2019-20 Onwards (MR-18)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	B.Tech. IV Semester		
Code: 80M01	**ENVIRONMENTAL SCIENCE**	**L**	**T**	**P**
Credits: NIL		**2**	**-**	**-**

Prerequisites: NIL

Course Objectives:

An interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences, including geo-systems, biology, chemistry, economics, political science and international processes. The ability to work effectively as a member of an interdisciplinary team on complex problem of environment.

MODULE I: Ecosystems: [05 Periods]

Definition, Scope and Importance of ecosystem, Concept of ecosystem, Classification of ecosystems, Structure and Structural Components of an ecosystem, Functions of ecosystem, Food chains, food webs and ecological pyramids, Flow of energy.

MODULE II: Natural resources, Biodiversity and Biotic resources [09 Periods]

Natural Resources - Classification of Resources: Living and Non-Living resources, Renewable and non- renewable E-RESOURCES. Water resources: use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources–case studies. Energy resources: growing energy needs, introduction to renewable and nonrenewable energy sources.

Biodiversity and Biotic resources - Introduction, Definition, genetic, species and ecosystem diversity. Values of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and intrinsic values. Threats to Biodiversity (habitat loss, poaching of wildlife, man-wildlife conflicts). Conservation of Biodiversity (In-situ and Ex-situ conservation)

MODULE III: Environmental pollution and control [06 Periods]

A: Classification of pollution and pollutants, Causes, effects and control technologies. Air Pollution: Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. Water pollution: Point and non-point sources of pollution, Major pollutant of water and their sources, drinking water quality standards.

B: Soil Pollution: Soil as sink for pollutants, Impact of modern agriculture on soil, degradation of soil. Marine Pollution: Misuse of International water for dumping of hazardous waste, oastal Pollution due to sewage and marine disposal of industrial effluents. E-waste and its management.

MODULE IV: Global Environmental Problems and Global effects: [06 Periods]

Green house effect, Green House Gases (GHG), Global Warming, Sea level rise, climate change and their impacts on human environment. Ozone depletion and Ozone depleting substances ODS). Deforestation and desertification. International conventions/Protocols: Earth summit, Kyoto protocol and Montréal Protocol.

MODULE V: Towards sustainable future: [06 Periods]

Concept of Sustainable Development, Threats to Sustainability, Population and its explosion, Crazy Consumerism, Over-exploitation of resources, Strategies for Achieving Sustainable development, Environmental Education, Conservation of Resources, Urban Sprawl, Sustainable Cities and Sustainable Communities, Human health, Role of IT in Environment, Environmental Ethics, Environmental Economics, Concept of Green Building, Clean Development Mechanism (CDM).

TEXT BOOKS:

1. R. Rajagopalan, **"Environmental studies From crisis to cure"**, Oxford University Press 2 nd Edition, 2005.
2. Anubha Kaushik, C. P. Kaushik, "**Environmental studies**" New age International Publishers,4 th Edition,2012.

REFERENCES:

1. Erach Bharucha, "**Environmental studies**" University Grants Commission, and University Press, 1st Edition, 2005.
2. M. Anji Reddy "**Text book of Environmental Science and Technology**" 3 rd Edition, 2007
3. Richard T. Wright, "**Environmental Science: towards a sustainable future** "PHL Learning,Private Ltd. New Delhi, 2 nd Edition., 2008
4. Gilbert McMasters and Wendell P. Ela, "**Environmental Engineering and science**", 3rd Edition, PHI Learning Pvt. Ltd., 2008.

E-RESOURCES

1. http://www.gdrc.org/uem/ait-terms.html (Glossary of Environmental terms).
2. http://www.environmentalscience.org/ (Environmental sciences Lectures series).
3. Journal of earth science and climatic change (OMICS International Journal).
4. Journal of pollution effects & control (OMICS International Journal).
5. nptel.ac.in/courses/120108004/ (Principles of Environment Management Lectures).
6. http://www.nptelvideos.in/2012/12/fundamentals-of- environmental-pollution.html

Course Outcomes:

At the end of the course, students will be able to

1. **To enable** the students to realize the importance of ecosystem, its structure, services. To make the students aware of Different natural functions of ecosystem, this helps to sustain the life on the earth.
2. **To use** natural resources more efficiently.
3. **To make** the students aware of the impacts of human actions on the environment, its effects and minimizing measures to mitigate them.
4. **To educate** the students regarding environmental issues and problems at local, national and international level.
5. **To know** more sustainable way of living

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak												
COS	**Programme Outcomes(POs)**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3		1		1	2	1					
CO2	2	3	2	3	1	3		2				
CO3	3	3	2	3	2	2		1				
CO4	3	2	2	1	2	1						
CO5	2	1	1			1	3	3				

MODULE-I

ECOSYSTEMS

ECO – SYSTEM (ECOLOGY)

Introduction:

The term 'Ecology' was originated from two 'Greek' words, 'Oikos' means 'Habitat', 'Place to live', 'House', 'Home' etc, 'Logos' means 'To study'. The total term 'Ecology' refers 'The study of environment'. The term 'Ecology' was first coined by German Biologist 'Ernst Haeckel' in '1869'. Every living organism depends upon other organism and its non – living environment for its existence. Thus ecology is defined as the scientific study of the relationship of living organisms with other and with their environment. An eco – system is a self – regulating group of biotic community of species interacting with one another and with their non – living environment exchanging energy and matter. Ecology is the study of eco – systems. Eco – system is the basic functional unit of ecology.

Types of Ecology: Ecology can be divided into Autecology and Synecology.
Autecology: It deals with the study of an individual organisms or an individual species.
Synecology: It seals with the study of groups of organisms that are associated as a unit.
Objective: The important objective of ecology is the study of the maintenance of ecological balance and the role of human beings in the degradation of the environment. It helps in ecological management by finding means to minimize the effects of pollution, deforestation, killing of animals, chemical, biological or nuclear welfare and population explosion.

Scope and Importance of Eco – System:

Concept: Eco – System is a community of interdependent organisms. It is also called as 'Biosphere'. Biosphere means plants and animals which live on the earth. There are variety of organisms in the biosphere or eco – system. They are broadly divided into plants, animals & microbes. More than 10,00,000 animal species & 3 lakh plant species are known to exist. These organisms exist in the zones of contact between the atmosphere, hydrosphere 7 the lithosphere. There is exchange of matter and energy between these three elements of the physical environment and the organisms in the biosphere. Animals are able to migrate from one place to another according to change in season but plants are rooted to the soil and they make physiological adjustments to seasonal changes. Plants and animals are interdependent on one another. Eco – systems are very necessary for the survival of man on earth.

Eco - Systems:

'Eco' means 'Environment', 'systems' means 'Interaction (or) inter relationship present between biotic & abiotic components'. The term 'Eco - System' was first coined by 'A.G.Tansley' in '1935'.

Model Eco – System:

Concept of Eco – System:

- Main concept of eco – system is interaction of biotic & abiotic components of environment.
- Transfer of energy throughout the eco – system through a series of organisms.

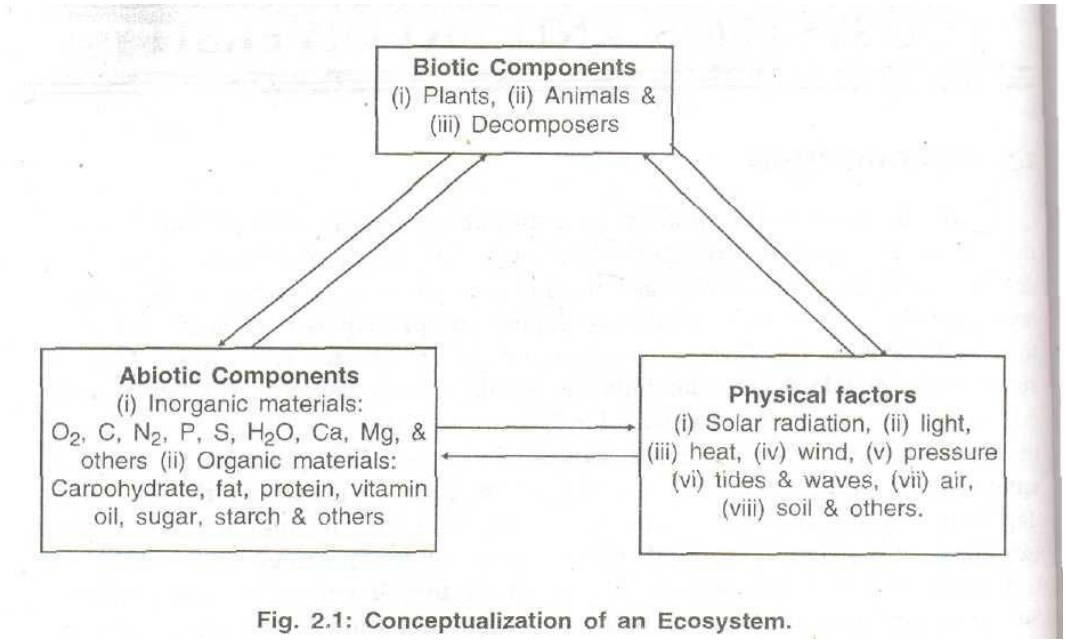

Fig. 2.1: Conceptualization of an Ecosystem.

Types of Eco – Systems:

Eco – Systems are divided into two types

- Natural Eco – Systems
- Artificial Eco – Systems

Natural Eco – Systems:

These operate under natural conditions without interference of man.

Natural eco – system are classified into two types.

- Terrestrial Eco – System
- Aquatic Eco – Systems

Terrestrial Eco – Systems:

Terrestrial means 'Land Area'. It refers interaction between abiotic and biotic components present on land area.

Terrestrial Eco – System is sub classified into three types.

- Grass Land Eco – System
- Forest Eco – System

- Desert Eco – System.

Grass Land Eco – System:

Interaction (or) interrelation ship between biotic and abiotic components of grass land environment is called as 'Grass Land Eco - System'.

Forest Eco – System:

Interaction (or) interrelation ship between biotic and abiotic components of forest environment is called as 'Forest Eco - System'.

Desert Eco – System:

Interaction (or) interrelation ship between biotic and abiotic components of desert environment is called as 'Desert Eco - System'.

Aquatic Eco – System:

Aquatic means 'Water'. It refers interaction between abiotic and biotic components of aquatic environment.

Aquatic Eco – System is sub classified into two types.

- Lotic Eco – System
- Lentic Eco – System

Lotic Eco – System:

Interaction (or) interrelation ship between biotic and abiotic components of lotic environment is called as 'Lotic Eco - System'.

Ex: Rivers, Ocens, Seas etc

Lentic Eco – System:

Interaction (or) interrelation ship between biotic and abiotic components of lentic environment is called as 'Lentic Eco - System'.

Ex: Lakes, Ponds etc.

Structure & Functions of Grassland Eco - System:

Structure of Grassland Eco – System:

Structure generally refers parts (or) components of eco – system. An eco – system consists of two important components (or) parts.

a) Biotic Components
b) Abiotic Components

a) Biotic Components:

Biotic components are called as 'Living Components' (or) 'Living Organisms'.

Biotic components are divided into three types

- Producers
- Consumers
- Decomposers

- **Producers:**
  - ➢ Producers are called as 'Food Makers'.
  - ➢ These are responsible for preparation of materials.

Ex: Grass.

Consumers:

Consumers are depending on producers for food materials. These are consuming the food materials. Consumers are divided into three types.

- Primary Consumers
- Secondary Consumers
- Tertiary Consumers

Primary Consumers (or) P.C (or) C_1:

- Primary consumers are directly depend on producers for food.
- Primary consumers are called as 'Herbivores'.

Herbivore:

An organism which eat plant material (or) which feed on plants is called as 'Herbivore'.

Ex: Rabbit, Insect, Grasshopper.

Secondary Consumers (or) S.C (or) C_2:

- Secondary consumers are directly depend on primary consumers and indirectly depend on producers.
- Secondary consumers are called as 'Carnivore'.

Carnivore:

An organism, which feed on fleshy animals is called as 'Carnivore'.

Ex: Frog, Lizard, etc.

Tertiary Consumers (or) T.C (or) C_3:

- Tertiary consumers are directly depend on secondary consumers and indirectly depends on primary consumers and producers.
- Tertiary consumers are called as 'Omnivore'.

Omnivore:

An organism, which feed on both plant and animals is called as 'Omnivore'.

Ex: Snake etc

Decomposers:

An organism, which is responsible of decomposition process, is called as 'Decomposer'.

Ex: Micro – Organism.

Finally the plant dead material and animal dead bodies are under go decomposition by bacterial activity.

(b) Abiotic Components:

- Abiotic components are called as 'Non – Living Components'.
- Abiotic components are divided into two categories.

I Category of Abiotic Components are air, Water, Soil etc.
II Category of Abiotic Components are called as 'Environmental Components'.

Environmental Factors:

Environmental Factors are divided as

a) Physical Factors
b) Chemical Factors
c) Climatic Factors

a) **Physical Factors:** Temperature, Humidity, Pressure etc
b) **Chemical Factors:** Different chemical Elements etc
c) **Climatic Factors:** Solar radiation, Rainfall, Wind etc.

Functions of an Eco – System:

The important functions of an eco – system are

- Transfer of Energy
- Transfer of Nutrients
- Food Chain
- Food Web
- Eco – System Development

- **Transfer of Energy:**

Energy transfers from producers to tertiary consumers through a series of organisms called as 'Transfer of Energy'. This concept of energy is called as '10% of Law'. In each level (or) step of an eco – system nearly 90% of energy is lost as heat and only 10% of energy is transferring at each trophic level.

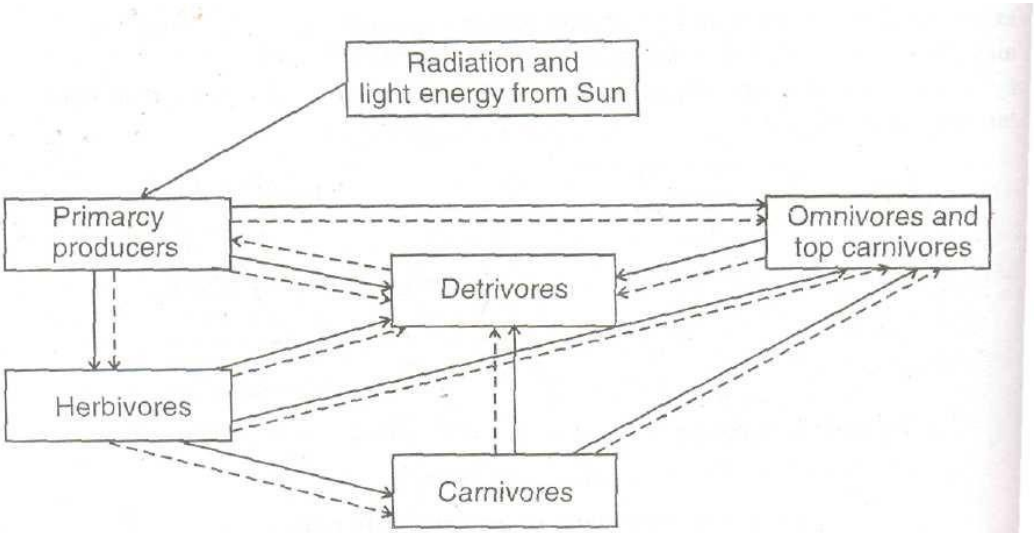

Fig. 2.5: Energy and Material Movements in an Ecosystem.

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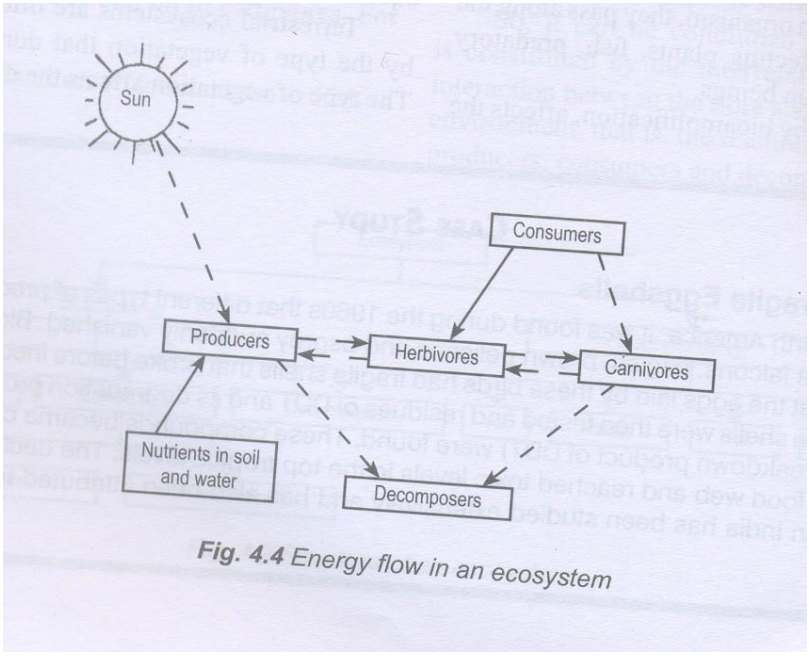


Fig. 4.4 Energy flow in an ecosystem

- **Transfer of Nutrients:**

Nutrients transfer from producer to tertiary consumers through a series of organisms is called as 'Transfer of Nutrients'.

Food Chains:

In any eco – system first organism is eaten by second one, in which turn the second one is eaten by third one so on…. this kind of feeding relation ship between producers & consumers are called as 'Food Chain'.

Types of Food Chains:

In nature, two general types of food chains are present.

a) Detritus Food Chain
b) Grazing Food Chain

a) Detritus Food Chain:

It starts with dead organic matter and goes to living organisms.

In detritus food chain dead organic matter accumulates into micro – organisms and then to organisms feeding on detritus and their predators.

It was discovered by 'Heald (1969)' and 'W.E.Odum (1970)'.

Ex: Leaf Litter • Algae • Crabs • Small Fish • Large Fish • Human Being
Dead Organic Matter • Fungi • Bacteria • Lizards • Frogs • Snake etc

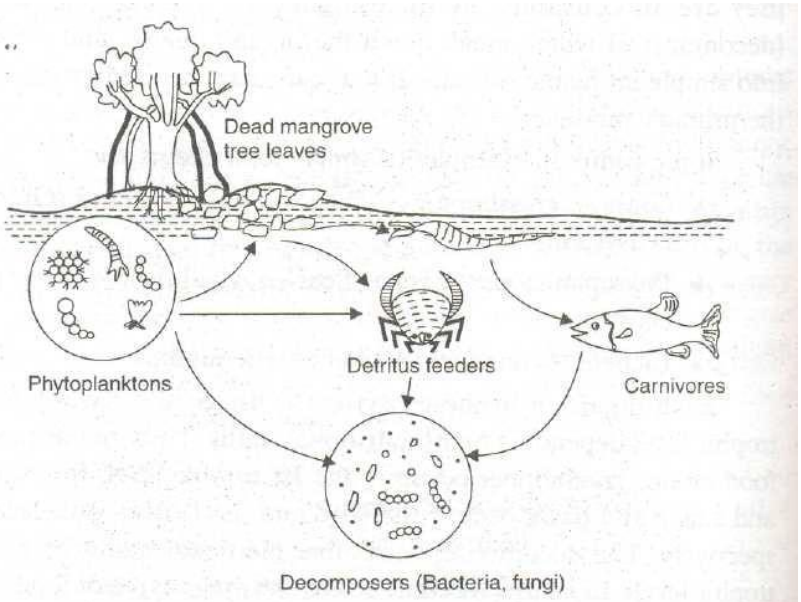


Fig. 3.3. A detritus food chain in an estuary based on dead leaves of mangrove trees.

b) Grazing Food Chain:

It starts with green plants (or) living organisms and goes to herbivores and on to carnivore.

Ex: Grass • Grasshopper • Lizards • Frogs • Snakes • Hawk etc

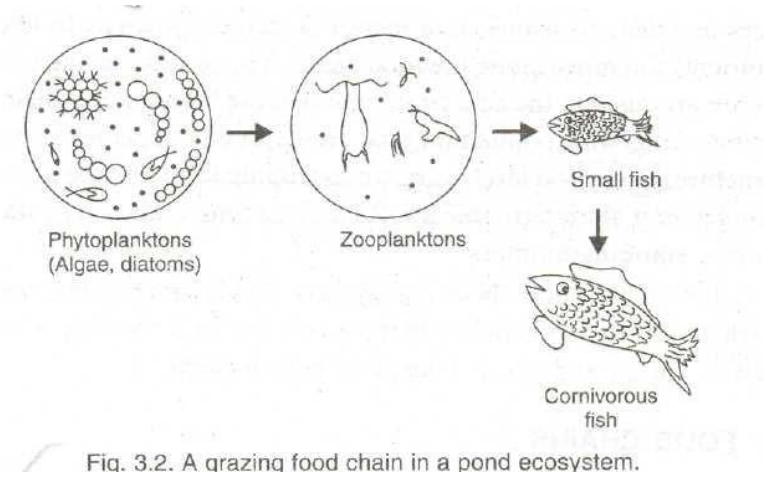


Fig. 3.2. A grazing food chain in a pond ecosystem.

Feeding Levels: feeding levels in a food chain called as 'Trophic Levels'.
Ex: in any eco – system grass is eaten by eaten by grasshopper, grasshopper is eaten by lizard, lizard is eaten by snake, snake is eaten by frog, frog is eaten by hawk so on…. This kind of feeding relationship between producers and consumers called as 'Food Chain'.

- **Food Web:**
  Complex network of inter connection of various food chains called as 'Food Webs'.

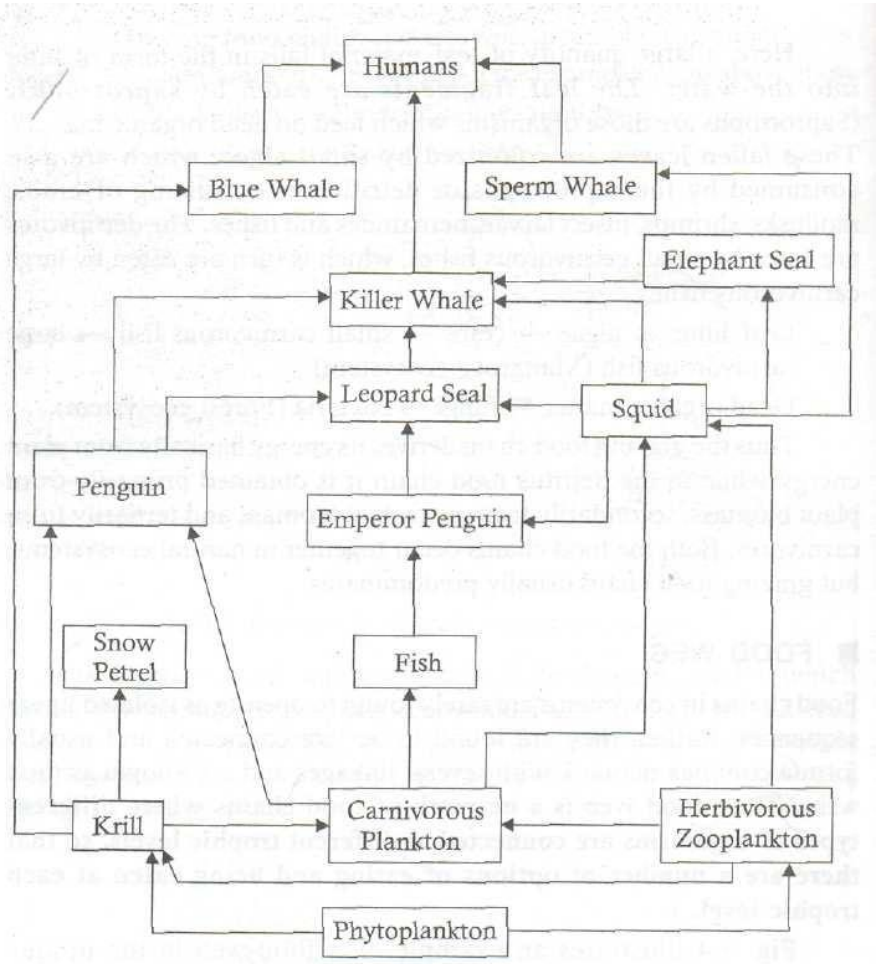


Fig. 3.4. A simplified food web in Antarctic ecosystem.

(or)

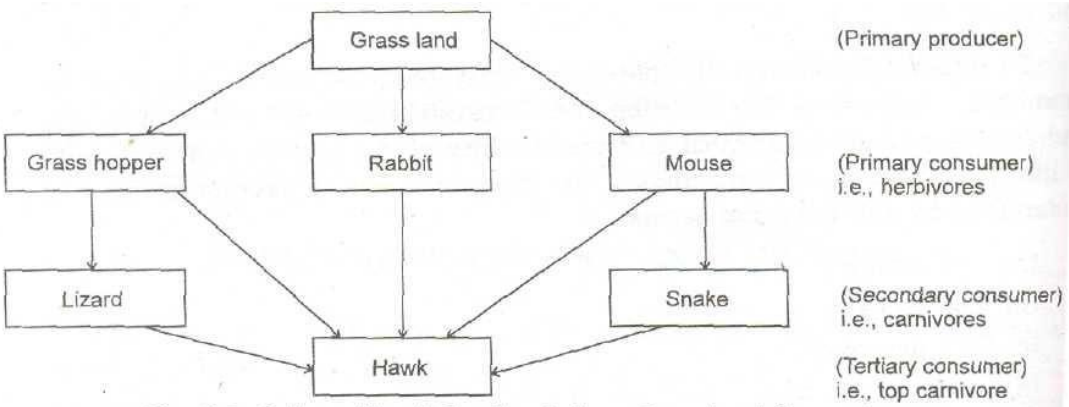


Fig. 2.3: Schematic of Food-web in a Grassland Ecosystem.

- **Eco – System Development:**
  Development of interactions between abiotic components and biotic components of environment is called as 'Eco – System Development'.

Trophic Levels:

In any eco – system 'producer' occupies 'first trophic level', 'primary consumer' occupies 'second trophic level', 'secondary consumer' occupies 'third trophic level', 'tertiary consumer' occupies 'fourth trophic level' etc.

The food energy passes from one group of organisms to another group at different levels. Each of these levels is called 'Trophic Levels', which is effectively the feeding level of a group of organisms in a food chain. The producers which create their own food by converting solar energy into chemical energy in the form of carbohydrates comprise trophic level – I. the green plants belong to this category. The primary consumers that do not produce their own food, like cows, sheep, goats and rabbits belong to trophic level – II. The secondary consumers, that is, the carnivores like lions, tigers and dogs belong to trophic level – III. Human beings and a few group of animals that obtain their food from the other three levels belong to trophic level – IV.

Ecological Pyramids:

Ecological pyramids are the 'Graphical representation of relationship of producers & consumers in terms of pyramids' are called as 'Ecological Pyramids'.

Types of Ecological Pyramids

Ecological pyramids are three types

a) Pyramids of Numbers
b) Pyramids of Biomass
c) Pyramids of Energy

a) Pyramids of Energy:

Graphical representation of relationship of producers & consumers in terms of energy are called as ' Pyramids of Energy'.

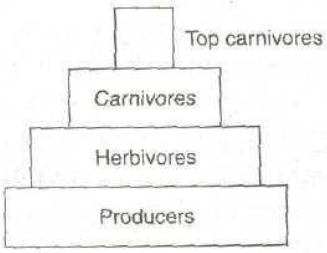


Fig. 3.7. Pyramid of energy.

b) Pyramids of Biomass:

Graphical representation of relationship of producers & consumers in terms of biomass are called as ‘ Pyramids of Biomass’.

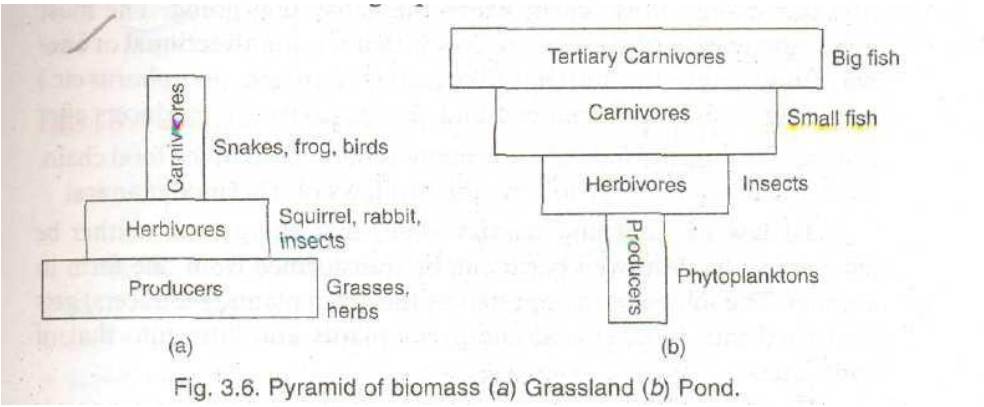


Fig. 3.6. Pyramid of biomass (*a*) Grassland (*b*) Pond.

c) Pyramids of Numbers:

Graphical representation of relationship of producers & consumers in terms of Numbers are called as ‘ Pyramids of Numbers.

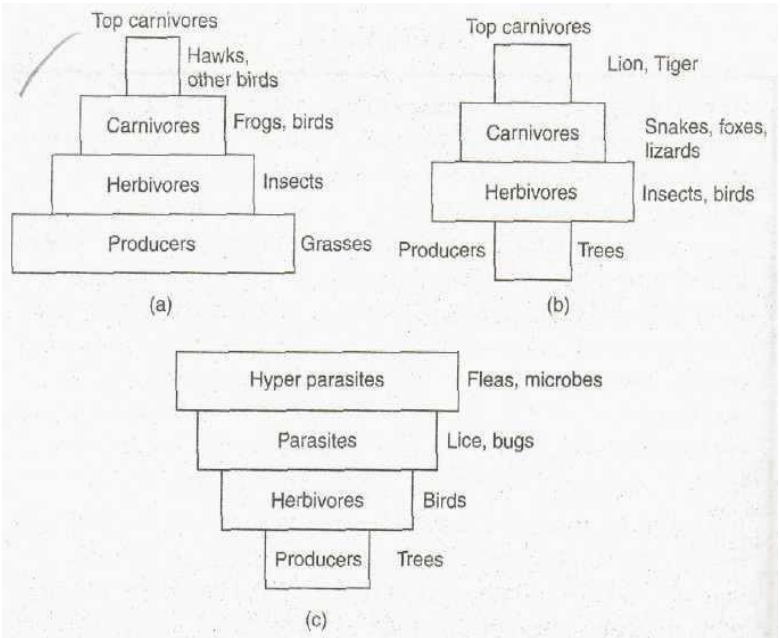


Fig. 3.5. Pyramid of numbers (*a*) grassland (*b*) forest (*c*) Parasitic food chain.

Ecological Succession: Succession means following in order one after another without intervention of anything else. This is the dictionary meaning of succession. Ecology is the branch of biology dealing with organisms having relations with one another and to their surroundings. The phenomenon of transition from one biotic community to another is called *'Ecological (or) Natural Succession'*.
According to Harmon (1973), 'Ecological Succession is the dynamic process by which eco – system change in order to develop greater stability over the course of time'.

Eco means Environment, Succession means development (or) progress, the total ecological succession refers environmental development or environmental progress. .

Ecological succession is two types

a) Allogenic Succession
b) Autogenic Succession

a) Allogenic Succession:

- Allo means 'Out Side', genic means 'Related'.
- It is the type of development occurred in the eco – system due to the interaction of external factors (or) forcing on it.
- Allogenic Succession is also called as 'Primary Succession'.

b) Autogenic Succession:

- Auto means 'Inside', genic means 'Related'.
- It is the type of development occurred in the eco – system due to the changes within the eco – systems (or) internal adjustments.
- Autogenic Succession is called as 'Secondary Succession'.

Ecological Succession in Different Areas:

Ecological Succession starting on different type of areas like ponds, rocks, sand, silt, desert etc.

a) Hydrarch (or) Hydrosere
b) Measarch (or) Mesosere
c) Xerarch (or) Xerosere

a) Hydrarch (or) Hydrosere:
Succession starts in water areas like Pond, Swamp, Bog etc
Ex: Ponds

b) Measrch(or) Mesosere:
Succession starts in an area of adequate moisture.
Ex: Fungi

c) Xerarch (or) Xerosere:
Succession starts on a dry area with little moisture.
Ex: Lichens (Algae & Fungi)

Process of Succession:

The process of succession takes place in a systematic order of sequential steps

a) Nudation
b) Invasion
c) Competition & Coaction
d) Stabilization

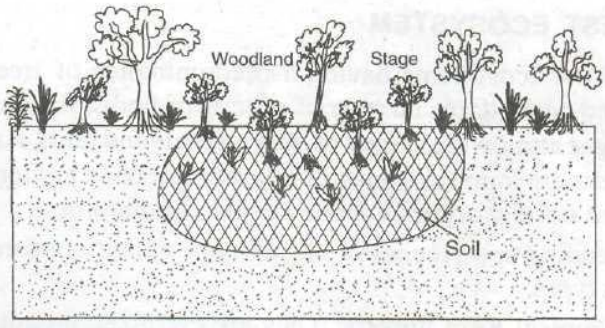
a) Nudation:
It is the development of a bare area without nay life forms. The bare area may be caused due to land slides, volcanic eruption, drought, over grazing, agricultural and industrial activities.

b) Invasion:
It is the successful establishment of one (or) more species on a bare area through dispersal (or) migration.

c) Competition & Coaction:
As the number of individuals grows there is competition both inter – specific between different species and intra – specific within the same species for space, water and nutrition. They influence each other in a number of ways known as 'Coaction'.

d) Stabilization:

Species with more resistance can survive environment and they become stabilized in environment and forms stable community. Species with less resistance are disappearing in environment.



(*d*) Eventually the former lake is covered by climax woodland community, representating a terrestrial ecosystem.

Fig. 3.15. Ecological succession: A hydrach—from lake to woodland community.

Classification of Lakes:

Lakes are classified into different types

a) Oligotrophic Lakes
b) Eutrophic Lakes
c) Dystrophic Lakes
d) Desert Salt Lakes
e) Volcanoic Lakes
f) Artificial Lakes

a) **Oligotrophic Lakes**:

Oligotrophic lakes with low nutrient content.

b) Eutrophic Lakes:

Lakes with high nutrient content

Ex: Dal Lake

c) Dystrophic Lakes:

Lakes with low pH, High humic acid content.

Ex: Bog Lake

d) Desert Salt Lake:

Occurred in desert area with high salt content.

Ex: Sambhar Lake in Rajasthan

e) Volcanoic Lake:

Water enter into the lake from magma after volcanoic eruptions

Ex: Many lakes in Japan.

f) **Artificial Lakes**:

That are created due to construction of dams.

Layers of the Lake:

Based on temperature in the lake, lake is divided into three important layers.

a) Epilimnion
b) Thermocline
c) Hypolimnion

a) Epilimnion:

- The surface layer of the lake is called 'Epilimnion'.
- It is called as 'Nutrient Rich Layer'.
- Large quantities of nutrients like Nitrogen, Phosphorus and Potassiums are present in the region.

b) Thermocline:

- Middle layer of the lake is called as 'Thermocline'.
- This layer consists of ideal temperature.
- This layer separates the bottom layer from the surface (or) top layer.

c) Hypolimnion:

- Bottom layer of the lake is called as 'Hypolimnion'.
- It is also called as 'Nutrient Poor Layer'.
- Sediments, sand, silt particles are present in this region.
- Temperature is very low.

Based on Vegetation and Light penetration lake is divided into three important layers.

a) Limnetic Zone
b) Profundal Zone
c) Littoral Zone

a) Limnetic Zone:

- It is the surface layer of the lake.
- Sunlight is easily penetrated into this zone.
- The rate of vegetation is high.
- Generally floating plant species & animals are present in this zone.

b) Profundal Zone:

- Middle layer of the lake is called as 'Profundal Zone'.
- Ideal temperature is present in this zone.
- Floating animal species are present in this zone.
- Light penetration is negligible.

c) Littoral Zone:

- Vegetation and light penetration are absent in this zone.
- Temperature is very low in deep waters.

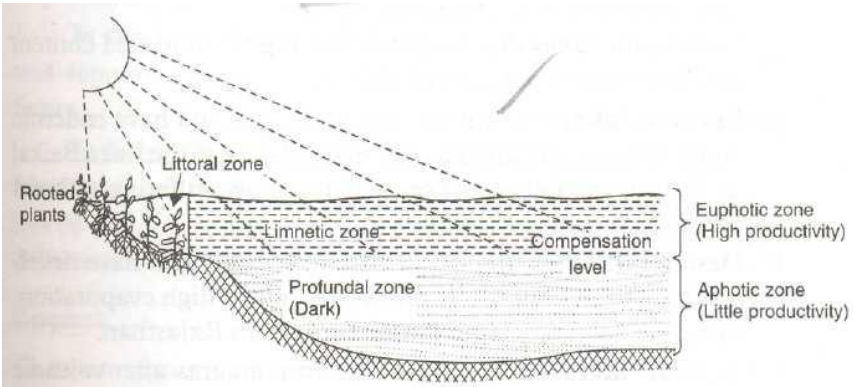


Fig. 3.16. Zonation in a lake ecosystem.

Energy Flow in an Eco – System or Flow of Energy:

Flow of energy in an eco – system takes place through food chain. The most important feature of this energy flow is that it is uni directional (or) one way flow. Unlike carbon,, nitrogen and phosphorus which move in a cycle manner and are reused by the producers after flowing through the food chain, energy is not reused in the food chain.

The sun is the source of energy. The movement of solar energy through and eco –system called as *'Energy Flow'*.

The flow of energy through the eco – systems is governed by the laws of thermodynamics. The laws state that:

a) Energy is neither created nor destroyed but may be transferred from one from to another.
b) During energy transfer, there is degradation of energy from a concentrated to a more dispersed form.

Bio – Geo Chemical Cycles:

Bio means Living Organisms, Geo means Earth and chemical elements includes Carbon, nitrogen, phosphorus, sulphur etc which are continuously go around in the cycle or moves in a circular path.

The cyclic path way of chemical elements moves from environment to organisms, and back to environment called as 'Bio – Geo Chemical Cycles'.

Types of Bio – Geo Chemical Cycles:

Bio – Geo Chemical cycles are two types

a) Gaseous Cycles
b) Sedimentary Cycles

a) Gaseous Cycles:
Ex: Carbon Cycle, Oxygen Cycle, Nitrogen Cycles etc

b) Sedimentary Cycles:
Ex: Sulphur Cycle, Phosphorus Cycle etc.

Water Cycle: Waster is essential component for survival of life on this earth. Water is abundantly available resource on this earth. Water is present in nature in three different states namely solid, liquid and gaseous states. Ex: Solid – Ice, Liquid - Water, Gaseous - Water Vapour

Out of 100% of water available on the earth, nearly

97% of water is present in Oceans, 2% of water is present in Polar Ice Caps in the form of Ice & only 1% of water is available for human consumption. This 1% of water is again using in different sectors for different purposes. Water is using in domestic sector for drinking, washing, bathing, cleaning & garden maintenance etc, sing in the industrial sector for running of boilers, turbines, electricity generation etc, using in the agricultural sector for the growth of the plant species and using in the commercial sector for drinking and other commercial activities.

Water Consumption in Developed & Developing Countries:

Out of 1% of water

0.7% of water is using for industrial activities, 0.2% is using for agricultural activities and 0.1% is using for domestic and commercial purposes.

Water Consumption in Developing Countries:

Out of 1% of water

0.7% of water is using in agricultural activities, 0.2% is using for industrial activities and 0.1% is using for commercial and domestic activities.

Water gets evaporated from the water bodies and the evaporated water gets condensed in the atmosphere in the form of clouds after sometime the condensed water reach the earth in the form of rain. This is known as '*Hydrological Cycle'.*

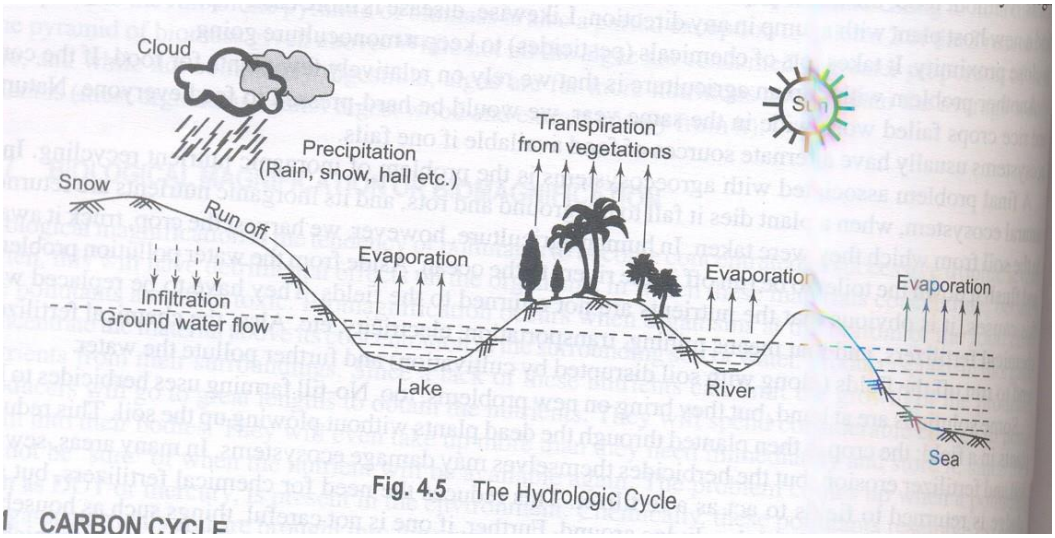


Fig. 4.5 The Hydrologic Cycle

CARBON CYCLE

Nitrogen Cycle: Nitrogen is present in atmosphere as N_2, large amount of nitrogen (78%) present in atmosphere; this nitrogen is fixed by the physical process of lightening or biologically by bacteria such as Cyano Bacteria or Blue Green Algae in the soil. This fixed nitrogen will be taken up by the plant species through the root systems and utilized in the metabolic activities such as bio – synthesis of amino acids, proteins, vitamins etc and finally this nitrogen will be fixed as organic nitrogen in tissues of plants and animals. After death of the plants and animals the organic nitrogen under goes decomposition by some bacteria such as ammonifying, nitrifying bacteria. The ammonifying bacteria convert the organic nitrogen as ammonia, nitrifying bacteria converts the organic nitrogen as nitrites and nitrates. Further the nitrates are converting as molecular nitrogen and release back into atmosphere and cycle goes on.

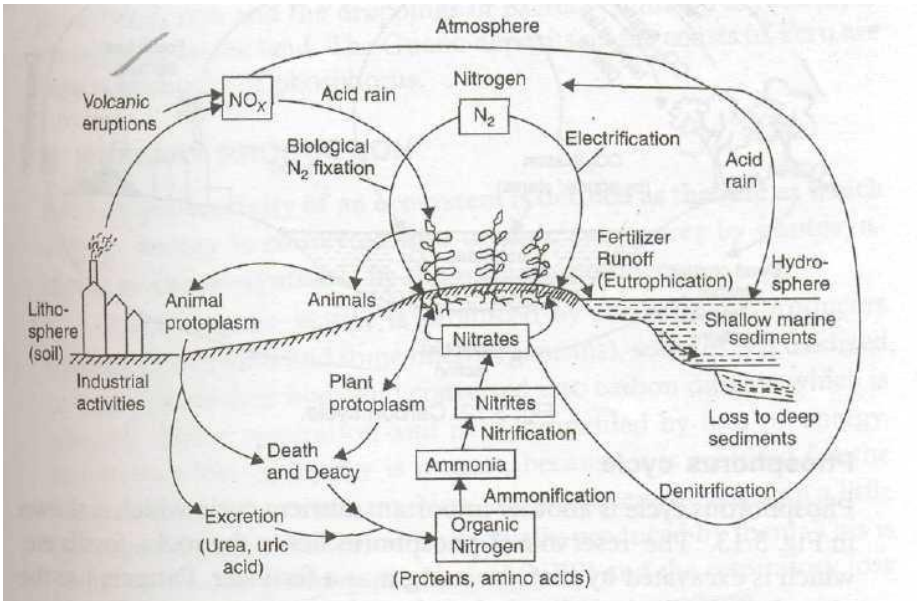


Fig. 3.11. Nitrogen cycle—a gaseous cycle with major reserve as N_2 (78%) in the atmosphere. Circulation of N- between living components and soil/atmosphere is mediated by a group of micro-organisms which convert one form of N into another.

Carbon Cycle: Sometimes human interferences disturb the normal cycling of such nutrients and create imbalances. For example, nature has a very balanced carbon cycle. Carbon on the form of carbon – di oxide is taken up by green plants as a raw material for photo synthesis, through which a variety of carbohydrates and other organic substances are produced**.** Through the food chain it moves and ultimately organic carbon present in the dead matter is returned to the atmosphere as carbon dioxide by micro organisms. Respiration by all organisms produces carbon dioxide, while the latter is used up by plants.

In the recent years carbon dioxide levels have increased in the atmosphere due to burning of fossil fuels etc, which has caused an imbalance in the natural cycle and the world today is facing the serious problem of global warming due to enhanced carbon dioxide emissions.

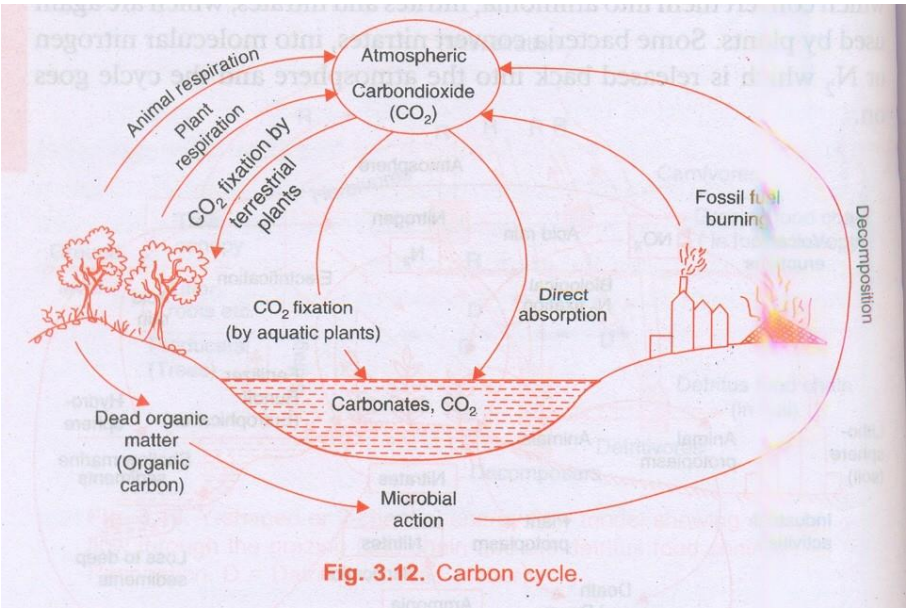


Fig. 3.12. Carbon cycle.

Phosphorus Cycle: Phosphorus cycle is another important cycle. The reservoir of phosphorus lies in rocks, fossil fuels etc, which is excavated by man using it as a fertilizer. Farmers use the phosphate fertilizers indiscriminately and as a result excess phosphates are lost as run – off, which ca uses the problem of eutrophication or over nourishment of lakes leading to algal blooms. A good proportion of phosphates moving with surface run – off reaches the oceans and is lost into to deep sediments. Our limited supply of phosphorus lying in the phosphate rocks of this earth are thus over – exploited by man and a large part is taken out of the normal cycle due to loss into oceans. So human beings are making the phosphorus cycle acyclic. Sea birds, on the other hand, are playing an important role in phosphorus cycle. They eat sea – fishes which are phosphorus rich and the droppings, or excreta of the birds return the phosphorus on the land. The Guano deposits on the coasts of Peru are very rich sources of phosphorus**.**

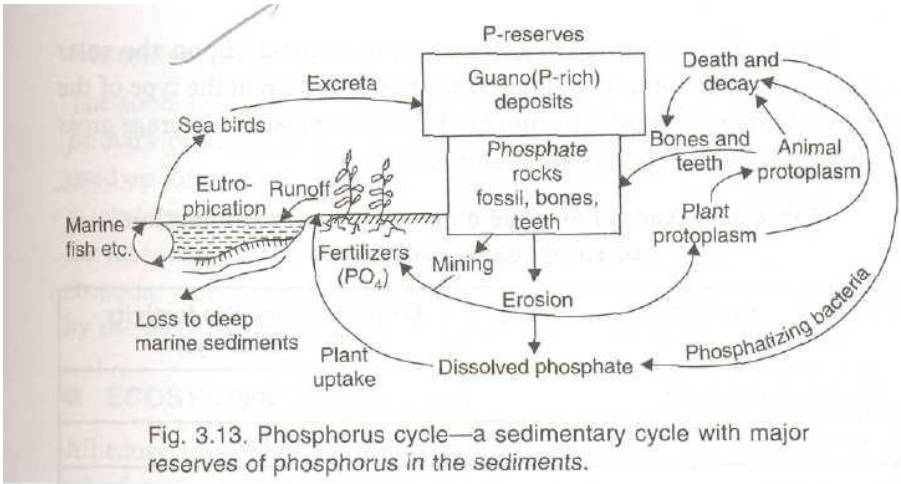


Fig. 3.13. Phosphorus cycle—a sedimentary cycle with major reserves of phosphorus in the sediments.

Sulphur Cycle:

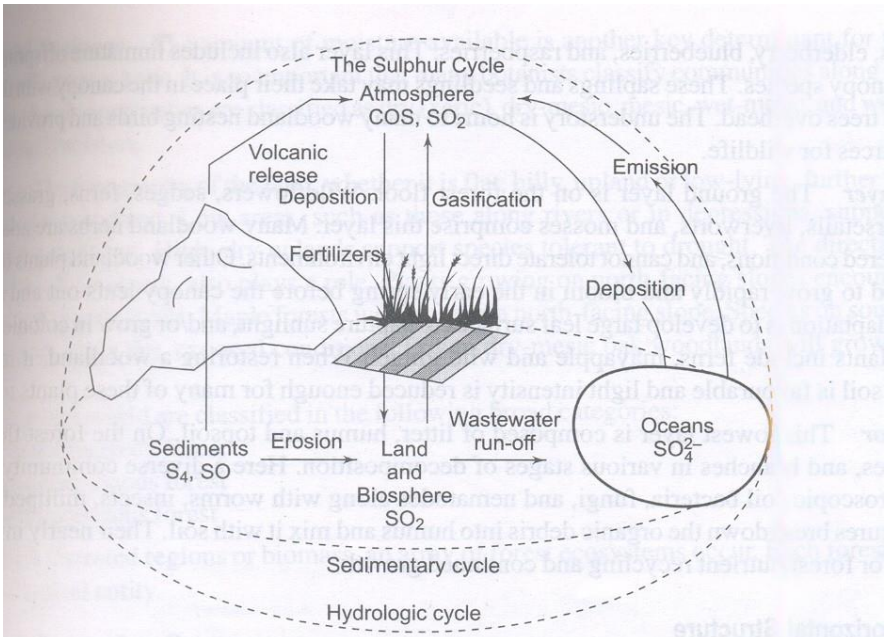


Fig. 4.9 Sulphur Cycle

Nutrient Cycling: Besides energy flow, the other important functional attribute of an eco – system is nutrient cycling. Nutrients like carbon, nitrogen, sulphur, oxygen, hydrogen, phosphorus etc, move in circular paths through biotic and abiotic components and are therefore known as 'Bio – Geo Chemical Cycles'. Water also moves in a cycle, known as 'Hydrological Cycle'. The nutrients too move through the food chain and ultimately reach the detritus compartment where various micro – organisms carry out decomposition. Various organically bound nutrients of dead plants and animals are converted into inorganic substances by microbial decomposition that are readily used by plants and the cycle starts afresh.

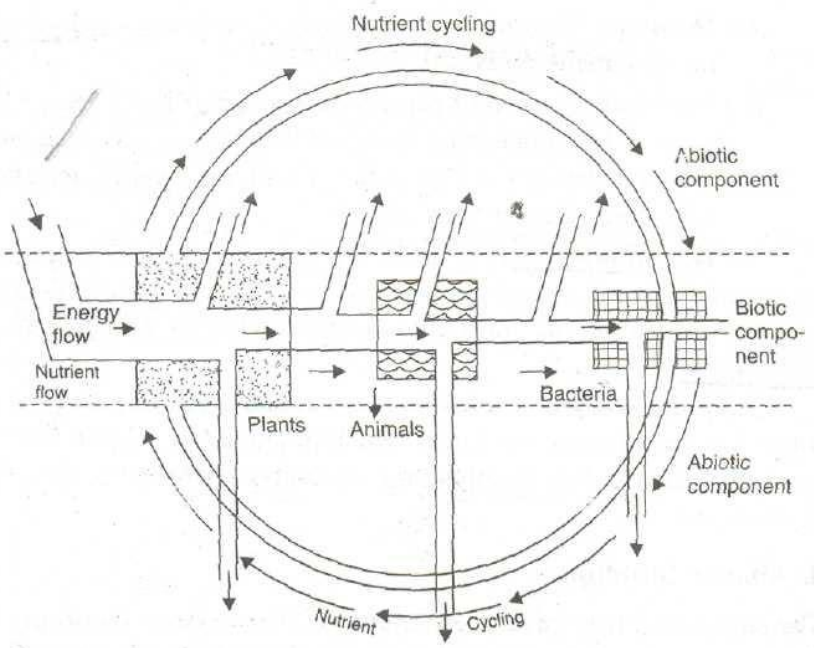


Fig. 3.1. Nutrient cycling and energy flow mediated through food-chain. The flow of energy is unidirectional while the nutrients move in a cyclic manner from the abiotic to biotic (food chain) to abiotic and so on.

Cybernetics: Cybernetics is the computer term, it is the study of the mechanics of electronic machine movements and the way in which electronic devices can be made to imitate human actions.

Homeostasis: It is the tendency of the system to resist change and maintains itself in the state of equilibrium.

Bio – magnification / Bio – Accumulation / Food Chain Concentration:
It refers to increase the concentration of toxic chemicals in the food chain from producers to tertiary consumers through primary & secondary consumers.
Ex: DDT

Carrying Capacity: It is the study to protect the maximum number of individuals of a species from various external factors in a given area. The carrying capacity of a region can be explained as a complex system where the basic needs of human beings are to be born by the associated activities of the system including industrial developmental projects.
Eco – system carrying capacity provides the physical limits to economic development and may be defined as the maximum rate of resource consumption and waste discharge that can be sustained indefinitely in a defined planning region without progressively impairing bio – productivity and ecological integrity.

Eco –System Services & Values:

- Maintenance of the Bio – Geo Chemical Cycles
- Hydrological Cycle or Water cycle including purification
- Carbon cycle
- Cycling of vital chemicals like Carbon, Nitrogen, Phosphorus, and Sulphur
- Modification of Climate
- Waste Removal and Detoxification
- Natural pest and Disease Control
- Erosion Control, Soil Building, Soil renewal
- Energy including renewable & non – renewable resources
- Materials like minerals Air and its purification
- Food (Plants, Animals, Fishes etc)
- Bio –d diversity and the gene pool
- Maintenance of food chains, food webs, ecological pyramids etc.

Values: a team of ecologists, economists and geographers have tries to answer this question. The team first divided the Earth's surface into 16 major biomes and aquatic life zones. They have listed 17 goods and services provided by nature in each of these areas and examined over 100 studies that have to put a money value on such services. Finally they came up with an estimate of the monetary value of eco – system services. Their conclusion was that the eco – system services were worth more than US$ 36 trillion per annum. This is comparable to the annual Gross World Product that is estimated to US $ 39 trillion. Some experts believe that this is a conservative figure and that the real worth of nature could be much more, even a million times more.

Impact of Human Activities on Eco – Systems:

The major environmental problems which continue t incite human concern are varied.

a) Over population
b) Soil Erosion
c) Depletion of Natural Resources
d) Poverty
e) Loss of Bio – Diversity
f) Environmental Pollution

All these problems of the environment are due to anthropogenic activities which are dangerous both to the earth and to us. Some of the problems are

a) **Over Population**:
   The population of the earth is growing at an incredible pace. At present, the rate of increase is such that there are too many people for our planet to support. The increase in the population have polluted the natural environment, ruined it, created and intensified a variety of problems. A few of the consequent

environment problems of over population are the disappearing forests, increasingly polluted water and air, depleting soil and water resources, increasing green house gas emissions, stratospheric ozone depletion. All these factors contribute mightily to the destruction of the global eco system.

b) **Wastage of Natural Resources**:

The various natural resources in the environment are land, water, minerals, forests and wildlife, with increase in the human population, there is increases in the usage of natural resources. Over usage of the non – renewable resources leads to its depletion in the long run. Over utilization of natural resources may lead to its unequal distribution in the eco – system.

c) Disappearance of the Forest Eco – System:

The disappearance of the forest eco – system is brought about by deforestation – a permanent destruction of indigenous forests and woodlands. Deforestation is carried out to convert forests and wood lands to agricultural land to feed the growing population, destruction of trees for wood, building material, browsing of young saplings by domestic animals like goats and cattle ranching.

The effects of Deforestation are many:

Some of them are:

1) Alteration or disruption of carbon cycle and water cycle.
2) Erosion of soil with the loss of protective cover.
3) Extinction of species
4) Desertification.
5) Increase in the temperature extremes.

d) **Soil Degradation**:

It refers to the undesirable depletion of the physical components of the soil thereby rendering it unhealthy for cultivation. This may also be referred to as soil retrogression or soil regression. The causative factors of soil degradation are deforestation, overgrazing, erosion by agents like wind, water and desertification. Much land is destroyed by water logging and salinity. The use of pesticides and chemical fertilizers reduce the fertility of the soil. Hence, loss of soil incurs a great loss for man kind.

e) Indiscriminate and overuse of Ground Water:

In order to fulfill the basic needs of people, the surface and ground water are being over utilized. We tend to waste a lot of water in our daily chores. The agriculturists use excess water to grow their crops. Water may be conserved by the farmers by using the drip irrigation systems. The surface and ground water are getting polluted by indiscriminate use of chemical fertilizers and pesticides.

f) **Depletion of agricultural or cultivable lands by unplanned urbanization**:

The intense utilization of farm land is leading to its degradation. The cultivable lands are being used for building homes, maintain pastures for domestic animals laying down roads and supporting the industries by creating towns and cities.

g) **Extinction of Species Leading to Loss of Bio – Diversity**:

The plant and animal species are disappearing at an accelerating rate. The environmentalists are of the opinion that the cause for extinction of living species is due to expansion of human activity in destroying their habitats. It is estimated that every year 17,500 species are being lost, which is about 2 every hour. At this rate, one million living species could be made extinct in the next 20 years.

h) Poverty of the Masses:

Poverty and environmental degradation are some what interlinked. The poor people cannot afford to take care of the environment. This is because their only source for sustenance is the environmental resources which they use unsustainably and inefficiently.

i) **Pollution of the Environment**:

The term environmental pollution refers to the ways and means by which people pollute or contaminate their surroundings or environment inhabited by them, thereby harming the natural environment. The major types of environmental pollution are air pollution, water pollution disposal of solid waste.

j) **Improper Implementation of the Laws of Environmental Problems**:

The environmental laws are a set of laws meant for the conservation and protection of the environment which includes the prevention of water and air pollution, protection of forests, land and water bodies, proper utilization of the resource. If the environment is caused any harm by an individual or institution they should be punished through a legal process. Proper implementation of environmental laws should be done so as to conserve and protect the environment.

Impacts on Forest Eco – System:

The clearing & burning of the forest resources for agriculture, cattle rearing, and timber extraction result in loss of bio – diversity, extinction of species, and soil erosion, resulting in the loss of vital top soil, and disturbance of the carbon cycle leading to global warming.

- The clear – cutting and conversion of forest land in hilly areas for agriculture, plantations, and housing lead to landslides and floods, which affect people in the forests and on the plains. It also increases the siltation of rivers.

- Many forests have been affected by acid deposition, originating from industries.
- The harvesting of old growth forests destroys crucial habitat for endangered species.
- Pesticide spraying to control the insects in forest plantations leads to poisoning all the way up the food chain and unintended loss of species like predatory hawks, owls and eagles this in turn leads to an increase in the pest population.
- Dams built in the forest areas for hydro power and water drowns huge areas, destroying species and depriving people of their lands; they could also include earth tremors.
- In wilderness areas like the Arctic, oil exploration and military activities disrupt the eco –system, contaminate areas, and leads to the decline of species.

Natural ecosystems provide human with services in the absence of which the human civilization would cease to thrive. Every day, many human activities disrupt, impair or reengineer eco systems which include the following.

a) Pollution of Land, Water and Air Resources
b) Over fishing
c) Soil Erosion
d) Deforestation
e) Destruction of Wet Lands
f) Introduction of Non – Native Species
g) Urban Sprawl

MODULE-II

NATURAL RESOURCES, BIODIVERSITY AND BIOTIC RESOURCES

NATURAL RESOURCES

Introduction:

Life on this earth depends upon a variety of goods and services provided by the nature which are known as 'Natural Resources'. Thus water, air, soil, minerals, coal, forests, crops and wildlife are all examples of natural resources. Natural resources are the components of the atmosphere, hydrosphere and lithosphere and are useful and essential for life. They include air, water, plants, animals, soil, minerals and fossil fuels.

Definition of Resource:

Resources are defined as those materials which are required for the survival, comfort and prosperity of human beings on the earth.

Classification of Resources:

Nature has given us abundant resources in the form of water, air, plants, land, animals, minerals, fossil fuels etc. Natural resources are classified as **living** (biotic) and **non living** (abiotic) resources. Plants, animals and fossil fuels are known as biotic resources and water, air, land are known as abiotic resources. But the most popular concept of natural resource classification is Renewable & Non – Renewable.

Natural resources are of two types

1. Renewable Resources
2. Non – Renewable Resources

1. Renewable Resources:

Which are inexhaustive and can be regenerated within a given span of time.

Ex: Solar Energy, Wind energy , Fresh water etc

2. Non – Renewable Resources:

Which cannot be regenerated Ex: Fossil Fuels like coal, petroleum, minerals etc. Once we exhaust these resources, the same cannot be replenished even our renewable resources can become non – renewable if we exploit them to such extent their rate of consumption exceeds their rate of regeneration. It is very important to protect and conserve our natural resources and use them in a judicious manner so that we do not exhaust them.

Non – renewable resources can be further divided into two categories

a) Recyclable b) Non – Recyclable

a) **Recyclable:** These are non – renewable resources which can br collected after they are used and can be recycled. There are mainly the non – energy mineral resources which occur in the earth's crust. (Ex: Ores of Al, Cu, Hg etc) and deposits of fertilizer nutrients (Ex: Phosphate rock and Potassium and minerals used in their natural state).

b) **Non – Recyclable**: There are non – renewable resources which cannot be recycled in any way. Ex: Fossil fuels

MINERAL RESOURCES

Introduction: A mineral is a naturally – occurring substance of definite chemical composition and identifiable physical properties. An ore is a mineral or combination of minerals from which a useful substance, such as a metal, can be extracted and used to manufacture useful products. Minerals are formed over a period of millions of years in the earth's crust. Iron, Zn, Al, Mn & Cu are important raw materials for industrial use. Important non – metallic resources include Coal, Salt, Clay, Cement & Silica. Stones used for building materials such as granite, marble, lime stone, constitute another category of minerals.

Distribution of Mineral Resources:

Mineral resources are non – renewable resources. The geographical Distribution of mineral resources are very uneven in India.

According to Geological Information Systems (GIS) report, there are 50 mineral occurrences and more than 400 major mineral sites are available.

Indian Scenario: India is the producer of 84 minerals the annual value of which is about Rs 50,000 Crore. At least 6 major mines need a mention here which is known for causing severe problems.

a) Jadnguda Uranium Mine, Jharkhand – exploring to radio – active hazard.
b) Jharia Coal Mines, Jharkhand – underground fire leading to land subsidence and forces displacement of people.
c) Sukinda Chromite Mines, Orissa – seeking of hexavalent Chromium into river posing serious health hazard, Cr (VI) being highly toxic and carcinogenic.
d) Kudremukh Iron Ore Mine, Karnataka – causing river pollution & threat to bio – diversity.
e) East Coast Bauxite Mine, Orissa – Land encroachment & issue of rehabilitation unsettled.

Classification of Mineral Resources:

From Utilization point of view, minerals are placed under two classes.

a) Metallic Minerals.. Ex: Al, Cu, Fe, Zn, Pb etc ores
b) Non – Metallic Minerals.. Ex: Coal, Petroleum, Natural gas etc

Uses and exploitation of Minerals:

a) Development of industrial plants & machinery
b) Generation of energy Ex: Coal, Lignite , Uranium etc
c) Construction , housing, settlements
d) Defense equipments – weapons,armaments
e) Transportation means
f) Communication – telephone wires, cables, electronic devices etc
g) Formation of alloys for various purposes. Ex: Steel alloys
h) Jewellery – Ex: Au, Ag, pt, Diamond etc

Important Minerals and their Uses:

From origin point of view minerals are classified into two types.

a) Metallic Minerals
b) Non – Metallic Minerals

S.no	Metallic Mineral	Uses
1	Aluminium	Building Material, Electrical Wiring, Air Craft, Rockets etc
2	Beryllium	Refractories, Copper Alloys
3	Chromium	Refractory, Metallurgy, and Chemicals
4	Cobalt	Alloys, Radiography, Catalyst
5	Copper	Alloys, Electrical Products
6	Gold	Jewellery
7	Iron	Steel, Building Material
8	Lead	Batteries, Paints, Alloys
9	Tin	Tin Plates
10	Uranium	Nuclear Bombs, Electricity Generation
11	Vanadium	Alloys
12	Manganese	Alloy Steels
13	Magnesium	Structural Refractories
14	Titanium	Alloys, Pigment, Air Crafts
15	Zinc	Chemicals, Soldering, Dye Casting

Non – Metallic Minerals:

S.no	Non Metallic Mineral	Uses
1	Asbestos	Roofing, Insulation, Ceramics, Textile and Gasoline
2	Corundum	Abrasive
3	Felspar	Artificial Teeth
4	Nitrates	Fertilizers, Chemicals
5	Phosphates	Fertilizers, Chemicals
6	Potassium	Fertilizers, Chemicals
7	Salt	Chemicals, Glass, Metallurgy
8	Sulphur	Fertilizers, Acids, Iron & Steel Industry

a) Energy Generating Minerals:
i) Coal & Lignite: West Bengal, Jharkhand, Orissa, Madhya Pradesh & Andhra Pradesh
ii) Uranium: Jharkhand, Andhra Pradesh, Meghalaya, Rajasthan
b) Other Commercially Minerals:
i) Aluminium: Jharkhand, Maharastra, West /Bengal, Madhya Pradesh, TamilNadu
ii) Iron(Hematite & MAgnetite): Jharkhand, Orissa, Madhya Pradesh, Andhra Pradesh, Tamilnadu, Karnataka, Maharastra & Goa
iii) Copper(Copper Pyrites): Rajasthan, Bihar, Jharkhand, Karnataka, Madhya Pradesh, WestBengal, Andhra Pradesh & Uttarakahand.

Types of mines: Mines are of two types

a) Surface (Open-cast or strip mines)
b) Underground (deep of Shaft mines)

Mining Operations: Mining operations generally progress through four stages

a)Prospecting : Searching for Minerals
b) Exploration : Assessing the size, shape, location and economic value of the deposit.
c) Development : Work of Preparation for the extraction of mineral
d)Exploitation : Extracting the minerals from the mines.

Effects of extracting and using mineral resources:

- Degradation of land, i,e, the top soil as well as the plants are removed from the mining area.
- Ground water contamination.
- Pollution of surface water resources due to release of harmful trace elements.
- Severe adverse impacts on the growth of plants.
- Desertification includes loss of flora & fauna.
- Adverse impacts on historical monuments.
- Physical changes in the land, soil, water and air associated with mining activities directly and indirectly affect the biological environment.
- Occupational health hazards.
- Most of the miners suffer from various respiratory and skin diseases.
- Destruction of the eco – system.
- Noise Pollution.
- Deregulation & defacing of landscape
- Subsidence of land.
- Air pollution
- Noise Pollution

Mining Safety:

- Mining is a hazardous occupation
- Surface mining is less hazardous than underground mining
- Metal mining less hazardous than coal mining
- In all underground mines, rock and roof falls , flooding and inadequate ventilation are the greatest hazards
- Large explosions by using explosives – Miners suffer and may be killed
- Mining poses several long term occupational hazards to the miners. The dust produced during mining operations is injurious to health and causes a lung disease known as **Black lung or Pneumoconiosis**.
- The fumes generated by incomplete dynamite explosions are extremely poisonous. Methane gas is dangerous.
- Radiation is a life threatening hazard in uranium mines.

GROWING ENERGY NEEDS

Energy is the capacity for doing useful work. Economic growth of every nation is depending on the availability of energy resources. Agriculture, industry, mining transportation, all need energy. The fossil fuels like coal, oil and natural gas which at present are supplying 95% of the commercial energy of the world energy resources. Our life style is changing very fast and from a simple way of life we are shifting to a luxurious life style. Electronic gadgets, cars, bikes usage increased many folds and all of them consume energy.

Developed countries like the USA constitute about 5% of the world's population but consumes one fourth of global energy resources. An average person in the USA consumes 300GJ(=60 barrels of oil) per year. An average man in poor countries like Bhutan, Nepal consumes less than 1 GJ in a year. Per capita energy usage decides Gross National Product with direct proportional relation.

According to International Energy Agency(IEA), global electricity consumption is expected to increase 75% between 2007 and 2030. Developing countries will account for more than 80% of new demand.

ENERGY RESOURCES

Introduction:

Energy is the physical quantity, which can manifest itself as heat, as mechanical work, as motion and in the binding of matter by nuclear (or) chemical forces.

Definition:

Energy means capacity to do work (or) ability to do work, changing the physical state of motion of an object.

Classification of Energy Resources:

Energy resources are classified as

a) Renewable Energy Resources
b) Non – Renewable Energy Resources

a) **Renewable Energy Resources**:
Renewable resources which can be regenerated continuously in nature and are inexhaustible. Renewable energy resources as solar energy, wind energy, hydro power, bio – energy etc.

b) **Non – Renewable Energy Resources**:
Non – Renewable Energy Resources of energy are those which are not replaced (or) replenished by natural process. These resources are get depleted (or) exhausted by use.
Ex: Coal, Petroleum, Natural Gas.

Renewable Energy Resources:

a) Solar Energy:
Sun is the ultimate source of energy, directly or indirectly for all other forms of energy. The nuclear fusion reactions occurring inside Sun release enormous quantities of energy in the form of heat and light. The solar energy received by earth is approximately 1.4 KJ/Sec/m^2, known as **Solar Constant**.

Important Solar Harvesting Devices:

a) Solar Water Heater System
b) Solar Refrigerator
c) Solar Driers
d) Solar Cookers
e) Solar Green House
f) Solar Furnace
g) Solar Ponds
h) Solar Desalination System
i) Solar Photo Voltaic Cells

Solar Photo – Voltaic Cells (SPV):
Solar Photo Voltaic Cells converts the solar energy into Direct Current (DC) (or) Electrical Energy. This electrical energy can either be used as it is (or) can be stored in the battery. This stored electrical energy then can be used at night.

Applications of Solar Photo Voltaic Cells:

Solar Photo Voltaic Cells can be used for a number of applications such as

- Domestic Lighting
- Street Lighting
- Village Electrification
- Water Pumping
- Desalination of Salty Water
- Railway Signals etc.

b)Wind Energy:

The high speed winds have a lot of energy in them as kinetic energy due to their motion. The wind energy is harnessed by making use of wind mills. A large number of wind mills are installed in clusters called Wind Farms, which feed power to the utility grid and produce a large amount of electricity. These farms are located in coastal regions, open grasslands or hilly regions where the winds are strong and steady. The minimum wind speed required for satisfactory working of a wind generator is 15 Km/hour.

The wind power potential of India is estimated to be 20,000 MW, While at present generating about 1020MW. The largest wind farm of India is near Kanyakumari, Tamilnadu generating 380 MW electricity

Wind energy doesnot cause any air pollution and it is cheap

c)**Hydropower:**

The stored water in big dams is allowed to fall from height. The blades of turbine located in the bottom of the dam move with the fast moving water which in turn rotate the generator and produce electricity. We can also construct mini or micro hydal power plants on the rivers in hilly regions for harnessing the hydro energy on a small Scale, but the minimum height of water falls should be 10 meters.

The hydropower potential of India is estimated to be about $4X10^{11}$KW/ hour.

Hydropower does not create any air pollution

BIOMASS

Introduction:

Biomass is organic material, which has stored sunlight in the form of chemical energy. Biomass fuels include wood, wood waste, straw, manure, sugarcane, and many other by products from variety agricultural processes

Advantages of bio – Mass:

- Storage possible.
- Transportation possible.
- It is renewable.
- High-energy rich fuels can be obtained.
- Low capital input required.
- Technology mostly available.
- It is ecologically safe.

- It doesn't increase CO_2 content of the atmosphere.

Disadvantages:

- Land & water use competition.
- Collecting & storing is bulky & costly.
- Supply uncertainty initially.
- Costs uncertain.
- Fertilizer, soil, water required.
- Low conversion efficiency.

BIO – GAS:

Introduction:

Bio – Gas originates from the bacteria in the process of biodegradation of organic material under anaerobic conditions.

Sources of Bio – Gas:

Cattle Dung / Cow Dung

Other sources are

- Goat Dung
- Pig Dung
- Chicken Droppings
- Buffalos Dung etc

Composition of Bio – Gas:

Bio – gas contains

60% of Methane (CH_4)

40% of CO_2 and

Trace quantities of H_2S & N_2 gases.

Calorific Value of Bio – Gas:

The calorific value of bio – gas is more than 5,000 K.Cal / m^3.

Efficiency of Bio – Gas:

The calorific value of bio – gas is more than 5000 K.Cal / m^3. This calorific efficiency of using bio gas is 55% in stoves, 24% in engines, but only 3% in lamps.

Benefits of Bio – Gas:

- It is renewable source of energy.
- It is eco – friendly source of energy.
- No pollution.
- It is alternative source of energy.
- Manure / Dung can be used as bio – fertilizer.
- Savings in the cost of disposal.
- Time saved.

Benefits of bio – gas Technology:

- Production of energy (heat, light, electricity).

- Transformation of organic wastes into high quality fertilizer.
- Improvement of hygienic conditions through reduction of pathogens, worm eggs and flies.
- Environmental advantages through protection of soil, water, air and woody vegetation.
- Reduction workload, mainly for women in fire wood collection and cooking.

Ocean Thermal Energy Conversion (OTEC):

The oceans collect and store huge quantities of solar radiations in the form of heat. Most of the heat is stored on the surface of the sea water while the temperature of deep waters is very low.

Using this temperature difference, we can convert the heat energy into electricity. Many low boiling liquids like ammonia, butane and freons are used to extracting the heat and converting it to electricity.

GEO – THERMAL ENERGY RESOURCES: Geo means Earth, Thermal means heat, the total term geo – thermal energy refers that energy is produced from earth resources.

NON – RENEWABLE ENERGY RESOURCES:

Introduction:

Non – renewable energy resources are like Coal, Petroleum, Natural Gas and Nuclear Fuels.

Coal: There are mainly three types of coal is present in environment.

a) Anthracite Coal
b) Bituminous Coal
c) Lignite

Anthracite Coal:

- It is hard coal.
- It has maximum carbon content – 90%.
- Calorific Value is 8,700 K. Cal.

Bituminous Coal:

- It is soft coal.
- It has carbon content of 80%.
- Calorific value is less than 8,000 K. Cal

Lignite:

- It is brown coal.
- Carbon content in lignite is 70%.

Coal States of India:

The important coal states of India are Jharkhand, Orissa, Madhya Pradesh, Telangana & Maharashtra etc. Anthracite coal is occurs only in Jammu & Kashmir.

Effects: When coal is burnt it produces CO_2, which is a green house gas responsible for causing enhanced global warming. Coal also contains impurities like sulphur and there fore as it burns the smoke contains toxic gases like oxides of sulphur and nitrogen.

PETROLEUM:

Total 13 countries in the world having 67% of the petroleum reserves. Crude petroleum is a complex mixture of alkane hydrocarbons. Hence it has to be purified and refined by the process of 'Fractional Distillation'. During this process, different constituents separate out at different temperatures. We get a variety of products from this, namely petroleum gas, kerosene, petrol, diesel, fuel oil, lubricating oil, paraffin wax, asphalt, plastic etc.

Liquified Petroleum Gas:

The main component of petroleum is butane and other components are propane & ethane. The petroleum gas is easily converted into liquefied petroleum from under pressure as LPG. It is odour less gas, but the LPG in our domestic gas cylinder gives a foul smell. This is infact, due to ethyl Mercaptans, a foul smelling gas, add to LPG, so that any leakage of LPG from the cylinder can be detected instantaneously.

NATURAL GAS:

Introduction:

It is mainly composed of Methane (95%) with small amount of propane and ethane.

- It is fossil fuel.
- It is cleanest fossil fuel.
- It can be easily transported through pipelines.
- It has high calorific value of about 50 KJ / G and burns without any smoke.
- Natural gas is used as domestic fuel and industrial fuel.
- It is used as fuel in power plants to generate electricity.
- It is used as source of hydrogen gas in fertilizer industry.
- It is used as source of carbon in tyre industry.

Types of Natural Gas:

a) Compressed Natural Gas (CNG)
b) Synthetic Natural Gas (SNG)

a) Compressed Natural Gas (CNG):

- It is used as an alternative source to petrol and diesel for transport of vehicles.
- CNG reduces vehicular pollution.

b) Synthetic Natural Gas:

- It is mixture of Carbon monoxide and Hydrogen.
- It is a connecting link between a fossil fuel and substituted natural gas.

Advantages of Natural Gas:

- It eliminates the man power and mechanical power.
- Pollution Control
- Saves energy
- Higher boiling efficiency
- No storage yard required
- Better combustion.

Nuclear Energy:

Nuclear Energy is known for its high destructive power as evidence from nuclear weapons. The nuclear energy can also be harnessed for providing commercial energy.

Nuclear Energy (Power) Generation:

Nuclear energy can be generated by two types of reaction.

a) Nuclear Fission
b) Nuclear Fusion

a) **Nuclear Fission**: It is the nuclear change in which nucleus of certain isotopes with large mass numbers are split into lighter nuclei on bombardment by neutrons and a large amount of energy is released through a chain reaction.

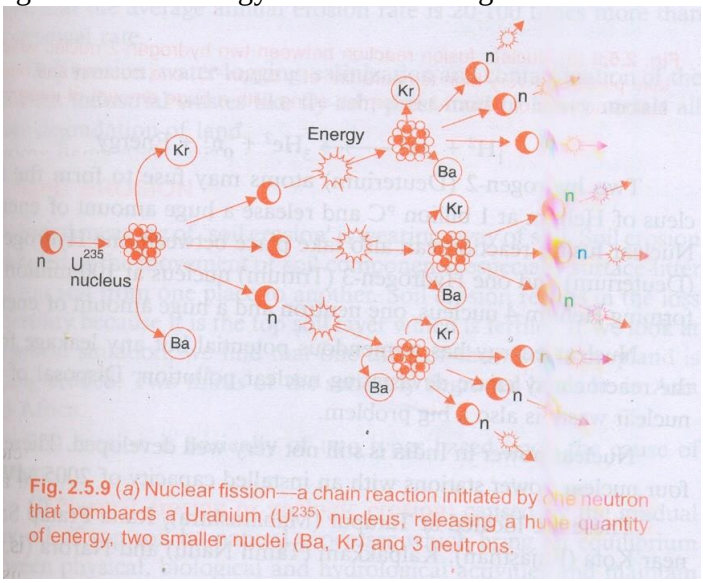


Fig. 2.5.9 (*a*) Nuclear fission—a chain reaction initiated by one neutron that bombards a Uranium (U^{235}) nucleus, releasing a huge quantity of energy, two smaller nuclei (Ba, Kr) and 3 neutrons.

b) **Nuclear Fusion**: Here two isotopes of a light element are forced together at extremely high temperatures until they fuse to form a heavier nucleus releasing enormous energy in the process.

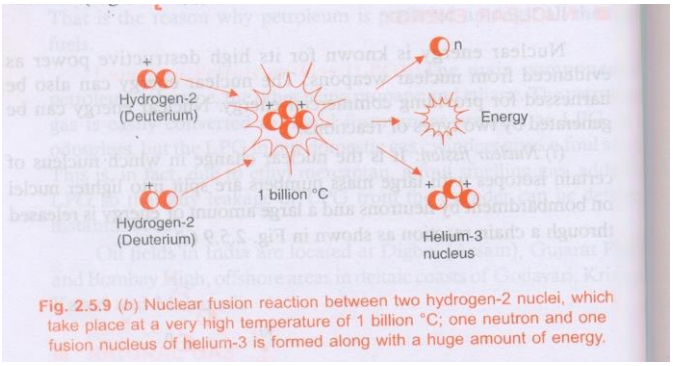


Fig. 2.5.9 (*b*) Nuclear fusion reaction between two hydrogen-2 nuclei, which take place at a very high temperature of 1 billion °C; one neutron and one fusion nucleus of helium-3 is formed along with a huge amount of energy.

Conservation of Energy Resources:

- Use public transportation, walk or riding a bicycle.
- Use stairs instead of elevators When you are not sick.
- Joining a car pool or driving a smaller or more energy efficient car.
- Insulate your house.
- Turn thermostats down in the winter & up in the summer.
- Create a wind break on the north side of your house.
- Use recycled glass metals & papers.
- Eat locally grown food in season.
- Buy locally made, long lasting materials.
- Use energy – efficient appliances, it can saves substantial amount of energy.
- Use paper saving devices.

WATER RESOURCES

Introduction:

Water is vital natural resource which forms the basis of all life. It is an essential component for survival of life. Water is present in three different forms in environment namely Solid, Liquid, Gaseous etc. Water covers 70% of the Earth's surface, but only 3% of this is fresh water, of this, 2% is present as polar ice caps and only 1% is usuable water in rivers, lakes and subsoil aquifers. Only fraction of this can be actually used.

Concept: Out of 100% of water present in nature nearly
97% of water is present in Oceans.
2% of water is present in Polar Ice Caps in the form of Ice.
1% of water is available for Human Consumption.

Totally 97% + 2% = 99% of water, which is present in oceans & polar ice caps are unavailable for human consumption.

Personal Water use by an Indian Urban Resident:

S.No	Use	Liters / Person / Day

1	Drinking	3
2	Cooking	4
3	Bathing	20
4	Flushing	40
5	Washing Clothes	25
6	Cleaning Utensils	20
7	Gardening	25
	Total	137

Possible Solution to the Water Crisis:

The following is a list of possible solutions to the water crisis in India and elsewhere:

- Reduce Demand
- Educate people to use less water
- Install water saving devices like self – closing taps, dual flush – toilets, spray taps in sinks etc
- Use decentralized waste water recycling systems at homes, apartment blocks, campuses and industries, using natural methods like planted filters.
- Adopt composting toilets to save water and also minimize the sewage disposal problems.
- Adopt agricultural practices that require less water
- Replace water hungry crops by those that require less water.
- Promote crops that can tolerate salty water.
- Return the indigenous species that can withstand drought.
- Switch to organic and natural farming.
- Reduce industrial consumption through recycling, reuse and new water- efficient technologies.
- Implement rain – water harvesting in urban and rural areas.

World Water Day: The international observance of World Water Day grew out of the 1992 United Nations Conference on Environment and Development (UNCED) in Rio – De – Janerio. In 1993, the Un assembly designated March 22 of each year as World Water Day.

Role of Water in different Sectors:

At global level 70% of water is used for agriculture, 25% of water for industry and only 5% of for domestic use. But in India, 90% of the water for agriculture, 7% for Industry and 3% for domestic purpose.

UNIQUE PROPERTIES OF WATER:

- It exits as liquid over a wide range of temperature i,e, from 0^{o} to $100^{o}C$.
- It has the highest specific heat, due to which it warms and cools down very slowly without causing any shocks of temperature jerks to the aquatic life.
- It is an excellent solvent for several nutrients, thus it can serve as a very good carrier of nutrients, including oxygen which is essential for life, but it can also dissolve various pollutants and became carrier of pathogenic micro – organisms.
- It has high surface tension because of strong attractive forces between the molecules.

Water Resources:

Water Resources are two types

a) Ground Water Resources
b) Surface Water Resources

a) **Ground Water Resources**:

About 9.86% of the total fresh water resources is in the form of ground water and it is about 35 – 50 times that of surface water supplies.

recharged by seeping down of from rainfall.

Water Usage in Different Sectors:

At global level 70% of water is used for irrigation (or) agriculture, 25% of the water for industry, 5% of water for domestic purpose.

India: But in India 90% of the water is used for agriculture, 7% of the water for Industry, and 3% of the water for domestic purposes.

Problems related with Water Resources:

Major problems related to water resources are

- About 40% of the world's population living in arid (or) Semi – arid region. These people have to spend substantial amount of time, energy and effort in obtaining water for domestic and agricultural use.
- To meet the requirement of population, they are depending on surface water bodies, thus results in decreased the water table level and it also effects on ground water table.
- Excessive irrigation practices in semi arid and arid regions can cause salt accumulation in soil, reduce crop productivity.
- Continuous depletion of ground water along the coastal regions often leads to the movement of saline sea water into fresh water well spoiling their water quality.

Uses and Over Utilization of Ground Water and Surface Water:

Water utilization varies from country to country. At global level, 70% of the water is used for agriculture, about 25% for industry and only 5% for domestic use. Industrialized countries use a greater percentage for industry. India uses 90% of its water for agriculture, 7% for industry and only 3% for domestic use.

The total annual fresh water withdrawals today are estimated at 3800 cubic kilometers, twice as much as just 50 years ago. Studies indicate that a person needs a minimum of 20 to 40 liters of water per day fro drinking and sanitation. However, more than one billion people worldwide have no access of clean water and to many more water supplies are unreliable**.**

India is expected to face critical levels of water stress by 2025, at the global level, 31 countries are already short of water and by 2025 there will be 48 countries facing serious water shortages. The Un has estimated that by the year 2050 4 billion people will be seriously affected by water shortages. Around 20 major cities in India face chronic or interrupted water shortages. There are 100 countries that share the waters of 13 large rivers and lakes.

Uses: Some of the important uses of Surface and ground water are mentioned below:

1. Domestic use: Estimated that 8% of worldwide water use is for residential purposes which includes drinking, cleaning, personal hygiene etc
2. Industrial use: Estimated that 22% of worldwide water is used for industrial purpose like for processing products and cooling etc
3. Hydropower
4. Irrigation
5. Navigation :
6. Recreation
7. Fishing

Effects of Over Utilization of Water Resources:

a) Lowering of water table
b) Ground Water Subsidence
c) Water Logging
d) Salt water intrusion
e) Reduced stream flow
f) Declining well yield
g) Increased costs for the users

a) Lowering of Water Table:

Excessive use of water for drinking, irrigation, industrial and commercial purposes has resulted in rapid depletion of water resources in various regions leading to lowering of water table and drying of well.

b) Ground Water Subsidence:

When ground water withdrawal is more than the recharging rate, the sediments in aquifer become compacted. It is called 'Ground Subsidence'. Huge economic losses may occur due to this phenomenon. The common problems are structural damage in buildings, fracture, and damage in pipes.

c) Water Logging

When excessive irrigation is done with brakish water it raises the water table gradually leading to water logging and salinity problems.

Sustainable Water Management:

Important Sustainable Water Management Methods are

- Building several small reservoirs instead of few large dams.
- Developing small catchment areas and it protects the surrounding wetlands.
- Soil management.
- A forestation permits recharging of under ground water.
- Preventing leakage from dams & Canals.
- Preventing loss in municipal pipes.
- Excessive rain water harvesting in urban environment.
- Water conservation measures in agriculture, such as using drip irrigation.
- Desalination of sea water and ground water to make it fit for human consumption.
- Increases irrigation efficiency in agricultural lands by reducing water wastage.
- Reduction in domestic water wastage by constructing waste water treatment plants and recycling the treated water.

Floods: Floods are due to rising water levels in earth as well as water bodies such as Rivers, Lakes etc, due to heavy rains. The effect of floods can be considerably reduced by the proper management. India is the worst flood affected country in the world. About 40 million hectares of nearly $1/8^{th}$ of the India's geo – graphical area is flood prone. Flood control measures involve construction of new embankments, drainage channels and a forestation. The satellite pictures of pre flood, flood and post flood along with other informatics contribute to the flood management process**.**

Floods are caused by both natural & anthropogenic factors
Natural factors are Siltation, Landslides
Anthropogenic factors are Deforestation, Overgrazing, Construction activities etc.

- Floods are important serious environmental hazards.
- Floods are usually occurs only in the rainy seasons.
- The loss of property was due to floods was 21 crores in 1951, which was increased to 1,130 crores in 1977.

Causes of Floods: Most of the human activities lead to the frequency and severity of flood. Some of them are

- Heavy rain fall
- Construction of buildings
- Removing vegetation
- Deforestation
- Urbanization
- Earthquakes
- Paving roads and parking areas etc.

Effects of Floods:

- Erosion of top soil and vegetation
- Damage and loss to lands, houses and properties
- Spreading of endemic water borne diseases
- Silting of reservoirs and dams

Control of Flood:

- Construction of flood control dam
- Deepening, widening and straight tightening of streams
- Lining of streams
- Banning construction of buildings in flood – plains
- Converting flood – plains into wildlife habitat, parks and recreation areas.

Precaution Measures:

- Valuable house hold items, animals, and other necessary materials like food, clothes, medicines etc should be shifted to safer places.
- Forecast, warnings and advices should be provided through media to educate and aware people about the steps to be taken.
- Government agencies and NGO's should be help the flood affected people by providing public health services.

Drought:

It has been a major problem in our country, especially in arid & semi – arid regions. It is an unpredictable climatic condition and occurs due to the failure of one of more monsoons.

Drought is lack or insufficiency of rain water for an extended period that causes considerable hydrological imbalances and consequently water shortages, depletion of ground water and soil erosion.

Drought not only leads to serious economic consequences but also leaves behind human misery. It also leads to food shortages and malnutrition which especially affects children.

Soil and water managements and afforestation are long term measures that reduce the impact of droughts. Similarly certain advanced techniques such as cloud seeding and artificial rains are short term measures.

Dams:

Dams are developmental activities of nature, provides lot of economy to country but it also shows environmental adverse impacts. Dams play an important role in communities and economics that harness these water resources for their economic development. Big dams and river valley projects have multi – purpose uses and have been referred to as 'Temples of Modern India'. However, these dams are also responsible for the destruction of vast areas of forests. India has more than 1550 large dams, the maximum being in the state of Maharastra (more than 600), followed by Gujarath (more than 250) and Madhya Pradesh (130). The highest one is 'Tehri Dam'on River 'Bhagirathi'in Uttarakhand and the largest in terms of capacity is 'Bhakranagal dam'on river 'Satluj' in Himachala Pradesh

First dam was built in the year 1890 in China. Today 45,000 dams are present over all the world. Dams are constructed for the purpose of National Development.

Advantages of Dams:

- Hydroelectric Generation
- Flood Control
- Agricultural Purpose
- Dam water is used as drinking water in remote areas
- Navigation
- Irrigation to agricultural fields
- Reduces Soil Erosion
- Increases Water Holding Capacity.

* Promote Fishery
* Promote tourism
* Employment

Disadvantages of Dams:

- So much of water losses through evaporation, that results in increases the salt content in water bodies.
- Accumulation of salts shows adverse impacts on plants growth.
- Spread of infectious diseases.
- It requires lot of Space.
- It requires lot of man – power.
- Construction takes more time.
- Investment & Maintenance cost will be high.
- If any damage is happens to dam, that water will be enter into the low lying areas.
- Loss of Flora & Fauna
- Deforestation, which leads to desertification
- Siltation
- Soil Erosion
- The fragmentation & physical transformation of rivers
- Serious impacts on river – eco – systems.
- Social consequences of large dams due to displacement of people.
- Water Logging and Salinization of the surrounding lands.
- Disloding animal populations, damaging their habitat & cutting off their migratory routes.
- Disruption of fishing & waterway traffic.

Conservation of Water Resources:

- Turn – off the taps while brushing the teeth, washing the clothes, cleaning the vessels etc.
- Take one bucket of water for bathing purpose, instead of using two or more buckets.
- In washing machines fill the water only to the level required for your clothes.

- Water the plants in your kitchen garden and lawns in the evening when evaporation losses are minimum.
- Use drip irrigation and sprinkler irrigation to improve irrigation efficiency and reduce evaporation.
- Built rain water harvesting system in your house

Conservation of Energy:

- Turn off lights and fans when not in use.
- Use solar cooker for cooking purpose.
- Recycle and reuse glass, paper, plastic etc.
- Use low voltage lights.
- Use tube lights & energy saver bulbs as they consume less electricity.
- Switch – off Radio & Television when not required.
- Use pressure cookers, it saves 75% of energy.
- Use public transport, rather than using own vehicles
- Keeping the vessel covered with a lid during cooking, helps to cook faster, thus saving 25% of energy.

Therefore an individual should

- Co operate with nature
- Try to sustain the ecological balance and bio-diversity of all species of earth
- Be responsible and minimize pollution and environmental degradation
- When an action is essential to meet a need , be sure it will not be harmful to other living organisms
- Use non – renewable resources continuously
- Use high quality energy and
- Keep in mind the long – term effects on natural resources before altering nature Sustainable development is based on carrying capacity and green accounting.

ROLE OF AN INDIVIDUAL IN CONSERVATION OF RESOURCES:

Every individual has a major role in the conservation and equitable use of natural resources for sustainable life styles, without natural resources, the survival of human beings is impossible. Different natural resources like forest, water, soil, food, mineral and energy resources play a vital role in the development of a nation. How ever, over use of these resources in our modern society is resulting in fast depletion of these resources and several related problems.

EQITABLE USE OF RESOURCES FOR SUSTAINABLE LIFE STYLES:

There is a big divide in the world as north and south, the more developed countries (MDC's) and less developed countries (LDC's), that haves and the have nots. The less developed does not mean that they are back ward as such they are culturally very rich or even much more developed, but economically they are less developed. The gap between the two is mainly because of population & resources.

The More Developed Countries have only 22% of world population, where as it is 78% in Less Developed Countries, Natural Resources Consumption is 88% in Developed countries, it is only 12% in less developed, energy utilization is 73% in developed, 27%

in less developed & per capita in con is 85% in more developed countries and 15% in less developed countries.
The gap increasing between the two is increasing with time due to sharp increase in population in Less Developed Countries.

Consumerism refers to the consumption of resources by the people. Technological development has been a key factor in the development of human society right from the earlier (or) stone age to the present country. Modern technologies have enabled the main to produce a huge amounts of consumer items.

The manufacturing and the use of several luxurious items like refrigerators, sir – conditioners, spray can dispensers, DVD's, VCD's etc, release substantial quantity of Chloro Flouro carbons into atmosphere which deplete the life saving ozone layer of the stratosphere. The problem of disposal of several products of modern technologies such as used batteries, plastics, polythenes and many electronic goods has become headache even for the industrially developed and technologically advanced countries. Consumerism and waste generation varies from country to country. More the consumption of resources more is the waste generation and greater in the degradation of the environment.

MODULE-III

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.

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

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

AIR POLLUTION

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

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

Eg: C, CO, 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.

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

→ CFC – 11 (Trichloro Fluoro Methane $CFCl_3$)
→ CFC – 12 (Dichloro Fluoro Methane CF_2Cl_2)
→ CFC – 113 (Trichloro Trifluoro Ethane $C_2F_3Cl_3$)
→ CFC – 114 (Dichloro Tetrafluoro Ethane $C_2F_4Cl_2$)
→ 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 environmental problems 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:

→ Inputs that do not contain the pollutants.

→ Operating process to minimize generation of the pollutants.

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

→ Removing the pollutants from the process. →Substitution of raw materials.

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

→ By involving the Process Modification:

Ex: Chemical and petroleum industries have changed by implementing automated operations, computerized process control by reducing the oxidation of 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

INTRODUCTION: Water is the essential natural resource for sustaining of life and environment, without water there would be no life. Water is one of the abundantly available substances in nature. 71% of the earth surface is covered by water, only a tiny fraction of water is available to us as fresh water.

Out of 100% of water, 97% of water is present in Oceans, 2% of water is present in Polar ice caps in the form of Ice and only 1% of water is available for human consumption.

Water availability on the planet: The water that is found in streams, rivers, lakes, wetlands and artificial reservoirs is called surface water. Water that percolates into the ground and fills the pores in soil and rock is called ground water. Porous water saturated layers of sand, gravel or bed rock through which ground water flows are called aquifers.

India receives most of her rainfall during the months of June to September due to the seasonal winds and the temperature differences between the land and the sea. The monsoon in India is usually reasonably stable but varies geographically.

DEFINITION: Release of unwanted materials like dust, smoke, pesticides, organic, inorganic compounds etc into water bodies and can cause adverse impacts on human beings, plants, animals and total environment is called 'Water Pollution'.

Hydrosphere: The study of water bodies' are called as 'Hydrosphere'. The hydrosphere consists of the oceans, lakes, rivers, glaciers and the ground water bodies that are connected to the surface water. The hydrosphere controls the climate and temperature of the earth and ensures continuous circulation of water between the ocean, the atmosphere and the biosphere.

Classification of Water bodies:

Water bodies are broadly classified into three levels

Based on Level – I classification: water bodies are two types. They are Lotic & Lentic water bodes.

Based on Level – II classification: Water bodies are two types. They are Fresh & Marine water bodies.

Based on Level – III classification: Water bodies are two types. They are Surface & Ground water bodies.

Distribution of Water: Water is distributed in nature in different forms, such as

a) Rain water

b) River water

c) Lake Water

d) Sea Water

➔ Rainwater is the purest from of naturally occurring water.

a) **Rain Water**: it is the purest form of natural water because it is obtained as a result of evaporation from surface water. However, when it falls on the surface of the earth through the atmosphere, it dissolves a considerable amount of acidic oxides like CO_2, SO_2, NO_2 and suspended solid particles.

b) **River Water**: water from rain and springs flows over the surface of the land, dissolves the soluble minerals in the soil and finally falls into rivers. River contains dissolved minerals such as chlorides, sulphates and bicarbonates of

sodium, calcium, magnesium and iron. River water also contains organic matter derived from the decomposition of plants and animals, and small particles of sand and rock in suspension.

c) **Lake Water**: lake water is usually contains a smaller amount of dissolved minerals but the quantity of organic matter present is quite high. Lakes hold standing fresh water throughout the year. As their water is much more accessible than ground water or glaciers, they are an important source of water. Water from this source is more uniform in quality than water from flowing rivers or streams.

d) **Sea Water**: sea water is the most impure form of natural water. Rivers join the sea and dispose their impurities into the sea. Also, continuous evaporation of water makes the sea water rich in dissolved impurities. Sea water contains about 3.5% dissolved salts of which 2.6% is sodium chloride. Other salts present are sodium sulphate, bicarbonates of K and Mg, and many others.

USES OF WATER:

Water is used in different sectors for different purposes. Water is used in

➔ Domestic sector

➔ Agricultural sector

➔ Industrial sector

➔ Commercial sector

SOURCES OF WATER: The chief and important sources of water supply for industrial and other sectors are

a) Ground water

b) Surface water

c) Sea water

d) Rain water

Point and Non – Point Sources of Pollution:

Broadly, water pollution causes due to either point source or non point source or both – the point sources are like drain pipes, ditches, sewer out falls etc., and Non – point sources are run – off, atmosphere deposition etc. Water Pollution may be caused by biotic and a biotic contaminants. The water pollution results from either natural sources or artificial sources. The natural phenomena, for ex, drought renders water levels to decline in aquifers allowing salt water to intrude; during rains, the running water gathers silt, harmful chemicals such as fertilizers and pesticides from the soil

and so on. Sewage is another major cause of water pollution. The human activities, industry, agriculture, mining, deforestation, power generation, cause water pollution. Population growth and unplanned urbanization also contribute to pollution of water. Factories and mines releases large quantities of toxic chemicals, organic wastes, heavy metals, heated effluents, inert wastes and radio active wastes causing water pollution. Toxic chemicals / wastes are not easily degradable by biological means. DDT and Mercury fall under this category. The water contaminated by them is highly poisonous and if contacted or consumed by plants or animals, may prove fatal.

CAUSES OF WATER POLLUTION: Water pollution is mainly caused by two processes

a) Natural sources

b) Anthropogenic sources

a) **Natural sources:** Natural processes include decomposed vegetable and animal waste, weathered products are brought into main water resources. All these processes are interdependent on each other and lead to deterioration of natural environment. If organic matter is added to water, it will not only influence the chemical characteristics, but will also affect the physical and biological properties.

b) **Anthropogenic sources:** Anthropogenic process such as industrial, agricultural, urban, radio – active, mining sources, use of pesticides, fertilizers by man etc.

CLASSFICATION OF WATER POLLUTANTS:

The various types of water pollutants can be broadly classified into following five major categories.

➔ Organic pollutants

➔ Inorganic pollutants

➔ Suspended solids & sediments

➔ Radio active pollutants

➔ Heat (or) thermal pollutants

➔ **Organic pollutants:** this group includes

(i)Oxygen Demanding wastes

(ii)Disease Causing Agents

(iii)Plant Nutrients

(iv) Sewage

(v)Synthetic organic compounds

(vi)Oils

(i) Oxygen Demanding Wastes: This group includes domestic and animal sewage, bio – degradable organic compounds and industrial wastes from food – processing plants, meat packing plants, slaughter houses, pulp – paper mills & tanneries as well as agricultural run – off. All these wastes are under go degradation and decomposition by bacterial activity in presence of dissolved oxygen. This results in rapid depletion of DO from the water, which is harmful to aquatic organisms.

Many organic substances are soluble in water. Most of the natural materials consist of the decay products of organic materials are usually from waste water discharges. The organic substances which are decomposed by bacteria in the presence of oxygen that is dissolved in water are called biodegradable oxygen demanding substances.

The presence of dissolved oxygen is essential for aquatic plants and animals. In waste or sewage water, aerobic oxidation takes place till the dissolved oxygen is present. Once the oxygen gets exhausted, anaerobic oxidation starts. During anaerobic oxidation, complex organic compounds split up and gases like carbon – di – oxide, hydrogen sulphide, ammonia and methane are released. As a result of oxygen deficiency occurs this causes a decrease in the growth of aquatic plants and animals.

The processes which affect the amount of dissolved oxygen are

- Re aeration
- Photosynthesis
- Respiration and oxidation of waste

(ii) Disease Causing Agents: These include pathogenic micro organisms which may enter the water along with sewage and other wastes and may cause tremendous damage to public health.

These microbes mainly bacteria and viruses can cause dangerous water born diseases such as Cholera, Typhoid, Hepatitis, dysentery etc.

(iii) Plant Nutrients: nutrients are essential for the growth and reproduction of aquatic plants. Nutrients consist of about 20 elements and absence of any one of them can restrict growth. The most common nutrients required by aquatic plants are carbon, nitrogen and phosphorus. Water bodies are enriched with nutrients through both natural and artificial sources

(iv) Synthetic Organic Compounds: There are man-made materials such as synthetic pesticides, Synthetic detergents, food additives, pharmaceuticals, insecticides, paints, synthetic fibers, solvents etc.

(v) Sewage and Agricultural Run-off: Sewage and runoff from agricultural lands supply plant nutrients, which may stimulate the growth of algae and other aquatic weeds in the receiving water body.

(vi) Oils: Oil pollution leads to unsightly and hazardous conditions, which are deleterious to marine life and seafood.

2. Inorganic Pollutants:

Inorganic Pollutants comprise of mineral acids, Inorganic salts, finely divided metals and metallic compounds, trace elements, cyanides, sulphates, nitrates, organo metallic compounds and complexes of metals with organics present in natural waters.

Algal growth in water and metal toxicity in aquatic ecosystem is also influenced by there interactions.

3. Suspended Solids and Sediments:

Sediments are mostly contributed by soil erosion by natural process, agricultural development, strip mining and construction wastes. Suspended Solids in water mainly comprise of silt, sand and minerals eroded from the land. Soil Erosion leads to qualitative and quantitative degradation of soil.

4. Radioactive Pollutants:

The emission of energy from radio – active substances which constitutes a health hazard is called 'Radio – active Pollution'. The sources of radio –activity are both natural and artificial.

The natural sources are as follows:

- Cosmic rays from outer space. The intensity of cosmic rays in the biosphere is low and so they are not a health hazard.
- Emission of radio – active elements present in the earth's crust. These elements are Ur^{235}, Ur^{238}, Ra^{224}, Th^{132}, and C^{14}.

The artificial Sources are:

- Use of radio active material in nuclear weapons
- Use of $U^{235,}$ Pu^{239} for fission
- Use of radio active materials in nuclear power plants, and
- Use of radio active isotopes in medical, industrial and research work
- Used medical X – rays
- Photographic films or negatives etc

Ex: I^{131}, P^{132}, CO^{60}, Ca^{45},$C^{14,}$ Nuclear Power Plants, Photographic films, Medical X-Rays.

5. Heat/ Thermal Pollutants:

Thermal Pollutants results from thermal power plant, particularly nuclear based power plants, and electricity generating units. Waste is produced in all processes in which heat is converted into mechanical work. In most of the industries water is used as coolant agent for cooling purpose. The waste hot water is returned to the original water bodies. Hence the temperature of the water body increases which adversely affect the aquatic life. The suspended solids in water may also cause bad odors and taste and also promote conditions favorable for the growth of pathogenic micro – organisms.
Thermal pollution is defined as the process of warming of water which leads to adverse effects on the living organisms in water.
The adverse effects are

- Toxic effects
- Reduction of growth of aquatic plants and animals
- Reduction in dissolved oxygen
- Spread of diseases
- Increase in oxygen demand for the survival of aquatic organisms with the increase in temperature.
- Disruption of eco – system in the natural environment, and
- Increase in the population of parasites.

Sources of Water Pollution: Sources of water pollution can be classified as follows

a) **Point Sources**
b) **Non – Point Sources**

a) **Point sources of Pollution:** Point sources of pollution occur when harmful substances are emitted directly into a body of water. The Exxon valdez oil spill best illustrates point sources of water pollution**.**
   Ex: Specific discharges from Municipalities or Industrial complex, organics or metals entering surface water as a result of waste water discharge from a manufacturing plant.
b) **Non – Point Sources of Pollution:** A non – point source delivers pollutants indirectly through environmental changes.
   Ex: An example of this type of water pollution is when fertilizers from a field is carried into a stream by rain, in the form of run – off which is turn affects aquatic life. Non – point sources are much more difficult to control.
   Pollutants from urban area, Industrial area, rural run – off (Sediment, Pesticides or Nitrates entering a surface water balance or run – off from agricultural farms).

Characterization of Waste Water:

Wastewaters are characterized on the basis of various physical, chemical and biological characteristics apart from flow data.

(a) Physical characteristics
(b) Chemical characteristics
(c) Biological characteristics.

(a) Physical characteristics: Colour, odour, dissolved oxygen (DO), insoluble substances, corrosive properties, radioactivity & Temperature range etc.,

(b) Chemical characteristics: It includes chemical oxygen demand (COD), pH, Alkalinity, Acidity, Hardness, total dissolved solids, total suspended solids, Phenols, Hydro carbons, Oils & Grease.

(C) Biological Characteristics: Biological Oxygen Demand (BOD), presence of pathogenic bacteria.

(a) Physical Properties:

Important physical properties are (i) Colour (ii) Temperature (iii) Turbidity

(i) Colour:

- Pure water doesn't produce any colour and taste.
- Colour is measured by using of two units
  a) Platinum – Turbidity Unit
  b) Hazen's Unit
- According to WHO standards for drinking water, the permissible limit / level of colour is 20 ppm.
- Colour is removed by using adsorption, Coagulation, and Filtration methods.
- Colour in water caused due to the presence of organic matter.

(ii) Temperature:

- An ideal temperature in water bodies is $4 – 10^0$ C. 26^0C is undesirable, if water consists of 35^0 C that is unfit for human consumption.

(iii) Turbidity:

- Turbidity is caused due to the presence of suspended & colloidal particles.
- Turbidity is measured by using two units
  a) Nephlometric Turbidity Unit
  b) Jackson Turbidity Unit

(b) Chemical Properties:

Chemical properties re (i) Total Solids (ii) Hardness (iii) pH (iv) Buffering Capacity (v) Salinity (vi) Chlorides (vii) Iron & Manganese etc

(i) **Total Solids**:
Solids in water bodies are three types

a) Suspended Solids
b) Dissolved Solids
c) Colloidal Solids

(a) **Suspended Solids**: The Size of the Suspended particle is > 10 □.
(b) Dissolved Solids
(c) **Colloidal Solids**: the Size of the colloidal particles are 0.01□ - 10 □.

The maximum permissible limit of total solids is 750 mg/ L.

(ii) Hardness:

Hardness of water is divided into two types

a) Temporary Hardness
b) Permanent Hardness

a) **Temporary Hardness**: Water gets temporary hardness due to the presence of Carbonates & Bi – Carbonates of Calcium and Magnesium.

b) **Permanent Hardness**: Water gets permanent hardness due to the presence of Chlorides & Sulphates of Calcium & Magnesium. Hardness is generally expressed in ppm (or) gm / L.

(iii) **pH**:

pH indicates the concentration of hydrogen ions in water
Neutral pH is 7
Acidic pH is 0 – 7
Alkaline pH is 7 – 14.

(iv) **Buffering Capacity**:

It is the ability of water to maintain stable pH value even if acids (or) bases are added.

(v) Salinity:

Salinity refers to the total amount of dissolved substances present in water.

(vi) Chlorides:

Excessive Chloride in water is dangerous and unfit for use.
The maximum permissible level of chlorides in drinking water 1< 250 ppm.

(vii) Iron & Manganese:

Brownish red colour in water is due to the presence of Iron & Manganese. It leads to the growth of microbial community and corrodes the water pipes

POTABLE WATER:

The water that is fit for or suitable for drinking purposes is called is called 'Potable Water'.

Characteristics of Potable Water:

- ➔ It should be colourless, odour less and taste less.
- ➔ It should be clear and aesthetically pleasant.
- ➔ It should be free from turbidity & other suspended impurities.
- ➔ It should be free from germs, bacteria and other pathogenic organisms.
- ➔ It should not contain toxic dissolved impurities such as heavy metals.
- ➔ It should have a pH range of 7 – 8.5.
- ➔ It should be moderately soft and should be aesthetically pleasant.
- ➔ It should not be corrosive to pipelines.
- ➔ It should not stain (or) damage the clothes.
- ➔ Its alkalinity should not be high.
- ➔ Its total dissolved solids content should not exceed 500 ppm.
- ➔ Its turbidity should not exceed 10 ppm.
- ➔ It should maintain the DO range of 4 – 6 microgram / L.

CLASSIFICATION OF A LAKE:

A lake may be regarded as made up of layers determined on the basis of

- ➔ The temperature
- ➔ The CO_2
- ➔ The O_2

➔ The presence of organisms

a) Top Layer

b) Middle Layer

c) Bottom Layer

a) **Top Layer**: It is called as 'Limnatic Zone'.

b) **Middle Layer**: It is called as 'Littoral Zone'.

c) **Bottom Layer:** It is called as 'Profundal Zone'.

Based on vegetation, a lake can be classified into 3 important layers.

➔ Epilimnion

➔ Thermo cline

➔ Hypolimnion

➔ **Epilimnion:** Surface layer of the lake is called 'Epilimnion'. It is also called as 'Nutrient Rich Layer'.

➔ **Thermocline**: Middle layer of the lake is called 'Thermocline'.

➔ **Hypolimnion:** Bottom layer of the lake is called 'Hypolimnion'.

EUTROPHICATION:

The term 'eutrophication 'is derived from 'Greek Word', 'Eutrophs' which means 'Enrichment'. The total term eutrophication refers 'Enrichment of Nutrients'.

TYPES OF EUTROPHICATION:

Eutrophication is divided into two types

➔ Natural Eutrophication

➔ Cultural Eutrophication (or) Artificial Eutrophication

IMPORTANT NUTRIENTS TO CAUSE EUTROPHICATION:

The three important nutrients useful for the process of eutrophication are

- ➔ Carbon
- ➔ Nitrogen
- ➔ Phosphorus

RATE OF EUTROPHCATION:

- ➔ Size of the water body
- ➔ Quantities of Nitrates, Phosphates, Potassium.

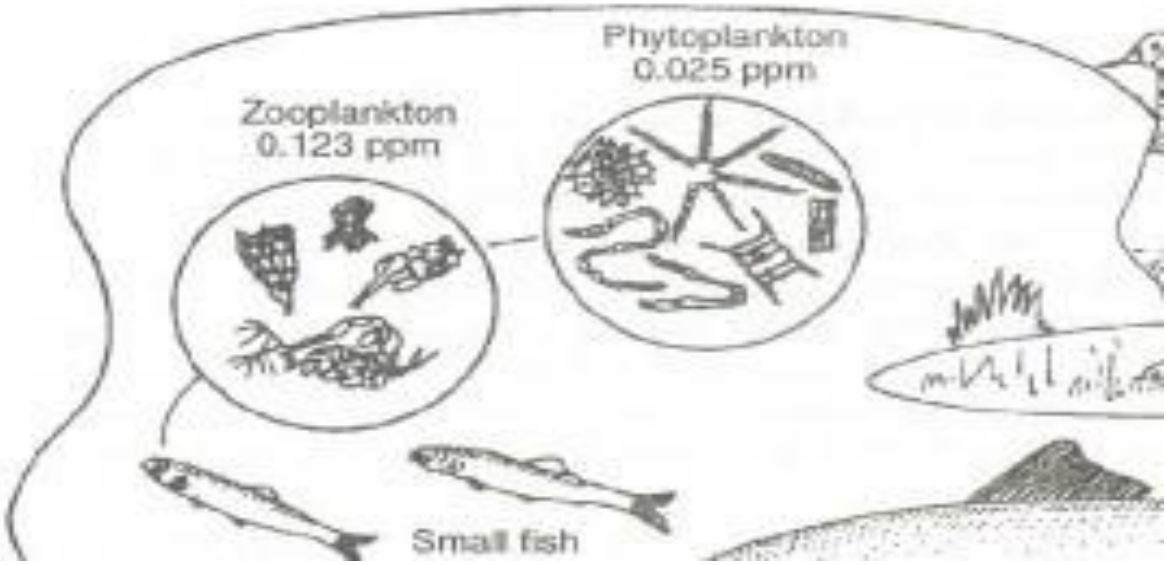
HARMFUL EFFCTS OF WATER POLLUTION:

- ➔ Reduction of Dissolved Oxygen
- ➔ Reduction of Light Penetration
- ➔ Eutrophication
- ➔ Sewage is an excellent medium for the growth of pathogenic bacteria, viruses,& Protozoa, these are also cause water born diseases like Cholera, Typhoid, Hepatitis, Dysentery.
- ➔ Oxygen deficiency leads to the production of objectionable odours in water.
- ➔ Discharge of nutrient rich effluents, sewage and domestic waste in combination with industrial waste poses serious health problems in man.
- ➔ Excessive use of nitrates causes 'Blue Baby Disease'.
- ➔ During eutrophication algal bloom release toxic chemicals, which kill Fish, Birds, & other aquatic animals causing water to sink.
- ➔ Bio – Magnification
- ➔ Decreases Oxygen availability
- ➔ Increases the demand of oxygen
- ➔ Causes turbidity
- ➔ Radiation effects
- ➔ Changes the composition of flora & fauna
- ➔ Increases the rate of decomposition

➔ Changes the physical, chemical & biological properties

➔ Changes the metabolic activities of organisms

➔ Increases the toxicity of pesticides, detergents etc.



Common Effluent Treatment Plants (CETP):

A small – scale industry cannot afford to clean up all its effluents. One solution to this problem is to collect the waste of several units from an industrial estate and treat it at a common location. The various state pollution control boards in India are now compelling specific polluting industries in an area to set up common effluent treatment plants (CETPs).

CETPs are a cost – effective, and perhaps the ideal, solution to controlling pollution. Half the cost is met by the industries and a quarter each by the sate and central governments. Each unit also contributes towards the running of the plant.

By 2002, 53 CETPs had been built and 83 more were under construction. The first plants were set up to treat tannery wastes in Tamil Nadu, textile wastes in Rajasthan, and industrial waste in Andhra Pradesh.

CETPs have run into many cases, reliable information is not available on the amounts and types of waste expected to reach the CETP. As a result, their design may not be appropriate. Further, a cocktail of different chemicals can be far more toxic than the individual chemicals themselves.

There are also problems of fixing the charges and getting the users to pay them. Questions also remain about the management and proper functioning of CETPs. For example, who should be held responsible if the treatment is poor and the CETP itself becomes a polluter?

PREVENTION & CONTROL OF WATER POLLUTION:

Waste water, whether domestic / Industrial waste water consists of various undesirable compounds like organic, inorganic pollutants, nitrates, phosphates, radio – active materials, phosphates, radio – active pollutants, heat / thermal pollutants that are potentially harmful to the environment and human health.

Sewage Treatment Plants (Waste Water Treatment Methods) STP:

It is estimated that every year 1.8 million people die to suffering from waterborne diseases. A large part of these deaths can be indirectly attributed to improper sanitation. Wastewater treatment is an important initiative which has to be taken more seriously for the betterment of the society and our future. Wastewater treatment is a process, wherein the contaminants are removed from wastewater as well as household sewage, to produce waste stream or solid waste suitable for discharge or reuse.

Objective of Waste Water Treatment:

The main objective of waste water treatment is the removal of contaminants from untreated water, so that the treated water can be reused for beneficial purposes. Substances that are removed during the treatment process include bacteria, fungi, virus, protozoa, minerals, toxic chemicals and other suspended and dissolved particles etc

- ➔ Treatment methods
- ➔ Reduction, Reuse & Reutilization (3R'S Method)
- ➔ Removal of Phosphorus by Electrolysis
- ➔ Removal of salts by Reverse – Osmosis

Treatment Methods:

Water treatment methods are classified into 4 types

1) Preliminary Treatment

2) Primary Treatment

3) Secondary Treatment

4) Tertiary Treatment

1) Preliminary Treatment:

The principle objective of preliminary treatment is the removal of gross particles (or) solids like floating materials, suspended solid matter, grit, oil, grease etc if they are present in considerable quantities.

The processes generally used in preliminary treatment are

a) Screening

b) Grit Chambers

c) pH Adjustment

a) Screening:

Screening is the first operation method used to remove coarse solids like wood pieces, oils, suspended particles, floating materials etc

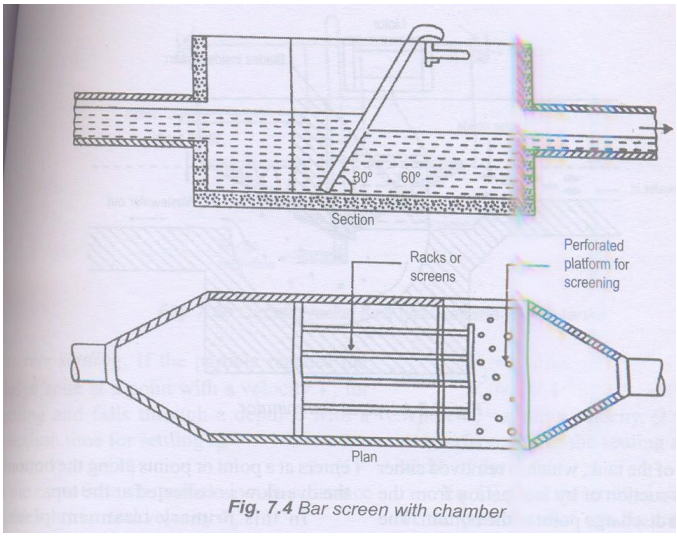


Fig. 7.4 Bar screen with chamber

b) Grit Chambers:

Grit: Grit is the detritus matter (or) decay of organic and inorganic matter. Grit is removed from this chamber. These chambers remove the organic and inorganic suspended matter in the form of 'Floc'.

c) pH Adjustment:

Distilled water has an average pH of 7, sea water has an average of 8.3 (Slightly Alkaline), if water is acidic then we can raise the pH of the water by adding of Lime (or) Soda ash. Now a days lime is commonly using to raise the pH because it is cheaper.

2) Primary Treatment: Primary treatment is called is called as 'Physical Treatment'. After removal of gross solids, grit materials and excessive quantities of oil and grease, the next step is to remove the remaining suspended solids as much as possible. and also remove physical properties like colour, odour, taste etc.

The Main Objective of Primary Treatment is:

To reduce the strength of the waste water.

Types of Primary Treatment:

a) Coagulation

b) Flocculation

c) Filtration

d) Sedimentation

a) Coagulation: It is the destabilization of colloids by addition of chemicals that neutralize the –Ve charges. Many of the suspended particles have –Ve electric charge. Coagulants are added in the tank to the mixture.

Commonly Used Coagulants are:

Aluminium Sulphate (Alum)

Iron Sulphate

Iron Chloride

Iron sulphate can work over a larger pH range than Alum. Alum reacts with H_2O to form 'Aluminium Hydroxide'. If Iron sulphate & Iron chloride is added as 'Coagulant' it causes brownish colour in water, but trace levels of Iron is not harmful to humans.

b) Flocculation:

Floc: Group of suspended particles present in water looks like a large particle is called as 'Floc'. In this method Flocculant aids/ coagulant aids are added to destabilize the particles after coagulant addition, H_2O is mixed slowly for 10 – 30 mins. Then this water is send to the next tank called as 'Sedimentation Tank'.

c) Sedimentation:

It is large tank with slow flow, then allow the floc to settle at the bottom of the tank. Sedimentation tank is in rectangular shape. Here large particles are settled at the bottom of the chamber and then lighter particles are settled on large particles. Finally a layer of sludge is formed on the floor of the tank.

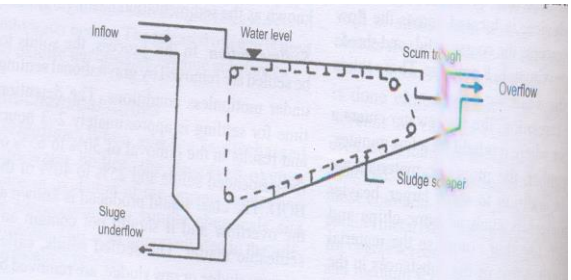


Fig. 7.6a Rectangular horizontal flow-type sedimentation tank

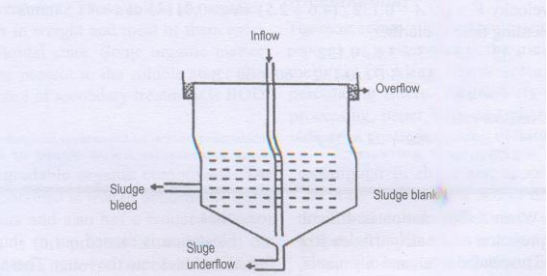


Fig. 7.6c Vertical flow type sedimentation tank

d) Filtration:

After separating most floc, the water is filtered as the final step to remove the remaining suspended solids and unsettled floc. Water is poured in vertical motion, the suspended particles are trapped in pore spaces. The upper layer / Top layer removes the organic suspended matter and bottom layer removes the inorganic suspended matted. Effective filtration extends into the depth of the filter. Generally filter consists of a layer of activated carbon and a layer of sand particles.

Types of Filters:

- Slow Sand Filters
- Rapid Sand Filters

3) Secondary Treatment: Secondary Treatment is also called as ‘Chemical Treatment’. Secondary treatment is substantially reduce the biological content of the sewage derived from human waste, includes food waste, detergents , soaps etc.

The effectiveness is depends on biota, in all these methods the bacteria, protozoa consume biodegradable soluble organic contaminants such as sugars, fats, lipids etc. These processes may be aerobic (or) anaerobic.

In anaerobic process, the bacteria and other micro – organisms consume the organic material as ‘Food’. The secondary treatment reduces BOD levels in water. It also removes the appreciable amounts of oil & phenol. The anaerobic process is mainly

employed for sludge digestion. The efficiency is depends on pH, temperature, quality of water , toxic materials present in water etc.

- In this method we can remove the suspended and dissolved solids etc. Different types of coagulants are added to this treatment for coagulation of pollutants in water body.

Oxidation Pond:

An oxidation pond is a large shallow pond with arrangements to measure the inflow and out flow. The water is enter into the pond at one end and the effluent is removed from the other end. Stabilization of organic matter in the water is brought about mostly by bacteria, such as Pseudomonas, Flavo bacterium and to some extent by facultative protozoa. The O_2 requirements for their metabolism is provided by algae present in the pond. The algae, in which turn utilize the CO_2 released by the bacteria for the photosynthesis process. In this way the bacteria and algae shows symbiotic relationship wit each other.

Oxidation ponds are called as 'Stabilization Ponds'.

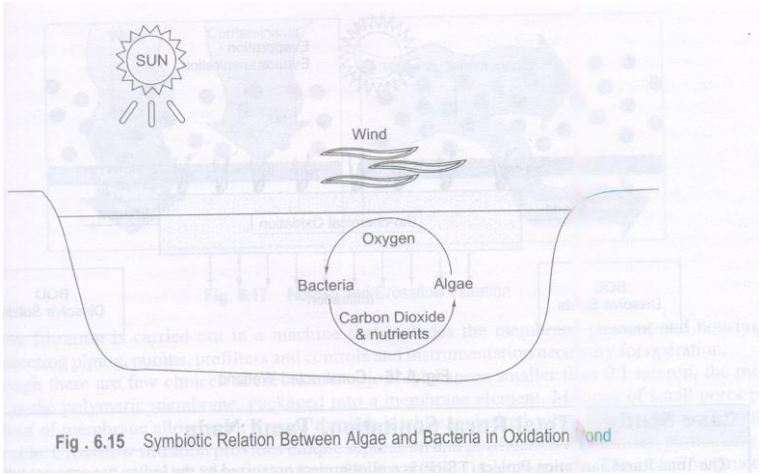


Fig . 6.15 Symbiotic Relation Between Algae and Bacteria in Oxidation Pond

4) Tertiary Treatment: Tertiary treatment is also called as 'Advanced Waste Water Treatment' (or) 'Biological Treatment'. It is the final treatment of waste water before discharging into the receiving environment like rivers, sea, lakes, streams etc .This process is called as 'Effluent Polishing'.

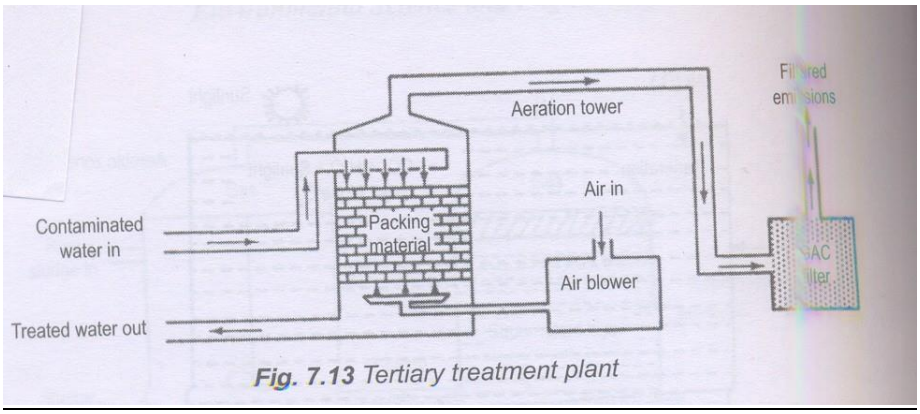


Fig. 7.13 Tertiary treatment plant

Disinfection:

The purpose of disinfection is the treatment of waste water is to reduce the number of micro – organisms present in water. The water is treated by U.V.light/ O_3/ Chlorides.

Objectives of tertiary treatment:

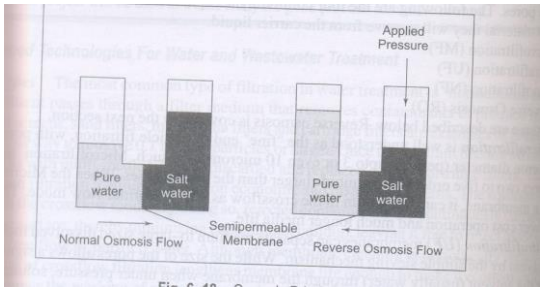
- Removal of fine suspended particles
- Removal of bacteria
- Removal of dissolved inorganic solids.

REMOVAL OF PHOSPORUS BY ELECTROLYSIS:

Organic sewage is mixed with 10 – 15% seawater and subjected to electrolysis to remove the phosphorus from treated as sewage, which enhances eutrophication. Phosphorus compounds in sewage get precipitation as Calcium and Magnesium Phosphate; H_2 gas is liberated during electrolysis makes the phosphate & sludge to flat on the surface as 'Scum'.

REMOVAL OF SALTS BY REVERSE – OSMOSIS:

Various salts and other toxic substances can be removed by reverse osmosis by flowing the wastewater through a semi permeable membrane.



Effluent Treatment Plants (ETP):

Effluent Treatment Plants or (ETPs) are used by leading companies in the pharmaceutical and chemical industry to purify water and remove any toxic and non – toxic materials or chemicals from it. These plants are used by all companies for environment protection. An ETP is a plant where the treatment of industrial effluents and waste waters is done. The ETP plants are used widely in industrial sector, for example, pharmaceutical industry, to remove the effluents from the bulk drugs. During the manufacturing process of drugs, varied effluents and contaminants are produced. The effluent treatment plants are used in the removal of high amount of organics, debris, grit, pollution, toxic, non toxic materials, polymers etc. From drugs and other medicated stuff. The ETP plants use evaporation and drying methods, and other auxillary techniques such as centrifuging, filtration, incineration for chemical processing and effluent treatment.

Indian Standards Specifications for Drinking Water :

S.No	Parameter	Requirement Desirable Limit	Remarks
1	Colour	5	May be extended up to 50 if toxic substances are suspected
2	Turbidity	10	May be relaxed up to 25 in the absence of alternate
3	pH	6.5 – 8.5	May be extended up to 9.2 in the absence
4	Total Hardness	300	May be extended up to 600
5	Calcium as Ca	75	May be extended up to 200
6	Magnesium as Mg	30	May be relaxed up to 100
7	Copper as Cu	0.05	May be extended up to 1
8	Iron	0.3	May be extended up to 1.5
9	Manganese	0.1	May be extended up to 1
10	Chlorides	250	May be extended up to 1000
11	Sulphates	150	May be extended up to 400
12	Nitrates	45	No Relaxation
13	Flourides	0.6 – 1.2	If the limit is below 0.6 water should be rejected, Max. Limit is extended to 1.5
14	Phenols	0.001	May be relaxed up to 0.002
15	Mercury	0.001	No Relaxation
16	Cadmium	0.01	No Relaxation
17	Selenium	0.01	No Relaxation
18	Arsenic	0.05	No Relaxation
19	Cyanide	0.05	No Relaxation
20	Lead	0.1	No Relaxation
21	Zinc	5.0	May be extended up to 10.0
22	Anioinc	0.2	May be relaxed up to 1

	Detergents (MBAS)		
23	Chromium as $Cr^{+}6$	0.05	No relaxation
24	Pesticides	Absent	
25	Mineral Oil	0.01	May be relaxed up to 0.03

Drinking Water Specification : Is: 10500, 1992 (Reaffirmed 1993) Tolerance Limits:

S.No	Parameter	IS: 10500 Requirement (Desirable Limit)	Undesirable Effect outside the Desirable Limit	IS: 10500 Permissible Limit in the Absence of Alternate Source
Essential Characteristics:				
1	pH	6.5 – 8.5	Beyond this range the water will effect the nucous membrane and / or water supply system	No Relaxation
2	Colour (Hazen Units) Max	5	Above 5, consumer accptance decreases	25
3	Odour	Unobjectionable		
4	Taste	Agreeable		
5	Turbidity, NTU, Max	5	Above 5, consumer acceptance decreases	10
Following Results are expressed in mg / L				
6	Total Hardness as $CaCO_3$, Max	300	Encrustation in water supply structure and adverse effects on domestic use	600
7	Iron as Fe, Max	0.30	Beyond this limit taste / appearance are affected , has adverse effect on domestic	1.0
8	Chlorides as Cl, Max	250	Beyond this limit taste, corrossion and palatability are	1000

			effcted	
9	Residual, Free Chlorine, Min	0.20	Beyond this palatability	
Desirable Characteristics:				
10	Dissolved Solids , Max	500	Decreases and may cause gastriintestinal irritation	2000
11	Caicium as CA, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200
12	Magnesium as Mg, Max	30		100
13	Copper as Cu, Max	0.05	Astringent taste, discoloration and corrosion of pipes, fitting and utensils will be caused beyond this	1.5
14	Manganese as Mn, Max	0.1	Beyond this limit taste / appearance are affected, has adverse effect on domestic uses and water structures	0.3
15	Sulphate as SO_4 Max	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are pressent	400
16	Nitrates as NO_3	45	Beyond this Methanoglobinemia takes palce	100
17	Fluoride, Max	1.0	Flouride may be kept as low as possible. High flouride3 may cause flourosis	1.5
18	Phenolic Compounds as C_6H_5OH, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002
19	Mercury as Hg, Max	0.001	Beyond this, the water becomes toxic	No Relaxation

20	Cadmium as Dd, Max	0.01	Beyond this, the water becomes toxic	No Relaxation
21	Selenium as Se,Max	0.01	Beyond this, the water becomes toxic	No Relaxation
22	Arsenic as As, Max	0.05	Beyond this, the water becomes toxic	No Relaxation
23	Cyanide as CN, Max	0.05	Beyond this, the water becomes toxic	No Relaxation
24	Lead as Pb, Max	0.05	Beyond this, the water becomes toxic	No Relaxation
25	Zinc as Zn, Max	5	Beyond this limit it can cause astringent taste and an opalescence in water	15

Flow Diagram of Waste Water Treatment Process:

SOIL POLLUTION

INTRODUCTION: Lithosphere is the outer solid component of the earth consisting of rocks, minerals and soil. Lithosphere is the solid shell on the surface of the earth. It consists of the crust, mantle and core.

In 'Greek' 'Lithos' means 'Rocks', thus the term lithosphere refers to the layers of the rock. Soil is the most important segment of the lithosphere. The word soil is derived from 'Latin Word', 'Solum ' means earthy material, in which growth of plants takes place.

PEDOLOGY (OR) EDAPOLOGY:

The study of soil (or) The study of 'Soil Sciences' is called 'Pedology' (or) 'Edapology'.

IMPORTANCE OF SOIL:

Soil is one of the most significant ecological factor, which is derived from the transformation of surface rock.

➔ Soil is the storehouse of 'Mineral Matter ' & 'Organic Matter'.

➔ Soil acts as 'Reservoir of Water'.

➔ Soil conserves the fertility and produces of vegetative growth.

DEFINITION:

Soil is a dynamic natural body on the surface of the earth in which plants grow, composed of mineral and organic material. (or) soil may be broadly defined as the weathered layer of the earth's crust with living organisms and their products of decay.

LITHOSPHERE:

The earth is a cold, spherical, solid planet on its axis and revolves around the sun at a certain fixed constant distance. This solid component of the earth is called 'Lithosphere'.

LAYERS OF THE LITHOSPHERE:

Lithosphere is multi layered rock and includes following three main layers.

➔ Crust

➔ Mantle

➔ Core

(a) Core: It is the inner layer of the earth.

➔ It is in liquid state.

➔ It consists of mainly two elements, namely Ni, Fe.

➔ Core is divided into two types (i) Inner Core (ii) Outer Core.

➔ The temperature of the core is around is $6{,}000^0$ C.

➔ Radius of the core is about 3440 kms from centre of the earth.

➔ The inner core contains nearly pure Iron, where as the outer core contains predominantly Iron.

➔ The thickness of the outer core is about 2140 kms, where as that of the inner core is about 1300 kms.

(b)Mantle: It is in semi – solid state.

- It extends about 2900 kms above the core.

➔ Middle layer of the earth is called 'Mantle'.

➔ It consists of three portions (i) Lower Mantle (ii) Transition Zone (iii) Upper Mantle

➔ (i) Upper Mantle (400 Kms).

➔ (ii) Transition Zone (300 Kms).

➔ (iii) Lower Mantle (2200 Kms).

➔ The density of the lower mantle is more that (or) less equal to that of upper mantle.

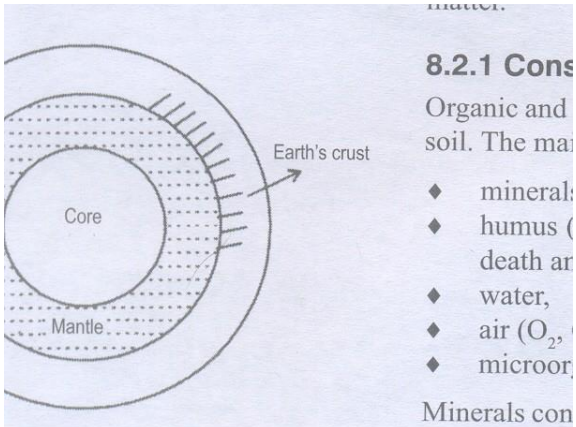
➔ Oxygen is the most predominant and Silicon is the most abundant element in mantle.

(a) **Crust** : It is the outer most solid layer of the earth.

➔ Its surface is covered with soil.

➔ It is only the part that is supporting rich and varied biotic community.

➔ It is about 30 Kms above the mantle.



3.1 The layers of the earth

8.2.1 Cons

Organic and
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ROCKS:

The earth crust is made up of three types of rocks.

(a) Igneous Rocks

(b) Metamorphic Rocks

(c) Sedimentary Rocks

(a) **Igneous Rocks:** These are forms by cooling and solidification of molten rock material called 'Magma'**. Ex** : Basalt, Diorite

(b) **Metamorphic Rocks**: These are formed by the result of metamorphosis of igneous and sedimentary rocks under the influences of high pressure and intense heat. **Ex:** Quartz, Slate, Marble.

(c) **Sedimentary Rocks:** These are developed as a result of gradual accumulation, Consolidation, Hardening of products of weathering of mineral materials brought by wind (or) waters.

Ex: Lime Stone, Sand Stone, Shale etc.

FORMATION OF SOIL: Soil is formed by weathering of rocks.

(a) Physical Weathering

(b) Chemical Weathering

(c) Biological Weathering

(a) **Physical Weathering**: Physical weathering is mainly brought about by changes in temperature, water, and wind. Physical weathering includes (i)Wetting – Drying (ii)Heating – Cooling (ii) Freezing (iv) Sand – blast.

(b) **Chemical Weathering:** Chemical weathering involves the process such as (i) Hydration (ii) Hydrolysis (iii) Carbonation (iv) Chelation (v) Oxidation – Reduction.

(c) **Biological Weathering:** Organisms such as Bacteria, Lichens, Algae, and some Fungi in presence of oxygen, moisture reacts and cause damages to the rocks.

COMPOSITION OF SOIL: Soil consists of four major components i,e,

➔ Mineral matter - 45%

➔ Organic matter - 5%

➔ Air - 25%

- ➔ Water - 25%

MINERAL MATTER:

Mineral matter of the soil is also called as 'Inorganic Matter'.

- ➔ It is present in top and middle soils.
- ➔ Mineral matter is divided into two types (i) Chief Inorganic Matter, (ii) Ordinary Inorganic Matter.
- ➔ **Chief Inorganic Matter**: Chief inorganic elements are Nitrogen, Phosphorus, Calcium, Aluminium, Magnesium, Iron, Silicon and Sodium.
- ➔ **Ordinary Inorganic Matter**: Ordinary Inorganic elements are Manganese, Copper, Zinc, Cobalt, Boron, Iodine and Fluorine.

ORGANIC MATTER:

Soil consists of 5% of organic matter present in top and middle soils. It contains a large number of organic compounds such as Amino acids, Proteins, Aromatic Compounds, Sugars, Sugars, Alcohols, Fats, Oils, Waxes, Resins, Tannins, Lignin, Pigments etc and as a result of humus is a black coloured, homogeneous material.

AIR: Soil consists of 25% air present in top, middle and bottom soils.

WATER: 25% of water is present in soils.

SOIL PROFILE:

Modification of mineral matter through interaction between Climate, Biological and topographic effects that leads to the formation of a profile, called as 'Soil - Profile'.

Soil is made up of horizontal layers called horizons.

Horizon – O(Organic Layer): The topmost organic layer of soil is made up of mostly decomposed organic matter (leaf litter and humus).

Horizon – A (Top Soil): This dark coloured layer is also called as 'Top Soil'. It is made up of humus (decomposed organic matter) mixed with mineral particles. Seeds germinate and plant roots grow in this layer.

Horizon – E (Eluviation Layer): This eluviation (leaching) layer is light in colour and is made up of mostly sand and silt. It has lost most of its minerals and clay by leaching as water drips through the soil.

Horizon – B (Sub Soil): This layer contains clay and mineral deposits like iron, aluminium oxides and calcium carbonate which has leached from the upper layers of soil.

Horizon – C (Regolith): It consists of slightly broken bed rock. Plant roots do not penetrate into this layer. Very little organic matter is found in this layer.

Horizon – R (Bed Rocks): This is unweathered rock layer and lies beneath all the layers.

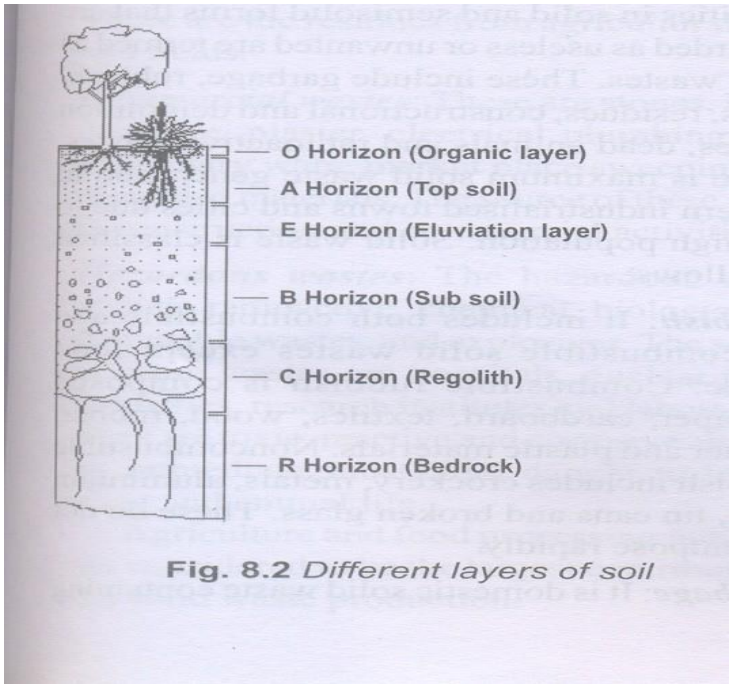


Fig. 8.2 *Different layers of soil*

CLASSIFICATION OF SOILS:

Based on the size of the soil particle, soils are divided into three types.

- ➔ Clayey Soils
- ➔ Sandy Soils
- ➔ Loam Soils

CLAYEY SOILS:

- ➔ The size of the clay particle is < 0.002 mm.
- ➔ They have very small interspaces and hence inhibit free circulation of water and air.
- ➔ They tend to become water logged and are unsuitable for the growth of plants.

SANDY SOILS:

➔ These are loose and dry particles.

➔ The size of the sand particle varies from < 0.002mm to 0.002 mm

➔ Low nutrient content.

➔ They have poor water holding capacity

LOAM SOILS:

➔ The size of the loam particle is >0.002 mm.

➔ They contain equal proportions of clayey, sandy and dry silt particles.

➔ These soils are best for the growth of plants.

FUNCTIONS OF ORGANIC MATTER IN SOIL:

Organic matter influences the soil properties and consequently the plant growth.

➔ It improves the physical conditions of the soil

➔ It increases the water holding capacity of soil

➔ It contains the major nutrients like N_2, p, S, K etc

➔ It is main source of energy for soil organisms.

➔ It improves aeration status of the soil

➔ It promotes a greater proportion of large pore sizes.

BIOLOGICAL ACTIVITY:

One kilogram of soil may contain as much as millions of bacteria actinomyctes and other fungi.

SOIL COLOUR:

Black colour of the soil is due to the presence of Humus, Red and Brown colour of the soil is due to the presence of Iron (Iron is present in Oxidation state in Yellow soils), Grey to White colour is due to the presence of High Salt content in soil.

CARBON IN THE SOIL:

Every year soils release 5% of their carbon to the atmosphere in the form of CO_2. This is a quantity 10 times that produced by the burning of fossil fuels. These wastes are garbage, plastic, glass, fiber etc and cause soil pollution.

AGRICULTURAL WASTES:

By using of different types of biocides such as pesticides, insecticides, fungicides, rodenticides to the soil, are responsible for cause of soil pollution.

Soil Pollution or Land Pollution:

Soil pollution is defined as the addition of any chemical substance in an indefinite proportion to the soil which reduces the fertility and changes the characteristics of soil. The substances which are capable of reducing or changing the fertility of the soil are called soil pollutants.

The main sources of soil pollution are

- Disposal of human and animal excreta (Solid and Liquid Waste).
- Application of chemicals like fertilizers and pesticides to plants and oil,
- Disposal of domestic refuse and industrial waste
- Dumping of wastes from mineral and coal mining land
- Discharge of radioactive wastes from hospitals, industrial and research centers
- Soil erosion due to deforestation, unplanned irrigation and defective agricultural practices.
- Exhaust gases from chemical industries and
- Fly ash from thermal power plants.

Domestic Waste:

It includes plastic, paper, bottles, discarded food, clothes. Leather goods, broken glass, exhausted batteries, scarp metal and domestic sewage all of which pollute soil. These pollutants reduce the fertility of soil. Disposal of human and animal excreta pollutes crops, soil and vegetables by contaminating them with pathogens that are present in excreta.

Industrial Waste: Industrial effluents containing lead, iron, mercury, copper, zinc, cadmium, cyanides, acids and alkalis pollute the soil directly or through water. They have an adverse effect on the physical, chemical and biological properties of soil and therby reduce its fertility.

Agricultural Waste: Organic insecticides and pesticides like DDT, aldrin and benzene hexachloride are used on agricultural land to kill soil – borne pests. These chemicals accumulate in the soil and undergo degradation slowly by soil and bacteria. The degradation products are absorbed by plants and then enter the food chain through the

consumers. To produce more crops and vegetables there is excessive use of fertilizers, pesticides and insecticides which creates various problems.

Radioactive Waste: The waste from nuclear power plants, hospitals, nuclear research and mining reach the soil through water or direct fall out. From the soil, the radioactive pollutants enter higher trophic levels of the food chains and cause diseases like cancer and anemia as well as genetic mutations.

Mining Waste: Mining is the process of extracting and processing minerals. The rate of mining is measured in two ways- per capita mining and per capita consumption. From world per capita mining data, it is seen that five minerals – coal, petrolwum, iron ore, aluminium and phosphate ore top the list. Mining involves environmental problems such as disturbance of land, air pollution from dust and smelter emission as well as water pollution from disrupted aquifers.

EFFECTS OF SOIL POLLUTION:

- ➔ Industrial waste consists of a variety of chemical elements, which are extremely toxic to living organisms.
- ➔ Metallic contaminants destroy bacteria, beneficial micro – organisms in the soil.
- ➔ Effluents containing acids and bases make the water corrosive.
- ➔ Sewage is an excellent medium for the growth of pathogenic bacteria, which causes water born diseases.
- ➔ If soil consists of high concentration of Lead results in weakness, Anaemia, Abdominal pain, Vomiting, Weight loss, Headache and finally leads Death.
- ➔ Excessive nitrogen fertilizers use makes the plants less resistant to diseases.

CONTROL OF SOIL POLLUTION:

Soil pollution can be controlled through the

- ➔ Proper disposal of waste
- ➔ Reducing the waste
- ➔ Incineration

(a) **PROPER DISPOSAL OF WASTE:** Solid waste will be collected from different places and dumped in low – lying areas and out skirts of towns and cities covered with soil.

(b) **REDUCING THE WASTE:** Waste material may be recycled to get useful products. Ex: Recycling of Paper waste, Making of Bricks from Fly ash coming from the industry

(c) **INCINERATION:** Burning of solid wastes at high temperatures is called 'Incineration'. **Ex**: Needles, Syringes.

Other methods used for control of soil pollution are

Using sanitary landfills, that is, putting solid wastes into deep trenches and covering with fresh soil.

Impacts of Over Grazing and Modern Agriculture Practices:
Overgrazing:

- Reduction in the diversity of plant species.
- Reduction in the growth of vegetation.
- Increased soil erosion.
- Land degradation.
- Loss of useful species.
- Dominant of plant species that are relatively undesirable to the cattle.

Effects of Agriculture:

The major problems are arised due to the modern agricultural practices are related to fertilizers, pesticides, water logging and salination.

Besides water, sunshine, CO_2, plants need small quantities of inorganic elements for their growth. The most important elements required by plants are Nitrogen, Magnesium, and Sulphur. Adding these chemicals in fertilizers stimulates growth of plant species.

Uses:

- They can be easier to store, handle, apply and transport than most natural fertilizers.
- Low pathogenic contamination.

Problems:

- Excess amounts of fertilizer enter in soil decreases quality of soil, it also harmful to micro – organisms present in soil.
- These are pollutes the aquatic systems near by the agricultural lands,
- Decreases quality of water resources.

Fertilizer Related Problems:

1. Micro Nutrient Imbalance
2. Nitrate Pollution
3. Eutrophication

Micro Nutrient Imbalance:

Farmers used nitrogen, phosphorus, and potassium, which are essential nutrients. Farmers usually use these fertilizers indiscriminately to boost up crop growth. Excessive use of fertilizers cause micro nutrient imbalance.

Nitrate Pollution:

It is an important fertilizer helpful for plants growth. The concentration of nitrogen exceeds 25 mg / L, they become the cause of a serious health hazard called 'Blue Baby Disease' or 'Blue Baby Disease' or 'Methaemoglobinemia'. Increased nitrogen concentration leads to death, this problem arised in many countries like Denmark, Germany & Nether land.

Eutrophication:

Excessive use of phosphorus & nitrogen in agricultural fields leads to another problem, which is not related to soil, but related to water bodies. Increased algal growth, these algal blooms effects aquatic food chains. The algal species quickly complete their life cycle and die, there by adding a lot of dead organic matter.

Pesticides:

A large amount of pesticides are used to ensure crop yield production. Pesticide is a common term for insecticides, Rodenticides, fungicides, herbicides etc.

The major agricultural pests are insects (feed on mainly leaves & stems of plants), Nematodes (feed on roots and other plant tissues), weeds (flowering plants), Vertebrates (mainly birds & rodents that feed on fruit & grain).

These are chemicals used to kill (or) control the population of unwanted fungi, plants and animals often called as pests.

Uses of Pesticides:

- To control weeds.
- For aesthetic reasons, lawn – care, garden flower and golf courses.
- To maximize crop or live stock yields.
- To reduce post – harvest losses to rodents, fungus etc.
- To improve appearance of crops or live stock.
- For disease control
- For preservation and maintenance of buildings, clothing, furniture etc.

Classification of Pesticides:

a) Persistent Pesticides
b) Non – Persistent Pesticides

a) Persistent Pesticides:

- Once applied are effective for a long time.

b) Non – Persistent Pesticides:

Tends to accumulated in soil (or) bodies of animals in food chains. When pesticides enter the food chain, their concentration increases as food chain increases.

The production of synthetic pesticides are started around 1939, at present more than 10,000 pesticides are present.

First Generation of Pesticides:

The first generation of pesticides include chemicals like Sulphur, Arsenic, Plum bum, Mercury to kill the pests.

Second Generation of Pesticides:

DDT is the second generation of pesticides discovered by Paul Muller in 1939.

Effects:

- Effects on other beneficial plants.
- Highly toxic compounds.
- Bio – magnification: Many of the pesticides are non – biodegradable and keep on accumulating in the food chain. This process is called as 'Bio - Magnification'.
- Short Term Effects
- Long Term Effects
- Short Term Effects: Short – term effects are called as 'Acute Effects'.
  Ex: Vomiting, Drowsiness
- Long Term Effects: Long – term effects are called as 'Chronic Effects'.
  Ex: Cancer, Mental Disorders etc.
- Over use
- Poor selectivity of compounds
- Toxicity and slow breakdown
- Pesticide resistance and pest resurgence.
- Tendency to be concentrated by food web.
- Misuse or unsafe methods of application.
- Creation on new pests due to the killing of beneficial predators that previously kept a number of pests under control.

Water Logging:

The problem arises due to high water table (or) excess water to accumulate under ground. Due to this situation,, the crop yield production decreases (or) very poor.

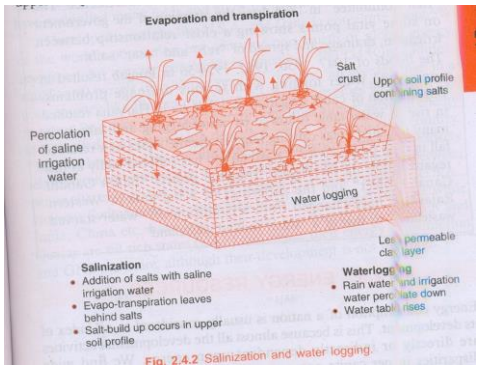


Fig. 2.4.2 Salinization and water logging.

Impacts of Overgrazing& Modern Agriculture Practices:

IMPACTS OF OVERGRAZING AND AGRICULTURE

Efforts to increase food production have several side effects as illustrated in Fig. 2.4.1.

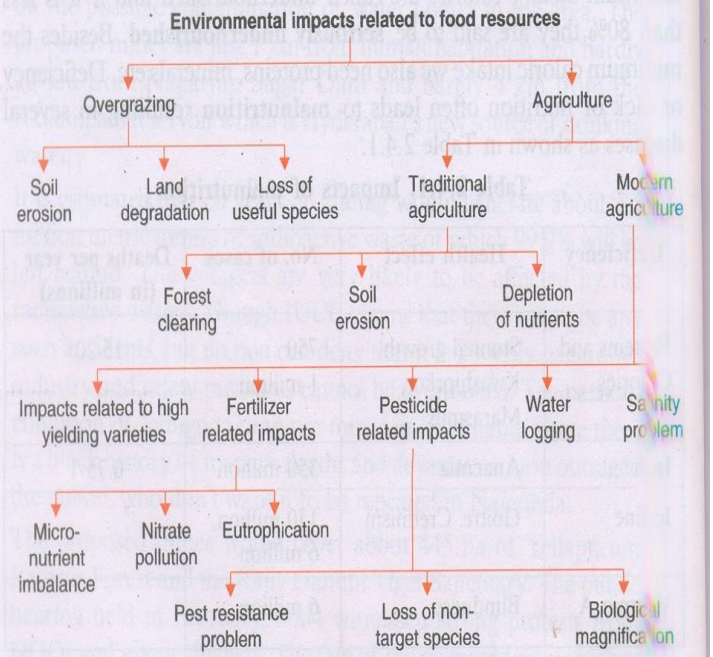


Fig. 2.4.1. Chain of side effects on environment due to intensive practices for increased food production.

(A) Overgrazing

BIO – DIVERSITY

Introduction:

Biological diversity is abbreviated as 'Bio - Diversity'. Bio - diversity is an 'Index' of national wealth. Nearly 65% of national wealth is getting from all these bio – diversity products. Bio – means 'Living Organisms' and diversity means 'Variation'. The total term biodiversity refers 'Variability and Variations among living organisms'. Diversity starts from 'Unicellular Fungi, Protozoa to multi cellular Plants and Animal Species'. The term Bio – diversity was first coined by 'Walter Rosen' in '1980'.

Definition:

As per IUCN (International Union for Conservation of Nature & Natural Resources) bio – diversity is 'The sum of Genes, Species and Eco – Systems in a region'. Diversity can be defined as the number of different items and their relative frequency.

Bio – diversity includes the different types of animals and different types of plants and other species. Different ways in which species interact with their environment. Ways species live together.

Types of Bio – Diversity:

Bio – diversity covers a wide range of concepts and can be examined at different levels.

a) Genetic Diversity
b) Species Diversity
c) Eco – System Diversity

a) Genetic Diversity:

Genetic diversity is the variation of genes within species. Genes are the basic units of all life on earth. Genetic diversity is responsible for both similarities and the differences between organisms. The variation may be in size, shape, resistance against diseases, pests, insects etc.

b) Species Diversity:

Species are the basic and most important units in modern systems for classifying living organisms. The variations between two species, the species may be plant, animal and micro – organisms. The classification between two different species in a eco – system called as 'Species Diversity '.

c) Eco – System Diversity:

Variation between two eco – systems terrestrial and aquatic eco – system called as 'Eco – System Diversity'.

d) Land Scape Diversity:

It refers to size & distribution of several eco – systems. It is a special type of diversity.

Functions of Bio – Diversity:

- It is the source of species on which the human complete depends for food, fuel, shelter and medicine.
- It maintains environmental quality.
- It depends on the biosphere, which in turn leads to the stability in climate, water, soil, air and the over all health of biosphere.

Value of Bio – Diversity:

The value of bio – diversity in terms of its ecological services, commercial utility, social and aesthetic value is enormous. Some times we realize and appreciate the values of the organism only after it is lost from this earth. Very small, insignificant, useless looking organism may play a crucial role in the ecological balance of the eco – system.
The multiple uses of bio – diversity between classified by Mc. Nelly et al in 1990.

a) Consumptive Use Value
b) Productive Use Value
c) Social Value
d) Ethical Value
e) Aesthetic Value
f) Option Value
g) Eco – System Service Value

a) Consumptive Use Value:

These are direct use values where the bio – diversity product can be harvested and consumed directly.

Ex: Fuel, Food, Drugs, Fiber etc

Food:

A large number of wild plants are consumed by human beings as 'Food'. About 80,000 edible plant species have been reported from wild. About 90% of food crops have been domesticated from wild and tropical plants.

Drugs & Medicines:

About 75% of the world's population depends upon plants, plant products and animals for preparation of various drugs & medicines. Ex: Pencilin is derived from a fungus called 'Pencillium'. 'Tetracyclin' is derived from a 'Bacterium' called as 'Tetracycilinium'. 'Quinine' the is used in the cure for 'Malaria' is obtained from the bark of 'Cinchona' tree. Recently 'Vinblastin'& 'Vinasprin' two anti cancer drugs, have been obtained from 'Periwinkle' plant (Catharanthus) posses 'Anti Cancer' alkaloids.

Fuel:

The fossil fuels Coal, Petroleum and natural gas are also products of fossilized bio – diversity by individuals are not normally marketed but are directly consumed by tribal and local villagers.

b) Productive Use Values:

It is assigned to products that are derived from wildlife and sold in commercial markets both national & international markets. These may include the animal products like tusks

of elephants, musk form musk deer, silk from silk – worm, wool from sheep, fir from many animals, lac from lac insects etc.

Many industries are dependent upon the productive use values of bio – diversity.

Ex: The paper and pulp industry, silk industry, textile industry, leather industry and pearl industry etc. developing countries in Asia, Africa and Latin America are the richest bio – diversity centers and the countries smuggled wildlife products and marketed in large quantities to some rich western countries and also to china and Hong kong where export of Cat skins and Snake skins fetches a bomming business.

c) Social Values:

These are the values associated with the social life, customs, religion and psycho – spiritual aspects of the people. Many of the plants are considered holy and sacred in our country like Tulasi, Neem, Peepal, Mango, Lotus etc. the leaves, fruits (or) Flowers of these plants are used in worship (or) the plant itself is worshipped. Many animals like Cows, Snake, Bull, Peacock, Owl etc also have significant place in our psycho – spiritual arena and thus hold special social importance.

d) Ethical Values:

It is also some times known as 'Existance Value'. It involves ethical issues like 'all life must be preserved'. It is based on the concept of 'Live & Let Live'. We are not deriving any thing direct from Kangaroo, Zebra , Giraffe, but we all strongly feel that these species should exist in nature.

e) Aesthetic Value:

Great aesthetic value is attached to bio – diversity.

Ex: Eco – Tourism

It is related to visit of placed related to environmental aspects.

f) Option Value:

These values include the potentials of bio – diversity that are presently unknown and need to be explored. The option value also includes the values, in terms of the option to visit areas where a variety of flora and fauna (or) specially some endemic, rare (or) endangered species exist.

g) Eco – System Service Values:

It refers to the services provided by eco – systems like prevention of soil- erosion, prevention of floods, maintenance of soil – fertility, cycling of nutrients, fixation of nitrogen, cycling of water, pollutant absorption etc.

MODULE-IV

GLOBAL ENVIRONMENTAL PROBLEMS AND GLOBAL EFFORTS

UNIT - V: GLOBAL ENVIRONMENTAL PROBLEMS & GOBAL EFFORTS

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

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

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

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

The major uses of CFCs are:

- as coolants in refrigerators (CFC 11, 12, 113,114,115);
- in air-conditioners and in fire extinguishers (Halogen + HCFC 123);
- as solvent in cleaning particularly electronic circuit boards (Methyl chloroform and Carbon Tetrachloride).
- CFC's are used as sterilization agent in medical field (mixture of CFC12 & ethylene oxide) and propellant in aerosols like deodorants; shaving foam, perfumes etc .

Man made CFC's however, are the main cause of stratospheric ozone depletion. CFCs have a lifetime in the atmosphere of about 20 to 100 years and as a result one free chlorine atom from CFC molecule can do a lot of damage.

Methane (CH_4): The major source of methane is extraction from geological deposits known as Natural gas and used as fuel. Since it is a gas at normal conditions, methane is distributed through pipe lines. It is also called as LNG (Liquified Natural Gas). Methane reacts with halogens and produce Methyl Chloride (CH_3Cl), Chloroform ($CHCl_3$) and Carbon tetrachloride (CCl_4).

Since the beginning of the Industrial Revolution, the burning of fossil fuels has contributed to the increase in carbon dioxide in the atmosphere from 280 ppm to 390 ppm. When these gases are ranked by their direct contribution to the greenhouse effect, the most important are:

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

Of these gases, CO_2 accounts for about 55% of the earth's Green House effect. Other gases are capable of changing the energy balance and causes for increase of temperature of the earth. A number of changes usually take place in the energy which comes from the sun through the atmosphere. In detail:

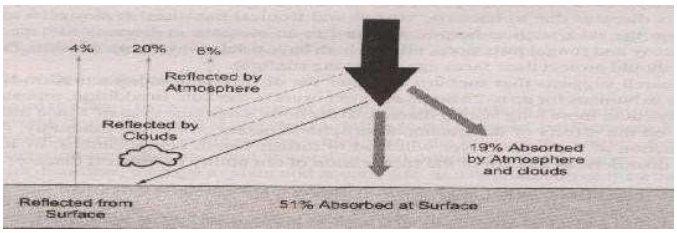
26% of the energy is reflected back to the space by clouds and particles whereas about 19% of the energy is absorbed by some of the gases especially ozone in the atmosphere. 4% is reflected from the surface back to space.

Of the remaining 51% of the solar energy is then used in a number of process including the heating of the ground surface, evaporation of water etc….

The main sources of greenhouse gases due to human activity are:

- Burning of fossil fuels and deforestation leading to higher carbon dioxide concentrations in the air.
- Use of chlorofluorocarbons (CFCs) in refrigeration systems, and use of CFCs and halogens in fire suppression systems and manufacturing processes. Some halogens are used in fire extinguishers; they in turn produce CFC's. Hence, CFC emissions increases in the atmosphere and then causing Green House Effect .
- Agricultural activities, including the use of fertilizers, that lead to higher nitrous oxide (N_2O) concentrations.

Hence, **Green House effect** is a naturally occurring process that aids the heating of the earth's surface and atmosphere. Green House effect results from the gases such as CO_2; CH_4 (methane); N_2O (Nitrous Oxide); CFC's; Halogens (F, Br, Cl, I) & O_3. Ultimately, the Green House effect may lead to the death of both plants and animals including human beings.



GLOBAL WARMING: Earth has become warmer over the last centaury. As a result of higher concentrations of gases (especially CO_2) ; the earth's climate become warmer and this is referred to as Global Warming. Reports that the average climate / temperature of the earth has increased during the twentieth century by about 0.6^oC (+/- 0.2^oC).

The IPCC (Inter-government Panel on Climate Change), a group established by the World Meteorological Organization (W M O) and The United Nations Environment Programme (UNEP) revealed the following effects of global warming:

- Global warming causes, rate of precipitation decreases on land and causes a decrease of rainfall by 40% all over the world.
- Sea level raises and low lying areas will be inundated (to cover an area of land with water)
- Global Warming change the direction of wind.
- CFC's convert O_3 into oxygen and oxygen radical and thus ozone depletes in the atmosphere.
- Global temperature will increase atleast by 4^oC.
- Decrease of earth's albedo (the amount of sun light reflection by the earth's surface to the moon).
- People suffer from many undiagnosible diseases.
- CFC-11; 12 and 113 in the atmosphere for a longer period harmful to the human beings.

SOLUTIONS FOR GLOBAL WARMING:

- By reducing the emissions of Green House gases.
- Clean electricity technologies such as wind mills/turbines; solar panels; tidal energy etc are to be used
- Bio-fuels (eg: ethanol - a type of alcohol) and Bio-diesel could substantially cut down the CO_2 emission.
- By avoiding the driving of vehicles (walking / bicycling is to be followed)

CLIMATE CHANGE & their impacts on Human Environment

The weather conditions and seasonal variations in a region over a long period is called CLIMATE. The average temperature in many regions has been increasing in recent decades. Globally, 1990 was the warmest decade on record.

Climatologists of the Inter-governmental Panel on Climate changes (IPCC) have carried out several experiments in order to estimate the changes in climate.

Accordingly, First Assessment Report (FAR) was completed in 1990 and Second Assessment Report (SAR) in 1997. Following are the main points from the climate reports:

- The concentration of Green House Gases in the atmosphere such as CO_2; Methane; Nitrous Oxide have all increased markedly since 1750 and now exceeded the levels.

- Emissions of Carbon dioxide from fossil fuel has been increased from 1990's onwards.

The Third Assessment Report (TAR) on climate change 2001 is the most comprehensive and up-to-date scientific assessment of past, present and future climate change. The report:

- Analyses an enormous body of observations of all parts of the climate system.
- Increasing concentrations of atmospheric greenhousegases.
- Assesses our understanding of the processes and feedbacks which govern the climate system.
- Projects related to scenarios of future climate change using a wide range of models of future emissions of greenhouse gases andaerosols.

Fourth Assessment Report was released in 2007 and concluded that 90% of human beings are caused for GlobalWarming.

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

- The studies have also shown that in the near future the Global surface temperature will rise by 1.4^{o}C to 5.8^{o}C and leads to floods and/or droughts.

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

- The studies / reports also stated that a few regions such as NILE DELTA in Egypt and Ganges – Brahmaputra delta in Bangladesh may become vulnerable (liable to be damaged).

Finally, it was concluded that continued Green House Gas emissions cause further Global warming and induce many changes in the Global climate system during the 21st centaury.

IMPACTS ON HUMAN BEINGS

- Human environment will be seriously affected by extremes of climate by means of Floods and Droughts.
- Due to extreme changes in Climate, Human beings suffer from safe drinking water.
- Changes in climate may affect the distribution of vector species (eg mosquitoes) which in turn spread infectious diseases such as Malaria; Filariasis, Dengue, diarrhea; Yellow fever etc..
- The reduction in food production would lead to starvation.
- Climate change could lead to migration of humans.

OZONE LAYER and Ozone layer depletion

The earth's atmosphere is composed of several layers viz.,

EXOSPHERE …….	The outer most layer extended upto 960 ms….
THERMOSPHERE…	Layer extended upto 400 km from Mesosphere
MESOSPHERE	another layer extended upto 80km from the surface of the earth
STROTOSPHERE ..	next layer extended upto 50 km from the surface of the earth
TROPOSPHERE …	lower layer extended upto 18 km from the surface of the earth

OZONE FORMATION: Ozone is a form of oxygen that has three atoms in each molecule (O_3). Ozone is bluish colored and highly poisons gas that has a boiling point of 112^oC. At atmospheric pressure, ozone can partially dissolve in water. At standard temperature and pressure, the solubility of ozone is thirteen times that of oxygen.

Standard Temperature and Pressure**:** STP is commonly used to define standard conditions for temperature and pressure which is important for the measurements and documentation of chemical and physical processes. *STP is defined by IUPAC (International Union of Pure and Applied Chemistry) as air at 0^oC (273.15 K, 32 ^oF) and 10^5 pascals or 100 kPa .*

The atmospheric ozone density is measured in Dobson Unit (DU). 1 Dobson unit under standard temperature and pressure is 2.69 x 10^{16} ozone molecules per sq cm. The instrument to measure total ozone from the ground is called the Dobson ozone Spectrophotometer.

Ozone is formed by the action of sunlight on oxygen. When normal oxygen absorbs solar ultra violet radiation; splitting oxygen molecules into radical oxygen (O). This atomic oxygen quickly combines with further oxygen molecules to form ozone . This action takes place naturally in the atmosphere.

$$O_2 + UV \longrightarrow O + O$$
$$O + O_2 \longrightarrow O_3$$

DESTROY OF OZONE LAYER : *Two different processes destroy ozone naturally:* The first is when a free oxygen radical combines with an ozone molecule to produce two diatomic oxygen molecules.

$$O + O_3 \qquad 2O_2$$

The other process when ozone molecules absorb ultraviolet radiation and form one diatomic oxygen molecule and one free oxygen radical .

$$O_3 + UV \qquad O + O_2$$

OZONE DEPLETING SUBSTANCES (ODS)

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

EFFECTS on human beings:

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

EFFECTS on Global environment :

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

Depletion of ozone causes Global warming.

INTERNATIONAL CONVENTIONS / PROTOCOLS

Convention: large formal meeting of people with the same interest or work.

Protocol: The rules about what you must do and how you behave in an official situation.

The objectives of the International Conventions are to stabilize the Green House Gas concentrations in the atmosphere to certain levels to prevent dangerous human interference with the climate system of the world..

EARTH SUMMIT: The **United Nations Conference on Environment and Development** (UNCED), also known as the **Rio Summit**, **Rio Conference**, **Earth Summit** (Portuguese) was a major conference held in Rio de Janeiro from 3 June to 14 June 1992. Totally 172 Governments were participated with their heads and representatives, NGO's accounting 17000 people. The issues included:

- Systematic scrutiny of patterns of production of Toxic components such as lead in gasoline.
- Alternative sources of energy to replace the use of fossil fuels which are linked to global climatic changes.
- By introducing new public transport system in order to reduce vehicle emissions in cities.
- Alarming the growing scarcity of water and has been decided to come out with proper utilization methodologies.
- Not to carryout any activities on lands that would cause environment degradation.

MONTREAL PROTOCOL:

Several meetings have taken place to address the ozone layer depletion problem. The well known meeting was held in Montreal on 16-09-1987 and the agreement signed is called the Montreal Protocol, which set a timetable to phase out of CFCs as well as halogens which contain bromine and 96 harmful chemicals in the Protocol subject the schedules.

The **Montreal Protocol** on substances that deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987, and entered into force on January 1, 1989, followed by a first meeting in Helsinki (Finland), May 1989.

Since then, it has undergone seven revisions, in 1990 (London), 1991 (Nairobi capital of Kenya), 1992 (Copenhagen, capital of Denmark), 1993 (Bangkok in Thailand, SE Asia), 1995 (Vienna, capital of Austria), 1997 (Montreal, Canada), and 1999 (Beijing, china).

After implementing the schedules, following are the identified advantages of Montreal protocol:

- The highest calculated level of consumption of CFCs was 16,255 metric tons in 1988. Substances were used chiefly as refrigerants, cleaning solvent, foam blowing agents and propellants in spray can. In 1996 the consumption level was reduced to zero and maintain at that level since.

- HCFCs have been used as one of the alternative substances for CFCs since 1996. As a result, consumption of HCFCs was reduced from around 630 ODP (Ozone Depletion Potential) metric tons in 1996 to 383 ODP metric tons in 2004, which indicated a 40% reduction from the baseline level.

- Without the protocol there would be a doubling effect of Ultra violet – Beta radiations reached the earth in the northern latitudes and also the amount of ozone depleting chemicals in the atmosphere would have been 5 times greater.

- It also ensured the improved scientific understanding which can be incorporated in decisions quickly.
- It is believed that if the International agreement is adhered (sticking to) the ozone layer is expected to recover by 2050.

KYOTO PROTOCOL :

The Kyoto Protocol is a legally binding International agreement to reduce Green House Gas (GHG) emissions of 5.2% by the year 2012.

The Protocol states that "developed countries are committed, individually or jointly to ensure that the emissions of Green House Gases do not exceed amounts assigned to each country in Annexure A to the Protocol.

The agreement specifies that all countries must follow a number of statements and some of which are as follows:

- Design and implementation of climatic change mitigation (to reduce the harmful effects of something) and adoption programmes.
- Preparation of a national inventory of emission removal procedures.
- Promotion of climate friendly technology transfer.
- Accounting, reporting and review to ensure the integrity (honesty and the ability to do) of the protocol.

DEFORESTATION AND DESERTIFICATION

Forests are one of the most important natural resources and a part of biosphere since these are natural assets on this earth. Forests predominantly composed of trees, shrubs, woody vegetation etc… Approximately $1/3^{rd}$ of the earth's total land area is covered by forests.

Forests are important ecologically and economically. Ecologically forests are to be considered as earth's lungs because they consume CO_2 and release O_2 which is required for sustaining the life on this earth. The poisonous gas CO_2 is absorbed by the trees of forests and reduce the global warming; helps to continue hydrological cycle, reduce soil erosion….

Forest ecosystems are extremely good & hold a good quantity of water. Economically forests provide timber, fodder to grazing animals, firewood (conventional fuel), bamboos, rubbers, medicines, gums, resins, food items etc.

Deforestation refers to the loss of forest cover (or) the aimless destruction of trees . The clearing of forests across the earth has been occurring on a large scale basis for many centuries. This process involves the cutting down, burning and damaging of forests.

Currently 12 million hectares of forests are cleared annually and the current rate of deforestation continues, the world's forests will vanish within the next
100 years About 80% of the original forests on the earth has already been cleared.

Deforestation is taking place in many parts of the world for many reasons such as:

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

EFFECTS OF DEFORESTATION:

The removal of trees leads to soil exposure & results in soil erosion, rapid water run-off, loss of wildlife.

Deforestation ---- cause unknown effects on global climate and eliminating the majority of plant and animal species on this earth. Various living beings (wildlife is diminish) may come down resulting in imbalance of forest ecosystem.

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

CASE STUDIES:

Chipko movement related to mining or quarrying opposed by Sundarlal Bahuguna in North India (refer text books for further information)

Sardar Sarovar – Narmada project is a multipurpose project in Gujarat (refer text books for further information)

DESERTIFICATION:

The processes by which an area becomes even more barren, less capable of retaining vegetation and is known as a desert. This may become a disaster in long term. Hence, desertification refers to land degradation in arid and semi-arid areas due to anthropogenic activities.

Desertification often starts as patchy destruction of productive land. Increased dust particles in atmosphere also lead to desertification.

The chief causes of desertification also include:

Climatic factors and (ii) human factors (population growth, increased population density

According to the United Nations Environmental Programme (UNEP), deforestation is an important factor contributing to desertification. At the time of Independence in India, about 22% of area was under forest cover and today this has been reduced to 19%

UNEP estimated that desertification threatened 35% of the world's land surface and 20% of the world's population.

MODULE-V

TOWARDS SUATAINABLE DEVELOPMENT

5.1 SUSTAINABLE DEVELOPMENT

Sustainable Development means improvement of quality of life with continuous progress without exhausting natural resources. Society of the population must require to meet the needs by managing the natural resources efficiently and maximizing the benefits from them so as not to overload the world's ecosystem. Sustainable development implies using the natural resources in such a manner which doesn't eliminate or diminish their usefulness for future generations eg: coal, crude oil; forests. Hence, the concept of Sustainable Development could be termed development without destruction.

5.1.1 MEASURES FOR SUSTAINABLE DEVELOPMENT

Following are the measures for the sustainable development:

1. **Population Control**: Population growth should be limited to the desirable level. Slow human population growth; reduce the stress on global life.
2. **Biodiversity :** variety of life on earth and how the living things interact with each other must be conserved.
3. **Recycling of wastes:** Recycle at least 60% of the materials which are discarded now as trash.
4. **Reduced Consumption:** Lifestyle should be shifted to lesser consumption of resources.
5. **Efficient usage of Resources:** Resources should be renewed or reused. For eg: solar energy should be encouraged.
6. **Water Resource Management:** Some of the consequences of poor water resource management such as (A) River flooding; (B) Silting of reservoirs, ponds, lakes; (C) over exploitation of groundwater; (D) Water logging by over irrigation (E) Improper drainage (F) Pollution of water bodies are to be taken up for implementation. So, Sustainable development insists optimum management of water resources locally and globally.
7. **Integrated Land use planning:** Using lands for agriculture, forestry, fodder cultivation, industrial growth, traffic etc should be planned.
8. **Creating Awareness:** Creation of environmental awareness and spreading environmental education among the people is must for fruitful results.

5.2 THREATS TO SUSTAINABILITY

Unprecedented population growth and their demands for more and more resources to meet their needs in an era of consumerism have become a threat to sustainability.

There are major threats to discussed here, are:

5.2.1 Population and its explosion

5.2.2 Consumerism

5.2.3 Crazy Consumerism

5.2.3 Over-exploitation of resources

5.2.1 POPULATION EXPLOSION

Sudden increase in population is called as Population Explosion. India is now passing through the phase of population explosion. Rapid growth of population causes poverty and proves to be a barrier to development.. The reasons of Population Explosion are: illiteracy Poor Family Planning awareness but better health care facilities increase in agricultural and industrial productivity.

IMPACT of Population Explosion:

Population Explosion causes Poverty; Malnutrition; Environment degradation; Over exploitation of natural resources; Spread of diseases; Economic inequity; more disposal of garbage; sanitation problems etc.

Problems of Population growth/ Population explosion:

Rapid population growth will over stress the earth's natural resources and crowded out undomesticated plant and animal species. Hence, population explosion is causing severe resource depletion and environmental degradation. Sources like water, fossil fuels, minerals etc are limited and due to over exploitation these resources are getting exhausted. In addition forests, grasslands etc.., are under tremendous pressure. Industrial and economic growth are raising the quality of life but adding toxic pollutants into the air, water and soil. As population increases, more resources are needed to meet basic requirements. At the same time people consume these resources of they produce waste that is again put back into the air, land and water. The greater amount of waste from larger populations puts more stress on ecosystems .Highest Population growth rates are found especially in developing countries but the G7 nations (the US, Canada, Britain, France, Germany, Japan & Italy) represent only 10% of global population but consume over 40% of the earths fossil fuels as well as most of the worlds

commodities and forest products. Though consumption rates are high in these countries, even small increases in population can have a significant impact. As the worlds population continuous to grow geometrically, great pressure is being placed on land, water, energy and biological resources to provide an adequate supply of food.

Water is critical for all crops and require during the growing season . About 87% of the worlds fresh water is consumed or used up by agriculture and thus is not recoverable. Water resources are under greater stress as populous cities and states require water from rivers, lakes as aquifers ever year. *Fossil energy* is another prime resource used for food production. The intensive farming technologies of developed countries use massive amounts of fossil energy for fertilizers, pesticides, irrigation and for machines as a substitute for human labour. Every second, on an average of 4 to 5 children are born and 2 people die, thus resulting a net gain of 2 persons every second. This means that every hour we are growing by about 7200 persons and everyday by about 1, 72, 800 persons and this is called as the **population clock.**

5.2.2 CONSUMERISM

i. Consumerism refers to the consumption of resources by the people. While early human societies used to consume much less resources, with the dawn of industrial era, consumerism has shown an exponential rise.
ii. It has been related both to the increase in the population size as well as increase in our demands due to change in lifestyle.
iii. Earlier we used to live a much simpler life and used to have fewer wants.
iv. In the modern society our needs have multiplied and so consumerism of resources has also multiplied.
v. Our population was less than 1 million for thousands of years ever since we evolved on this earth.
vi. Today we have crossed the six billion mark and are likely to reach 11 billion by 2045 as per World Bank estimates.

5.2.3 CRAZY CONSUMERISM

i. We have seen that consumerism patterns vary greatly between the developed and less developed nations.
ii. However, in the modern age of globalization, even in developing countries consumerism has fast increased following the foot-steps of the west.
iii. There is a mad race to acquire more and more, which has been facilitated by easy financing.

iv. So consumerism has assumed crazy dimensions where different brands of products are introducing new ways to promote consumerism and the consumers are consuming various resources in a manner that could never be imagined even a couple of decades back.

Though this trend represents economic growth, but crazy consumerism is a threat to sustainability.

5.2.3 OVER-EXPLOITATION OF RESOURCES

The over-use or over-harvesting of plants, animals or natural resources threatens the Earth's biodiversity is called as over - exploitation. Over-exploitation causes diminishing of resources which include medicinal plants, forest wood, grazing pastures, fish stocks, forests; water aquifers and species extinctions. If over-exploitation is sustained, it can lead to the destruction of the environment. Over-hunting has been a significant cause of the extinction of hundreds of species including whales large mammals etc. Commercial hunting, both legal and illegal is the principal threat. Deforestation, Desertification, Extinction of species; Soil erosion; Fossil fuel depletion; Ozone depletion; increase of Green House Gases etc may arise from over-exploitation of natural resources.

5.3 STRATEGIES FOR ACHIEVING SUSTAINABLE DEVELOPMENT

1) **Using appropriate technology**: It is one which is locally adoptable, eco-friendly, resource-efficient and culturally suitable. It mostly involves local resources and local labour. The technology should use less resources and should produce minimum waste.
2) **Reduce, Reuse, Recycle approach (3R's) :** The 3-R approach minimizes the resource use, using them again and again instead of passing them on to the waste stream and recycling the materials. It reduces pressure on resources as well as reduces waste generation and pollution.
3) **Promoting environmental education and awareness:** Making environmental education the centre of all learning process will greatly help in changing thinking and attitude of people towards Earth and environment.
4) **Resource utilization as per carrying capacity:** Sustainability of a system depends largely upon the carrying capacity of the system. If the carrying capacity of the system is crossed a limit, environmental degradation starts and continuous till it reaches a point of no return.

5) **Improving quality of life including social, cultural and economic dimensions:** Development should not focus just on one section of people. Rather it should include sharing of benefits between the rich and the poor.

5.4 ENVIRONMENTAL EDUCATION

Education plays a very important role in dealing with the global issue. Environmental Education is an integral process, which deals with man's interrelationship with his (natural and man-made) surroundings viz., relation of population, pollution, resource allocation, resource depletion, conservation, technology ; urban and rural planning.

Environmental Education is intended to promote the awareness and understanding of the environment among the citizens. Hence, Environmental Education is meant to bring about the required changes in knowledge, understanding attitudes and skills pertaining to the environment, conservation and ecological balance. So, Environmental Education must be considered as a solution for all environmental problems and the goal of Environmental Education should be to improve and enhance the quality of life.

5.4.1 The objectives of Environmental Education are*:*

- **Awareness**--- To help individuals acquire an awareness of environment and its allied problems.
- **Knowledge**--- To acquire basic understanding of the environment
- **Skills** --- To acquire the skills for solving environmental problems.
- **Participation**- To develop responsibility regarding environmental problems to ensure appropriate action to solve those problems.

5.4.2 Importance of Environmental Education*:* The importance of environmental protection has long been recognized in our country. Article 51 (g) of the constitution states " It shall be the duty of every citizen to protect and improve the Natural environment including forests, lakes, rivers, wild life" etc.. Education about environment provides learners with the know-how on environment. Education for environment will be concerned about conservation, preservation and upgradation.

5.5 CONSERVATION OF RESOURCES

As the human population increases, greater demands are placed upon the available natural resources. Large areas of the earth are being converted for the exclusive use of man. Thus, many valuable natural resources, which were available yesterday are not seen today.

At present, world environment is suffering critical stress not only by utilization of natural resources but also with the environmental damage inflicted by deforestation, species loss and climate change. So, a new environmental ethic with responsibility is required to recognize the earth's limited capacity of natural resources. This ethic must motivate the people to effect the needed changes.

The global population had already crossed 6 billion and may reach 8 billion by 2019 while the per capita availability of forests, pasture lands, crop lands etc will be decreased. Resources consumption in developed countries causes significant pollution problems, environmental degradation and resource depletion. For eg: an average US citizen consumes 50 times as much as the average citizen of India. Hence, there must be a holistic way of thinking regarding the management of land resources, water resources, forest resources etc..

5.7 SUSTAINABLE CITIES AND SUSTAINABLE COMMUNITIES

A sustainable city, is a city designed with consideration of environment impact, to minimize required inputs of energy, water, food and waste and also to reduce the outputs of heat, emissions of CO2, methane . Richard first coined the term “ecocity” in his 1987 book, “Ecocity Berkley: building cities for a healthy feature”.

The crux of this is to create the possible ecological foot print, and to produce the lowest quantity of pollution; to efficiently use land; recycle conversion of waste to energy, and thus the city's overall contribution to climate change will be minimal .

It is estimated that around 50% of the world's population now lives in cities and urban areas. In order to make achievements, building design and practice, as well as perception and lifestyle must adopt sustainability thinking.

Practical achievements: These ecological cities are achieved through various means such as:

- Zero-emission transport.
- Zero-energy building.
- Sustainable urban drainage systems.
- Energy conservation systems/devices.
- Xeriscaping – garden and landscape design for water conservation.

The industrial park in Kalundborg is often cited as a model sustainable city in Denmark.

India is working on **Gujarat International Finance Tec-City (GIFT)** which is an under construction world class city in Gujarat. It will come up on 500 acres (2.0 km^2) of land. It will also be first of its kind fully sustainable city.

5.8 SUSTAINABLE COMMUNITIES

Sustainable communities are communities planned, built to promote sustainable living. A sustainable community is one that: Acknowledges that economic, environmental and social issues are

- interrelated and that these should be addressed "holistically". (Treating the
- whole of something and not a part of it).
- →Understands and begins to shift away from polluting and wasteful practices.
- →Considers the full environmental, economic and social impacts of
- development and community operations.
- →Understands its natural, cultural; historical and human assets and resources
- and acts to protect and enhance them.
- →Promotes resource conservation and pollution prevention.
- →Focuses on improving community healthy and quality of life.
- →Acts to create value added products and services in the local economy.

5.8 HUMAN HEALTH

Health is the general condition of a person in all aspects. It is also a functional, metabolic efficiency of an organism. Public health problems caused by environmental contamination and emerging infectious diseases are a growing concern worldwide. These public health threats are affected by the relationship between people and the physical, chemical and biological nature of our natural environments. Vector borne and Zoonotic diseases; water contaminants; airborne contaminants Environmental threats to public health require marshalling of all our scientific knowledge and know-how to develop new solutions.

The Nation's natural science agency, play a significant role in providing scientific knowledge and information that will improve our understanding of the environmental contributions to disease and human health.

The following factors may cause harmful effects in the human health:

a) Infectious organisms
b) Chemicals
c) Noise
d) Radiations
e) Diet
f) Settlements etc

5.9 ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT

Information Technology has tremendous potential in the field of environmental education as in other fields like business, economics, politics. Development of Internet facilities, World Wide Web, Geographical Information System through satellites has generated a wealth of up to date information on various aspects of environment. A number of software's have been developed for environment and health studies in understanding the subject especially in India.

(a) Prediction of any natural calamity through the use of IT: Population in a State or country will be subjected to many environmental disasters. Scientists study and predict the same through information technology and express the possible occurrence of the natural disaster quite before.

The predictions about any disaster that is about to occur in a short time, in future should be studied well and the information about the forthcoming disaster should be informed to all people through the information technology or e – communication.

(b) Public awareness of environmental disasters through the information technology: Whenever any environmental disaster occurs, people concerned should prepare to do some activities to minimize the effects and it is possible only through I.T.

(c) Database on Environment: It is usually in computerized form and can be retrieved whenever required. Database is also available for diseases like HIV /AIDS, malaria etc..

The Govt of India under the Ministry of Environment and Forests established an Environmental Information System (ENVIS) as a plan & to provide environmental information to scientists, engineers, research workers all over the country.

National Management Information System (NMIS) under the Dept of science and Technology has compiled a database on Research and Development projects related to environmental information on environmental pollution (eg: ground water pollution, marine pollution, forest destruction etc).

5.10 ENVIRONMENTAL ETHICS

It is a branch of philosophy that considers the moral relations between human beings and their natural environment. Environmental Ethics is concerned with the morality (right or wrong) of human actions as they affect the environment where we live in.

Environmental Ethics deals with issues that are related to how we utilize and distribute resources. There are many ethical decisions that human beings make with respect to the environment. For example:

- Should we continue to cut the forests for the sake of human consumption?
- Should we continue to propagate?

What environmental obligations do we need to keep for future generations?

- Is it right for humans to knowingly cause the extinction of a species for the convenience of humanity?.

Environmental Ethics can provide the guidelines for putting our beliefs into action and help us decide what to do when faced with crucial situations. Some important ethical guidelines known as Earth ethics or **Environmental ethics are as follows:**

- You should love and honour the earth since it has blessed your life and governs your survival
- You should keep every day sacred to earth and celebrate the changing of its seasons.
- You should not hold yourself above other living things and have no right to drive them to extinct.
- You should be grateful to the plants and animals which nourish you by giving food.
- You should not waste your resources.
- You should not run after gains at the cost of nature.
- You should not steal from future generations their right to live in a clean and safe planet.

5.11 CONCEPT OF GREEN BUILDING

Green Building, is also known as Green Construction is the practice of creating structures such as design, construction, operation, maintenance, renovation etc throughout a building's life cycle.

Green building helps to preserve the external environment and provides great benefits to humans through the use of safe building materials, efficient use of natural resources, human safety etc..

The most fundamental benefit of Green Building is that it is environmentally friendly and safe for people occupying the building. Its aesthetic design and well architectural features such as sufficient safe, proper layouts and pleasant lighting to people. While, elements such as clean air, clean water make it safe and beneficial to human health.

Another important benefit of Green Building is Energy efficiency which results in reduced energy consumption for AC and Heating needs. Effective use of natural lighting, cool roof and wall panels which leads directly cost savings to the building owners.

The use of Solar Energy in green building can provide free electricity for the building owners. Solar panels can be installed on the roof top of the building where the solar energy will be converted to electricity.

Another way to generate electricity is through the use of wind energy by setting in pathway of winds.

The important aspects of green building are Materials, Energy, Water, Health.

a) Green-building Materials:

- The materials should be eco-friendly
- Should be obtained from local renewable resources.
- Should be recyclable.

b) Energy Consideration in Green building:

- Solar panel can meet the hot water requirements and efficient lighting
- Compact Fluorescent Lamps (CFLs) can reduce the electricity requirements.
- Low E glazed windows are preferred in green buildings.
- A green building can have green roof system. E-rated reflective roof coating
- reduces roof heating.

c) Water requirements in Green building:

- Water is used efficiently by employing water efficient appliances like low flush toilets, waterless urinals etc.

- Waste water is treated and reused for gardening
- Permeable pavements and rain water harvesting technology help in recharging ground water.

d) **Health Consideration in Green Building**:

- Provides sufficient air circulation.
- Non-toxic materials and breathable walls help maintain good indoor air quality

Rating of Green-Buildings:

Buildings are evaluated on the basis of a number of parameters of environmental importance. Different ratings are given to such green buildings. "Platinum Rating" is the highest rating for green buildings.

5.12 CLEAN DEVELOPMENT MECHANISM (CDM)

With the Kyoto Protocol becoming legally on 16 February 2005, the Clean Development Mechanism (CDM) is a key instrument for limiting greenhouse gas emissions (GHG) and promoting sustainable development. For both developing and developed countries to benefit from the CDM, it is important to establish increased awareness and understanding of its various aspects. A CDM project should result in a net decrease of Green House Gases emissions.

The Clean Development Mechanism defined in article 12 of the Protocol, under the Kyoto Protocol to implement an emission-reduction projects in developing countries.

The **CDM** allows in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO2. These CERs can be traded and sold, and used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol.

The CDM is the main source of income for the UNFCCC Adaptation Fund, which was established to finance adaptation projects and programmes in developing countries particularly vulnerable to the adverse effects of climate change. The Adaptation Fund is financed by @ 2% levy on CERs issued by the CDM.

A CDM Project activity might involve, for eg , a rural electrification project using solar panels or the installation of more energy – efficient boilers. From a business point of view, CDM represents new opportunities for entrepreneurs in the developed countries.