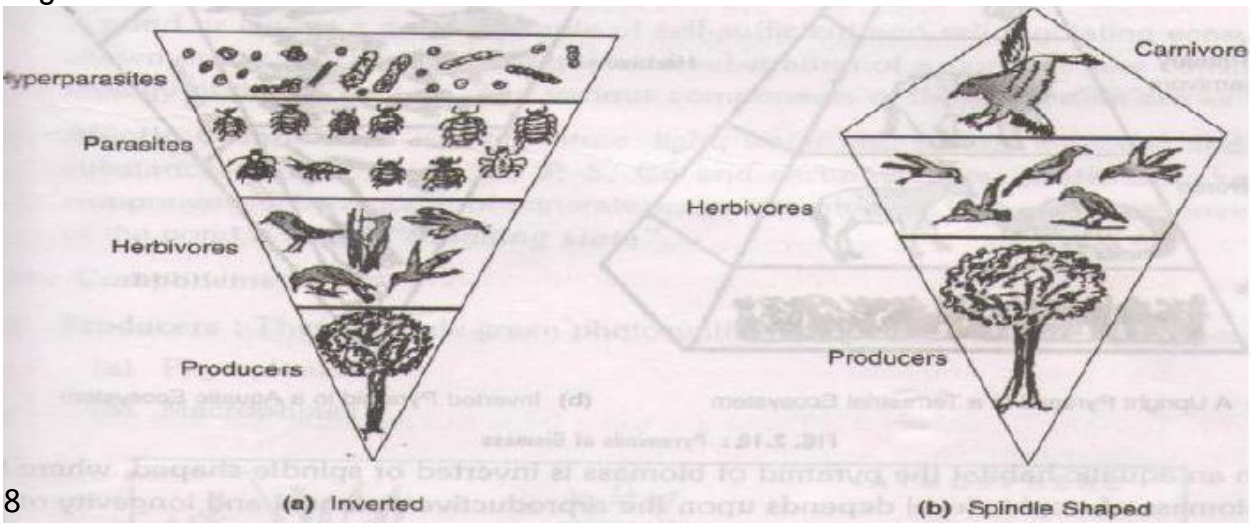


The pyramids may be **inverted** in a few cases:

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



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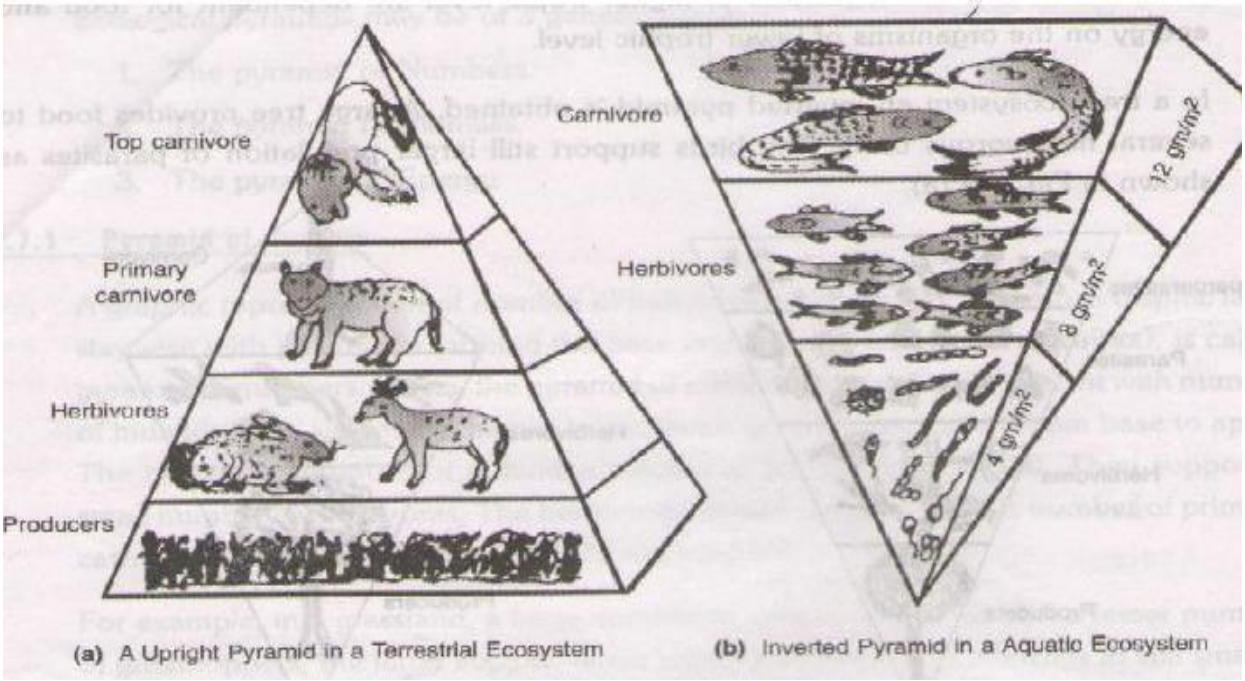
2. The Pyramid of Biomass: The amount of organic matter present in environment is called biomass. In pyramids of biomass, the relationship between different trophic levels is mentioned in terms of weight of organisms**.** The pyramid may be upright for grassland ecosystem and inverted for pond ecosystem.

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 /m^2 / year or KJ / m^2 / year.
Large Fish ---126 KJ / m^2 / year
Small Fish ----840 – 126 KJ / m^2 / year Zooplankton ---- 7980 KJ / m^2 / year Phytoplankton (producers) --- 31080 KJ / m^2 / 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 (CH_2O) 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.

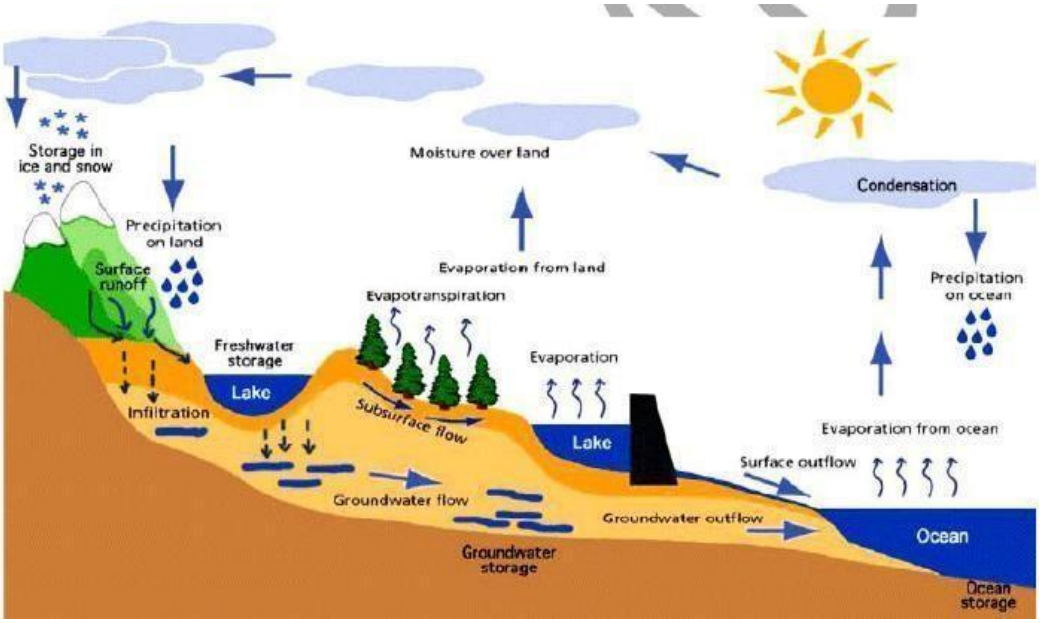
Bio – Geo-Chemical Cycles: In every ecosystem sunlight or solar radiant energy is accepted by producers (green plants) and the energy doesn‟t recycle through an ecosystem. But nutrients like Carbon; Nitrogen; Oxygen, Hydrogen; Water, Sulphur, Phosphorous etc move in circular paths through biotic and 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

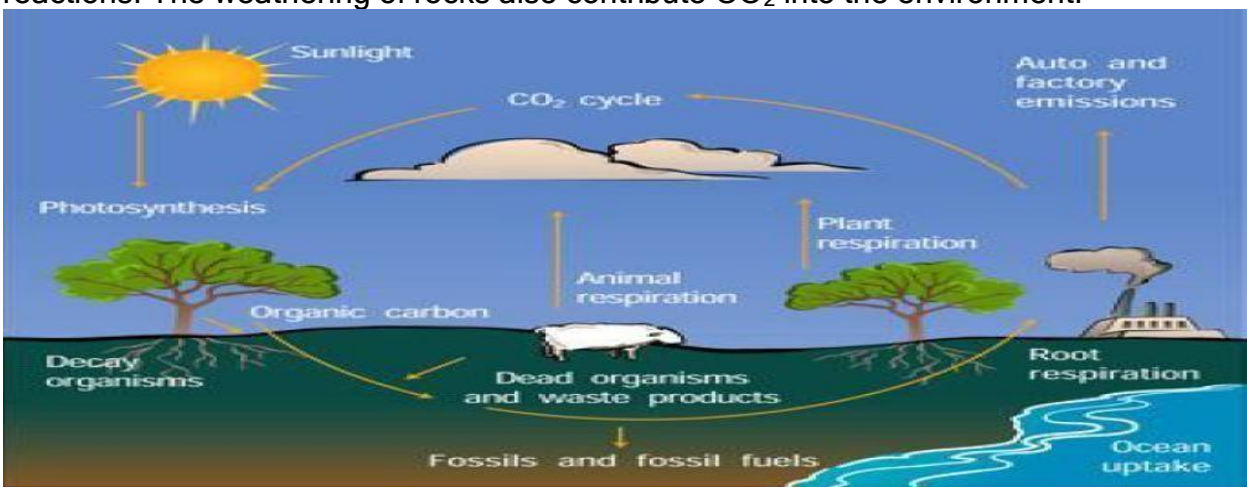
CARBON CYCLE

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 byweight. In comparison, oxygen and silicon make up 45.2% and 29.4% respectively of the earth‟s surface rocks. Plants absorb CO_2 during photosynthesis whereas animals emit CO_2 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 releasecarbon in the form of CO_2. 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 CO_2 into the environment.



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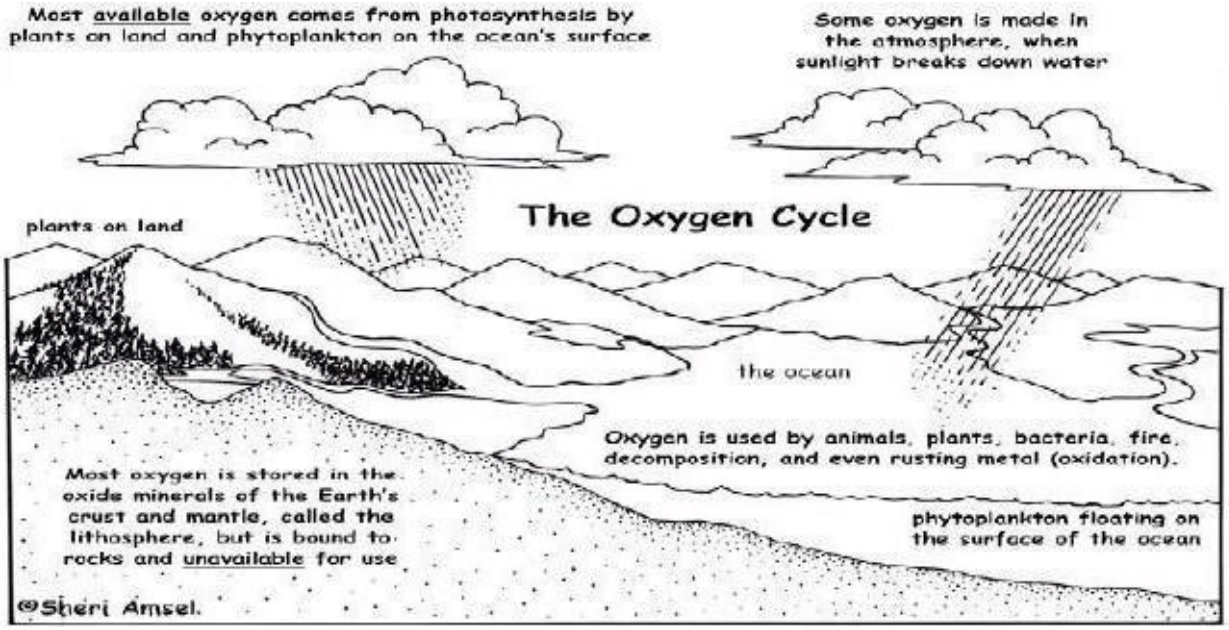
OXYGEN CYCLE: Oxygen is present in CO_2, CH_2O (carbohydrates) and H_2O. Oxygen is released into the atmosphere by plants during photosynthesis and taken up both autotrophs and Heterotrophs during respiration. All the oxygen in the atmosphere is biogenic ie., it was released from water through the process 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 N_2. 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.

$N_2 + 2(O) \xrightarrow{-\text{electric discharge}} 2\,NO$

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 (N_2O_5). These nitrogen oxides get dissolved in rain water and react with mineral compounds to form Nitrates and Nitrogenous compounds on the earth.

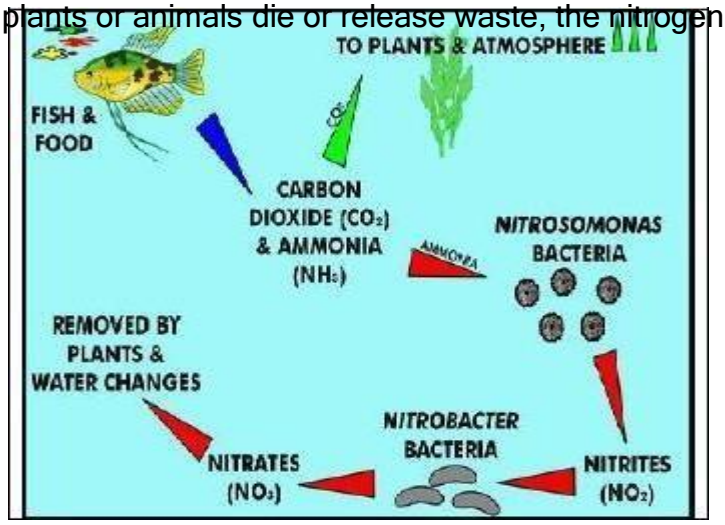
$N_2O_5 + H_2O \rightarrow 2HNO_3$

$2HNO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$

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



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oil as ammonia. The bacteria (nitrite bacteria) in the soil and in the water which take up ammonia and convert it to Nitrite (NO_2). 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.

Primary and Secondary Productivity

'The amount of organic matter or biomass produced by an individual organism, population, community or ecosystem during a given period of time is called productivity'.

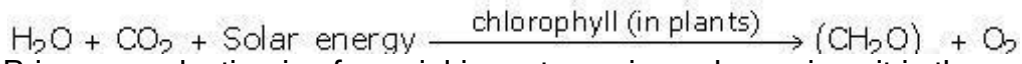
Primary production refers to all or any part of the energy fixed by plants possessing chlorophyll. The total amount of solar energy converted (fixed) into chemical energy by green plants (by the process of photosynthesis) is called 'Gross Primary Production' (GPP).

The rate at which, organic matter is synthesized by producers per unit time and area is called 'Gross Primary Production' (GPP).

A certain portion of gross primary production is utilised by plants for maintenance (largely respiratory energy loss) and the remainder is called 'Net Primary Production (NPP)' which appears as new plant biomass.

or

'The rate of organic matter build up or stored by producers in their bodies per unit time and area is called net primary production (NPP)'.
\GPP - Energy lost by respiration and maintenance = NPP
The biochemical formula that describes photosynthesis is,



Primary production is of special importance in ecology, since it is the energy fixed by plants by converting solar energy into chemical energy of food material that supports life in other trophic levels.
Secondary production refers to the net quantity of energy transferred and stored in the somatic and reproductive tissues of heterotrophs over a period of time.

Some heterotrophs (consumers and decomposers) feed on net

primary production and some on other heterotrophic organisms. Thus, productivity by hetertrophic organisms in the ecosystem is called secondary productivity.
Or

The rate of increase in the biomass of heterotrophs per unit time and area is called secondary productivity.

Secondary productivity serves as an index of significance of the population in terms of food resources available to the heterotrophic populations, including man, in the food chain.

Herbivores and carnivores ingest the food material where a part of this is assimilated and a part is egested. A large part of assimilated food (energy) is utilised for metabolism (largely respiration), growth, reproduction, maintenance of body and other activities. Remaining part is stored in somatic and reproductive tissues and thus compared to net production.

Secondary productivity by decomposer organisms (in a detritus food chain) is different. Here the matter is recycled and microorganisms show a high growth rate.

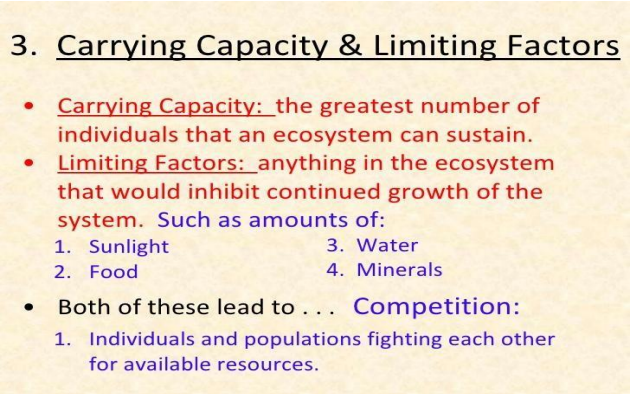
Community productivity is 'the rate of net synthesis or built up of organic matter by a community per unit time and area'.

Consumers: The primary consumers are Ants, beetles, leaf hoppers, bugs, spiders,

THE **CARRYING CAPACITY** of a biological species in an environment

It is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment.

In population biology, carrying capacity is defined as the environment's maximal load, which is different from the concept of population equilibrium. Its effect on population dynamics may be approximated in a logistic model, although this simplification ignores the possibility of overshoot which real systems may exhibit.



VALUES OF ECOSYSTEM

ECO SYSTEM VALUE:

Economists assign several types of values to ecosystems:

*direct use value attributed to direct utilisation of ecosystem services;

*indirect use value attributed to indirect utilisation of ecosystem services, through the positive externalities that ecosystems provide;

*option value attributed to preserving the option to utilise ecosystem services in the future;

*existence value attributed to the pure existence of an ecosystem

*altruistic value based on the welfare the ecosystem may give other people

*request value based on the welfare the ecosystem may give future generations

Ecosystems products and services

PRODUCTS

• Food, Fuel wood ,Non-timber forest products , Fisheries products ,Marine products ,Wetlands products , Medicinal and biomedical products ,Forage and agricultural products, Water ,Reeds, Building material

FUNCTIONS/SERVICES

• hydrological services,Purification of water, Capture, Storage and release of surface and groundwater ,Mitigation of floods and droughts ,Biodiversity ,Maintenance of biodiversity (plants and animals) ,Climate ,Partial stabilization of climate through carbon sequestration ,Moderation of temperature extremes and the force of winds and waves

ECOSYSTEM SERVICES

PROVISIONING, REGULATING, SUPPORTING,CULTURAL

POVISIONING SERVICES - These are the most obvious and are the varied products or materials that we extract from different ecosystems for human use in its broadest sense.

They include plant and animal material for direct consumption as food, other plant or animal materials such as wood, plant fibers or skins and sinews employed in shelters and clothing, herbs of medicinal value and even water that is trapped in rain in elevated forested areas and fed into streams and aquifers, and even water that may be used to generate energy.

REGULATING SERVICES - Regulating services include a diversity of natural processes that provide stability to ecosystems and are beneficial to all life, including man of course. .

One most important service is water and air purification. Another is decomposition of wastes, particularly organic wastes. Another is pollination f many plants.

Again another service is pest and disease regulation. Perhaps the one that may not be as obvious is carbon sequestration and its role in climate regulation.

II. NATURAL RESOURCES: classification of resources

Natural resources are useful raw materials that we get from the Earth. They occur naturally, which means that humans cannot make natural resources. Instead, we use and modify natural resources in ways that are beneficial to us. The materials used in human-made objects are natural resources. Some examples of natural resources and the ways we can use them are:

Natural Resource	Products or Services
Air	Wind energy, tires
Animals	Foods (milk, cheese, steak, bacon) and clothing (wool sweaters, silk shirts, leather belts)
Coal	Electricity
Minerals	Coins, wire, steel, aluminum cans, jewelry
Natural gas	Electricity, heating
Oil	Electricity, fuel for cars and airplanes, plastic
Plants	Wood, paper, cotton clothing, fruits, vegetables
Sunlight	Solar power, photosynthesis
Water	Hydroelectric energy, drinking, cleaning

Biotic and Abiotic Natural Resources

There are several ways to classify natural resources, including where they come from and if they are renewable or not. If natural resources come from living things or organic materials, then they are considered **biotic resources**. Biotic resources include plants, animals, and fossil fuels. The three **fossil fuels** are coal, oil, and natural gas. Fossil fuels are classified as biotic resources because they were formed from the decay of organic matter over millions of years. On the other hand, **abiotic resources** originate from nonliving and inorganic materials. For example, air, sunlight, and water are abiotic natural resources. Minerals (gold, copper, iron, diamonds) are also considered abiotic.

Renewable and Nonrenewable Resources

Renewable resources are those that can be replenished during our lifetime, such as sunlight, wind, water, plants, and animals. The rate at which renewable resources are replenished may

differ. For example, we will never run out of sun and wind in our lifetime because the Earth constantly supplies these resources.

A. **Renewable resources** are resources that are replenished by the environment over relatively short periods of time. This type of resource is much more desirable to use because often a resource renews so fast that it will have regenerated by the time you've used it up.

Ex: forests, wild life, wind energy, biomass energy, tidal energy, hydropower, solar energy etc

Non-Renewable resources are resources that are not easily replenished by the environment once they are exhausted

Ex: fossil fuels, like coal, petroleum, minerals

Water resources

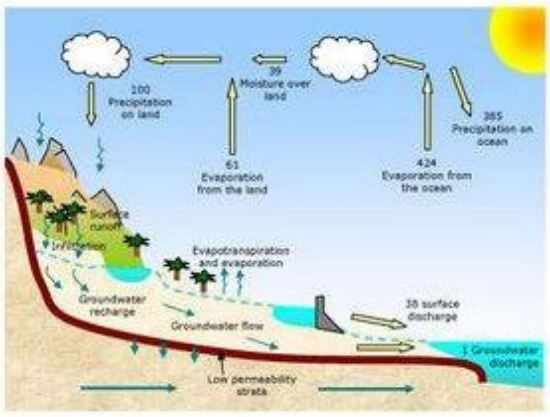
Water resources are under major stress around the world. Rivers, lakes, and underground aquifierssupply fresh water for irrigation, drinking, and sanitation, while the oceans provide habitat for a large share of the planet's food supply. Today, however, expansion of agriculture, damming, diversion, over-use, and pollution threaten these irreplaceable resources in many parts of the globe.
Providing safe drinking water for the more than 1 billion people who currently lack it is one of the greatest public health challenges facing national governments today. In many developing countries, safe water, free of pathogens and other contaminants, is unavailable to much of the population, and water contamination remains a concern even for developed countries with good water supplies and advanced treatment systems. And over-development, especially in coastal regions and areas with strained water supplies, is leading many regions to seek water from more and more distant sources

This unit describes how the world's water supply is allocated between major reserves such asoceans, ice caps, and groundwater. It then looks more closely at how groundwater behaves and howscientists analyze this critical resource. After noting which parts of the world are currently strainingtheir available water supplies, or will do so in the next several decades, we examine the problems posed by salinization, pollution, and water-related diseases.
Scientists widely predict that global climate change will have profound impacts on the hydrologic cycle, and that in many cases these effects will make existing water challenges worse. As we will see "Earth's Changing Climate," rising global temperatures will alter rainfall patterns,
making them stronger in some regions and weaker in others, and may make storms more frequent and severe in some areas of the world. Warming will also affect other aspects of the water cycle by reducing the size of glaciers, snowpacks, and polar ice caps and changing rates of evaporation and transpiration. In sum, climate change is likely to make many of the water-management challenges that are outlined in this unit even more complex than they are today.
At the same time, many current trends in water supply and water quality in Europe and North America are positive. Thirty years ago, many water bodies in developed countries were highly polluted.

2 The Global Water Cycle

Water covers about three-quarters of Earth's surface and is a necessary element for life. During their constant cycling between land, the oceans, and the atmosphere, water molecules pass repeatedly through solid, liquid, and gaseous phases (ice, liquid water, and water vapor),

but the total supply remains fairly constant. A water molecule can travel to many parts of the globe as it cycles.
"Atmosphere," and "Oceans," water vapor redistributes energy from the sun around the globe through atmospheric circulation. This happens because water absorbs a lot of energy when it changes its state from liquid to gas. Even though the temperature of the water vapor may not increase when it evaporates from liquid water, this vapor now contains more energy, which is referred to as latent heat. Atmospheric circulation moves this latent heat around Earth, and when water vapor condenses and produces rain, the latent heat is released.
Very little water is consumed in the sense of actually taking it out of the water cycle permanently, and unlike energy resources such as oil, water is not lost as a consequence of being used. However, human intervention often increases the flux of water out of one store of water into another, so it can deplete the stores of water that are most usable. For example, pumping groundwater for irrigation depletes aquifers by transferring the water to evaporation or river flow. Our activities also pollute
water so that it is no longer suitable for human use and is harmful to ecosystems.
There are three basic steps in the global water cycle: water precipitates from the atmosphere, travels on the surface and through groundwater to the oceans, and evaporates or transpires back to the atmosphere from land or evaporates from the oceans. Figure 2 illustrates yearly flow volumes in thousands of cubic kilometers.
Supplies of freshwater (water without a significant salt content) exist because precipitation is greater
than evaporation on land. Most of the precipitation that is not transpired by plants or evaporated, infiltrates through soils and becomes groundwater, which flows through rocks and sediments and discharges into rivers. Rivers are primarily supplied by groundwater, and in turn provide most of the freshwater discharge to the sea. Over the oceans evaporation is greater than precipitation, so the net effect is a transfer of water back to the atmosphere. In this way freshwater resources are continually renewed by counterbalancing differences between evaporation and precipitation on land and at sea,
and the transport of water vapor in the atmosphere from the sea to the land.
Nearly 97 percent of the world's water supply by volume is held in the oceans. The other large reserves are groundwater (4 percent) and icecaps and glaciers (2 percent), with all other water bodies together accounting for a fraction of 1 percent. Residence times vary from several thousand years in the oceans to a few days in the atmosphere



OVER-UTILIZATION OF SURFACE & GROUND WATER

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

I. The increased extraction of groundwater far in excess of the natural recharge led to decreased groundwater level. The erratic and inadequate rainfall caused reduction in storage of water in reservoirs. This also led to decrease of groundwater.

II. Building construction activities seal permeable soil zone and reduce the area for percolation of rainwater thereby increasing surface runoff.

III. If groundwater withdrawal rate is higher than recharge rate, sediments in aquifers get compacted resulting in sinking of overlaying land surface. This is called land subsidence which leads to structural damage in buildings, fracture in pipes and reverses the flow of canals leading to tidal flooding

IV. Over-utilization of groundwater in arid and semi-arid regions for agriculture disturbs equilibrium of reservoir in the region causing problems like lowering of water table and decreased pressure in aquifers coupled with changes in speed and direction of water flow.

V. Over utilization of groundwater in coastal areas leads to rapid intrusion of salt water from the sea thereby rendering it unusable for drinking and agriculture.

VI. Over-utilization of groundwater lads to decrease in water level thereby causing earthquake, landslides and famine.

VII. Over-utilization of groundwater leads to drying-up of dug wells as well as bore wells.

VIII. Due to excess use of groundwater near agricultural fields, agricultural water that contains nitrogen as a fertilizer percolates rapidly and pollutes the groundwater thereby rendering the water unfit for potable use by infants. (Nitrate concentration exceeding 45 mg/L).

Dams are the massive artificial structures built across the river to create a reservoir in order to store water for many beneficial purposes. Big dams and river valley projects (RVP) have multi-purpose uses and have been referred to as “Temples of modern India”. In a developing country like India, more than 75% of the population depends on agriculture; the execution of river valley project is an important element of growth strategy. India has more than 1550 large dams, the maximum being in the state of Maharashtra (>600), followed by Gujarat (>250) and M.P (>130).

Although these projects have several benefits, they also have cost the society a great deal. The biggest economic social and environment cost of river valley project is the submergence of large tracts of lands, forests, dwellings, railways and roads

For example Narmada RVP, will submerge tracts, 23km of railways, 85km of roads,45km of telephone lines, 10,000 buildings and 3300 drinking wells.

1. Effect on Tribal people:

The greatest social cost of big dam is the widespread displacement of local people. It is estimated that the number of people affected in India over the past 50 years can be as high as 20 millions. The Hirakud dam, one of the largest dams executed in fifties, has displaced more than 20,000 people residing in 250 villages.

2. Effect on Forests:

Thousands of hectares of forests have been cleared for executing river valley projects. For example, the Narmada project alone has submerged 1, 44,731 ha of land, out of which 56,547 ha is forest land.

3. Effect on wild Animals:

Construction of dams under these projects will lead to lose of wild animals.

4. Effect on Environment:

The big river valley projects also cause water logging which leads to salinity and in turn reduces the fertility capacity of the land.

A. **FLOODS**

It is a natural event or occurrence where a piece of land (or area) that is usually dry land, suddenly gets submerged under water. Some floods can occur suddenly and recede quickly. Others take days or even months to build and discharge.

When floods happen in an area that people live, the water carries along objects like houses, bridges, cars, furniture and even people. It can wipe away farms, trees and many more heavy items.

Flooding is extremely dangerous and has the potential to wipe away an entire city, coastline or area, and cause extensive damage to life and property. It also has great erosive power and can be extremely destructive, even if it is a foot high.

Here are a few events that can cause flooding:

a) Heavy rains
b) River overflow: Rivers can overflow their banks to cause flooding
c) Strong winds in Coastal areas: Sea water can be carried by massive winds and hurricanes
dry coastal lands and cause flooding.

Impacts of floods:

- As most people are well aware, the immediate impacts of flooding include loss of human life, damage to property, destruction of crops, loss of livestock, and deterioration of health conditions owing to waterborne diseases. As communication links and infrastructure such as power plants, roads and bridges are damaged and disrupted, some economic activities may come to a standstill, people are forced to leave their homes and normal life is disrupted.

- Similarly, disruption to industry can lead to loss of livelihoods. Damage to infrastructure also causes long-term impacts, such as disruptions to supplies of clean water, wastewater treatment, electricity, transport, communication, education and health care. Loss of livelihoods, reduction in purchasing power and loss of land value in the floodplains can leave communities economically vulnerable.

- Floods can also traumatise victims and their families for long periods of time. The loss of loved ones has deep impacts, especially on children. Displacement from one's home, loss of property and disruption to business and social affairs can cause continuing stress. For some people the psychological impacts can be long lasting.

DROUGHTS

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

Causes of drought:

Natural/physical causes:

-Weather: increased amount of anticyclone weather (hot and dry) means air holds less moisture so you get less rain.

-Global warming: weather patterns change (eg: sahel is becoming hotter and drier)

-Hotter weather: more evaporation than precipitation

-El Nino: random weather event that reverses normal weather patterns (e.g. Australia has years of drought and then years of flood)

Human causes:

-Over population: Too many people living in an area using too much water

-over cultivation: Planting too many crops which use up too much water

-Over extraction: removing too much water from wells so they dry up

-Deforestation: cutting down trees which otherwise store water and hold soil together

-politics: fighting over water or companies being greedy and taking too much water to then sell on

Impacts of Drought:

- Economic impact: agriculture and the income generated from crops in short term and unemployment of farmers and even retailers can occur at long term
- Environmental impact: insect infestations and plant diseases, increased erosion, habitat and landscape degradation in short term and plant and animal species can suffer tremendously and over time desertification can happen with an extreme lack of moisture at long term
- Social impact: disputes between users of available water, inequalities in water distribution between wealthy and poor, siparties in areas in need of disaster relief and a decline in health.

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:

6. During Second World War many water dams were bombed.
7. Central dams over YALU River were attacked during Korean War.
8. Water supply systems in North Vietnam were bombed by US in1960‟s during Vietnam War.
9. 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.
10. 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.
11. The Sutlej –Yamuna link is the dispute between Punjab & Haryana.
12. 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
Yamuna	Delhi, Haryana, Rajasthan, Himachal Pradesh, Uttar Pradesh.
Narmada	Maharashtra, Gujarat, Rajasthan, Madhya Pradesh
Krishna	Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka.
Godavari	Andhra Pradesh, Maharashtra, Orissa, Madhya Pradesh.
Cauvery	Tamil Nadu, Karnataka

DAM ADVANTAGES:

1. Once a dam is constructed, electricity can be produced at a constant rate.

2. If electricity is not needed, the sluice gates can be shut, stopping electricity generation. The water can be saved for use another time when electricity demand is high.

3. Dams are designed to last many decades and so can contribute to the generation of electricity for many years / decades.

4. The lake that forms behind the dam can be used for water sports and leisure / pleasure activities. Often large dams become tourist attractions in their own right.

5. The lake's water can be used for irrigation purposes.

6. The build up of water in the lake means that energy can be stored until needed, when the water is released to produce electricity.

7. When in use, electricity produced by dam systems do not produce green house gases. They do not pollute the atmosphere.

DISADVANATGES:

1. Dams are extremely expensive to build and must be built to a very high standard.
2. The high cost of dam construction means that they must operate for many decades to become profitable.
3. The flooding of large areas of land means that the natural environment is destroyed.
4. People living in villages and towns that are in the valley to be flooded, must move out. This means that they lose their farms and businesses. In some countries, people are forcibly removed so that hydro-power schemes can go ahead.
5. The building of large dams can cause serious geological damage. For example, the building of the Hoover Dam in the USA triggered a number of earth quakes and has depressed the earths surface at its location.
6. Although modern planning and design of dams is good, in the past old dams have been known to be breached (the dam gives under the weight of water in the lake). This has led to deaths and flooding.
7. Dams built blocking the progress of a river in one country usually means that the water supply from the same river in the following country is out of their control. This can lead to serious problems between neighbouring countries.
8.. Building a large dam alters the natural water table level. For example, the building of the Aswan Dam in Egypt has altered the level of the water table. This is slowly leading to damage of many of its ancient monuments as salts and destructive minerals are deposited in the stone work from rising damp caused by the changing water table level.

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: 1tsp 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.

OVER EXPLOITATION OF MINERAL RESOURCES

Mining is hazardous occupation:

1. This occupation involves several health risk dust produced during mining operation are injurious to health and cause lung diseases.
2. . Extraction of some toxic or radioactive minerals leads to life threatening hazards.
3. Dynamite explosion during mining is very risky as fumes produced are extremely poisonous.
4. Underground mining is more hazardous than surface mining as there are more chances if accidents like roof falls, flooding and inadequate ventilation etc.

(b) Rapid depletion of high grade minerals:

Increasing demand for high grade minerals has compelled miners to carry out more extraction of minerals, which require more energy sources and produce large amount of waste materials.

(c) Wastage of upper soil layer and vegetation:

Surface mining results in the complete destruction of upper soil layer and vegetation. After extraction, the wastes are dumped in an area which destroys the total surface and vegetation.

(d) Environmental problems:

Over exploitation of mineral resources resulted in many environmental problems like:

1. Conversion of productive land into mining and industrial areas.

2. Mining and extraction process are one of the sources of air, water and land pollution.

3. Mining involves huge consumption of energy resources like coal, petroleum, natural gas etc. which are in-turn non renewable sources of energy.

4. Surface mining directly degrades the fertile soil surface thus effect ecology and climate if that particular area

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 andGujarat 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 studieshave 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 most simply defined as " the Solid portion of the Earth's surface".

❖ I t is a significant natural resource which plays an important role in the development of human society.

Uses of Land Resources:

- Land is used for Agriculture
- Land contains huge amount of Minerals
- It is also contains water in the form of underground water.
- Most of the animals have their habitat on land
- Land provides all the resources required to fulfils the basic needs of human civilization such as food ,cloth and shelter.

Land Degradation

Land degradation is the temporary or permanent lowering of the productive capacity of land (UNEP, 1992

Causes of Land Degradation:

Natural Causes:

- Heavy rains lead to the removal of topsoil making soil infertile and hence unsuitable for agriculture
- Natural disasters: Earthquake and floods can have considerable impact on land resources.
- High -speed winds: Winds of high intensity and storms are responsible for land degradation

Anthropogenic Causes:

Mining: generates a lot of waste that destroys vegetation and disrupts water circulation over large tracts, causes land degradation

Urbanization: The growing urbanization all over the world is major cause of concern

Deforestation: The indiscriminate and uncontrolled removal of trees have led to the destruction of forests.

Overgrazing: lowers soil quality and leads to land degradation

Dams and Canals: Construction of large dams and canals are also responsible for loss of vegetation leading to land degradation.

Fertilizers: Most of the chemical fertilizers used in modern Agriculture affect the productivity of soil and leads to land degradatic

SOIL EROSION

Many people do conceive the idea of soil degradation but a good number lacks the knowledge of its precise definition. To fill this knowledge gap, soil degradation simply means the decline in soil quality which comes about due to aspects such as improper land use, agriculture, and pasture, urban or industrial purposes. It involves the decline of the soil‟s physical, biological and chemical state.

Soil degradation examples include decline in soil fertility, adverse changes in alkalinity, acidity or salinity, extreme flooding, use of toxic soil pollutants, erosion, and deterioration of the soil‟s structural condition. These elements contribute to a significant amount of soil quality depreciation annually. Excessive soil degradation thus gives rise to immediate and long-term impacts which translate into serious global environmental headaches.

While soil degradation may occur naturally, it has been highly exuberated by anthropogenic activities. Besides, climate change combined with human activities continues to worsen soil

degradation. With the objective of understanding the distinct nature of soil quality decline, here are the causes, effects, and solutions of soil degradation.

uses of Soil Degradation

1. Physical Factors

There are several physical factors contributing to soil degradation distinguished by the manners in which they change the natural composition and structure of the soil. Rainfall, surface runoff, floods, wind erosion, tillage, and mass movements result in the loss of fertile top spoil thereby declining soil quality.

All these physical factors produces different types of soil erosion (mainly water and wind erosion) and soil detachment actions, and their resultant physical forces eventually changes the composition and structure of the soil by wearing away the soil‟s top layer as well as organic matter. In the long-term, the physical forces and weathering processes lead to the decline in soil fertility and adverse changes in the soil‟s composition/structure.

2. Biological Factors

Biological factors refer to the human and plant activities that tend to reduce the quality of soil. Some bacteria and fungi overgrowth in an area can highly impact the microbial activity of the soil through bio-chemical reactions, which reduces crop yield and the suitability of soil productivity capacity. Human activities such as poor farming practices may also deplete soil nutrients thus diminishing soil fertility. The biological factors affect mainly lessens the microbial activity of the soil.

3. Chemical Factors

The reduction of soil nutrients because of alkalinity or acidity or water logging are all categorized under the chemical components of soil degradation. In the broadest sense, it comprises alterations in the soil‟s chemical property that determine nutrient availability. It is mainly caused by salt buildup and leaching of nutrients which corrupt the quality of soil by creating undesirable changes in the essential soil chemical ingredients. These chemical factors normally bring forth irreversible loss of soil nutrients and productivity capacity such as the hardening of iron and aluminum rich clay soils into hardpans.

4. Deforestation

Deforestation causes soil degradation on the account of exposing soil minerals by removing trees and crop cover, which support the availability of humus and litter layers on the surface of the soil. Vegetation cover primarily promotes thee binding of the soil together and soil formation, hence when it is removed it considerably affects the capabilities of the soil such as aeration, water holding capacity, and biological activity.

When trees are removed by logging, infiltration rates become elevated and the soil remains bare and exposed to erosion and the buildup of toxicities. Some of the contributing activities include logging and slash and burn techniques used by individuals who invade forest areas for farming, rendering the soils unproductive and less fertile in the end.

5. Misuse or excess use of fertilizers

The excessive use and the misuse of pesticides and chemical fertilizers kill organisms that assist in binding the soil together. Most agricultural practices involving the use of fertilizers and pesticides often entail misuse or excessive application, thereby contributing to the killing of soil‟s beneficial bacteria and other micro-organisms that help in soil formation.

The complex forms of the fertilizer‟s chemicals are also responsible for denaturing essential soil minerals, giving rise to nutrient losses from the soil. Therefore, the misuse or excessive use of fertilizers increases the rate of soil degradation by destroying the soil‟s biological activity and builds up of toxicities through incorrect fertilizer use.

6. Industrial and Mining activities

Soil is chiefly polluted by industrial and mining activities. As an example, mining destroys crop cover and releases a myriad of toxic chemicals such as mercury into the soil thereby poisoning it and rendering it unproductive for any other purpose. Industrial activities, on the other hand, release toxic effluents and material wastes into the atmosphere, land, rivers, and ground water that eventually pollute the soil and as such, it impacts on soil quality. Altogether, industrial and mining activities degrade the soil‟s physical, chemical and biological properties.

7. Improper cultivation practices

There are certain agricultural practices that are environmentally unsustainable and at the same time, they are the single biggest contributor to the worldwide increase in soil quality decline. The tillage on agricultural lands is one of the main factors since it breaks up soil into finer particles, which increase erosion rates. The soil quality decline is exuberated more and more as a result of the mechanization of agriculture that gives room for deep plowing, reduction of plant cover, and the formation of the hardpan. Other improper cultivation activities such as farming on steep slope and mono-cropping, row-cropping and surface irrigation wear away the natural composition of the soil and its fertility, and prevent soil from regenerating.

8. Urbanization

Urbanization has major implications on the soil degradation process. Foremost of all, it denudates the soil‟s vegetation cover, compacts soil during construction, and alters the drainage pattern. Secondly, it covers the soil in an impermeable layer of concrete that amplifies the amount of surface runoff which results in more erosion of the top soil. Again, most of the runoff and sediments from urban areas are extremely polluted with oil, fuel, and other chemicals. Increased runoff from urban areas also causes a huge disturbance to adjacent water sheds by changing the rate and volume of water that flows through them, and impoverishing them with chemically polluted sediment deposits.

9. Overgrazing

The rates of soil erosion and the loss of soil nutrients as well as the top soil are highly contributed by overgrazing. Overgrazing destroys surface crop cover and breaks down soil particles, increasing the rates of soil erosion. As a result, soil quality and agricultural productivity is greatly affected.

Effects of Soil Degradation

1. Land degradation

Soil quality decline is one of the main causes of land degradation and is considered to be responsible for 84% of the ever diminishing acreage. Year after year, huge acres of land lost due to soil erosion, contamination and pollution. About 40% of the world‟s agricultural land is severely diminished in quality because of erosion and the use of chemical fertilizers, which prevent land from regenerating. The decline in soil quality as a result of agricultural chemical fertilizers also further leads to water and land pollution thereby lowering the land‟s worth on earth.

Drought and aridity

Drought and aridity are problems highly influenced and amplified by soil degradation. As much as it‟s a concern associated with natural environments in arid and semi-arid areas, the UN recognizes the fact that drought and aridity are anthropogenic induced factors especially as an outcome of soil degradation. Hence, the contributing factors to soil quality decline such as overgrazing, poor tillage methods, and deforestation are also the leading causes of desertification characterized by droughts and arid conditions. On the same context, soil degradation may also bring about loss of biodiversity.

3. Loss of arable land

Because soil degradation contributes to land degradation, it also means that it creates a significant loss of arable land. As stated earlier, about 40% of the world‟s agricultural land is lost on the account of soil quality depreciation caused by agro-chemicals and soil erosion. Most of the crop production practices result in the topsoil loss and the damage of soil‟s natural composition that make agriculture possible.

4. Increased flooding

Land is commonly altered from its natural landscape when it rids its physical composition from soil degradation. For this reason, the transformed land is unable to soak up water, making flooding more frequent. In other words, soil degradation takes away the soil‟s natural capability of holding water thus contributing to more and more cases of flooding.

5. Pollution and clogging of waterways

Most of the soil eroded from the land together with the chemical fertilizers and pesticides utilized in agricultural fields are discharged into waterways and streams. With time, the sedimentation process can clog waterways, resulting in water scarcity. The agricultural fertilizers and pesticides also damage marine and freshwater ecosystems and the limits the domestic uses of the water for the populations that depend on them for survival.

Solutions of Soil Degradation

1. Reducing deforestation

Avoiding deforestation completely is an uphill task. However, deforestation can be cut down and this can create an impressive way of reshaping and restoring forests and vegetation cover. As populations grow, individuals can be sensitized and educated regarding sustainable forest management and reforestation efforts. Also, preserving the integrity of guarded areas can significantly reduce demonstration.

Hence, there is a necessity for individuals all over the world to respect forest cover and reduce some of the human-driven actions that encourage logging. With the reduction of deforestation, soil‟s ability to naturally regenerate can be restored. Governments, international organizations, and other environmental stakeholders need to ensure there are appropriate measures for making zero net deforestation a reality so as to inhibit soil degradation.

2. Land reclamation

The outcomes of soil erosion and quality decline are widely irreversible. Still, soil organic matter and plant nutrients can be replenished. To restore the lost soil mineral matter and organic content, it would require what is known as land reclamation. Land reclamation encompasses activities centered towards restoring the previous organic matter and soil‟s vital minerals. This may include activities such as the addition of plant residues to degraded soils and improving range management.

Salinized soils can be restored by salt level correction reclamation projects and salinity control. One of the simplest but most forgotten methods of land reclamation is planting of vegetation such as trees, crops, and flowers over the affected soils. Plants act as protective covers as they are helpful at making the soil stronger by stabilizing the land surface.

3. Preventing salinization

Just like the old adage states that “prevention is better than cure,” so does the same concept apply in solving the worldwide problem of soil degradation through salinization. The costs of preventing salinization are incredibly cheaper than the reclamation projects in salinized areas. Consequently, actions such as reducing irrigation, planting salt tolerant crops, and improving irrigation efficiency will have high pay offs because the inputs and the labor-demanding aspects associated with reclamation projects are zero. Preventing salanization in the first place is thus an environmentally friendly means of offering solution to soil degradation.

4. Conservation tillage

Proper tillage mechanisms hold as one of the most sustainable ways of avoiding soil quality decline. This is otherwise known as conservation tillage, which means tillage mechanisms targeted at making very minimal changes to the soil‟s natural condition and at the same time improving the soil‟s productivity. Examples include leaving the previous year‟s crop residue on the surface to shield the soil from erosion and avoiding poor tillage methods such as deep plowing.

A.Commercial Uses

Forests provide us a large number of commercial goods which include timber, firewood,

pulpwood, food items, gum, resins, non-edible oils, rubber, fibers, bamboo canes, medicine,

drugs, and many more items, the total worth of which is estimated to be more than $300

billion per year.

- Half of the timber cut each year is used as fuel for heating and cooking.
- One third of the wood harvest is used for building materials as lumber, plywood and hardwood, particle board and clipboard
- One sixth of the wood harvest is used for paper industry
- Many forest lands are used for mining, agriculture, grazing and for development of dams.

Ecological Uses:

While a typical tree produces commercial goods worth about $590 it provides environmental services worth nearly $196, 250. The ecological services provided by our forests may be summed up as follows.

1. Production of oxygen:

The trees produce oxygen by photosynthesis which is so vital for life on this

earth. They are likely called as earth‟s lungs.

2. Reducing global warming:

The main greenhouse gas carbon dioxide (CO_2) is observed by the forests as a raw material for photosynthesis. Thus the forest canopy acts as a sink for co2 there by reducing the problem of global warming caused by green house gas co2.

3. Wild life habitat:

Forests are the homes of millions of wild animals and plants. About 7 million species are found in the tropical forests alone.

4. Regulation of hydrological cycle:

Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff and slowly releasing the water for recharge of springs. About 50-80% of the moisture in the air above tropical forests comes from their transpiration which helps in bringing rains.

5. Soil conservation:

Forests bind the soil particles tightly in their roots and prevent soil erosion.

6. Pollution moderators:

Forests can absorb many toxic gases can help in keeping the air pure. They have also been reported to absorb noise and thus help in preventing air and noise pollution.

7. Driving energy flow and nutrient cycling:

Their huge biomass and enormous biological and biochemical diversity support energy flow and nutrient cycling.

A. Deforestation is one of the major causes to the environmental degradation which is affected by the agents like small farmers, ranches, loggers and plantation companies. There is a broad consensus that expansion of cropped areas and pastures are a major source of deforestation. The term „deforestation" describes the complete long term removal of tree cover. The loss forest cover influences the climate and contributes to a loss of biodiversity. The economic activity is adversely affected by siltation, flooding, soil degradation and reduced timber supplies. Thus, in turn, threatens the livelihood of people.

Causes for Deforestation:

1. Shifting cultivation:

There are an estimated 300 million people living a shifting cultivator who practice slash and burn agriculture and are supposed to clear more than 5 Lakh ha of forest for shifting cultivation annually. In India, we have this practice in north-east and to some extent in Andhra Pradesh, Bihar and M.P which contribute to nearly half of the forest clearing annually

2. Agriculture:

Conversion of forests to agricultural land to feed growing needs of people. There are an estimated 300 million people living as shifting cultivators who practice slash and burn agriculture and are supposed to clear more than 5 lakh ha of forests for shifting cultivation annually. In India, we have this practice in North-east and to some extend in Andhra Pradesh, Bihar and M.P. which contribute to nearly half of the forest clearing annually.

3. Commercial logging:

(Which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forest for agriculture. Cutting of trees for fire wood and building material, the heavy lopping of foliage for fodder and heavy grazing of saplings by domestic animals like goals.

4. Mining:

This causes environmental impacts like erosion, formation of sinkholes, loss of biodiversity, and contamination of soil, groundwater and surface water by chemicals from mining processes. In some cases, additional forest logging is done in the vicinity of mines to increase the available room for the storage of the created debris and soil.

Contamination resulting from leakage of chemicals can also affect the health of the local population if not properly controlled. Extreme examples of pollution from mining activities include coal fires, which can last for years or even decades, producing massive amounts of environmental damage.

5. Increase in population:

The needs also increase and utilize forests resources. To meet the demands of rapidly growing population, agricultural lands and settlements are created permanently by clearing forests.

6. Urbanization and industrialization:

Since Industrialization and Urbanization needs land to grow, so major amount of forest lands are cut in order to promote Industrialization and Urbanization. This creates harmful effect on environment and forest ecological balance.

7. Construction of dam reservoirs:

For building big dams, large scale devastation of forests takes place which breaks the natural ecological balance of the region. Floods, droughts and landslides become more prevalent in such areas. Forests are the repositories of invaluable gifts of nature in the form of biodiversity and by destroying these we are going to lose these species even before knowing them. These species could be having marvelous economic or medicinal value. These storehouses of species which have evolved over millions of years get lost due to deforestation in a single stroke.

8. Forest fires:

They may be natural or manmade, and cause huge forest loss.

9. Overgrazing:

Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. It can be caused by either livestock in poorly managed agricultural applications, or by overpopulations of native or non- native wild animals. Overgrazing reduces the usefulness, productivity, and biodiversity of the land and is one cause of desertification and erosion. Overgrazing is also seen as a cause of the spread of invasive species of non-native plants and of weeds.

Consequences of Deforestation:
Depending on the needs of the social group concerned, deforestation has made it possible for communities to be built. Forest makes way for residential houses, office buildings and factories. Governments are able to built reads to make trade and transport easier and therefore more convenient to residents.

Deforestation can also mean the conversion of forest land to productive land for agricultural uses. This results in better and more abundant production of food and materials, virtually eradicating periods of want and lack. Economically, deforestation has contributed much in giving many communities the opportunity to make positive changes in their times. Unfortunately, the negative consequences of deforestation for outweigh its positive effects.

Here are few of them.

1. Food problems:

Most of the area that has undergone deforestation is actually unsuitable for long-term agricultural use such as ranching and forming. Once deprived of their forest cover, the lands rapidly degrade in quality, losing their fertility and arability.

The soil in many deforested areas is also unsuitable for supporting annual crops. Much of the grassy areas are also not as productive compared to more arable soils and are therefore not fit for long-term cattle grazing.

2. Exposing soil to heat and rain:

Heavy rainfall and high sunlight quickly damage the topsoil in clearings of the tropical rain forests. In such circumstance, the forest will take much longer to regenerate and the land will not be suitable for agricultural use for quite some time.

3. Flooding:

Deforestation can results to watersheds that are no logger able to sustain and regulate water flows from rivers to steams. Trees are highly effective in absorbing water quantities, keeping the amount of water in watersheds to a manageable level. The forest also serves as cover against erosion. Once they are gone, too much water can results to downstream flooding, many of which have cause disasters in many parts of the world.

The fertile top soil is eroded and flooded into the lower regions, many coastal fisheries and coral reefs suffer from the sedimentation brought by the flooding. This results to negative effects in the economic viability of many business and fatalities in wildlife population.

4. Loss of biodiversity:

This is probably most serious consequence of Deforestation. Put simply, it means the destruction and extinction of many plants and animal species, many of un-home remain unknown and whose benefits will be left undiscovered.

5. Displacement of indigenous communities:

Some indigenous people‟s may of life and survival are threatened by the loss of forests. Fewer trees results an in secure future for forests workers.

6. Climate change:

Deforestation can cause the climate to become extreme in nature. It increases CO2 concentration in atmosphere and contributes to global warming.

7. Economic loss:

The occurrence of floods and droughts are affecting the economy. It also leads to loss of future markets for ecotonism. The value of a forest is often higher when it is left standing than it could be worth when it is harvested.

8. Health issues:

The stress of environmental change may make some species more susceptible to the effect of

ENERGY ESOURCES.

A. 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 likedestruction 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 4000 ^{o}C. 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 H_2S, NH_3, CO_2 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.

→ Favorable in geographic locations which are away from cities.

→ Wind turbine design, manufacturing, installation is complex due to varying atmospheric conditions.

→ 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%), CO_2 (31%) and N_2 (1%). Methane gas (CH_4) 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 CO_2 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.

A. 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. CO_2 pollution leads to green house effect(global Warming).

Crude oil: It is obtained in the form of liquid. The crude oil is heated up to 600 C in the oil refinery and condenses the vapors 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. Thetransport 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 CO_2 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 $E = mc^2$). 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.

A. 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.

4. ***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 …

5. ***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.

6. ***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..

7. ***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.

8. ***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 .
(3)***Desert soils***: These soils cover the parts of areas of Rajasthan and Kutch where the annual rainfall is less than 50 cms per annum.

(4) ***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;

→ ***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.

→ ***Mulching***: Stems of maize, cotton, tobacco etc are used as a mulch (decay of leaves) to reduce soil moisture, evaporation.

→ ***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.

→ ***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 forlandslides. 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 up to 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:

→ Inherent of rocks (weakness in the structure of a rock)
→ due to heavy seismic or volcanic activity and

→ due to various environmental conditions.

UNIT – III: BIODIVERSITY

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:

1. 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.

7. 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.

8. 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 biodiversityto 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 to know anything

about them.

The biodiversity value may be classified as follows:

(d) 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.

(e) 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.

e. The bacterium **Bacillus thuringiensis** produces toxic proteins that kill certain insects.

f. 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, attachedwith 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.

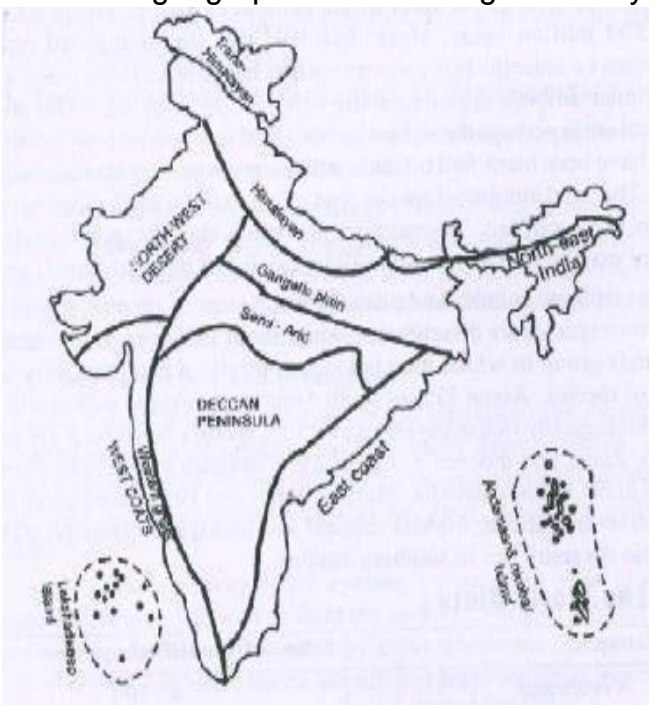
5. Aesthetic Value: Every one of us would like to visit vast stretches of lands to enjoy the visible life. People from farther areas, spend a lot of time and money to visit wild life areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco tourism. Eco-tourism 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 UnionConservation of Nature (IUCN) classified the species of plants and animals as:

13. Endangered species
14. Vulnerable species means depleted species.
15. Threatened species: Species (including animals, plants, fungi, etc.) which are vulnerable to

endangerment in the near future)

16. 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(Tige Leopard; India Lio Golden cat; Desert ca Sloth bear Red fo Indian wo golde monkey; Lio taile Macaque	13	20	2	5	13	53
BIRDS (Siberian white crane; Vulture Gre Indian Bustar peacock; pelican	6	20	25	13	5	69
REPTILES (Gharia green sea turtle; st 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 spotscontaining 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

4. 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
5. 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 andBhutan. 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:

6. Himalayan region
7. The Gangetic river plains or Indo-Gangetic plains.
8. The southern (Deccan) Plateau and

9. The islands of Lakshadweep, Andaman and Nicobar. The Himalayas in the North include the highest peaks in the world.

The highest mountains are:

9. Khanchen Junga (8586 mts) which is located in Sikkim;
10. Pir Panjal (3,600 – 4,600 mts) in Kashmir;
11. Dhaula dhar in Himachal Pradesh and
12. 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:

(5) The reservoirs of the Deccan Plateau in south
(6) the vast saline expanses of Rajasthan and Gujarat
(7) Fresh water lakes and reservoirs from Gujarat eastwards.
→ The delta wet lands and lagoons of India‟s east coast.
→ The fresh water marshes of Gangetic plain
→ The Flood plain of Brahmaputra
→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
→ 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.,
→ Semi – ever green rain forests
→ Deciduous forests
→ Thorn forests
→ Pine forests
→ Tropical forests (Andaman & Nicobar Islands; the Western Ghats)
→ Rain forests (Orissa)
→ Western Ghats monsoon forests contain rosewood, Malabar, teak.
→ 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.
a) Green turtle
b) Logger head
c) Olive Ridley
d) Hawksbill
e) 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:
4. Maintenance of a number of species in protected areas such as National Parks, Sanctuaries.
5. To improve the biosphere reserves
6. Implement strict restrictions of export of rare plants and animals
7. Educate the public on these through the Govt agencies and NGO‟s. Conservation of biodiversity can be carried out in two ways, as shown:

The Biological Diversity Act 2002

The Act covers conservation, use of biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey and bio-utilisation. It provides a framework for access to biological resources and sharing the benefits arising out of such access and use. The Act also includes in its ambit the transfer of research results and application for intellectual property rights (IPRs) relating to Indian biological resources.

The Act covers foreigners, non-resident Indians, body corporate, association or organization that is either not incorporated in India or incorporated in India with non-Indian participation in its share capital or management. These individuals or entities require the approval of the National Biodiversity Authority when they use biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey or bio-utilisation.

UNIT-4
ENVIRONMENTAL POLLUTION AND CONTROL

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.

9. 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

10. 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.

(f) 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, CO_2, SO_x ,N, S,H, NO_x, 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 (O_3); Smog; Para Acetyl Nitrate (PAN); Acid Rain; Aerosols.

(g) 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 (C_6H_6), Methane (CH_4), 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 (SO_2); Sulphur Trioxide (SO_3)
3	Nitrogen oxides	NO2; Nitrous oxide (N_2O); Nitrogen Peroxide (N_2O_5)
4	Organic compounds	Methane; Propane ($C_3 H_8$) ; Benzene; Chloro Fluro Carbons (CFC)
5	Photochemical Oxidants	Ozone (O_3); 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: SO_2 is a gas produced from burning of coal, mainly in thermal power plants. Some industries such as paper mills produce SO_2. 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 SO_2 causing the paper to become brittle and fragile. SO_2 polluted air leads to corrosion of metals such as Fe, Zn, Cu, steel etc… SO_2 is a major contributor to Smog and acid rain.

Sulphur trioxide is more irritant than SO_2 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. NO_2 poisoning results SILOFILTER disease. High levels of NO_2 exposure causes cough and make the human beings feel short of breath. People who are exposed to NO_2 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:

g. CFC – 11 (Trichloro Fluoro Methane $CFCl_3$)
h. CFC – 12 (Dichloro Fluoro Methane CF_2Cl_2)
i. CFC – 113 (Trichloro Trifluoro Ethane $C_2F_3Cl_3$)
j. CFC – 114 (Dichloro Tetrafluoro Ethane $C_2F_4Cl_2$)
k. CFC – 115 (Chloropenta Fluoro Ethane C_2F_5Cl)

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 (O_3) / 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 environmentalproblems and poses significant adverse impact on soils, rivers, lakes, forests and monuments. The phenomenon occurs when SO_x and NO_x 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 SO_x and NO_x. Increased urban and industrial activities cause air pollution resulting in the rise of concentration of SO_2 and NO_x. Sulphur dioxide and NO_2 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	N_2	78.09	Major
Oxygen	O_2	20.94	Major
Argon	Ar	00.93	Minor
Carbon dioxide	CO_2	0.0318	Minor
Ne,He,Kr,H_2, CO, O_3			Traces
NH_3; NO_2, SO_2; H_2S, 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:

6. Inputs that do not contain the pollutants.
7. Operating process to minimize generation of the pollutants.
8. Replacing the process with one does not generate the pollutant.
17. 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 eliminatesulphur emission.

18. By involving the Process Modification:

Ex: Chemical and petroleum industries have changed by implementing automated operations, computerized process control by reducing the oxidation of SO_2 to SO_3 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 20 ^{o}C, generally measured for 5 days. When water is polluted by unwanted materials, naturally the O_2 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 O_2: 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 O_2 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:

6. 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.

7. 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 asa 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

10. Coral reef decline
11. 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 veryabundant 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 raftsor 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:

13. Back pain and cannot easily bend.

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

15. 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:

(8) Drinking water should be boiled, cooled and then used.

(9) Disinfection of drinking water should be done by using chemicals like bleaching powder.

(10) Pesticides and insecticides should be prevented from nearby use of water lakes, ponds and pools.

(11) Drainage water should not be allowed to mix with drinking water.

(12) Drainage system should be maintained properly.

(13) 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. Thestationary 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 theceiling 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 Thecoastal 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, SO_2, NO_2, 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:

f) 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.

g) Cooling ponds are employed for thermal discharges. Heated effluents on the surface of water in cooling ponds maximize dissipation of heat to the atmosphere.

h) 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 wastetreatment 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:

8. 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.

9. 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 finesolid particles result from the burning of wood, coal and other combustible wastes.

10. 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 60 ^{o}C) → 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:

(5) Geological in nature like the earthquakes.

(6) Landslides (rocks slides down from the side of a hill), volcanic eruptions etc.

(7) 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. Naturalcalamities are of two types:

(a) Major calamities: Ex: earthquakes; droughts; floods, tsunamis; cyclones etc

(b) 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.

Major International Protocols: Earth Summit, Kyoto Protocol and Montreal Protocol

Three major international protocols are as follows :

Earth summit:

The issues addressed in Earth Summit are:

i. Systematic scrutiny of patterns of production particularly the production of toxic components, such as lead in gasoline, or poisonous waste including radioactive chemicals

4. ii. Alternative sources of energy to replace the use of fossil fuels which are linked to global climate change

5. iii. New reliance on public transportation systems in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smog

6. iv. The growing scarcity of water

7. he Convention on Biological Diversity was opened for signature at the Earth Summit, and made a start towards redefinition of money supply measures that did not inherently encourage destruction of natural Eco regions and so-called uneconomic growth.

8. **The Earth Summit resulted in the following documents:**

9. a. Rio Declaration on Environment and Development

10. b. Agenda

11.. Convention on Biological Diversity

12. d. Forest Principles

13. e. Framework Convention on Climate Change (UNFCCC).

14. Both Convention on Biological Diversity and Framework Convention on Climate Change were set as legally binding agreements.

Kyoto Protocol:

The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC or FCCC), aimed at fighting global warming. The UNFCCC is an international environmental treaty with the goal of achieving stabilization of greenhouse gas concentrations in the atmosphere at a level that would minimize dangerous anthropogenic interference with the climate system.

Under the Protocol, 37 industrialized countries called as Annex 1 countries, commit themselves to a reduction of four greenhouse gases (GHG) namely carbon dioxide, methane, nitrous oxide, sulphur hexafluoride and two groups of gases like hydro fluorocarbons and per fluorocarbons produced by them, and all member countries give general commitments.

Annex I countries agreed to reduce their collective greenhouse gas emissions by 5.2% from the 1990 level. Emission limits do not include emissions by international aviation and shipping, but are in addition to the industrial gases, chlorofluorocarbons, or (CFCs), which are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

The Protocol allows for several flexible mechanisms, such as emissions trading, the Clean Development Mechanism (CDM) and joint implementation to allow Annex I countries to meet their GHG emission limitations by purchasing GHG emission reductions credits from elsewhere, through financial exchanges, projects that reduce emissions in non-Annex I countries, from other Annex I countries, or from annex I countries with excess allowances. Kyoto is intended to cut global emissions of greenhouse gases.

The objective is the stabilization and reconstruction of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The objective of the Kyoto climate change conference was to establish a legally binding international agreement, whereby all the participating nations commit themselves to tackling the issue of global warming and greenhouse gas emissions.

The target agreed upon was an average reduction of 5.2% from 1990 levels by the year 2012. Contrary to popular belief, the Protocol will not expire in 2012. In 2012, Annex I

countries must have fulfilled their obligations of reduction of greenhouse gases emissions established for the first commitment period (2008-2012).

The five principal concepts of the Kyoto Protocol are:

i. Commitments to reduce greenhouse gases that are legally binding for annex I countries, as well as general commitments for all member countries.

ii. Implementation to meet the Protocol objectives, to prepare policies and measures which reduce greenhouse gases, increasing absorption of these gases (for example through geo-sequestration and bio-sequestration) and use all mechanisms available, such as joint implementation, clean development mechanism and emissions trading; being rewarded with credits which allow more greenhouse gas emissions at home.

iii. Minimizing impacts on developing countries by establishing an adaptation fund for climate change.

iv. Accounting, reporting and review to ensure the integrity of the Protocol.

v. Compliance by establishing a compliance committee to enforce commitment to the Protocol.

Montreal Protocol:

The Montreal Protocol on Substances That Deplete the Ozone Layer, a protocol to the Vienna Convention for the Protection of the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of a number of 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, May 1989. Since then, it has undergone seven revisions, in 1990 (London), 1991 (Nairobi), 1992 (Copenhagen), 1993 (Bangkok), 1995 (Vienna), 1997 (Montreal) and 1999 (Beijing).

It is believed that if the international agreement is adhered to, the ozone layer is expected to recover by 2050. Due to its widespread adoption and implementation it has been hailed as an example of exceptional international co-operation with Kofi Annan quoted as saying that “perhaps the single most successful international agreement to date has been the Montreal Protocol”. It has been ratified by 196 states.

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UNIT – V
ENVIRONMENTAL IMPACT ASSESSMENT
&
ENVIRONMENTAL MANAGEMENT PLAN

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:

11. Direct impacts
12. Indirect impacts
13. Cumulative impacts.

According to their nature, these three groups reveal:

→ Positive and negative impacts

→ Reversible and irreversible impacts

(h)Light, moderate and severe impacts

(i) Local and widespread impacts

(j) Short – term and long – term impacts

Ex: To construct a major project: **Direct impacts are** related to:

l. aesthetics in the area (understanding of beautiful things)
m. traffic at nearby junctions,
n. removal of natural vegetation;
o. interference with natural water ways;
p. 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.

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, SO_x; NO_x)

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:

9. All aspects of consequence reports (especially a bad result report) about existing and future emissions to air.
10. Projection of pre-situation, accidental situations etc of the site area should be mapped.
11. Screening to determine the effect of impacts in a proposed project require a full or partial impact assessment study

12. To identify the potential impacts to assess the alternative solutions that avoid adverse impacts on biodiversity

E I A Methodologies include:

19. 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.

20. 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

8. 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.

9. 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.

10.Environmental Index: Following some of the codes are considered:

L denotes Criteria

P denotes completely satisfied N
denotes criteria not satisfied

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

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

12.Mild Projects

13.Moderate Projects

14.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 statements , generally forwarded to MoEF. The EIS has Typically four sections

16. An introduction including a statement of the purpose and the need of the proposed action.
17. A range of alternatives to the proposed action.
18. A description of the affected environment
19. 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,

project (positive and negative ideas).

EF.

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:

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;

The green belt has many benefits for people:

The general consideration involved while developing the greenbelt are:

(14) Trees growing up to 10 m or above in height should be planted .

(15) Planting of trees should be undertaken in appropriate encircling rows around the project site.

(16) 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 itrinus 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:

→ Indus Valley Civilization in Western & Northern India especially at both Mohenjodaro and Harappa.

→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.

→ 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.***

→ *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*:**

i) *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).

j) *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.

11. *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.

12. *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.

13. *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.

14. *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 datathat 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:

→**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.

→**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.

→**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).

→**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:

radars etc) mounted on platforms (aircraft and satellites) which are at a considerable height from the earth surface.

Phphot

ographic 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.

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.