DIRECTORATE OF DISTANCE EDUCATION

UNIVERSITY OF JAMMU
JAMMU

SELF LEARNING MATERIAL
B.A./B.COM SEMESETER - III

Subject : Environmental Studies **Unit I to III**
Course No. : ES-301 **Lesson 1 to 13**

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ENVIRONMENTAL STUDIES

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SYLLABUS

ENVIRONMENTAL STUDIES - IIIrd SEMESTER

Couse No. :	**ES 301 (Theory)**	**Max. Marks**	**: 50**
Duration :	**45 Minutes**	**Theory**	**: 35**
		S. A.	**: 15**

Unit - I Introduction of environment studeis and ecosystem.

1.1 Definition, Scope and importance of ecology and environment, need for public awareness.

1.2 Concept of structure and function of ecosystem : Products, Consumers and decomposers. Energy flow in ecosystems.

1.3 Concept of ecological succession.

1.4 Food chain, food web and ecological pyramids.

1.5 Introduction, types and characteristic features of the following ecosystemsof India :

i) Forest ecosystem

ii) Grassland ecosystem

iii) Desert ecosystem

iv) Aquatic ecosystem

Unit - II Environmental Pollution

2.1 Definition, causes, effects and control measures of :

i) Air pollution

ii) Water Pollution

iii) Soil Pollution

iv) Noise Pollution

v) Radiation Pollution

2.2 Soild waste management; casuses, effects and control measures of urban and industrial waste.

2.3 Acid rain

2.4 Ozone depletion

2.5 Global Warming

Unit - III Environmental laws and disasters

3.1 Salient features of following acts

i) Environmental Protection Act, 1986

ii) Air (Prevention and control of pollution) Act, 1981

iii) Water (Prevention and control of pollution) Act, 1974

iv) Wildlife protection Act, 1972

v) Forest conservation Act, 1980

3.2 Disaster Management : Floods, Earthquakes, Cyclones, Landslides, Drought.

3.3 Wasteland reclamation

3.4 Resettlement and rehaibiliation of people, its problems and concerns.

3.5 Environmental ethics, issues and possible solutions.

Field / Practical Work

All the students are required to undertake the following field/practical work based on which they will be assessed for their Internal Assessment Test

i) Visit to a local area to document environmental assests/ecosystems River/ Forest/Grassland/Mountain

ii) Construction of Foods Chain / Food Web / of teh visited area.

iii) To identify the sources of air/water/soil/noise pollution of your area.

Note : The Sessional Assessment of 15 marks will be distributed as follows :

Attendance in theory and practical	**-**	**05**
Tets based on field work	**-**	**10**

For Theory Paper Setter : The question paper of 35 marks will consist of 35 multiple choice questions based on above topics. Questions should be equally distributed from all the units. Each question would be of ONE mark.

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UNIT-I **LESSON-I**

INTRODUCTION OF ENVIRONMENT STUDIES AND ECOSYSTEM

DEFINITION, SCOPE AND IMPORTANCE OF ECOLOGY AND ENVIRONMENT, NEED FOR PUBLIC AWARENESS

1.1 INTRODUCTION

1.2 OBJECTIVES

1.3 CONCEPT OF ENVIRONMENT

1.4 ENVIRONMENTAL STUDIES AS A MULTIDISCIPLINARY SUBJECT

1.5 SCOPE OF ENVIRONMENTAL STUDIES

1.6 SCOPE AND IMPORTANCE OF ECOLOGY

- 1.6.1 CHARACTERISTICS OF ECOLOGY
- 1.6.2 BRANCHES OF ECOLOGY
- 1.6.3 IMPORTANCE OF ECOLOGY

1.7 NEED FOR PUBLIC AWARENESS

1.8 COMPONENTS OF ENVIRONMENT

1.9 SUMMARY

1.10 GLOSSARY

1.11 SELF ASSESSMENT QUESTIONS

1.12 SUGGESTED READINGS / REFERENCES

1.1 INTRODUCTION

Everything that surrounds and affects living organisms is environment .'Environment' is derived from the French word ***Environner*** **,** which means to encircle or surround. All the biological and non-biological entities surrounding us are included in environment.

According to **Environment Protection Act,1986**, Environment includes all the physical and biological surroundings of an organism along with their interactions. **Environment** is thus defined as **"the sum total of water, air and land and the inter-relationships that exist among them and with the human beings, other living organisms and materials."**

1.2 OBJECTIVES

- To study the concept of environment
- To study the scope and importance of ecology and environment

1.3 CONCEPT OF ENVIRONMENT

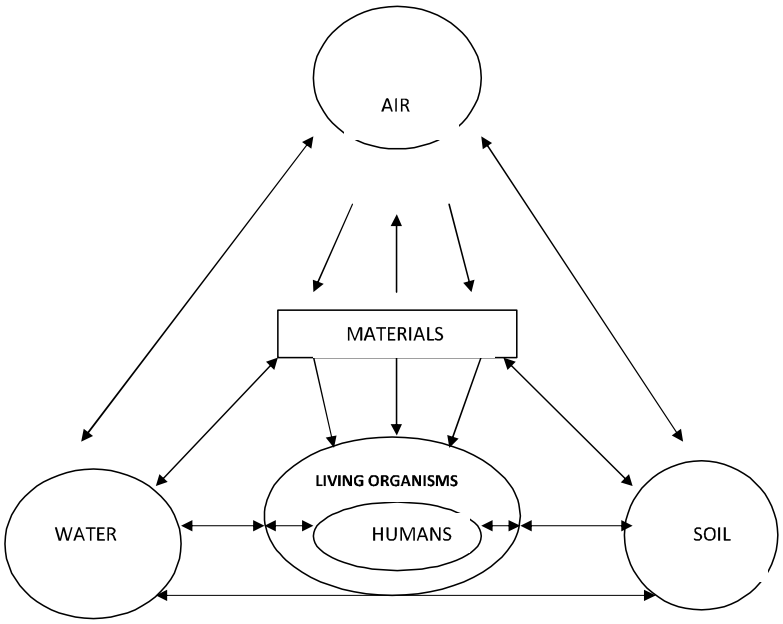

Fig.1.3.1

Concept of Environment :air, water, land, living organisms and materials surrounding us and their interactions together constitute an environment.

Figure 1.3.1 depicts the environment of human beings. Air, water and land surrounding us constitute our environment and influence us directly. At the same time we too have an influence on our environment by overuse or over-exploitation of resources or by discharge of pollutants in the air, water and land .The flora, fauna and microorganisms as well as the man-made structures in our surroundings have a bi-directional interaction with us directly or indirectly. The totality of all these components and their interactions constitute the environment.

1.4 ENVIRONMENTAL STUDIES AS A MULTIDISCIPLINARY SUBJECT

Environmental studies deal with the working of the earth, its life-support systems, its interactions, influences , its problems and solutions .Keeping in view the complex nature of environment, knowledge and information from various disciplines of science, social science,law and engineering have to be included in environmental studies to understand it completely. Figure 1.4.1 depicts the multidisciplinary nature of environmental studies.

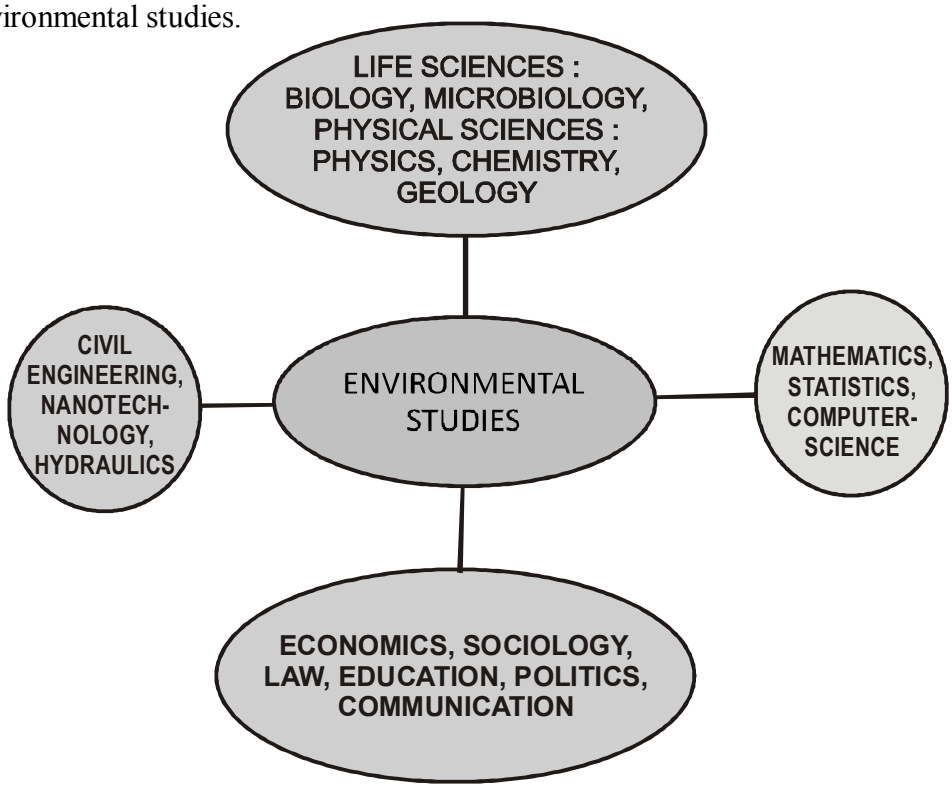

Fig. 1.4.1 depicts the multidisciplinary nature of environmental studies.

- Life sciences including botany, zoology, microbiology and genetics help in understanding the biotic components and their interactions.
- Physical and chemical sciences including physics, chemistry, geology, geography, atmospheric science help in understanding the physical and chemical structure of abiotic components of environment.
- Mathematics , statistics and computer science likewise serve as effective tools in environmental modeling.
- Subjects like economics, management and sociology provide the inputs for dealing with the socio-economic aspects associated with various developmental activities.
- Introduction of civil engineering, hydraulics, chemical engineering and nanotechnology provide the technical solutions to environmental pollution control and waste treatment which are extremely important for the protection of the environment.
- Environmental laws provide the guidelines and legal measures for effective management and protection of the environment.

1.5 SCOPE OF ENVIRONMENTAL STUDIES

Due to its complex and multi-disciplinary nature environmental studies as a subject has a wide scope. It encompasses a large number of areas and aspects, which may be summarized as follows:

- **Natural resources- Their conservation and management** :The environmentalists all over the world are very much engaged in the development of various strategies which enable us to make use of our natural resources to the fullest extent ,while still maintaining them for continued use in future.
- **Ecology and bio-diversity**: Ecology is the study of reciprocal interrelationships between an organism and its environment .The knowledge of ecology has proved to be useful in solving various problems faced by the living organisms.

- **Environmental pollution and control:** Environmental pollution has become a major threat to the world. It is not the problem of any one country but has become an international problem. Environmental studies play a crucial role in solving this major problem of the world .It exihibits great applications in understanding the causes of pollution and its control .
- **Human population and environment** :The problems and effects of disposal of wastes, deterioration of habitat, contamination of air, water, soil etc. can be taken up only with the help of trained environmentalists.
- **Social issues in relation to development and environment** :Most of the socio-economic, political and other similar policies of the world are now based on the ecological aspects.

In the recent years, the scope of environmental studies has expanded dramatically over the world. Several career options have emerged in this field that are broadly categorized as :

i) **Research and development in environment** : Skilled environmental scientists have an important role to play in examining various environmental problems in a scientific manner and carry out research and development activities for developing cleaner technologies and promoting sustainable development.

ii) **Green advocacy** : With increasing emphasis on implementing various acts and laws related to environment, need for environmental studies has emerged, which should be able to plead the cases related to pollution, forest, wildlife etc.

iii) **Green marketing** : Green marketing is the marketing of environmentally friendly products and services. Such products have ecomark or ISO 14000 certification.Environmental auditors and environmental managers would be in great demand in the coming years.

iv) **Green media** : Environmental awareness can be spread amongst masses through mass media like television, radio, newspaper, magazines, advertisements etc. for which environmentally educated persons are required.

v) **Environment consultancy** : Many non-government organizations (NGOs), industries and government bodies are engaging environment consultants for systematically studying and tackling environment related problems.

1.6 SCOPE AND IMPORTANCE OF ECOLOGY

Ecology is the branch of biology which deals with the study of living organisms and their interaction with the environment. In 1868, Reiter introduced the term "***Oekologie***" but he did not gave any definition. Earnst Haeckel in 1869 defined Oekologie as "***the study of reciprocal relations between living organisms and their environment***". Warming in 1905 utilised this science for the study of plants. The ecology was coined by Ernst Haeckel in 1869. Ecology is derived from two Greek words "***Oikos***" meaning "***house or dwelling place***" and "***Logos***" meaning "***the study of***". So, ecology deals with the study of organisms in their natural home interacting with their surroundings.

Example:-How a small insect in a forest interacts with other animals, plants, soil, air or water is studied in its ecology. Thus, ecology is the science that studies such interactions and relationships of an organisms or a group of organisms.

Odum in 1969 defined ecology as "***the study of structure and function of ecosystems***".

The work of F.E.Clements, V.Shelford and several others established ecology as a unified biological science. In modern ecology, the concept of levels of organization is visualized as a biological spectrum.

1.6.1 Characteristics of ecology:-

1) It includes all types of environment- physical, cultural, social and psychological.
2) It is the study of interdependence and inter-relationship between the organisms and the environment.
3) It emphasizes inter-organisms relationship.
4) It is the scientific study for analyzing the relationship between organisms and the environment.

1.6.2 Branches of ecology:-

1) Autoecology:- It is the study of individual species in relation to its environment. It includes geographical distribution, morphology, life-cycle and the impact of ecological factors on its life cycle at different stages. Autoecology is also known as species ecology.

2) ***Synecology***:- It is the study of plant communities (structure, organization and development) in relation to environment. The study of a community, its birth, growth is called synecology. It is also known as community ecology.

Other branches are:-

1) ***Habitat ecology***:- It is the study of plants/animals in relation to the habitat.

2) ***Genecology***:-It is the study of ecology in relation to genetics. This branch deals with the origin of ecosystem, ecads etc.

3) ***Palaecology***:- It is the study of life form and environment of past ages.

4) ***Radiation ecology***:- It is the study of effect of radiation on organisms.

1.6.3 Importance of ecology:-

Ecology has an important role in agriculture, forestry, conservation of soil, control of floods, pest control, wild-life preservation, fresh-water biology and management of natural resources. A knowledge of ecology is essential for solving the problems of environmental pollution. The survival of human population depends on intelligent use of natural resources and maintenance of environmental quality by prevention of pollution.

1.7 NEED FOR PUBLIC AWARENESS

If we want to protect and sustain our earth, we have no other option but to make everyone environmentally educated. It is absolutely essential to create awareness about environment because:

- **Rapidly changing technologies lead to abandoned wastes**: In the modern era of development there is greater inclination for adopting the latest product of technological advancement and discarding the older one as obsolete. People change their cars, computers, mobile phones and electronic goods within a few years , thus adding to the vast electronic waste (e-waste) stream.

  Our fast and energy demanding life style pollutes the environment: To keep pace with the fast and busy life, people become increasingly dependent on machines to get the work done fast and make life more comfortable for us. But all

these machines are energy demanding. Over dependence on machines increases resource depletion and energy consumption.

Crazy consumerism leads to environmental degradation: There is a sharp increase in consumerism. With increasing buying capacity people have started over-consumption .The wasteful life style of people leads to environmental degradation. People should know how their activities influence the environment.

The earth has a definite capacity to tolerate pollutants and sustain populations : Beyond that the earth cannot assimilate wastes and support life. How the earths's life support system works, what is the structure of its system and what are the principles on which it works are very important subjects that everyone should know.It is equally important to know that what should be done to protect the earth and our environment .

1.8 COMPONENTS OF ENVIRONMENT

Environment mainly consists of four main components which are discussed below:

(1) Lithosphere

(2) Hydrosphere

(3) Atmosphere

(4) Biosphere.

ATMOSPHERE It is the gaseous envelope surrounding the earth and extends upto 500 kms above the earth's surface. The composition of the atmosphere is given in Table 1.6

The atmosphere, which is a gaseous cover, protects the earth from cosmic radiations and provides life sustaining Oxygen, the macronutrient Nitrogen and Carbon dioxide

Table 1.6 : The composition of the Atmosphere

Constituent	Volume %
Nitrogen	78.1
Oxygen	20.9
Water vapours	0.1-5
Argon	0.9
Carbon dioxide	0.03
Trace constituents	Helium, neon, krypton, xenon, etc.

needed for photosynthesis. The atmosphere screens the dangerous UV radiations from the sun and allows only radiations in the range of 300 nm – 2500 nm (near UV to near IR) and radio waves. The atmosphere plays a major role in maintaining the heat balance of the earth by absorbing the re-emitted radiation from the earth. In addition the atmosphere is the medium of carriage of water from the oceans to the land in the hydrological cycle.

The atmosphere is broadly divided into four major zones viz. Troposphere, Stratosphere, Mesosphere and Thermosphere. Characteristics of these zones are pictorially represented in Fig. 1.

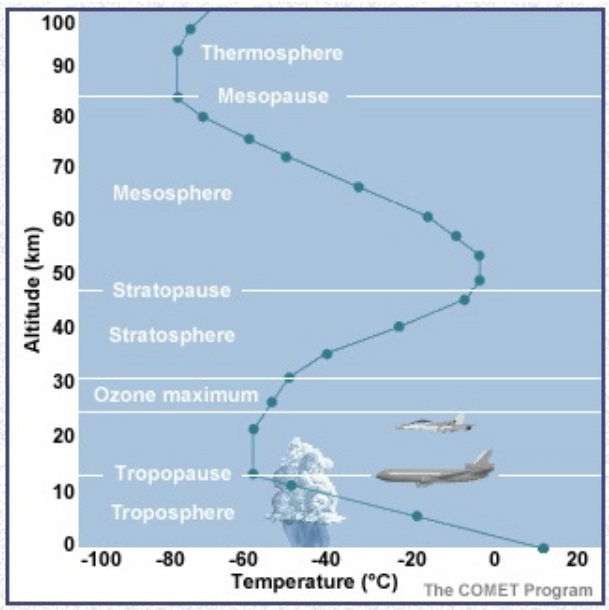

Fig. 1: Showing different layers of Atmosphere

TROPOSPHERE : Troposphere is the layer of air nearest to the ground. Temperature decreases with height. The average temperature drops from 15ºC at sea level to –56.5ºC at 11,000 m above sea level. Mixing of the air molecules due to their constant movement (winds) keeps the composition of the gases more or less same throughout the troposphere. An exception to this is water vapor. Most water vapor evaporates from the surface of the Earth and is found in the lower troposphere. Most of the weather occurs in the troposphere. Tropopause is the top of the troposphere, which is a transition layer between Troposphere and Stratosphere.

STRATOSPHERE: Stratosphere is the layer of air above the troposphere where temperature increases with height. The average temperature rises to –2.5ºC at 50,000 m above sea level. Ozone is found in higher concentrations between 20 and 30 km above the surface. Hence sometimes this layer is referred to as the "ozone layer". Ozone absorbs radiant energy from the sun and hence warmer temperatures are encountered in the stratosphere. Stratopause is the top of the stratosphere, which is a transition layer between Stratosphere and Mesosphere.

MESOSPHERE : Mesosphere is the layer of air above the stratosphere where temperature decreases with height. The average temperature decreases to –90°C at

90,000 m. This is the coldest layer of the atmosphere. Mesopause is the top of the mesosphere, which is a transition layer between Mesosphere and Thermosphere.

THERMOSPHERE : Thermosphere is the layer of air above the mesosphere. The temperatures in the thermosphere increase with increasing height, but there are not many molecules in this layer. The air becomes less and less dense as we reach space.

LITHOSPHERE : The earth's crust consisting of the soil and rocks is the lithosphere. The soil is made up of inorganic and organic matter and water. The main mineral constituents are compounds or mixtures derived from the elements of Si, Ca, K, Al, Fe, Mn, Ti, O etc. (Oxides, Silicates, and Carbonates). The organic constituents even though form only around 4% – 6% of the lithosphere, they are responsible for the fertility of the soil and hence its productivity.

HYDROSPHERE : This comprises all water resources both surface and ground water. The world's water is found in oceans and seas, lakes and reservoirs, rivers and streams, glaciers and snowcaps in the Polar Regions in addition to ground water below the land areas. The distribution of water among these resources is as under Figure-2.

The water locked up in the Oceans and Seas are too salty and cannot be used directly for human consumption, domestic, agriculture or Industrial purposes. Only less than 1% of water resources are available for human exploitation.

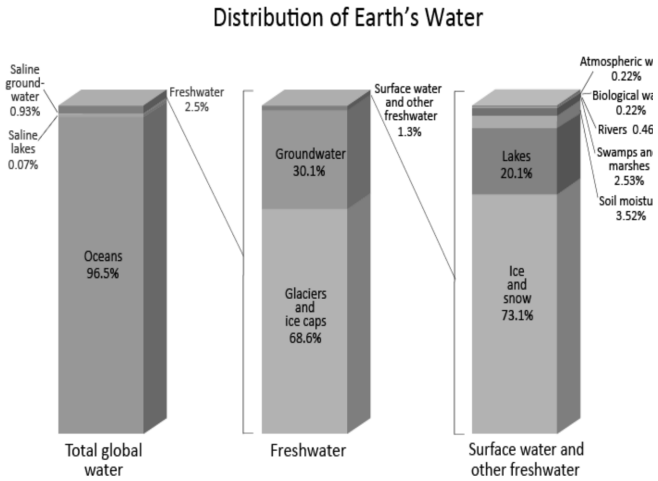

Fig. 2 : The distribution of water among these resources.

BIOSPHERE: The biosphere is a capsule encircling the earth's surface wherein all the living things exist. This portion extends from 10000 m below sea level to 6000 m above sea level.Life forms do not exist outside this zone. The biosphere covers parts of other segments of the environment viz. Lithosphere, Hydrosphere and Atmosphere. Life sustaining resources like food, water and oxygen present in the biosphere are being withdrawn and waste products in increasing quantities are being dumped. The biosphere has been absorbing this and assimilating them. However the rate of waste dumping has gone beyond the assimilating capability of the biosphere and signals of this stress is becoming evident.

ENVIRONMENTAL CONCERN AND RECOGNITION AT INTERNATIONAL LEVEL :

Environmental issues received international attention about 35 years back in Stockholm conference, held on 5th June, 1972.since then all over the world we celebrate world environment day on 5th June. At the united nations conference on environment and development held at Rio de Janerio,in 1992, popularly known as EARTH SUMMIT, and ten years later , the world summit on sustainable development, held at Johannesberg in 2002,key issues of global environmental concern were highlighted.

1.9 SUMMARY : Everything that surrounds and affects living organisms is environment. All the biological and non-biological entities surrounding us are included in environment . The science of Environment studies is a multi-disciplinary science because it comprises various branches of studies like chemistry, physics, medical science, life science, agriculture, public health, sanitary engineering etc. It is the science of physical phenomena in the environment. It studies of the sources, reactions, transport, effect and fate of physical and biological species in the air, water and soil and the effect of from human activity upon these. The environment studies enlighten us about the importance of protection and conservation of our indiscriminate release of pollution into the environment. At present a great number of environment issues, have grown in size becoming complex day by day thereby threatening the survival of mankind on earth. We study about these issues besides and effective suggestions in the Environment Studies.

1.10 GLOSSARY : Atmosphere : The mass of air surrounding the Earth.

Biosphere : The portion of Earth and its atmosphere that can support life.
CFCs : Short for 'chloroflurocarbons', which are chemicals used in manufacturing and in the past in aerosol cans and refrigerators, which can damage the ozone layer.
Climate : The pattern of weather in a particular region over a set period of time, usually 30 years or too cold.

Climate change :A change in the climate of a region over time due to natural forces or human activity. In the context of the UN Framework Convention on Climate Change, it is the change in climate caused by higher levels of greenhouse gases in the atmosphere due to human activities as well as natural climate changes.

Deforestation : The reduction of trees in a wood or forest due to natural forces or human activity such as burning or logging.

Ecosystem :A community of organisms that depend on each other and the environment they inhabit.

Flora and fauna : The plants and animals that are native to a particular area or period of time.

Global warming : The gradual increase in temperature of the Earth's surface caused by human activities that cause high levels of carbon dioxide and other gases to be released into the air.

Greenhouse effect : The warming of the Earth's atmosphere caused by increasing levels of gases, such as water vapour and carbon dioxide. These gases absorb radiation emitted naturally from the ground, so slowing down the loss of energy from Earth.

Greenhouse gases : Gases such as carbon dioxide and methane, which tend to trap heat, radiating from the Earth's surface, so causing warming in the lower atmosphere. The major greenhouse gases that cause climate change are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (NO_2).

Habitat : The area occupied by a community or species (group of animals or plants), such as a forest floor, desert or sea shore.

Litter : Waste that is thrown away carelessly, mainly made up of plastic, metal, glass, paper or food.

Organism : Any living thing from bacteria and fungi through to insects, plants, animals and humans.

Ozone layer : The thin protective layer of gas 10 to 50km above the Earth that acts as a filter for ultraviolet (UV) radiation from the sun. High UV levels can lead to skin cancer and cataracts and affect the growth of plants.

Reforestation :The process of planting trees in forest lands to replace those that have been cut down.

Sustainable development : Development using land or energy sources in a way that meets the needs of people today without reducing the ability of future generations to meet their own needs.

Water vapour : Water in its gas form – instead of liquid or solid (ice).

1.11 MULTIPLE CHOICE QUESTIONS:

1. Biotic environment includes

(a) producers (b) consumers (c) decomposers (d) all the above

Answer : (d) all the above

2. Decomposers include

a) bacteria (b) fungi (c) both (d) animals

Answer : (c) both

3. Abiotic environment does not include

(a) air (b) water (c) soil (d) plants

Answer : (d) plants

4. The group of organisms which convert light into food are called

(a) autotrophs (b) heterotrophs (c) decomposers (d) omnivores

Answer : (a) Autotrophs

5. World Environment Day is celebrated on

(a) 5th May (b) 5th June (c) 5th July (d)5th August

Answer : (b) 5th June

6. **In our country the Van Mahotsav Day is observed on**

(a) Second of October (b) First of December

(c) Tenth of August (d) First of July

Answer: (d) First of July

7. Plants are green because of the presence of a pigment called:

(a) glucose (b) nitrogen (c) chlorophyll (d) oxygen

Answer: (a) chlorophyll

8. The Earth summit was held in the year

(a) 1992 (b) 1995 (c) 2000 (d) none

Answer : (a) 1992

9. Chief source of energy in environment is

(a) fire (b) moon (c) sun (d) stars

Answer: (c) sun

10. 71% of earth surface is covered with:

(a) land (b) air (c) water (d) coal

Answer: (c) water

1.12 SUGGESTED READINGS / REFERENCES:

Odum E P and Barrett GW (2005) Fundamentals of ecology by 5th edition Cengage learning.

Subrahmanyam N S and Sambamurty AVSS (2000) Ecology by, 2nd . Narosa publishing house.

Kaushik A and Kaushik C P (2007) Environmental studies, by 4th edition .New age international publishers.

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Unit - I **LESSON-II**

CONCEPT OF STRUCTURE AND FUNCTION OF ECOSYSTEM: PRODUCERS, CONSUMERS AND DECOMPOSERS. ENERGY FLOW IN ECOSYSTEM

2.1 INTRODUCTION

2.2 OBJECTIVES

2.3 CONCEPT OF ECOSYSTEM

2.4 STRUCTURE OF ECOSYSTEM

2.5 FUNCTIONS OF ECOSYSTEM

2.5.1 ENERGY FLOW

2.5.2 PRODUCTIVITY

2.5.3 BIOGEOCHEMICAL CYCLES

2.6 SUMMARY

2.7 GLOSSARY

2.8 SELF ASSESSMENT QESTIONS

2.9 SUGGESTED READINGS / REFERENCES

2.1 INTRODUCTION

Various kinds of life supporting systems like the forests, grasslands, oceans, lakes, rivers, mountains, deserts and estuaries show wide variations in their structure composition and functions. However, they all are alike in the fact that they consist of living entities interacting with their surroundings exchanging matter and energy. How do these different units differ in the type of their flora and fauna, how do they derive their energy and nutrients

to live together, how do they influence each other and regulate their stability are the questions that are answered by ecosystem and ecology.

2.2 OBJECTIVES

- **To study the concept of ecosystem**
- **To understand the structure and functions of ecosystem**

2.3 CONCEPT OF ECOSYSTEM

All organisms present in the environment exist in a systematic way. Organisms of different species living in a community affect each other as well as their environment by their actions. The word "ecosystem" is derived from two words–**"Eco" meaning "Home" and "System"** meaning **"Orderly arrangement".** Therefore Ecosystem means a system of inter-relationship. Ecosystem is a self regulating group of biotic communities of species interacting with one another and with their non living environment exchanging energy and matter. It is the basic structural and functional unit of nature. The term Ecosystem was coined by **Sir Arthur G Tansley in 1935.**

Definitions

Sir Arthur G Tansley (1935):-"the system resulting from the integration of all living and non living factors of the environment".

E.P.Odum (1971):-"Ecosystem is a functional unit of the environment which constantly interacts with their own components and other ecosystems".

2.4 STRUCTURE OF ECOSYSTEM:

Ecosystems shows large variations in size, structure and composition. However, all the ecosystems are characterized by certain basic structural and functional features which are common to all.

Biotic (living) structure /components:

Life in an ecosystem is nutritionally structured. Plants, animals and micro-organisms constitute biotic component. These have different nutritional behavior and status in the ecosystem and are accordingly known as producers, consumers or decomposers, based on how they get their food.

1) **Producers**:-These are those organisms which produce their own food. Producers are the only creatures on the earth which convert light energy /radiation energy into chemical energy and store it in the form of food. Producers are of two types-

   a) **Photo-autotrophs** which produce their own food in the presence of sunlight. "Photo" means "light", "auto" means "self" and "troph" means "food" .eg : green plants and cyanobacteria.

   b) **Chemo-autotrophs** which produce their own food by chemical reactions. "Chemo" means "chemicals", "auto" means "self" and "troph" means "food". e.g.:- Sulphur bacteria, Iron bacteria.

2) **Consumers**:- Theses are those organisms which do not produce their own food but depends upon others for their nutritional requirements .These are also called as Heterotrophs. Consumers are further of different types

   a) **Herbivores**:-These are those organisms which depend upon plants for their nutritional requirements. These are also called as primary consumers. e.g. :-rabbit, insects, deer, goat, cattle etc.

   b) **Carnivores**:- Carnivores feed on other consumers. They are called as meat eaters. If feed upon herbivores, they are Secondary consumers e.g.:- frog, fox, centipede etc. If feed upon secondary consumers then they are called tertiary consumers eg:-snake, wolf eating upon the fox etc. And if feed upon tertiary consumers then they are quaternary consumers e.g.:- lion, tiger etc.

   c) **Omnivores**:-Omnivores are both plant eaters as well as meat eaters. e.g.:- humans, rat, many birds etc.

   d) **Detritivores**: - These feed upon dead tissues. eg:-beetles, termites, ants, crabs, earthworms, vulture etc.

3) **Decomposers**:- Organisms which live on dead and decaying plants or animals parts and are consumers of special kinds. They are also known as saprotrophs. Decomposers carry out decomposition process by which complex organic

matter of dead plants or animals are broken down into simpler compounds that are latter used by green plants.

Abiotic (non living) structure /components:-

Abiotic components are broadly divided into two components- **Physical and Chemical**

Physical factors include:-

- **Climatic factors like:-**

1) **Sunlight**

Sunlight is an important factor that has far reaching effects on both plants and animals. It is essential for photosynthetic organisms for the preparation of food. Most animals are sensitive to light and they have special photoreceptors eg:-cockroaches, moths and bats which become active during night. It is also useful for seed germination and phototaxis (which is movement in response to light)

2) **Temperature**

Influence all forms of life by exerting its action through increasing or decreasing the vital activities of organisms like behavior, metabolism, reproduction, development and death. Normal life activities continue in a specific range of temperature called optimum temperature range beyond that there is minimum or maximum temperature which organisms can't tolerate.

3) **Humidity**

Humidity, i.e., moisture content of the atmosphere is also an important factor. It directly regulates the rate at which water evaporates from the body surface of land organisms by transpiration, precipitation and other means.

4) **Rainfall**

Water is called the liquid of life because no life can exist without water. Rainfall is the amount of water falling on the surface of earth. Depending upon the rainfall vegetation also varies.

5) **Winds**

Blowing air largely determines weather conditions. It affects the plants in various ways particularly their rate of transpiration. Winds also help in dispersal of seeds and fruits.

- **Edaphic factors**

The edaphic factors comprises of soil and substratum and include Soil type, Soil moisture and Soil reactions which determines the type and abundance of vegetation.

- **Geographic factors**

Surface configuration or physical feature of an area is called topography. It influence distribution of organisms. The geographic factors include

1) **Latitude** :-Tropics are considered to be the richest biome. They support large number of species of plants and animals. As we move from equator to poles, the diversity of plants and animals increases towards equator and decreases towards poles. In polar regions, there is harsh climatic conditions and so only those plants and animals which can withstand these climatic conditions grow there and hence results in low diversity.

2) **Altitude** :- There is change in climatic conditions as we move from bottom to the top in case of mountains. Oxygen content and temperature decreases with height and precipitation, windspeed as well as atmospheric moisture increases with altitude which in turn affect the distribution of plants and animals in those regions.

Chemical factors include:-

1) Major nutrients like carbon (C), Nitrogen (N), Phosphorus (P), Potassium (K), Hydrogen (H), Oxygen (O), Sulphur (S) etc., which largely influence the functioning of the ecosystem.

2) Trace elements like iron (Fe), copper (Cu), zinc (Zn) which are essential for electron transport, nitrogen assimilation, nucleic acid replication and transcription

2.5 FUNCTIONS OF AN ECOSYSTEM:-

Functional aspects of an ecosystem depicts how abiotic and biotic factors of an ecosystem are related to one another and their interaction among themselves resulting in a system. Functions of an ecosystem include:-

1) The rate of biological energy flow

2) The rate of materials or nutrient cycles

3) Productivity

4) The biological or ecological regulation of organisms by the environment or vice-versa

5) Biological diversity and maintenance of stability

6) Food chain relationship

2.5.1 ENERGY FLOW

Energy flow is the movement of energy through an ecosystem from the external environment through a series of organisms and back to the external environment. It is one of the most fundamental processes that is common to all ecosystems. Living organisms are operated by means of energy. No species, no ecosystem can survive without a constant supply of energy to maintain the basic structures and their functions. Sun is the ultimate source of this energy. If the quality or quantity of energy input in an ecosystem is reduced, then the ecosystem begin to degrade. Energy flow or movement of energy is unidirectional. Energy once used by an organism is converted into heat and is soon lost from the ecosystem. So energy must be supplied from external source to keep biological processes running.

Diagramatic representation of Energy flow:-

Energy flow is the key function of an ecosystem. It is determined by two basic laws of thermodynamics-1st law of thermodynamics and 2nd law of

thermodynamics. The 1st law of thermodynamics states that "energy can neither be created nor be destroyed but it can be transformed from one form to another". The 2nd law of thermodynamics states that whenever energy is transformed there is always a loss of energy through the release of heat. i.e.,energy conversion is not 100% efficient.

Energy Flow models:-

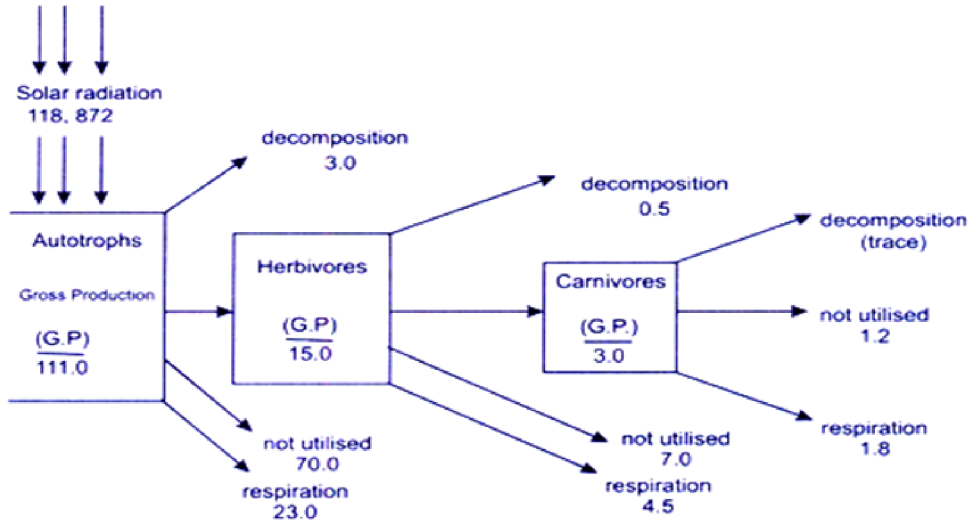
Energy flow in an ecosystem can easily be explained with the help different models. A few models are as follows. All these models have the same characteristic features which are as under:-

a) There is unidirectional flow of energy from the sun to the producers and then to various types of consumers of the food chain.

b) During each energy transfer, about 80-90% of energy is lost as heat in metabolic reactions eg, respiration, excretion etc. So only 10-20% of energy is available to the next trophic level.

c) There is also corresponding decrease in biomass.

d) Energy flow follows both the laws of thermodynamics.



Examples:

1. Lindeman's Energy flow model of a Lake

The unidirectional energy flow model of a lake as given by Lindeman shows that:-.

a) Producers or autotrophs can utilize only **0.1%** (**111.0 g.cal./cm²/year** out of **118,872 g.cal./cm²/year)** of incident solar radiations in their primary gross production or total photosynthesis.

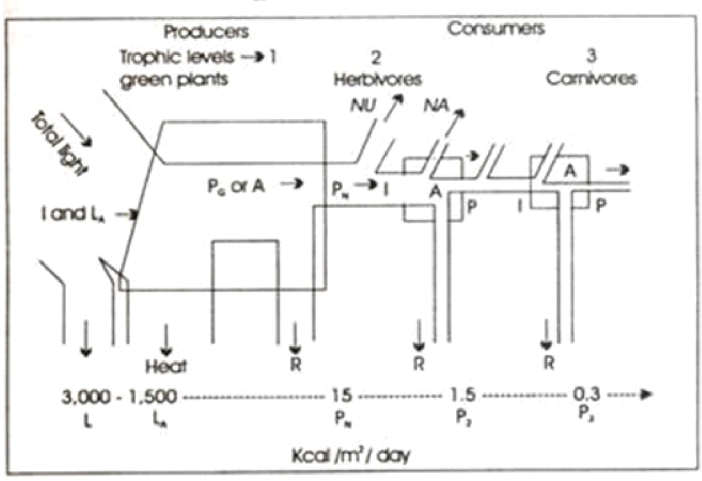
b) Out of this gross production, about **21%** is consumed in metabolic functions of the autotrophs e.g. respiration, growth and reproduction; **63%** remains unutilized and about **3%** is utilized in the process of decomposition so that only **13-14%,** (i.e.**15g.cal./cm²/ye**ar) of primary gross production is available to the herbivores.

c) At the herbivore level, out of **15g.cal./cm²/year** about **30%** is utilized in the metabolic reactions; **47%** of energy available unutilized and **3%** of it is utilized in decomposition so that only **20%** of energy of autotrophs is utilized in secondary net production of primary carnivores.

d) Process is repeated during transfer of energy from the primary to secondary carnivores and so on.

2. Odum's Energy flow model of three trophic levels

Energy Flow in a Food Chain



Odum (1963) proposed a simplified energy flow diagram depicting three trophic levels (boxes) in a linear food chain. The model explains that of the **3000 kcal** of total light falling upon green plants, approximately **50% (i.e.1500 kcal**) is absorbed, of which only **1% (i.e.15 kcal)** is converted at first trophic level. The **15 kcal** is the net primary production. Secondary productivity (P_2 and P_3 as shown in figure) tends to be about **10%** at successive consumer trophic levels, i.e., herbivores and carnivores. Percentage of secondary productivity may vary at the carnivore level (**P_3 = 0.3 kcal**).

2.5.2 PRODUCTIVITY

The rate of biomass production is known as productivity. Productivity in an ecosystem is expressed in terms of dry matter produced or energy captured per unit area of land per unit time. Energy captured is expressed in calorie/cm^2/year and dry organic matter is expressed in gram/$meter^2$/year.

Primary productivity :- It is the rate at which radiant energy is converted by the photosynthetic and chemosynthetic activity of producer organisms (chiefly green plants) to organic substances. In other words, it is the rate at which energy accumulates in green plants.

Gross primary productivity (GPP) is the total photosynthesis or total assimilation, including the organic matter used up in respiration during the period of measurement.

Net primary productivity is the rate of storage of organic matter in plant tissues that exceeds the respiratory use by plants during the period of measurement. This is also termed as net assimilation.

(NPP = GPP-Energy lost in respiration)

Secondary productivity:- It is rate of energy storage at consumer level. In other words, it is the productivity of animals in the ecosystem.

2.5.3 BIOGEOCHEMICAL CYCLES:-Nutrients move in a cyclic manner within an ecosystem. Besides energy flow, the other important functional attribute of an ecosystem is nutrient cycling. Nutrient like carbon, nitrogen, sulphur, oxygen, hydrogen, phosphorus etc. move in circular paths through biotic and abiotic components and are therefore referred to as biogeochemical cycles or cycles of matter. It is the movement of nutrient elements through the living and non-living

components of the biosphere. The nutrients move through the food chain and ultimately reach the detritus compartment (containing dead organic matter) where various micro-organisms carry out decomposition and release inorganic substances that are readily used up by plants and the cycle starts afresh. Biogeochemical cycles are of two types- gaseous cycle and sedimentary cycle.

1) Gaseous cycle:-

1) Gaseous cycle pertains to gases.

These have reservoir pool in atmosphere and hydrosphere

These occur fast (quick) and take less time to complete its cycle

These are perfect systems as elements remain uniformly in circulation

Eg :-carbon (C),nitrogen (N),oxygen (O) and water (H_2O) cycle

2) Sedimentary cycle:-

Sedimentary cycle pertains to minerals

These have reservoir in Lithosphere

These occur very slowly and take long time to complete

These are less perfect as the elements get locked in the reservoir pool for a longer period.

Eg :-phosphorus (P), sulphur (S) cycle.

2.6 SUMMARY

All organisms present in the environment exist in a systematic way. Organisms of different species living in a community affect each other as well as their environment by their actions. Ecosystem is a self regulating group of biotic communities of species interacting with one another and with their non living environment exchanging energy and matter. Ecosystems shows large variations in size, structure and composition. However, all the ecosystems are characterized by certain basic structural and functional features which are common to all. And the study of structure and functions of ecosystems is called ecology. Ecology

deals with the study of organisms in their natural home interacting with their surroundings.

2.7 GLOSSARY

Abiotic : Non Living components of an ecosystem, such as water, air, light and nutrients

Autotrophs : Produce its own food (as photosynthetic plants)

Altitude : The height of an object or point in relation to sea level..

Assimilation : The absorption and digestion of food or nutrients by the body or any biological system.

Biotic : Refers to the living components of an ecosystem

Biological magnification : Increase in the concentration of a chemically stable substance or element such as pesticides, radioactive materials, or heavy metals) as it moves up a food chain

Carbon cycle : Movement of carbon between the atmosphere, hydrosphere and biosphere

Cyanobacteria : Group of bacteria that posses chlorophyll a and carry out photosynthesis

Decomposers : Organisms, typically bacteria and fungi, that obtain energy from the breakdown of dead organic matter

Decomposition : Breakdown of complex organic materials into simpler products

Detritivores organisms that feed on dead or decaying organic matter (such as earthworms)

Detritus food chain : Food chain in which the primary producers are not consumed by grazing herbivores, but where dead and decaying plant parts form litter(detritus) on which decomposers (bacteria and fungi) and detritivores feed, with subsequent transfer of energy through the detritus food chain

Ecosystem : A biotic community and its abiotic environment functioning as a system

Ecology : Branch of science dealing with interactions and relationships between organisms and the environment

Environment : Everything that surrounds and affects living organisms

Food chain : Sequence of eating and being eaten in an ecosystem

Food Web : Network of food chains

2.8 MULTIPLE CHOICE QUESTIONS:

1) Term ecology was coined by

a) Ernst Haeckel b) E. P. Odum c) A.G.Tansley d) None

Ans: Ernst Haeckel

2) Study of inter-relationship between the organisms and their environment is

a) Ecology b)Topology c)Ecosystem d)Hexicology

Ans: Ecology

3) The term ecosystem was proposed by

a) Odum b) Tansley c)Warming d)Haeckel

Ans: Tansley

4) Importance of ecosystem lies in:

a) Flow of energy b) Cycling of materials
c) Both a and b d) None of these

Ans: Both a and b

5) Auto ecology means:

a) Effect of soil on plants b) Effect of rainfall on plants
c) Relationship of species or population with their environment
d) Relationship of communities with their environment

Ans : d. Relationship of species or population with their environment.

2.9 SUGGESTED READINGS / REFERENCES:

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UNIT-I **LESSON-III**

CONCEPT OF ECOLOGICAL SUCCESSION

3.1 INTRODUCTION

3.2 OBJECTIVES

3.3 CONCEPT OF ECOLOGICAL SUCCESSION

3.4 CHARACTERSTICS OF ECOLOGICAL SUCCESSION

3.5 CAUSES OF ECOLOGICAL SUCCESSION

3.6 TYPES OF ECOLOGICAL SUCCESSION

3.7 PROCESS OF ECOLOGICAL SUCCESSION

3.8 TRENDS OF SUCCESSION

3.8.1 HYDROSERE

3.8.2 XEROSERE

3.9 SUMMARY

3.10 GLOSSARY

3.11 SELF ASSESSMENT QESTIONS

3.12 SUGGESTED READINGS / REFERENCES

3.1 INTRODUCTION

The environment is always changing over a period of time due to –a. Variations in climatic and physiographic factors .b. The activities of the species of the communities themselves .These influences bring about marked changes in the dominants of the

existing community, which is thus sooner or later replaced by another community at the same place. This process continues and successive communities develop one after the another over the same area until final community (climax community) becomes more or less stable for a period of time. This occurrence of a relatively definite sequence of communities over a period of time in the same area is known as ecological succession.

3.2 OBJECTIVES

- To study the concept and characteristics of ecological succession
- To understand the types, process and trends of ecological succession

3.3 CONCEPT OF ECOLOGICAL SUCESSION

The ecological succession means the natural development of a series of biotic communities, one after the other, in the same area, till a permanent climax community is established. The occurrence of relatively definite sequence of communities over a period of time in the same area is known as ecological succession. The replacement of existing plants and animals communities with new ones in an orderly sequence in an area with time due to change in the physical conditions is called ecological succession.

The first community to inhabit an area is termed **Pioneer Community**; the succeeding ones are called **Transitional Communities** and last one is known as **Climax Community.** The entire series of communities is known as sere and the individual transitional communities as seral communities or seral stages.

3.4 CHARACTERISTICS OF ECOLOGICAL SUCCESSION

1) It starts with short lived plants and progresses towards large, long lived plants.

2) It results in gradual increase in the biomass.

3) It leads from very low to very high diversity of life.

4) In successive seral stages, there is not only a change in the species of organisms present but also an increase in the number of species.

5) It progresses towards a stability (i.e. complete adjustment with the environment)

3.5 CAUSES OF ECOLOGICAL SUCCESSION

1) Initial causes or initiating causes: it includes biotic factors and climatic factors. **Biotic factors** are the interactions among organisms in a community (e.g. competition).**Climatic factors** like erosion and deposits ,wind, fire etc caused by volcanic eruptions or lightning ,frost, hails, and storms and landslides.

2) Ecesis or continuing causes: such as migration competition, aggregation, reaction.

3) Stabilizing causes: According to Clements, climate of an area is chief cause of stabilization.

3.6 TYPES OF ECOLOGICAL SUCCESSION

On the basis of nature of area of succession

1) Primary succession – It begins at primary substratum or sterile area having no living matter e.g. sand dune or glaciated surface or land formed due to volcanic lava. It is a slow period of succession so may take about 1000 years.

2) Secondary Succession- It begins at secondary substratum or biologically fertile area with dead organic matter .It occurs over an area where organisms were killed due to some external climatic conditions or biotic factors..It is faster succession so may take only 100-200 years.

On the basis of cause of succession

1) Autogenic Succession – In this, existing community modifies its own environment and causes its own replacement by new community.

2) Allogenic Succession – This succession is caused by external abiotic factor (e.g. drought, extreme, temperature, erosion) or biotic factor (e.g. pathogens ,overgrazing)

On the basis of environment(moisture content)

1 Hydrosere (hydrarch) - it occurs in plenty of water e.g. ponds, lakes, streams.

2. Mesarch - it occurs in area with moderate moisture conditions .

3. Xerosere - it occurs in area with minimum moisture conditions. It has three sub types –

   a) Lithosere (on rocks)

   b) Psammosere (on sandy area)

   c) Halosere (in saline soil or water)

On the basis of origin -

1) Autotrophic succession – It is characterized by early and continued dominance of autotrophic organisms like green plants .There is a gradual increase in the organic matter content supported by energy flow.

2) Heterotrophic Succession – It is characterized by early dominance of heterotrophs such as bacteria, actinomycetes, fungi and animals. It begins in a predominantly organic environment and there is progressive decline in energy content.

3.7 GENERAL PROCESS OF SUCCESSION

The steps involved are

Step 1) Nudation – this is the development of a bare area without any form of life . Area may develop due to several causes like landslide, fires, erosion, hails, frost, diseases, epidemics etc.

Step 2) Invasion – this is the successful establishment of a species in a bare area. Invasion is completed in 3 successive stages –

a) Migration (dispersal)- seeds, spores reach the bare area which is carried by air , water, etc

b) Ecesis (establishment) – after reaching a new area, process of successful establishment of species takes place.

c) Aggregation – as a result of reproduction, number of species increase in number and they come close to each other.

Step 3) Competition and co-action – after aggregation, there develops a competition (intraspecific or interspecific competition) mainly for space and nutrition. Individuals of a species affect each other's life in various ways and this is called co- action.

Step 4) Reaction – the mechanism of the modification of the environment through the influence of living organisms on it,is called reaction. As a result of reaction, changes takes place in soil, water, light conditions, temperature etc. of the environment.

Due to all these the environment is modified, becoming unsuitable for the existing community which sooner or later is replaced by another community(seral community)

Step 5) Stablization – finally there occurs a stage in the process when the final community becomes more or less stable for a longer period of time and it can maintain itself in equilibrium with the climate of the area. This final community is not replaced and is known as climax stage.

3.8 TREND OF SUCCESSION

Pioneer community	Seral communities					Climax community
1	2	3	4	5	6	7
Phytoplankton stage	Rooted submerged stage	Rooted floating stage	Reed swamp stage	Sedge-meadow stage	Woodland stage	Forest stage
Diatoms, bacteria BGA	*Utricularia*, *Myriophyllum*, *Vallisneria*, *Elodea*, *Hydrilla*, *Ceratophyllum*.	*Nymphaea*, *Trapa*, *Azolla*, *Wolfia*, *Pistia*, *Nelumbo* *Potamogeton*.	*Phragmites*(reed-grasses), *Typha* (cattail), *Zizania* (wild rice)	*Cyperus*, *Carex* *Juncus*	*Salix* (willow), *Alnus* (alder), *Populus* (poplar).	forest if the climate is humid, grassland in case of subhumid environment, or a desert in arid and semi-arid conditions.

3.8.1 Hydrosere

- Stages
    - Bare rocks
    - Crustose lichen stage
    - Foliose lichen stage
    - Moss stage
    - Herb stage
    - Shrub stage
    - Tree stage
    - Climax stage

Hydrosere is the primary succession sequence which develops in aquatic environments such as lakes and ponds. It results in conversion of water body and its community into a land community.

Phytoplankton stage

Unicellular floating algal plants such as diatoms are pioneer species of a bare water body, such as a pond. Their spores are carried by air to the pond. The phytoplanktons are followed by zooplankton. They settle down to the bottom of the pond after death, and decay into humus that mixes with silt and clay particles brought into the basin by runoff water and wave action and form soil. As soil builds up, the pond becomes shallower and further environmental changes follow.

Rooted Submerged stage

As the water body becomes shallower, more submerged rooted species are able to become established due to increasing light penetration in the shallower water. This is suitable for growth of rooted submerged species such as *Utricularia*, *Myriophyllum, Vallisneria*, *Elodea*, *Hydrilla*, and *Ceratophyllum*. These plants root themselves in mud.

Rooted Floating stage

The floating plants are rooted in the mud, but some or all their leaves float on the surface of the water. These include species like *Nymphaea*, *Trapa, Azolla, Wolfia, Pistia*, *Nelumbo* and *Potamogeton*. Some free-floating species also become associated with root plants. The large and broad leaves of floating plants shade the water surface and conditions become unsuitable for growth of submerged species which start disappearing. The plants decay to form organic mud which makes the pond shallower yet (1–3 ft).

Reed swamp stage

This stage is known as amphibious stage. The pond is now invaded by emergent plants such as *Phragmites* (reed-grasses), *Typha* (cattail), and *Zizania* (wild rice) to form a reed-swamp (in North American usage, this habitat is called a marsh). These plants have creeping rhizomes which knit the mud together to produce large quantities of leaf litter. This litter is resistant to decay and reed peat builds up, accelerating the autogenic change. The surface of the pond is converted into water-saturated marshy land.

Sedge-meadow

Successive decreases in water level and changes in substratum help members of *Cyperaceae* and *Graminae* such as *Carex* spp. and *Juncus* to establish themselves. They form a mat of vegetation extending towards the centre of the pond. Their rhizomes knit the soil further. The above water leaves transpire water to lower the water level further and add additional leaf litter to the soil. Eventually the sedge peat accumulates above the water level and soil is no longer totally waterlogged. The habitat becomes suitable for invasion of herbs (secondary species) such as *Mentha*, *Caltha*, *iris*, and *Galium* which grow luxuriantly and bring further changes to the environment. Mesic conditions develop and marshy vegetation begins to disappear.

Woodland stage

The soil now remains drier for most of the year and becomes suitable for development of wet woodland. It is invaded by shrubs and trees such as *Salix* (willow),

Alnus (alder), and *Populus* (poplar). These plants react upon the habitat by producing shade, lower the water table still further by transpiration, build up the soil, and lead to the accumulation of humus with associated microorganisms.

Climax stage

Finally a self-perpetuating climax community develops. It may be a forest if the climate is humid, grassland in case of sub-humid environment, or a desert in arid and semi-arid conditions. A forest is characterized by presence of all types of vegetation including herbs, shrubs, mosses, shade-loving plants and trees. Decomposers are frequent in climax vegetation.

The overall changes taking place during development of successional communities are building up of substratum, shallowing of water, addition of humus and minerals, soil building and aeration of soil. As the water body fills in with sediment, the area of open water decreases and the vegetation types moves inwards as the water becomes shallower. Many of the above-mentioned communities can be seen growing together in a water body. The center is occupied by floating and submerged plants with reeds nearer the shores, followed by sedges and rushes growing at the edges. Still further are shrubs and trees occupying the dry land.

3.8.2 Xerosere

Pioneer community	Seral communities				Climax community
1	2	3	4	5	6
Crustose lichen stage	Foliose lichen stage	Moss stage	Herb stage	Shrub stage	Forest stage
e.g *Rhizocarpon, Rinodina, Lecanora.*	e.g *Parmelia, Dermatocarpon*	e.g *Polytrichum,Tortula, Grimmia*	e.g *Aristida,Festuca, Poa*	e.g *Rhus, Phytocarpus*	The forest type depends upon climatic conditions.

- Stages
    - Bare rocks
    - Crustose lichen stage
    - Foliose lichen stage
    - Moss stage
    - Herb stage
    - Shrub stage
    - Tree stage
    - Climax stage

Bare rocks are produced when glaciers recede or volcanoes erupt. Erosion of these rocks is brought by rain water and wind loaded with soil particles. The rain water combines with atmospheric carbon dioxide that corrodes the surface of the rocks and produce crevices. Water enters these crevices, freezes and expands to separate boulders. These boulders move down under the influence of gravity and wear particles from the rocks. Also when the wind loaded with soil particles strikes against the rocks, it removes soil particles. All these processes lead to formation of a little soil at the surface of these bare rocks. Animals such as spiders which can hide between boulders or stones invade these rocks. These animals live by feeding on insects which have been blown in or flown in. Algal and fungal spores reach these rocks by air from the surrounding areas. These spores grow and form symbiotic association, the lichen, which act as pioneer species of bare rocks. The process of succession starts when autotrophic organisms start living in the rocks.

Crustose lichen stage

A bare rock consists of solid surface or very large boulders and there is no place for rooting plants to colonize. The thalli of crustose lichens can adhere to the surface of rock and absorb moisture from atmosphere; therefore, these colonize the bare surfaces of rocks first. The propagules of these lichens are brought by air from the

surrounding areas. The substratum colonised by pioneers is very poor in moisture and organic matter subjected with extremes of temperature. Lichens of this stage are species of *Rhizocarpon, Rinodina, Lecanora.* These lichens produce acids which corrode the rock and their thalli collect wind blown soil particles among them that help in formation of a thin film of soil. When these lichens die their thalli are decomposed to add humus. This promotes soil building and the environment becomes suitable for growth of foliose and fruticose type of lichens. The lichens absorb water during dry season, but are normally inactive during the dry season.

Foliose lichen stage

Foliose lichens have leaf-like thalli, while the *fruticose* lichens are like small bushes. They are attached to the substratum at one point only, therefore, do not cover the soil completely. They can absorb and retain more water and are able to accumulate more dust particles. Their dead remains are decomposed to humus which mixes with soil particles and help building substratum and improving soil moisture contents further. The shallow depressions in the rocks and crevices become filled with soil and topsoil layer increases further. These autogenic changes favor growth and establishment of mosses.

Moss stage

The spores of xerophytic mosses, such as *Polytrichum*, *Tortula*, and *Grimmia*, are brought to the rock where they succeed lichens. Their rhizoids penetrate soil among the crevices, secrete acids and corrode the rocks. The bodies of mosses are rich in organic and inorganic compounds. When these die they add these compounds to the soil, increasing the fertility of the soil. As mosses develop in patches they catch soil particles from the air and help increase the amount of substratum. The changing environment leads to migration of lichens and helps invasion of herbaceous vegetation that can out-compete mosses.

Herb stage

Herbaceous weeds, mostly annuals such as asters, evening primroses, and milk weeds, invade the rock. Their roots penetrate deep down, secrete acids and enhance the process of weathering. Leaf litter and death of herbs add humus

to the soil. Shading of soil results in decrease in evaporation and there is a slight increase in temperature. As a result, the xeric conditions begin to change and biennial and perennial herbs and xeric grasses such as *Aristida*, *Festuca*, and *Poa*, begin to inhabit. These climatic conditions favor growth of bacterial and fungal populations, resulting in increase in decomposition activity.

Shrub stage

The herb and grass mixture is invaded by shrub species, such as *Rhus* and *Physocarpus*. Early invasion of shrub is slow, but once a few bushes have become established, birds invade the area and help disperse scrub seeds. This results in dense scrub growth shading the soil and making conditions unfavorable for the growth of herbs, which then begin to migrate. The soil formation continues and its moisture content increases.

Tree stage

Change in environment favors colonization of tree species. The tree saplings begin to grow among the scrubs and establish themselves. The kind of tree species inhabiting the area depends upon the nature of the soil. In poorly drained soils oaks establish themselves. The trees form canopy and shade the area. Shade-loving scrubs continue to grow as secondary vegetation. Leaf litter and decaying roots weather the soil further and add humus to it making the habitat more favorable for growth to trees. Mosses and ferns make their appearance and fungi population grows abundantly.

Climax stage

The succession culminates in a climax community, the forest. Many intermediate tree stages develop prior to establishment of a climax community. The forest type depends upon climatic conditions.

3.9 SUMMARY

The Ecological succession means the natural development of a series of biotic communities one after the other in the same area till a permanent climax community is established. The first community to inhabit an area is termed **Pioneer Community** the succeeding ones are called **Transitional Communities** and last one is known as

Climax Community. The entire series of communities is known as sere and the individual transitional communities as seral communities or seral stages.It starts with short lived plants and progresses towards large ,long lived plants.It results in gradual increase in the biomass .In successive seral stages ,there is not only a change in the species of organisms present but also an increase in the number of species . It progresses towards a stable of stability (ie. complete adjustment with the environment).

3.10 GLOSSARY

Allogenic Succession – this succession is caused by external abiotic factor (eg;drought,extreme temperature,erosion) or biotic factor (eg pathogens ,overgrazing)

Autogenic Succession – in this, existing community modifies its own environment and causes its own replacement by new community.

Hydrosere (hydrarch) - it occurs in plenty of water eg;ponds ,lakes,streams.

Mesarch - it occurs in area with moderate moisture conditions

Nudation – this is the development of a bare area without any form of life .

Primary succession – it begins at primary substratum or sterile area having no living matter eg; sand dune or glaciated surface or land formed due to volcanic lava.

Secondary Succession - It begins at secondary substratum or biologically fertile area with dead organic matter .

Xerosere - it occurs in area with minimum moisture conditions.

3.11 MULTIPLE CHOICE QUESTIONS

1) The first community to inhabit an area is called

a) Pioneer community c) climax community

b) Sere community d) none

Ans : (a)

2) Final community is also known as

a) Pioneer community c) climax community

b) Sere community d) none

Ans : (c)

3) Give the sequence of stages in hydrosere.

a) Phytoplankton stage, Submerged stage, Floating stage, Reed swamp stage, Sedge-meadow stage, Woodland stage, Climax stage.

b) Phytoplankton stage, Submerged stage, Floating stage, Woodland stage, Reed swamp stage, Sedge-meadow stage , Climax stage.

c) Phytoplankton stage, Climax stage,Submerged stage, Floating stage, Woodland stage, Reed swamp stage, Sedge-meadow stage .

d) none

Ans : (a)

4) Movement of organisms is known as

a) migration c) invasion

b) ecesis d) ecological succession

Ans : (a)

5) Ecological succession occurring on sandy area is known as

a) Psammosere c) hydrosere

b) Xerosere d) none

Ans : (a)

6) Succession occurring in minimum moisture conditions

a) Psammosere c) hydrosere

b) Xerosere d) none

Ans : (b)

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UNIT - I **LESSON-1V**

FOOD CHAIN, FOOD WEB AND ECOLOGICAL PYRAMIDS

4.1 INTRODUCTION

4.2 OBJECTIVES

4.3 CONCEPT OF FOOD CHAIN

4.3.1 CHARACTERSTICS OF FOOD CHAIN

4.3.2 TYPES OF FOOD CHAIN

4.4 FOOD WEB

4.4.1 COMMON FEATURES OF FOOD WEB

4.5 SIGINIFICANCE OF FOOD WEB AND FOOD CHAIN

4.6 ECOLOGICAL PYRAMIDS

4.6.1 TYPES OF ECOLOGICAL PYRAMIDS

4.6.2 LIMITATIONS OF ECOLOGICAL PYRAMIDS

4.7 SUMMARY

4.8 SELF ASSESSMENT QESTIONS

4.9 SUGGESTED READINGS/ REFERENCES:

4.1 INTRODUCTION

In all ecosystems , food is the primary source of energy for all animals and plants, but green plants are the only organisms which are able to trap solar energy and convert it into chemical energy which is stored in the form of food.

4.2 OBJECTIVES

- **To study the concept of food chain and food web**
- **To acquaint the learner with the concept of ecological pyramids**

4.3 CONCEPT OF FOOD CHAIN

This food energy travels from plants through a series of organisms with repeated eating and being eaten which is referred to as food chain..Food chain is a series of group of organisms called trophic levels in which there is repeated eating and eaten by so as to transmit the food energy. The producers and consumers are arranged in the ecosystem in a definite manner and their interaction along with population size is expressed together as trophic structure. Each food level in an ecosystem is known as trophic level and the amount of living matter at each trophic level at a given time is known as standing crop or standing biomass.

4.3.1 Characteristics:-

1) In a food chain, there is repeated eating in which each group eats the smaller one and is eatenby the larger one.
2) There is unidirectional flow of energy from sun to producers and then to a series of consumers. A food chain is always straight.
3) Usually 80-90% of potential energy is lost as heat at each transfer.
4) Generally, there are 4 or 5 trophic levels in the food chain. Shorter the food chain more will be the energy available at different trophic levels.
5) Omnivores generally occupy more than one trophic level in a food chain.

Some common examples of simple food chains are :-

Grass - Grasshopper - Frog - Snake - Hawk (Grassland ecosystem)

Lichens - Reindeer - Man (Arctic tundra)

4.3.2 Types of food chains:-

1) Grazing food chain:- It starts with green plants and culminates in carnivores. These are characterized by:-

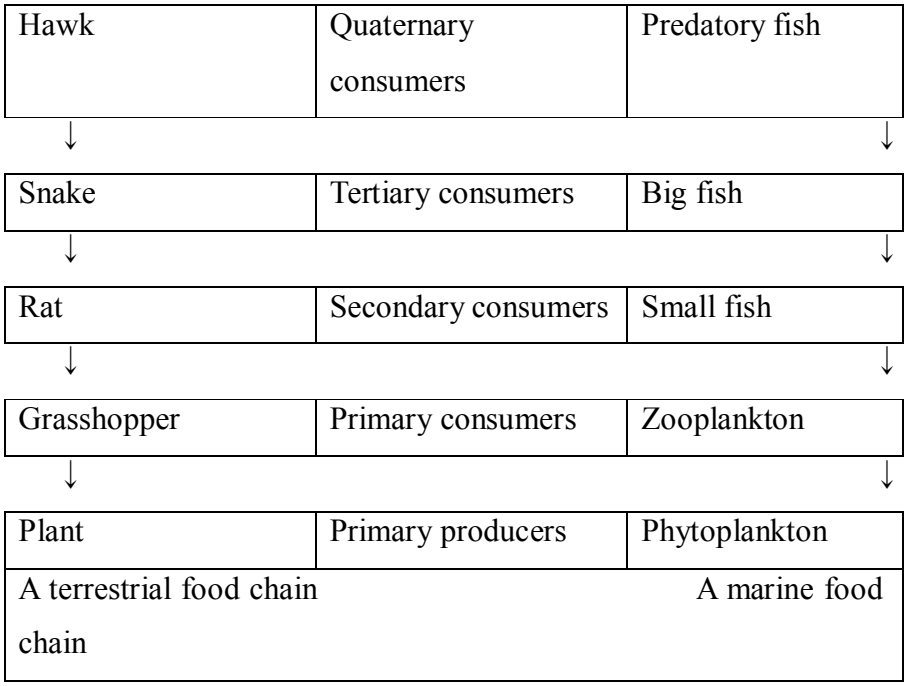
1) These are directly dependent upon solar radiations as the primary source of energy.

2) Green plants or producers form the first trophic level of the food chain and synthesize their food by the process of photosynthesis.

3) Herbivores or primary consumers eat upon the producers and form the second trophic level.

4) Herbivores are eaten by the carnivores (secondary consumers) which form the third trophic level.

5) These always end at decomposer level.



2) Detritus food chain:- It starts with dead organic matter which the detritivores and decomposers consume. These are characterized by:-

1) The primary source of energy in detritus food chain is dead organic matter.

2) Main sources of dead organic matter are fallen leaves or dead animal bodies.

3) Primary consumers are detritivores. These include protozoans, bacteria, fungi etc.

4) The detrivores are eaten by secondary consumers which include insect larvae, crustaceans, mollusks etc.

Example of the detritus food chain is seen in a Mangrove Ecosystem.

Leaf litter - Algae - Crabs - Small carnivorous fish - Large carnivorous fish

Dead organic matter - Fungi - Bacteria (Forest ecosystem)

4.4 FOOD WEB

Food chains in ecosystem are rarely found to operate as isolated linear sequences. Rather, they are found to be interconnected and usually form a complex network with several linkages and are known as food webs. So, Food web is a network of food chains where different types of organisms are connected at different trophic levels so that there are number of options of eating and being eaten at each trophic level.

The food web become more complicated because of variations in taste and preference, availability and compulsion, and several circumstancial factors, e.g. tigers normally do not eat fish or crabs, but in Sundarbans they are forced to feed on them.

4.4.1 Common features of food web

1) Linkage density is constant for food webs with few species but can increase with increase in diversity.

2) Species at higher trophic levels have more prey and fewer predators than those at lower levels.

3) Food webs having small numbers of species commonly have internal overlaps in the predators use of prey species.

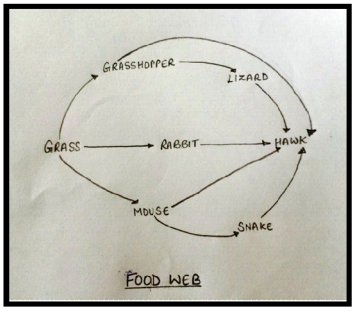


Fig. showing a typical food web

4.5 SIGNIFICANCE OF FOOD WEB AND FOOD CHAIN

1) Food Chain and Food Web have significant role in ecosystem because of two most important functions. Energy flow and nutrient cycling take place through them.

2) These help in maintaining and regulating the population size of different animals and thus help maintain the ecological balance.

3) Food chain show a unique property of biological magnification of some chemicals.

4.6 ECOLOGICAL PYRAMIDS

A food chain in an ecosystem has several trophic levels such as producer level , primary consumer level and secondary consumer level. According to the second law of thermodynamics, the biomass is one-tenth of the preceding level at each successive trophic level in a food chain.It means that starting from producers one finds a regular decrease in the properties and characteristics such as number , biomass, energy.when such phenomenon is represented graphically , these relationships assume the shape of a pyramid with a broad base and tapering apex. Such pyramids are known as ecological pyramids.

Definition : It is defined as the graphic representation of number, biomass or status of accumulated energy at different trophic levels in a food chain in an ecosystem.

In a food chain starting from the producers to the consumers, there is a regular decrease in the properties (i.e. energy, biomass and number). Since some energy is lost at each trophic level, it becomes progressively smaller at the top.

The concept of ecological pyramids was given by **Charles Elton in 1927**,that's why also known as ***Eltonian*** pyramids.

4.6.1 TYPES OF ECOLOGICAL PYRAMIDS

Ecological pyramids are of three types:

Pyramid of number: It is the graphic representation of number of organisms present at different trophic levels in a food chain. Pyramid of number may be upright or inverted.

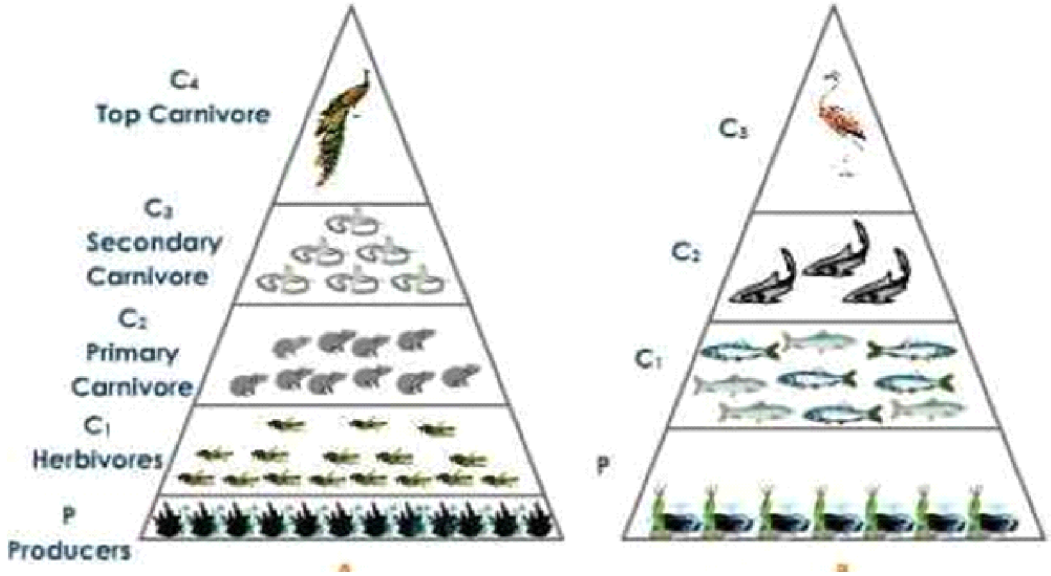


Fig : Upright pyramids of number in a grassland and a pond ecosystem

- The grasses occupy the lowest trophic level (base) because of their abundance.
- The next higher trophic level is primary consumer – herbivore (example – grasshopper).
- The individual number of grasshopper is less than that of grass. The next energy level is primary carnivore (example – rat).
- The number of rats are less than grasshopper, because, they feed on grasshopper. The next higher trophic level is secondary carnivore (example – snakes). They feed on rats.
- The next higher trophic level is the top carnivore. (eg: Hawk).
- With each higher trophic level, the number of individual decreases.
- In inverted shaped pyramid, the number of individuals increased from lower level to higher trophic level.

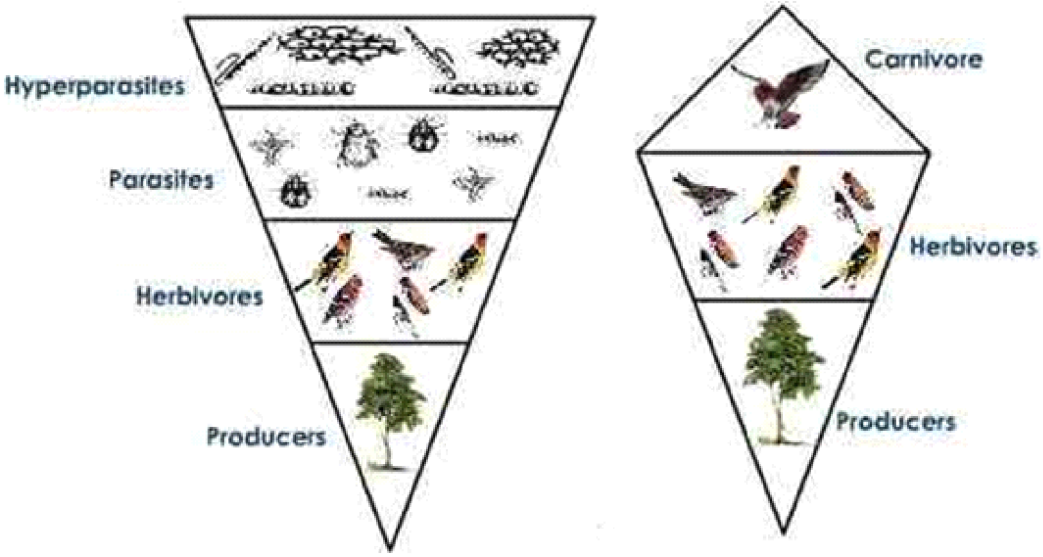


Fig : a) Inverted pyramid in a parasitic food chain
b) Spindle-shaped pyramid in a forest ecosystem.

1. Pyramid of biomass

- Pyramid of biomass is usually determined by collecting all organisms occupying each trophic level separately and measuring their **dry weight**.
- This overcomes the size difference problem because all kinds of organisms at a trophic level are weighed. Biomass is measured in g/m^2.
- The biomass of a species is expressed in terms of fresh or dry weight. Measurement of biomass in terms of dry weight is more accurate.
- Each trophic level has a certain mass of living material at a particular time called as the **standing crop**.
- The standing crop is measured as the mass of living organisms (biomass) or the number in a unit area.
- For most ecosystems on land, the pyramid of biomass has a large base of primary producers with a smaller trophic level perched on top.

- The biomass of producers (autotrophs) is at the maximum. The biomass of next trophic level i.e. primary consumers is less than the producers. The biomass of next higher trophic level i.e. secondary consumers is less than the primary consumers. The top high trophic level has very less amount of biomass.

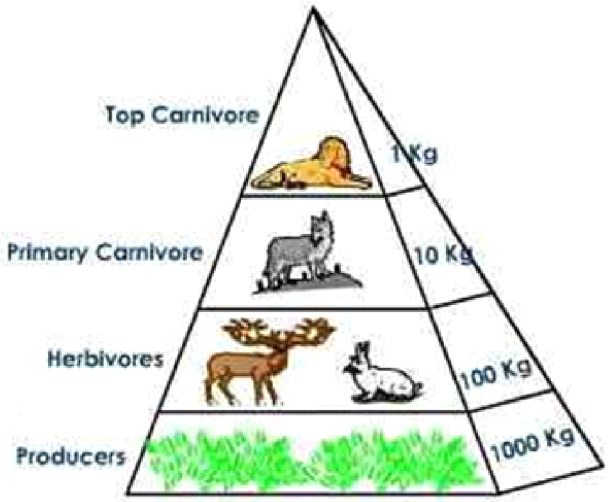


Fig. : Upright pyramid of biomass in a terrestrial ecosystem

- In contrast, in many **aquatic ecosystems**, the pyramid of biomass may assume an inverted form. This is because the producers are tiny phytoplankton that grow and reproduce rapidly.
- Here, the pyramid of biomass has a small base, with the consumer biomass at any instant actually exceeding the producer biomass and the pyramid assumes inverted shape.

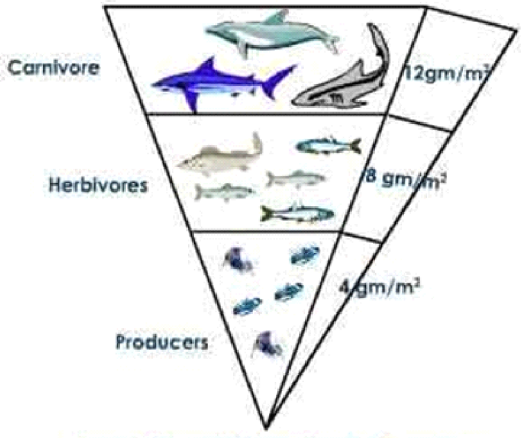


Fig. : Inverted pyramid of biomass in an aquatic ecosystem

3. Pyramid of energy

- To compare the functional roles of the trophic levels in an ecosystem, an energy pyramid is **most suitable**.
- An energy pyramid represents the amount of energy at each trophic level and loss of energy at each transfer to another trophic level. Hence the pyramid is **always upward** with a large energy base at the bottom.
- Suppose an ecosystem receives 1000 calories of light energy in a given day. Most of the energy is not absorbed some is reflected back to space of the energy absorbed only a small portion is utilized by green plants, out of which the plant uses up some for respiration and of the 1000 calories, therefore only 100 calories are stored as energy rich materials.
- Now suppose an animal say a deer, eats the plant containing 100 calorie of food energy. The deer uses some of it for its own metabolism and stores only 10 calorie as food energy. A lion that eats the deer gets an even smaller amount of energy. Thus usable energy decreases from sunlight to producer to herbivore to carnivore. Therefore, the energy pyramid will always be upright.

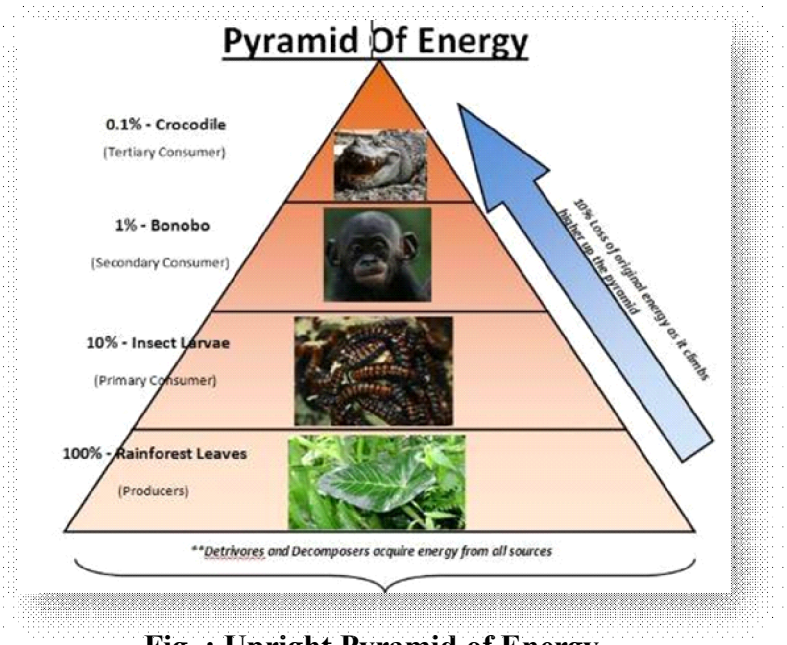


Fig. : Upright Pyramid of Energy

4.6.2 LIMITATIONS OF ECOLOGICAL PYRAMIDS

It does not take into account the **same species belonging to two or more trophic levels**.

- It assumes a simple food chain, something that almost never exists in nature it **does not accommodate a food web**.
- Moreover, saprophytes (plant, fungus, or microorganism that lives on decaying matter) are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

4.7 SUMMARY

Ecological pyramid is a graphical representation in the form of a pyramid showing the feeding relationship of groups of organisms. It is often represented in a way that the producers are at the bottom level and then proceeds through the various trophic levels in which the highest is on top.

Ecological pyramid also shows the flow of energy or biomass at each trophic level in a particular ecosystem. Biomass pertains to the amount of living or organic matter in an organism. Biomass pyramids are shaped that way to show that biomass is largest at the base and decreasing in amount as it goes through the apex. The two types of biomass pyramids are the upright and the inverted. The upright pyramid is found in most ecosystems. It results when the combined weight of producers is *larger* than the combined weight of consumers. An inverted type results when the combined weight of producers is *smaller* than the combined weight of consumers.

4.8 MULTIPLE CHOICE QUESTIONS:

1. In a pyramid of number in a grassland ecosystem , the largest population is that of

   (a) Herbivores (b) Primary consumers

   (c) Secondary consumers (d) Producers

   Ans : (d)

2. Which of the ecological pyramid is always upright ?

(a) Pyramid of number (b) Pyramid of biomass

(c) Pyramid of energy (d) All of these

Ans : (C)

3. Which of the following regarding ecological pyramid is not correct ?

(a) In most ecosystems, the pyramid of numbers and biomass are upright

(b) The total energy flow at successive trophic level always decreases

(c) The pyramid of energy expresses mainly the rate of food production

(d) In deep water ecosystem, the pyramid of biomass is upright.

Ans : (b)

6. Pyramid of energy in a pond ecosystem is

(a) Always inverted (b) Always erect

(c) Always upright (d) Constant

Ans : (c)

7. The energy transferred to the next higher level

(a) lncreases (b) Decreases

(c) Remains the same (d) None

Ans : (b)

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UNIT : 1 **LESSON-V**

INTRODUCTION, TYPES, CHARACTERISTIC FEATURES OF THE FOLLOWING ECOSYSTEMS OF INDIA

(FOREST AND GRASSLAND ECOSYSTEM)

5.1 INTRODUCTION

5.2 OBJECTIVES

5.3 ECOSYSTEM GOODS AND SERVICES

5.4 FOREST ECOSYSTEM

- 5.4.1 FOREST TYPES IN INDIA
- 5.4.2 FOREST UTILISATION
- 5.4.3 THREATS TO FOREST ECOSYSTEM
- 5.4.4 CONSERVATION OF FOREST ECOSYSTEM

5.5 GRASSLAND ECOSYSTEM

- 5.5.1 GRASSLAND TYPES IN INDIA
- 5.5.2 GRASSLAND UTILISATION
- 5.5.3 THREATS TO GRASSLAND ECOSYSTEM
- 5.5.4 CONSERVATION OF GRASSLAND ECOSYSTEM

5.6 SUMMARY

5.7 GLOSSARY

5.8 SELF ASSESSMENT QESTIONS

5.9 SUGGESTED READINGS/5.11 REFERENCES:

5.1 INTRODUCTION

Ecosystem represents the living community of plants and animals in any area along with the non-living components of the environment such as soil, water and air. Ecosystems are divided into two main habitats i.e. Terrestrial and Aquatic ecosystems.

Types of ecosystems

Terrestrial Ecosystems	Aquatic Ecosystems
Forest	Pond
Grassland	Lake
Semi arid areas	Wetland
Deserts	River
Mountain	Delta
Islands	Marine

5.2 OBJECTIVES

- To study the different types of terrestrial ecosystem and their utility
- To study the different threats on terrestrial ecosystems
- To understand various methods of conservation

5.3 ECOSYSTEM GOODS AND SERVICES

Direct Values:

These are resources that people depend upon directly and are easy to quantify in economic terms.

- Consumptive Use Value - Non-market value of fruit, fodder, firewood, etc. that are used by people who collect them from their surrounds.
- Productive Use Value – Commercial value of timber, fish, medicinal plants, etc. that people collect for sale.

Indirect Values:

These are uses that do not have easy ways to quantify them in terms of a clearly definable price.

- Non-consumptive use value – scientific research, bird-watching, ecotourism, etc.
- Option value - maintaining options for the future, so that by preserving them one could reap economic benefits in the future.
- Existence value - ethical and emotional aspects of the existence of wildlife and nature.

Terrestrial ecosystems in their natural state are found in different types of forests, grasslands, semiarid areas, deserts and sea coasts. Where the land is intensively used, these have been gradually modified over several thousand years into agricultural and pastoral regions. In the recent past they have been rapidly converted into intensively irrigated agricultural ecosystems or into urban and industrial centers. Though this has increased production of food and provides the raw material for 'consumer' goods that we use, the overuse and misuse of land and natural ecosystems has led to a serious degradation of our environment. The unsustainable use of environmental goods such as soil, water, fuel wood, timber from forest, grasses and herbs from grasslands for grazing and repeatedly burning the grass, degrades these natural ecosystems. Similarly, improper use of resources can destroy the services that the natural ecosystems provide. These processes of nature such as photosynthesis, climate control, prevention of soil erosion are disturbed by many human activities. When our human population was small, most ecosystems could supply all our needs. Resources were thus used 'sustainably'. As industrial development led to a very great increase in consumption of resources, the short term economic gains for people became an indicator of progress, rather than long term ecological benefits. This has resulted

in an 'unsustainable use' of natural resources. Forests thus disappear, rivers run dry, deserts begin to spread, and air, water and soil become increasingly polluted as by-products of development. Human well being itself is then seriously affected.

5.4 FOREST ECOSYSTEM Forests are formed by a community of plants which is predominantly structurally defined by its trees, shrubs, climbers and ground cover. Natural vegetation looks vastly different from a group of planted trees, which are in orderly rows. The most 'natural' undisturbed forests are located mainly in our National Parks and Wildlife Sanctuaries. The landscapes that make up various types of forests look very different from each other. Their distinctive appearance is a fascinating aspect of nature. Each forest type forms a habitat for a specific community of animals that are adapted to live in it.

WHAT IS A FOREST ECOSYSTEM?

The forest ecosystem has two parts:

- *The non-living or abiotic aspects of the forest*: The type of forest depends upon the abiotic conditions at the site. Forests on mountains and hills differ from those along river valleys. Vegetation is specific to the amount of rainfall and the local temperature which varies according to latitude and altitude. Forests also vary in their plant communities in response to the type of soil.
- *The living or the biotic aspects of the forest*: The plants and animals form communities that are specific to each forest type. For instance coniferous trees occur in the Himalayas. Mangrove trees occur in river deltas. Thorn trees grow in arid areas. The snow leopard lives in the Himalayas while the leopard and tiger live in the forests of the rest of India. Wild sheep and goats live high up in the Himalayas. Many of the birds of the Himalayan forests are different from the rest of India. Evergreen forests of the Western Ghats and North East India are most rich in plant and animal species.

  The biotic component includes both the large (macrophytes) and the microscopic plants and animals.

Plants include the trees, shrubs, climbers, grasses, and herbs in the forest. These include species that flower (angiosperms), and non-flowering species (gymnosperms) such

as ferns, bryophytes, fungi and algae. The *animals* include species of mammals, birds, reptiles, amphibians, fish, insects and other invertebrates and a variety of microscopic animals.

As the plant and animal species are closely dependent on each other, together they form different types of forest communities. Man is a part of these forest ecosystems and the local people depend directly on the forest for several natural resources that act as their life support systems. People who do not live in the forest buy forest products such as wood and paper which has been extracted from the forest. Thus they use forest produce indirectly from the market.

5.4.1 FOREST TYPES IN INDIA:

The forest type depends upon the abiotic factors such as climate and soil characteristics of a region. Forests in India can be broadly divided into Coniferous forests and Broadleaved forests.

They can also be classified according to the nature of their tree species – evergreen, deciduous, xerophytic or thorn trees, mangroves, etc. They can also be classified according to the most abundant species of trees such as Sal or Teak forests. In many cases a forest is named after the first three or four most abundant tree species. *Coniferous forests* grow in the Himalayan mountain region, where the temperatures are low. These forests have tall stately trees with needlelike leaves and downward sloping branches so that the snow can slip off the branches. They have cones instead of seeds and are called gymnosperms.

Broadleaved forests have several types such as evergreen forests, deciduous forests, thorn forests, and mangrove forests. Broadleaved forests have large leaves of various shapes.

Evergreen forests grow in the high rainfall areas of the Western Ghats, North Eastern India and the Andaman and Nicobar Islands. These forests grow in areas where the monsoon lasts for several months. Some even get two monsoons such as in Southern India. Evergreen plants shed a few of their leaves throughout the year. There is no dry leafless phase as in a deciduous forest. An evergreen forest thus looks green throughout the year. The trees overlap with each other to form a continuous canopy.

Thus very little light penetrates down to the forest floor. Only a few shade loving plants can grow in the ground layer in areas where some light filters down from the closed canopy. The forest is rich in orchids and ferns. The barks of the trees are covered in moss. The forest abounds in animal life and is most rich in insect life.

Deciduous forests are found in regions with a moderate amount of seasonal rainfall that lasts for only a few months. Most of the forests in which Teak trees grow are of this type. The deciduous trees shed their leaves during the winter and hot summer months. In March or April they regain their fresh leaves just before the monsoon when they grow vigorously in response to the rains. Thus there are periods of leaf fall and canopy regrowth. The forest frequently has a thick undergrowth as light can penetrate easily onto the forest floor.

Thorn forests are found in the semi- arid regions of India. The trees, which are sparsely distributed, are surrounded by open grassy areas. Thorny plants are called xerophytic species and are able to conserve water. Some of these trees have small leaves while other species have thick waxy leaves to reduce water losses during transpiration. Thorn forest trees have long or fibrous roots to reach water at great depths. Many of these plants have thorns which reduce water loss and protect them from herbivores.

Mangrove forests grow along the coast especially in the river deltas. These plants are able to grow in a mix of saline and fresh water. They grow luxuriantly in muddy areas covered with silt that the rivers have brought down. The mangrove trees have breathing roots that emerge from the mudbanks.

5.4.2 FOREST UTILISATION:

Natural forests provide local people with a variety of products if the forest is used carefully. Over-exploitation for fuel wood or timber, and conversion to monoculture plantations for timber or other products, impoverishes local people as the economic benefit goes to people who live elsewhere. The entire resource base on which local people have traditionally survived for generations, is rapidly destroyed.

Eventually the forest is completely degraded. Natural forest ecosystems play an important role in controlling local climate and water regimes. It is well-known that

under the canopy of a natural forest, it is cooler than outside the forest. During the monsoon, the forest retains moisture and slowly releases it through perennial streams during the rest of the year. Plantations fail to perform this function adequately. The loss of forest cover in the catchments of a river thus leads to irreversible changes such as excessive soil erosion, large run-off of surface water during monsoons leading to flash floods, and a shortage of water once the monsoons are over. Forest products that are collected by people include food such as fruit, roots, herbs and medicinal plants. People depend on fuelwood to cook food, collect fodder for domestic animals cut building material for housing, collect medicinal plants that have been known for generations for several ailments and use a variety of non timer forest products such as fiber, cane, gum, to make household articles. Wood from different species of trees have special uses. For instance a soft wood is used for the yok of a bullock cart while a very hard wood is used for its axil.

These forest products are of great economic value as they are collected, sold and marketed. Forest dwellers and agricultural people use these goods directly. Other people get them indirectly from the market. Traditional types of agriculture needs forest material such as branches and leaves which are burnt to form wood ash which acts as a fertilizer for crops such as rice.

Forest services include the control of the flow of water in streams and rivers. Forest cover reduces surface runoff of rainwater and allows ground water to be stored. Forests prevent erosion of soil. Once soil is lost by erosion, it can take thousands of years to reform. Forests regulate local temperature. It is cooler and more moist under the shade of the trees in the forest. Most importantly, forests absorb carbon dioxide and release oxygen that we breathe.

The wild relatives of our crop plants and fruit trees have special characteristics in their genes which are used to develop new crops and newer varieties of fruit. These newer varieties developed from wild relatives give greater yields or are more resistant to diseases.New industrial products are being produced from the wild plants of the forest.

Many of our new medicines come from wild plants.

Direct uses of forest products

- Fruits – mango, jamun, amla
- Roots – Dioscoria
- Medicine – Gloriosa, Foxglove
- Fuelwood – many species of trees and shrubs
- Small timber for building huts and houses
- Wood for farm implements
- Bamboo and cane for baskets
- Grass for grazing and stall feeding livestock

Indirect uses of forest products

- Building material for construction and furniture for the urban sector
- Medicinal products collected and processed into drugs
- Gums and resins processed into a variety of products
- Raw material for industrial products and chemicals
- Paper from bamboo and softwoods

5.4.3 WHAT ARE THE THREATS TO THE FOREST ECOSYSTEM?

As forests grow very slowly, we cannot use more resources than they can produce during a growing season. If timber is felled beyond a certain limit the forest cannot regenerate. The gaps in the forest change the habitat quality for its animals. The more sensitive species cannot survive under these changed conditions. Overutilizing forest resources is an unsustainable way of misusing our limited forest resources. We are now creating more and more goods that are manufactured from raw material from the forest. This leads to forest degradation and finally changes the ecosystem into wasteland. Wood is illegally extracted from many forests leading to a highly disturbed ecosystem. Developmental activities such as rapid population growth together with, urbanisation, industrialisation and the increasing use of consumer goods, leads

to over utilisation of forest produce. Forests are shrinking as our need for agricultural land increases.

It is estimated that India's forest cover has decreased from about 33% to 11% in the last century. The increasing use of wood for timber, wood pulp for paper and the extensive use of fuelwood results in continual forest loss. Forests are also lost by mining and building dams. As the forest resources are exploited beyond what they can produce the forest canopy is opened up, the ecosystem is degraded, and its wildlife is seriously threatened. As the forest is fragmented into small patches its wild plant and animal species become extinct. These can never be brought back. Extinction is forever.

WHAT WILL HAPPEN IF THE FORESTS DISAPPEAR?

When forests are cut down tribal people who depend directly on them for food and fuelwood and other products find it very difficult to survive. Agricultural people do not get enough fuelwood, small timber, etc. for making houses and farm implements. Urban people who depend on food from agricultural areas, which in turn depend on neighbouring forest ecosystems have to pay a higher price for food as human population grows.

Insects that live and breed in the forest such as bees, butterflies and moths decrease in abundance once forests are degraded. As their numbers decrease they are unable to effectively pollinate agricultural crops and fruit trees. This leads to a decrease in agricultural yields.

The rain that falls on deforested land flows directly into nearby rivers. Thus water is not retained under the ground. People thus do not get a sufficient quantity of water throughout the year. The exposed soil is rapidly washed away during the rains once the protective forest cover is removed. Thus agriculture is seriously affected in such areas. In deforested areas, the water in streams is brown in colour as soil is washed away while water in forested streams is crystal clear. Wild animals lose their habitat. This leads to extinction of our precious species. Residual forests must be protected from being destroyed any further if all the diverse species of plants and animals are to be kept for future generations.

5.4.4 HOW CAN FOREST ECOSYSTEMS BE CONSERVED?

We can conserve forests only if we use its resources carefully. This can be done by using alternate sources of energy instead of fuelwood. There is a need to grow more trees than are cut down from forests every year for timber. Afforestation needs to be done continuously from which fuelwood and timber can be judiciously used.

The natural forests with all their diverse species must be protected as National Parks and Wildlife Sanctuaries where all the plants and animals can be preserved.

5.5 GRASSLAND ECOSYSTEMS

A wide range of landscapes in which the vegetation is mainly formed by grasses and small annual plants are adapted to India's various climatic conditions. These form a variety of grassland ecosystems with their specific plants and animals.

WHAT IS A GRASSLAND ECOSYSTEM?

Grasslands cover areas where rainfall is usually low and/or the soil depth and quality is poor. The low rainfall prevents the growth of a large number of trees and shrubs, but is sufficient to support the growth of grass cover during the monsoon. Many of the grasses and other small herbs become dry and the part above the ground dies during the summer months. In the next monsoon the grass cover grows back from the root stock and the seeds of the previous year. This change gives grasslands a highly seasonal appearance with periods of increased growth followed by a dormant phase.

A variety of grasses, herbs, and several species of insects, birds and mammals have evolved so that they are adapted to these wide-open grass covered areas. These animals are able to live in conditions where food is plentiful after the rains so that they can store this as fat that they use during the dry period when there is very little to eat. Man began to use these grasslands as pastures to feed his livestock when he began to domesticate animals and became a pastoralist in ancient times.

5.5.1 GRASSLAND TYPES IN INDIA:

Grasslands form a variety of ecosystems that are located in different climatic conditions ranging from near desert conditions, to patches of shola grasslands that occur on hillslopes alongside the extremely moist evergreen forests in South India. In the Himalayan mountains there are the high cold Himalayan pastures. There are tracts of tall elephant grass in the low-lying Terai belt south of the Himalayan foothills. There are semi-arid grasslands in Western India, parts of Central India, and in the Deccan Plateau.

The *Himalayan pasture* belt extends upto the snowline. The grasslands at a lower level form patches along with coniferous or broadleaved forests. Himalayan wildlife require both the forest and the grassland ecosystem as important parts of their habitat. The animals migrate up into the high altitude grasslands in summer and move down into the forest in winter when the snow covers the grassland. These Himalayan pastures have a large variety of grasses and herbs. Himalayan hill slopes are covered with thousands of colourful flowering plants.

The *Terai* consists of patches of tall grasslands interspersed with a Sal forest ecosystem. The patches of tall elephant grass, which grows to a height of about five meters, are located in the low-lying waterlogged areas. The Sal forest patches cover the elevated regions and the Himalayan foothills. The Terai also includes marshes in low-lying depressions. This ecosystem extends as a belt south of the Himalayan foothills.

The *Semi-arid plains of Western India, Central India and the Deccan* are covered by grassland tracts with patches of thorn forest. Several mammals such as the wolf, the blackbuck, the chinkara, and birds such as the bustards and floricans are adapted to these arid conditions. The Scrublands of the Deccan Plateau are covered with seasonal grasses and herbs on which its fauna is dependent. It is teaming with insect life on which the insectivorous birds feed.

The *Shola grasslands* consist of patches on hill slopes along with the Shola forests on the Western Ghats, Nilgiri and Annamalai ranges. This forms a patchwork of grassland on the slopes and forest habitats along the streams and lowlying areas. Grasslands are not restricted only to low rainfall areas. Certain grassland types form when clearings are made

in different forest types. Some are located on the higher steep hill slopes with patches of forest that occur along the streams and in depressions. The grasslands are related to repeated fires that do not permit the forest to grow.

The grasses are the major producers of biomass in these regions. Each grassland ecosystem has a wide variety of species of grasses and herbs. Some grass and herb species are more sensitive to excessive grazing and are suppressed if the area is over grazed. Others are destroyed by repeated fires and cannot regenerate. Thus overused or frequently burnt grasslands are degraded and are poor in plant species diversity.

5.5.2 HOW ARE GRASSLANDS USED?

Grasslands are the grazing areas of many rural communities. Farmers who keep cattle or goats as well as shepherds who keep sheep, are highly dependent on grasslands. Domestic animals are grazed in the 'common' land of the village. Fodder is collected and stored to feed cattle when there is no grass left for them to graze in summer. Grass is also used to thatch houses and farm sheds. The thorny bushes and branches of the few trees that are seen in grasslands are used as a major source of fuelwood.

Overgrazing by huge herds of domestic livestock has degraded many grasslands.

Grasslands have diverse species of insects that pollinate crops.There are also predators of these insects such as the small mammals like shrews, reptiles like lizards, birds of prey, and amphibia such as frogs and toads. All these carnivorous animals help to control insect pests in adjoining agricultural lands.

5.5.3 WHAT ARE THE THREATS TO GRASSLAND ECOSYSTEMS

In many areas grasslands have been used for centuries by pastoral communities.

Overutilization and changes in landuse of the 'common grazing lands' of rural communities has lead to their degradation. The grassland cover in the country in terms of permanent pastures now covers only 3.7 percent of land.

A major threat to natural grasslands is the conversion of grasslands into irrigated farmlands. In the Deccan, grasslands have been altered to, irrigated farms and are now

mainly used to grow sugarcane. After continuous irrigation such land becomes saline and useless in a few years. More recently many of these residual grassland tracts have been converted into industrial areas. This provides short-term economic gains but result in long-term economic and ecological losses. Most grassland ecosystems are highly modified by human activities. Cattle, sheep and goat grazing, and lighting repeated fires affects grasslands adversely. Changing the grasslands to other forms of landuse such as agriculture, tree plantations and industrialisation forms a serious threat to this highly productive ecosystem. When fires are lit in the grasslands in summer, the burnt grass gets a fresh flush of small green shoots which the domestic animals graze on. If this is done too frequently the grasslands begin to deteriorate. Finally grasslands become bare the soil is solidly compacted by trampling, or is washed away during the monsoon by rain and whipped into dust storms during the hot dry summer. The land is degraded as there is no grass to hold the soil in place. It becomes a wasteland.

WHY ARE OUR GRASSLAND SPECIES VANISHING ?

Most people feel that it is only our forests and its wildlife that is disappearing. However, other natural ecosystems such as grasslands are disappearing even more rapidly. Many of the grassland species have disappeared from several parts of India in which they were found 50 or 60 years ago. The Cheetah is extinct in India. The Wolf is now highly threatened. Blackbuck and chinkara are poached for meat. Birds such as the beautiful Great Indian Bustards are vanishing. Unless grassland species are protected they will vanish from their shrinking habitat, as natural and undisturbed grasslands are left in very few locations. If these animals and birds are killed or their habitat is reduced further, their extinction will rapidly follow.

WHAT IF OUR GRASSLANDS DISAPPEAR?

If our grasslands are lost we will lose a highly specialised ecosystem in which plants and animals have been adapted to these habitat conditions over millions of years. Local people will not be able to support their livestock herds. The extinction of species is a great loss to Mankind. The genes of wild grasses are extremely useful for developing new crop varieties. New medicines could well be discovered from wild grassland plants. It is possible that

genes from wild herbivores such as wild sheep, goats and antelopes may be used for developing new strains of domestic animals.

5.5.4 HOW CAN GRASSLAND ECOSYSTEMS BE CONSERVED?

Grasslands should not be overgrazed and areas of the grasslands should be closed for grazing. It is better to collect grass for stall feeding cattle. A part of the grassland in an area must be closed every year so that a rotational grazing pattern is established. Fires must be prevented and rapidly controlled. In hilly areas soil and water management in each micro-catchment helps grasslands to return to a natural highly productive ecosystem.

To protect the most natural undisturbed grassland ecosystems, Sanctuaries and National Parks must be created. Their management should focus on preserving all their unique species of plants and animals. Thus they should not be converted into plantations of trees. The open grassland is the habitat of its specialised fauna. Planting trees in these areas reduces the natural features of this ecosystem resulting in the destruction of this unique habitat for wildlife.

WHAT SHOULD WE DO?

- There is a need to preserve the few natural grassland areas that still survive by creating National Parks and Wildlife Sanctuaries in all the different types of grasslands.
- Animals such as the wolf, blackbuck, chinkara and birds such as bustards and floricans have now become rare all over the country. They must be carefully protected in the few National Parks and Wildlife Sanctuaries that have natural grassland habitats as well as outside these Protected Areas.
- We need to create an awareness among people that grasslands are of great value. If we are all concerned about our disappearing grasslands and their wonderful wildlife, the Government will be motivated to protect them.
- Keeping grasslands alive is a National priority.

5.6 SUMMARY

Terrestrial ecosystems in their natural state are found in different types of forests, grasslands, semi-arid areas, deserts and sea-coasts. Over thousands of years, these ecosystems have been modiûed for human use and converted into intensively irrigated agricultural ecosystems and urban industrial centres. Land use changes, habitat loss, disruption of environmental cycles and population pressure are some of the driving forces of ecosystem degradation. Ecosystems provide a range of goods and services essential to human life. Therefore, it is crucial that we protect and conserve our natural ecosystems and its resources.

5.7 GLOSSARY

Abiotic : Non living component

Afforestation : Planting of trees

Biotic : living component

Canopy : A leafy portion of tree

Endemic : confined to given

Macrophytes : Large aquatic plants

5.8 MULTIPLE CHOICE QUESTIONS

1. In a food chain.

(a) there is repeated eating in which each group eats the bigger one and is eaten by the larger.

(b) there is repeated eating in which each group eats the smaller one and is eaten by the larger.

(c) both a, b

(d) None of these

Ans. (b)

2. Which provides greater energy

(a) a food Chain With 3 levels (b) a food chains with 4 levels

(C) a food Chain With 5 levels (d) a food chain with 6 levels

Ans. (a)

3. Mention the area of environmental studies

(a) Natural resources (b) Biodiversity

(c) Ecology (d)All of these

Ans. (d)

4. Our forests are dwelling on account of

(a) Soil erosion (b) Landslides

(C) Cyclones (d) Indiscriminate felling of tree and grazing

Ans. (d)

5. In India, tropical rain forests are found in

(a) Tamil Nadu, Kerala (b) Andaman and Assam

(c) Western Ghats (d) All Of these

Ans. (c)

6. The main cause for Land Degradation is

(a) Over grazing (b) Over exploration (c) Deforestation (d) All of these

Ans. (d)

7. In our country the Van Mahotsav Day is observed on

(a) Second of October (b) First of December

(c) Tenth of August (d) First of July

Ans.(d)

8.The group of organisms which convert light into food are called

(a) autotrophs (b) heterotrophs

(c) decomposers (d) omnivores

Ans.(a)

9. Plants are green because of the presence of a pigment called

(a) glucose (b) nitrogen

(c) chlorophyll (d) oxygen

Ans.(c)

10. When trees are cut, amount of oxygen

(a) decreases (b) increases

(c) both (a and b) (d) remains same

Ans.(a)

5.9 SUGGESTED READINGS/5.11 REFERENCES:

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UNIT : 1 **LESSON-VI**

INTRODUCTION, TYPES, CHARACTERISTIC FEATURES OF THE FOLLOWING ECOSYSTEMS OF INDIA

(DESERT AND AQUATIC ECOSYSTEM)

6.1 INTRODUCTION

6.2 OBJECTIVES

6.3 DESERT ECOSYSTEM

6.3.1 UTILISATION OF DESERT ECOSYSTEM

6.3.2 THREATS TO DESERT ECOSYSTEM

6.3.3 CONSERVATION OF DESERT ECOSYSTEM

6.4 AQUATIC ECOSYSTEM

6.4.1 TYPES OF AQUATIC ECOSYSTEM

6.4.2 UTILISATION OF AQUATIC ECOSYSTEM

6.4.3 THREATS TO AQUATIC ECOSYSTEM

6.4.4 CONSERVATION OF AQUATIC ECOSYSTEM

6.5 SUMMARY

6.6 GLOSSARY

6.7 SELF ASSESSMENT QUESTIONS

6.8 SUGGESTED READINGS / 6.10 REFERENCES:

6.1 INTRODUCTION

Desert and semi arid lands are highly specialized and sensitive ecosystems that are easily destroyed by human activities. The species of these dry areas can live only in this specialised habitat.

6.2 OBJECTIVES

- To study the different types of aquatic ecosystem and their utility
- To study the different threats on desert and aquatic ecosystems
- To understand various methods of conservation

6.3 WHAT IS A DESERT OR A SEMI-ARID ECOSYSTEM?

Deserts and semi arid areas are located in Western India and the Deccan Plateau. The climate in these vast tracts is extremely dry. There are also cold deserts such as in Ladakh, which are located in the high plateaus of the Himalayas. The most typical desert landscape that is seen in Rajasthan is in the Thar Desert. This has sand dunes. There are also areas covered with sparse grasses and a few shrubs, which grow if it rains. In most areas of the Thar the rainfall is scanty and sporadic. In an area it may rain only once every few years. In the adjoining semi arid tract the vegetation consists of a few shrubs and thorny trees such as kher and babul.The Great and Little Rann of Kutch are highly specialised arid ecosystems. The Great Rann is famous,as it is the only known breeding colony of the Greater and Lesser Flamingos in our country.The Little Rann of Kutch is the only home of the wild ass in India. Desert and semi arid regions have a number of highly specialized insects and reptiles. The rare animals include the Indian wolf, desert cat, desert fox and birds such as the Great Indian Bustard and the Florican. Some of the commoner birds include partridges, quails and sandgrouse.

6.3.1 HOW ARE DESERT AND SEMI-ARID ECOSYSTEMS USED?

Areas of scanty vegetation with semi-arid scrubland have been used for camel, cattle and goat grazing in Rajasthan and Gujarat, and for sheep grazing in the Deccan Plateau. Areas that have a little moisture, such as along the watercourses, have been used for growing crops such as jowar, and bajra. The natural grasses and local varieties

of crops have adapted to growing at very low moisture levels. These can be used for genetic engineering and developing arid land crops for the future.

6.3.2 WHAT ARE THE THREATS TO DESERT ECOSYSTEMS ?

Several types of development strategies as well as human population growth have begun to affect the natural ecosystem of the desert and semi arid land. Conversion of these lands through extensive irrigation systems has changed several of the natural characteristics of this region. The canal water evaporates rapidly bringing the salts to the surface. The region becomes highly unproductive as it becomes saline. Pulling excessive groudwater from tube wells lowers the water table creating an even drier environment. Thus human activities destroy the naturalness of this unique ecosystem. The special species that evolved here over millions of years may soon become extinct.

HOW CAN DESERT ECOSYSTEMS BE CONSERVED?

Desert ecosystems are extremely sensitive. Their ecological balance that forms a habitat for their plants and animals is easily disturbed. Desert people have traditionally protected their meager water resources. The Bishnois in Rajasthan are known to have protected their Khejdi trees and the blackbuck antelope for several generations. The tradition began when the ruler of their region ordered his army to cut down trees for his own use. Several Bishnois were said to have been killed while trying to protect their trees.

There is an urgent need to protect residual patches of this ecosystem within National Parks and Wildlife Sanctuaries in desert and semi arid areas. The Indira Gandhi Canal in Rajasthan is destroying this important natural arid ecosystem, as it will convert the region into intensive agriculture. In Kutch, areas of the little Rann, which is the only home of the Wild Ass, will be destroyed by the spread of salt works.

Development Projects alter the desert and arid landscape. There is a sharp reduction in the habitat available for its specialised species bringing them to the verge of extinction. We need a sustainable form of development that takes the special needs of the desert into account.

6.4 AQUATIC ECOSYSTEMS

The aquatic ecosystems constitute the marine environments of the seas and the fresh water systems in lakes, rivers, ponds and wetlands. These ecosystems provide human beings with a wealth of natural resources. They provide goods that people collect for food such as fish and crustaceans. Natural aquatic systems such as rivers and seas break down chemical and organic wastes created by man. However, this function has limitations, as the aquatic ecosystem cannot handle great quantities of waste.

Beyond a certain limit, pollution destroys this natural function. If aquatic ecosystems are misused or over utilized, their ability to provide resources suffers in the long term. Over-fishing leads to a fall in the fish catch. River courses that are changed by dams to provide electricity affect thousands of people who do not get a continuous supply of water downstream for their daily use. When wetlands are drained, their connected rivers tend to cause floods. These are all examples of unsustainable changes in the use of natural resources and nature's ecosystems that are dependent on hydrological regimes. Water is an important factor in all our ecosystems. Several ecosystems exist in freshwater and marine salt water. There is very little fresh water on earth, which is a key resource for people all over the world.

WHAT IS AN AQUATIC ECOSYSTEM?

In aquatic ecosystems, plants and animals live in water. These species are adapted to live in different types of aquatic habitats. The special abiotic features are its physical aspects such as the quality of the water, which includes its clarity, salinity, oxygen content and rate of flow. Aquatic ecosystems may be classified as being (lentic) stagnant ecosystems, or (Lotic) running water ecosystems. The mud gravel or rocks that form the bed of the aquatic ecosystem alter its characteristics and influence its plant and animal species composition. The aquatic ecosystems are classified into freshwater, brackish and marine ecosystems, which are based on the salinity levels.

The fresh water ecosystems that have running water are streams and rivers. Ponds, tanks and lakes are ecosystems where water does not flow. Wetlands are special ecosystems in which the water level fluctuates dramatically in different seasons.

They have expanses of shallow water with aquatic vegetation, which forms an ideal habitat for fish, crustacean and water birds.

Marine ecosystems are highly saline, while brackish areas have less saline water such as in river deltas. Coral reefs are very rich in species and are found in only a few shallow tropical seas. The richest coral reefs in India are around the Andaman and Nicobar islands and in the gulf of Kutch.

Brackish water ecosystems in river deltas are covered by mangrove forests and are among the world's most productive ecosystems in terms of biomass production. The largest mangrove swamps are in the Sunderbans in the delta of the Ganges.

6.4.1 TYPES OF AQUATIC ECOSYSTEMS

POND ECOSYSTEM

The pond is the simplest aquatic ecosystem to observe. There are differences in a pond that is temporary and has water only in the monsoon, and a larger tank or lake that is an aquatic ecosystem throughout the year. Most ponds become dry after the rains are over and are covered by terrestrial plants for the rest of the year.

When a pond begins to fill during the rains, its life forms such as the algae and microscopic animals, aquatic insects, snails, and worms come out of the floor of the pond where they have remained dormant in the dry phase. Gradually more complex animals such as crabs frogs and fish return to the pond. The vegetation in the water consists of floating weeds and rooted vegetation on the periphery which grow on the muddy floor under water and emerge out of the surface of the water.

As the pond fills in the monsoon a large number of food chains are formed. Algae is eaten by microscopic animals which are in turn eaten by small fish on which larger carnivorous fish depend. These are in turn eaten by birds such as kingfishers, herons and birds of prey. Aquatic insects, worms and snails feed on the waste material excreted by animals and the dead or decaying plant and animal matter. They act on the detritus which is broken down into nutrients which aquatic plants can absorb thus completing the nutrient cycle in the pond.

The temporary ponds begin to dry after the rains and the surrounding grasses and terrestrial plants spread into the moist mud that is exposed. Animals such as frogs, snails and worms remain dormant in the mud awaiting the next monsoon.

LAKE ECOSYSTEM

A lake ecosystem functions like a giant permanent pond. A large amount of its plant material is the algae which derives energy from the sun. This is transferred to the microscopic animals which feed on the algae. There are fish that are herbivorous and are dependent on algae and aquatic weeds. The small animals such as snails are used as food by small carnivorous fish, which in turn are eaten by larger carnivorous fish. Some specialised fish, such as catfish, feed on the detritus on the muddy bed of the lake.

Energy cycles through the lake ecosystem from the sunlight that penetrates the water surface to the plants. From plants energy is transferred to herbivorous animals and carnivores. Animals excrete waste products, which settle on the bottom of the lake. This is broken down by small animals that live in the mud in the floor of the lake. This acts as the nutrient material that is used byaquatic plants for their growth. During this process plants use Carbon from CO2 for their growth and in the process release Oxygen. This Oxygen is then used by aquatic animals, which filter water through their respiratory system.

STREAM AND RIVER ECOSYSTEMS

Streams and rivers are flowing water ecosystems in which all the living forms are specially adapted to different rates of flow. Some plants and animals such as snails and other burrowing animals can withstand the rapid flow of the hill streams. Other species of plants and animals such as water beetles and skaters can live only in slower moving water. Some species of fish, such as Mahseer, go upstream from rivers to hill streams for breeding. They need crystal clear water to be able to breed. They lay eggs only in clear water so that their young can grow successfully.

As deforestation occurs in the hills the water in the streams that once flowed throughout the year become seasonal. This leads to flash floods in the rains and a shortage of water once the streams dry up after the monsoon.

The community of flora and fauna of streams and rivers depends on the clarity, flow and oxygen content as well as the nature of their beds. The stream or river can have a sandy, rocky or muddy bed, each type having its own species of plants and animals.

MARINE ECOSYSTEMS

The Indian Ocean, the Arabian Sea and the Bay of Bengal constitute the marine ecosystems around peninsular India. In the coastal area the sea is shallow while further away, it is deep. Both these are different ecosystems. The producers in this ecosystem vary from microscopic algae to large seaweeds. There are millions of zooplankton and a large variety of invertebrates on which live fish, turtles and marine mammals.

The shallow areas near Kutch and around the Andaman and Nicobar Islands are some of the most incredible coral reefs in the world. Coral reefs are only second to tropical evergreen forests in their richness of species. Fish, crustacean, starfish, jellyfish and the polyps that deposit the coral are a few of the thousands of species that form this incredible world under the shallow sea.

Deforestation of adjacent mangroves leads to silt being carried out to sea where it is deposited on the coral which then dies. There are many different types of coastal ecosystems which are highly dependent on the tide. The marine ecosystem is used by coastal fisherfolk for fishing which forms their livelihood. In the past, fishing was done at a sustainable level.

The marine ecosystem continued to maintain its abundant supply of fish over many generations.

Now with intensive fishing by using giant nets and mechanized boats, fish catch in the Indian Ocean has dropped significantly.

SEASHORE ECOSYSTEMS

Beaches can be sandy, rocky, shell covered or muddy. On each of these different types, there are several specific species which have evolved to occupy a separate niche. There are different crustacean such as crabs that make holes in the sand. Various

shore birds feed on their prey by probing into the sand or mud on the sea shore. Several different species of fish are caught by fishermen. In many areas the fish catch has decreased during the last decade or two.

6.4.2 HOW ARE AQUATIC ECOSYSTEMS USED?

Man uses aquatic ecosystems for the clean freshwater on which his life is completely dependent.

We need clean water to drink and for other domestic uses. Water is essential for agriculture.

Fisherfolk use the aquatic ecosystems to earn a livelihood. People catch fish and crabs. They also collect edible plants. This is used locally as food or for sale in the market. Over fishing leads to a serious decline in the catch and a long-term loss of income for fisherfolk.

Marshes and wetlands are of great economic importance for people who live on their fish, crustacean, reeds, grasses and other produce.

Modern man impounds water in dams to be able to store it throughout the year. Agriculture and industry are highly dependent on large quantities of water. However this leads to problems for tribal people who have lived there before the dams were built as they are displaced to build large dams. These dams make rich people richer in the farmland and supports people in large urban centres that use enormous quantities of water. The poor tribal folk become even poorer as the natural resources they depend on are taken away as their lands are submerged under the water of the dam.

Dams are built across rivers to generate electricity. A large proportion of this energy is used by urban people, by agriculturists in irrigated farmlands and in enormous quantities for industry.

Large dams have serious ill effects on natural river ecosystems. While water from dams used for irrigation has lead to economic prosperity in some areas, in semiarid areas that are artificially irrigated the high level of evaporation leads to severe salinisation as salts are brought up into the surface layers of the soil. This makes such lands gradually more and more saline and unproductive.

6.4.3 WHAT ARE THE THREATS TO AQUATIC ECOSYSTEMS ?

Water pollution occurs from sewage and poorly managed solid waste in urban areas when it enters the aquatic ecosystem of lakes and rivers. Sewage leads to a process called eutrophication, which destroys life in the water as the oxygen content is severely reduced. Fish and crustacean cannot breathe and are killed. A foul odour is produced. Gradually the natural flora and fauna of the aquatic ecosystem is destroyed. In rural areas the excessive use of fertilizers causes an increase in nutrients, which leads to eutrophication. Pesticides used in adjacent fields pollute water and kills off its aquatic animals. Chemical pollution from industry kills a large number of life forms in adjacent aquatic ecosystems. Contamination by heavy metals and other toxic chemicals affects the health of people who live near these areas as they depend on this water.

CASE STUDY

Threats to wetlands in Assam Almost 40% of all wetlands in Assam are under threat. A survey conducted by the Assam Remote Sensing Application Center (ARSAC), Guwahati, and the Space Research Center, Ahemadabad, has revealed that 1367 out of 3513 wetlands in Assam are under severe threat due to invasion of aquatic weeds and several developmental activities. The wetlands of Assam form the greatest potential source of income for the State in terms of fisheries and tourism. Though the wetlands of Assam have the capacity of producing 5,000 tones of fish per hectare per year, around 20,000 tones of fish have to be imported to meet local demands. This is primarily due to poor wetland management.

6.4.4 HOW CAN AQUATIC ECOSYSTEMS BE CONSERVED ?

For sustainable use of an aquatic ecosystem, water pollution must be prevented. It does not make sense to allow water to be polluted and then try to clean it up. Changing the nature of the aquatic ecosystem from a flowing water ecosystem to a static ecosystem destroys its natural biological diversity. Thus dams across rivers decrease the population of species that require running water, while favouring those that need standing water.

Aquatic ecosystems, especially wetlands, need protection by including them in Sanctuaries or National Parks in the same way in which we protect natural forests.

These sanctuaries in aquatic ecosystems protect a variety of forms of life as well as rare fish which are now highly endangered such as the Mahseer. Wetland Sanctuaries and National Parks are of greatest importance as this is one of the most threatened of our ecosystems. As the proportion of the earth's surface that is naturally covered by wetlands is very small compared to forests or grasslands, the wetland ecosystems are very highly threatened.

6.5 SUMMARY

Deserts are characterized by extremely hot days and cold nights. Only those organisms which have specialized structural, physiological and behavioral adaptations to withstand the extremes of temperature and aridity can survive there. Desert and semi-arid lands are extremely specialized and sensitive ecosystem that are easily destroyed by human activities. Aquatic ecosystems comprise the marine environments of the seas and freshwater systems in lakes, rivers, ponds and wetlands. Ecosystems provide a range of goods and services essential to human life. Therefore, it is crucial that we protect and conserve our natural ecosystems and its resources.

6.6 GLOSSARY

Arid zone: Zone of low rainfall.

Eutrophication: A rapid increase in algal growth in an aquatic system.

Lentic: standing water

Marshes: Water logged ground with largely minerals.

Sanctuaries: An area usually in natural conditions which is reserved for the protection of fauna.

6.7 MULTIPLE CHOICE QUESTION

1. Deserts are characterized by

(a) scanty ûora (b) Low fauna

(c) animals with adaptations (d) None of these

Ans. (a, b, c)

2. Some desert species are

(a) swifts (b) Qualis (c) Doves (d) All of these

Ans. (d)

3. An animal that can tolerate the heat of desert is

(a) rats (b) camel

(c) cow (d) lion

Ans.(b)

4. Animal(s) which is/are active at night.

(a) owl (b) rat

(c) cockroach (d) all the above

Ans.(d)

5. Salt concentration in an open sea is usually

(a) 3.5% (b) 2.5% (c) 6.3% (d) 52%

Ans. (a)

6. An estuary

(a) is the area at the mouth of a river (b) is the area at the mouth of a sea

(c) is the area at the mouth of deep sea (d) all of them

Ans. (a)

7. Abiotic environment does not include

(a) air (b) water

(c) soil (d) plants

Ans.(d)

8. Oceans

(a) are main sinks of carbon dioxide

(b) play an important role in regulating many biochemical cycles

(C) regulate hydrological cycle

(d) All of these

Ans. (d)

9. Chief source of energy in environment is

(a) ûre (b) moon

(c) sun (d) Stars

Ans.(c)

10. Zooplanktons are

(a)Botanical gardens (b)Floating animals

(c) Floating plants (d)Microscopic floating animals

Ans.(d)

11.Which is the aquatic ecosystem

(a)Desert (b)Forest

(c) Oceans (d)All of these

Ans.(c)

12. Which of the following is a lotic type of ecosystem

(a)Stream (b)Sea

(c)Swamp (d)All of these

Ans.(a)

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Unit II **Lesson VII**

(ENVIRONMENTAL POLLUTION)

AIR AND WATER POLLUTION

7.1 Introduction

7.2 Objectives

7.3 Air pollution:

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7.4.5 Control measures of water pollution

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7.1 INTRODUCTION

The increase in human population, urbanization and industrialization has resulted in qualitative as well as quantitative change in normal composition of environment which is called **Environmental pollution.** Due to environmental pollution i.e. deteriorated air, water and soil the biodiversity has been affected, many species got extinct, many species are at verge of extinction and ultimately man may himself become victim of self created pollution.

7.2 OBJECTIVES

The main objective of this lesson is to acquaint the students with effects, causes and control measures of air and water pollution so that they can educate the common masses to protect the good quality of environment.

7.3 AIR POLLUTION

Any qualitative as well as quantitative change in normal composition of air is called **air pollution.**

7.3.1 Causes of air pollution:

The air pollution is caused by man-made as well as natural activities.

The man-made activities are:

1. **Burning of Fossil Fuels:** Sulfur dioxide emitted from the combustion of fossil fuels like coal, petroleum and other factory combustibles is one the major cause of air pollution. Pollution emitting from vehicles including trucks, jeeps, cars, trains, airplanes cause immense amount of pollution. Carbon monoxide caused by improper or incomplete combustion and generally emitted from vehicles is another major pollutant along with Nitrogen oxides, which is produced from both natural and manmade processes.

2. **Agricultural activities:** Ammonia is a very common by product from agriculture related activities and is one of the most hazardous gases in the atmosphere. Use of insecticides, pesticides and fertilizers in agricultural activities has grown quite a lot. They emit harmful chemicals into the air and can also cause water pollution.

3. **Exhaust from factories and industries:** Manufacturing industries release large amount of carbon monoxide, hydrocarbons, organic compounds and chemicals into the air thereby depleting the quality of air. Manufacturing industries can be found at every corner of the earth and there is no area that has not been affected by it. Petroleum refineries also release hydrocarbons and various other chemicals that pollute the air and also cause land pollution.

4. **Mining operations:** Mining is a process wherein minerals below the earth are extracted using large equipments. During the process dust and chemicals are released in the air causing massive air pollution. This is one of the reasons which is responsible for the deteriorating health conditions of workers and nearby residents

5. **Indoor air pollution:** Household cleaning products, painting supplies emit toxic chemicals in the air and cause air pollution.

6. **Suspended particulate matter (SPM)** is another cause of air pollution. SPM is usually caused by dust, combustion etc.

7. **Waste deposition** in landfills, which generate methane which is highly flammable and may form explosive mixtures with air. Methane is also an asphyxiant and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5% by displacement.

8. **Military resources** such as nuclear weapons, toxic gases, germ warfare and rocketry.

The Natural activities are:

9. **Dust** from natural sources, usually large areas of land with little or no vegetation.

10. **Methane** emitted by the digestion of food by animals, for example cattle.

11. **Radon** gas from radioactive decay within the Earth's crust. Radon is a colorless, odorless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard. Radon

gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer after cigarette smoking.

12. **Smoke and carbon monoxide** from wildfires.

13. **Vegetation** like Black gum, poplar, oak and willow in some regions, emits environmentally significant amounts of Volatile organic compounds (VOCs) on warmer days. These VOCs react with primary anthropogenic pollutants—specifically, NO_x, SO_2, and anthropogenic organic carbon compounds — to produce a seasonal haze of secondary pollutants. are some examples of vegetation that can produce abundant VOCs.

14. **Volcanic activity** which produces sulfur, chlorine and ash particulates

7.3.2 SOURCES AND COMMON EFFECTS OF COMMON AIR POLLUTANTS

Carbon monoxide: It is a colourless, odourless gas that is poisonous for animals. It is by incomplete combustion of carbon containing fuels. Source of carbon monoxide is cigarette smoking and incomplete combustion of fossil fuels (more than 77% comes from motor vehicle exhaust). **Health effects** include reduced ability of red blood cells to carry oxygen to body cells and tissues. This leads to headache and anemia. At high levels it causes coma, irreversible brain damage and death.

Nitrogen Dioxide: It is a reddish-brown irritating gas that causes photochemical smog. In the atmosphere, it gets converted into nitric acid (HNO_3). It is caused by burning fossil fuels in industries and power plants. **Health effects** include lung irritation and damage. **Environmental effects** involve acid deposition leading to damage of trees, lakes, soil and ancient monuments. NO_2 can damage fabrics.

Sulphur Dioxide: It is a colourless and irritating gas that is formed by combustion of sulphur containing fossil fuels such as coal and oil. In the atmosphere it is converted into Sulphuric acid which is a major component of acid deposition. **Health effects** involve

breathing problems for healthy people. **Environmental effects** involve reduced visibility and acid deposition on trees, lakes, soils and monuments leading to their deterioration and adverse effect on aquatic life.

Suspended Particulate Matter (SPM): Includes a variety of particles and droplets (aerosols) that can be suspended in atmosphere for short to long periods.

Human sources for SPM include burning coal in power and industrial units, burning diesel and other fuels in vehicles, agriculture, unpaved roads, construction, etc.

Health effects include nose and throat irritation, lung damage, bronchitis, asthma, reproductive problems and cancer. **Environmental Effects** include reduced visibility and acid deposition that may lead to damaged trees, soils and aquatic life in lakes.

Ozone is a highly reactive gas with an unpleasant odour occurring in the stratosphere where it protects mankind from the harmful ultra-violet rays from the Sun. However on earth ,it is a pollutant. It occurs on earth due to reaction between Volatile Organic Compounds (VOCs) and Nitrogen Oxides. It produces chest pain coughing and eye irritation.

Photochemical smog is a brownish smoke that frequently forms on clear, sunny days over large cities with significant amounts of automobile traffic It is mainly due to chemical reactions among nitrogen oxides and hydrocarbons in the presence of sunlight.

Health effects include breathing problems, cough, eye, nose and throat irritation, heart diseases, reduced resistance to colds and pneumonia. **Environmental effects** involve damage to plants and trees. Additionally, Smog reduces visibility.

Lead is a solid and highly toxic metal. Its compounds are emitted into the atmosphere as particulate matter. **Human Sources** are paints, smelters (metal refineries), lead manufacture, storage batteries, leaded petrol etc. **Health effects**: Lead accumulates in the body and brain leading to nervous system damage and mental retardation (especially in children), digestive and other health problems. Lead containing chemicals are known to cause cancer in test animals.**Environmental Effects:** It can harm wildlife .

Hydrocarbons Lower haydrocarbons accumulate due to decay of vegetable matter.**Human**

Effects : They are carcinogenic.

Chromium: It is a solid toxic metal emitted into the atmosphere as particulate matter. from Paint, Smelters, Chromium manufacture, Chromium plating. **Health Effects**: Perforation of nasal septum, chrome holes, etc.

Besides this air pollution is also responsible for **global warming, acid rain, ozone depletion and loss of biodiversity.**

7.3.3 CONTROL MEASURES

The atmosphere has several built-in self cleaning processes such as dispersion, gravitational settling, flocculation, absorption, rain-washout, etc to cleanse the atmosphere. However, control of contaminants at their source level is a desirable and effective method through preventive or control technologies. Some measures that can be adopted in this direction are:

1. Using unleaded petrol
2. Using fuels with low sulphur and ash content
3. Encouraging people to use public transport, walk or use a cycle as opposed to private vehicles.
4. Ensure that houses, schools, restaurants and playgrounds are not located on busy streets.
5. Plant trees along busy streets as they remove particulates, carbon dioxide and absorb noise.
6. Industries and waste disposal sites should be situated outside the city preferably on the downwind of the city.
7. Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons

Control measures in industrial centers

1. Emission rates should be restricted to permissible levels by each and every industry.

2. Incorporation of air pollution control equipment in design of plant layout must be made mandatory.

3. Continuous monitoring of the atmosphere for pollutants should be carried out to know the emission levels.

EQUIPMENT USED TO CONTROL AIR POLLUTION

Air pollution can be reduced by adopting the following approaches.1.Ensuring sufficient supply of oxygen to the combustion chamber and adequate temperature so that the combustion is complete thereby eliminating much of the smoke consisting of partly burnt ashes and dust.2.To use mechanical devices such as scrubbers, cyclones, bag houses and electro-static precipitators in manufacturing processes. Wet scrubber can additionally reduce sulphur dioxide emissions.3.The air pollutants collected must be carefully disposed. The factory fumes are dealt with chemical treatment.

7.4 WATER POLLUTION

Any qualitative as well as quantitative change in normal composition of water is called **water pollution i.e.** "the alteration in physical, chemical and biological characteristics of water which may cause harmful effects on humans and aquatic life or makes water unsuitable for desired uses.

7.4.1 CAUSES OF WATER POLLUTION

1. **Industrial waste :** Industries produce huge amount of waste which contains toxic chemicals and pollutants like lead, mercury, sulphur, asbestos, nitrates and many other harmful chemicals. Many industries do not have proper waste management system and drain the waste in the fresh water which goes into rivers, canals and later in to sea.

2. **Sewage and waste water:** The sewage and waste water that is produced by each household is released in drains and to fresh water sources. The sewage water carries harmful bacteria and chemicals that can cause serious health problems. Pathogens are known as a common water pollutant. The sewers of

cities house several pathogens and thereby diseases. Microorganisms in water are known to be causes of some very deadly diseases and become the breeding grounds for other creatures that act as vector of various pathogens causing inflict these diseases like Malaria.

3. **Mining activities:** Mining is the process of crushing the rock and extracting coal and other minerals from underground. These elements when extracted in the raw form contains harmful chemicals and can increase the amount of toxic elements when mixed up with water which may result in health problems. Mining activities emit several metal waste and sulphides from the rocks and is harmful for the water.

4. **Chemical fertilizers and pesticides:** Chemical fertilizers and pesticides are used by farmers to protect crops from insects and bacteria. They are useful for the plants growth. However, when these chemicals are mixed up with water become harmful for plants and animals.

5. **Leakage from sewer lines:** A small leakage from the sewer lines can contaminate the underground water and make it unfit for the people to drink. Also, when not repaired on time, the leaking water can come on to the surface and become a breeding ground for insects and mosquitoes.**6. Radioactive waste:** Nuclear energy is produced using nuclear fission or fusion. The element that is used in production of nuclear energy is Uranium which is highly toxic chemical. The nuclear waste that is produced by radioactive material needs to be disposed off to prevent any nuclear accident. Nuclear waste can have serious environmental hazards if not disposed off.

7. **Leakage from the landfills:** Landfills are nothing but huge pile of garbage that produces awful smell and can be seen across the city. When it rains, the landfills may leak and the leaking landfills can pollute the underground water with large variety of contaminants.

8. **Animal waste:** The waste produced by animals is washed away into the rivers when it rains. It gets mixed up with other harmful chemicals and

causes various water borne diseases like cholera, diarrhea, jaundice, dysentery and typhoid.

7.4.2 EFFECTS OF WATER POLLUTION

1. Reduction in Dissolved Oxygen(DO)

Dissolved Oxygen (DO) is the amount of oxygen dissolved in a given quantity of water at a particular pressure and temperature. The saturated point of DO varies from 8 to 15 mg/L .

Organic wastes such as animal manure and plant debris that can be decomposed by aerobic (oxygen-requiring) bacteria. Large populations of bacteria decomposing these wastes can degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen-consuming aquatic life to die.

2. Compounds of toxic metals such as lead (Pb), arsenic (As) and selenium (Se), Salts, Surface runoff, industrial effluents and household cleansers can a. Make freshwater unusable for drinking and irrigation ,b Cause skin cancer and neck damage c. Damage nervous system, liver and kidneys ,d. Harm fish and other aquatic life and .e. Lower crop yields and f .Accelerate corrosion of metals exposed to such water. **Minimata disease** is caused due to mercury and **itai itai (ouch-ouch disease)** is caused due to chromium.

3. Organic chemicals like oil, gasoline, plastics, pesticides, cleaning solvents and Detergents, effluents, household cleansers and surface run off from farms can threaten human health by causing nervous system damage and some cancers and also harm fish and wildlife.

4. Plant nutrients like Water soluble compounds containing nitrate, phosphate and ammonium ions can

a. cause excessive growth of algae and other aquatic plants, which die, decay, increases Biological Oxygen Demand (BOD), deplete dissolved oxygen in water thereby killing fish leadind to **eutrophication** and

b. Drinking water with excessive levels of nitrates lower the oxygen carrying capacity of the blood and can kill urban children and infants. In infants excess nitrate reacts with haemoglobin to form non-functional methaemoglobin that impairs oxygen transport .This condition is called **methaemoglobinemia or blue baby syndrome**

5. **Sediment like** Soil, silt, and Land erosion

a. Causes cloudy water thereby reducing photosynthetic activity and disrupting aquatic food chain.

b. Carries pesticides, bacteria and other harmful substances c. Settles and destroys feeding and spawning grounds of fish and Clogs and fills lakes, artificial reservoirs, stream channels and harbours.

6. **Radioactive materials**: like Radioactive isotopes of Iodine, Radon, Uranium, Cesium and Thorium, Nuclear power plants effluents, mining and processing of uranium and other ores, nuclear weapon production and natural sources causes genetic mutations, birth defects and certain cancers.

7.4.3. THERMAL POLLUTION

Thermal pollution is defined as sudden increase or decrease in temperature of a natural body of water which may be ocean, lake, river or pond by human influence. This normally occurs when a plant or facility takes in water from a natural resource and puts it back with an altered temperature. Usually, these facilities use it as a cooling method for their machinery or to help better produce their products.

Causes of Thermal Pollution

1. Water as Cooling Agent in Power, Manufacturing and Industrial plants: Production and Manufacturing plants plants draw water from nearby source to keep machines cool and then release back to the source with higher temperature. When heated water returns to the river or ocean, the water temperature rises sharply.

2. Soil Erosion: Soil erosion is another major factor that causes thermal pollution. Consistent soil erosion causes water bodies to rise, making them more exposed to sunlight. The high temperature could prove fatal for aquatic biomes as it may give rise to anaerobic conditions.**3. Deforestation:** Trees and plants prevent sunlight from falling directly on lakes, ponds or rivers. When deforestation takes place, these water bodies are directly exposed to sunlight, thus absorbing more heat and raising its temperature. Deforestation is also a main cause of the higher concentrations of greenhouse gases i.e. global warming in the atmosphere.**4. Runoff from Paved Surfaces:** Urban runoff discharged to surface waters from paved surfaces like roads and parking lots can make water warmer. During summer seasons, the pavement gets quite hot, which creates warm runoff that gets into the sewer systems and water bodies. **5. Natural Causes:** Natural causes like volcanoes and geothermal activity under the oceans and seas can trigger warm lava to raise the temperature of water bodies. Lightening can also introduce massive amount of heat into the oceans. This means that the overall temperature of the water source will rise, having significant impacts on the environment.

Effects of Thermal Pollution

1. Decrease in DO (Dissolved Oxygen) Levels: The warm temperature reduces the levels of DO (Dissolved Oxygen) in water. The warm water holds relatively less oxygen than cold water. The decrease in DO can create suffocation for plants and animals such as fish, amphibians and copepods, which may give rise to anaerobic conditions. Warmer water allows algae to flourish on surface of water and over the long term growing algae can decrease oxygen levels in the water.

2. Increase in Toxins: With the constant flow of high temperature discharge from industries, there is a huge increase in toxins that are being regurgitated into the natural body of water. These toxins may contain chemicals or radiation that may have harsh impact on the local ecology and make them susceptible to various diseases.

3. Loss of Biodiversity: A dent in the biological activity in the water may cause significant loss of biodiversity. Changes in the environment may cause certain species of organisms to shift their base to some other place while their could be significant number of species that may shift in because of warmer waters. Organisms that can adapt easily may have an advantage over organisms that are not used to the warmer temperatures.

4. Ecological Impact: A sudden thermal shock can result in mass killings of fish, insects, plants or amphibians. Small water temperature increases the level of activity while higher temperature decreases the level of activity. Many aquatic species are sensitive to small temperature changes such as one degree Celsius that can cause significant changes in organism metabolism and other adverse cellular biology effects.

5. Affects Reproductive Systems: Excessive temperature can cause the release of immature eggs or can prevent normal development of certain eggs.

6. Increases Metabolic Rate: Thermal pollution increases the metabolic rate of organisms as increasing enzyme activity occurs that causes organisms to consume more food than what is normally required, if their environment were not changed. It disrupts the stability of food chain and alter the balance of species composition.

7. Migration: The warm water can also cause particular species of organisms to migrate to suitable environment that would cater to its requirements for survival. This can result in loss for those species that depend on them for their daily food as their food chain is interrupted.

7.4.4 MARINE POLLUTION :

Oceans are the largest water bodies on the planet Earth. Over the last few decades, surplus human activities have severely affected the marine life on the Earth's oceans. Ocean pollution, also known as marine pollution, is the spreading of harmful substances such as oil, plastic, industrial and agricultural waste and chemical particles into the ocean. Since oceans provide home to wide variety of marine animals and plants, it is responsibility of every citizen to play his or her part in making these oceans clean so that marine species can thrive for long period of time.

Causes of Ocean Pollution: There are various ways by which pollution enters the ocean. Some of them are :

1. **Sewage** Pollution can enter the ocean directly. Sewage or polluting substances flow through rivers, or drainages directly into the ocean.

2. **Toxic Chemicals From Industries** are into the ocean's ecosystem thereby effecting oceanic life.

3. **Industrial and agricultural waste** are another most common form of wastes that are directly discharged into the oceans, resulting in ocean pollution.

4. **Land Runoff** is another source of pollution in the ocean. This occurs when water infiltrates the soil to its maximum extent and the excess water from rain, flooding or melting flows over the land and into the ocean. This water picks up man-made, harmful contaminants like fertilizers, petroleum, pesticides, fertilizers and waste from land animals and humans that pollute the ocean.

5. **Large Scale Oil Spills** Ship pollution is a huge source of ocean pollution, the most devastating effect of which is oil spills. Crude oil lasts for years in the sea and is extremely toxic to marine life, often suffocating marine animals to death.

6. **Ocean Mining** in the deep sea is yet another source of ocean pollution. Ocean mining sites drilling for silver, gold, copper, cobalt and zinc create sulfide deposits up to three and a half thousand meters down in to the ocean. thereby causing damage to the lowest levels of the ocean and increase the toxicity of the region.

7. **Littering** Pollution from the atmosphere is, believe it or not, a huge source of ocean pollution. This occurs when objects like dust , sand, man-made objects such as debris and trash. ,plastic debris are blown by the wind over long distances and end up in the ocean.

Effects of Ocean Pollution :

1. Animals like turtles, dolphins, fish, sharks, crabs, sea birds, and crocodiles can become snagged on the plastic or mistake it for food, slowly killing them over a long period of time.

2. In addition, the temperature of the ocean is highly affected by carbon dioxide and climate changes, which impacts primarily the ecosystems and fish communities that live in the ocean. In particular, the rising levels of Co_2 acidify the ocean in the form of acid rain. Even though the ocean can absorb carbon dioxide that originates from the atmosphere, the carbon dioxide levels are steadily increasing and the ocean's absorbing mechanisms, due to the rising of the ocean's temperatures, are unable to keep up with the pace.

3. Oil spill is dangerous to marine life in several ways. The oil spilled in the ocean could get on to the gills and feathers of marine animals, which makes it difficult for them to move or fly properly or feed their children.

4. The long term effect on marine life can include cancer, failure in the reproductive system, behavioral changes, and even death.

5. Disruption to the Cycle of Coral Reefs.

6. Oil spill floats on the surface of water and prevents sunlight from reaching to marine plants and affects in the process of photosynthesis.

7. Skin irritation, eye irritation, lung and liver problems can impact marine life over long period of time.

8. Most of the debris in the ocean does not decompose and remain in the ocean for years. It uses oxygen as it degrades. As a result of this, oxygen levels go down. and the chances of survival of marine animals like whales, turtles, sharks, dolphins, penguins for long time also goes down.

9. Failure in the Reproductive System of Sea Animals due to accumulation of chemicals from in the fatty tissue of animals.

10. Effect on Food Chain Chemicals used in industries and agriculture get washed into the rivers consumed by Small which are later eaten by large animals thereby affecting the whole food chain.

11. Animals from impacted food chain are then eaten by humans which affects their health and lead to cancer, birth defects or long term health problems.

7.4.5 CONTROL MEASURES OF WATER POLLUTION

1. Taking bath and washing clothes at bank of water bodies should be prohibited.

2. Scientific techniques should be adopted for environmental control of catchment areas of rivers, ponds or streams.

3. Industrial plants should be based on recycling operations as it helps prevent disposal of wastes into natural waters but also extraction of products from waste.

4. Overuse of fertilizers and pesticides should be avoided **5.** Solid waste should not be dumped in water bodies.

6. No type of waste (treated, partially treated or untreated) should be discharged into any natural water body. Industries should develop closed loop water supply schemes and domestic sewage must be used for irrigation.

7. Qualified and experienced people must be consulted from time to time for effective control of water pollution.

8. Public awareness must be initiated regarding adverse effects of water pollution using the media.

9. Laws, standards and practices should be established to prevent water pollution and these laws should be modified from time to time based on current requirements and technological advancements.

10. Basic and applied research in public health engineering should be encouraged.

7.5 SUMMARY

Any qualitative as well as quantitative change in normal composition of environment is called **Environmental pollution.** Any qualitative as well as

quantitative change in normal composition of air is called **air pollution**. This is caused by man-made as well as natural activities. The man-made activities are Burning of Fossil Fuels, Agricultural activities. Exhaust from factories and industries, Mining operations, Indoor air pollution, Suspended particulate matter (SPM), Waste deposition, Military resources. The Natural activities are. Dust, Methane Radon, Smoke and carbon monoxide, **Vegetation and Volcanic activity** which produces sulfur, chlorine and ash particulates**.**

Carbon monoxide : Causes reduced ability of red blood cells to carry oxygen to body cells and tissues.

Nitrogen Dioxide : Causes lung irritation and damage.

Sulphur Dioxide : Causes breathing problems for healthy people. reduced visibility

Suspended Particulate Matter (SPM) : Causes include nose and throat irritation, lung damage, bronchitis, asthama, reproductive problems and cancer. reduced visibility and acid deposition.

Ozone : Produces chest pain coughing and eye irritation.

Photochemical smog : Causes breathing problems, cough, eye, nose and throat irritation, heart diseases, reduced resistance to colds.

Lead : Accumulates in the body and brain leading to nervous system damage and mental retardation (especially in children), digestive and other health problems.

Hydrocarbons are carcinogenic.

Chromium : causes perforation of nasal septum, chrome, holes, etc. Besides this air pollution is also responsible for **global warming, acid rain, ozone depletion and loss of biodiversity.**

Some measures that can be adapted to control air pollution are Use of unleaded petrol, Use of fuels with low sulphur and ash content, Encouraging people to use public transport, walk or use a cycle as opposed to private vehicles, Ensure that houses, schools, restaurants and playgrounds are not located on busy streets, Plant trees along busy streets as they remove particulates, carbon dioxide and absorb noise,

Industries and waste disposal sites should be situated outside the city preferably on the downwind of the city and Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons.

Control measures in industrial centers are Emission rates should be restricted to **permissible** levels by each and every industry ,Incorporation of air pollution control equipment in design of plant layout must be made mandatory and Continuous monitoring of the atmosphere for pollutants should be carried out to know the emission levels. **Water pollution -** Any qualitative as well as quantitative change in normal composition of water is called **water pollution .** This is caused by **Industrial waste, Sewage and waste water,Mining activities , Chemical fertilizers and pesticides , Leakage from sewer lines , Radioactive waste , Leakage from the landfill , Animal waste . Effects of water pollution Water pollutants like organic and inorganic factors.** endanger the flora, fauna and humans that use it along its path.,**Reduction in Dissolved Oxygen(DO)** causes fish and other forms of oxygen-consuming aquatic life to die.**. Compounds of toxic metals** such as lead (Pb), arsenic (As) and selenium (Se) Salts , Surface runoff, industrial effluents and household cleansers makes freshwater unusable for drinking and irrigation causes skin cancer and neck damage , Damage nervous system, liver and kidneys **,** Accelerate corrosion of metals exposed to such water. **Minimata disease** is caused due to mercury and **itai itai (ouch-ouch disease)** is caused due to chromium.**Organic chemicals** like Oil, Gasoline, Plastics, Pesticides, Cleaning solvents and Detergents. threaten human health by causing nervous system damage and some cancers and b. Harm fish and wildlife. **Plant nutrients like** Water soluble compounds containing nitrate, Phosphate and Ammonium ions can **a**. cause **eutrophication** and **b** .Drinking water with excessive levels of nitrates causes **methaemoglobinemia or blue baby syndrome. Radioactive materials**: like Radioactive isotopes of Iodine, Radon, Uranium, Cesium and Thorium, Nuclear power plants effluents, mining and processing of uranium and other ores, nuclear weapon production and natural sources causes genetic mutations, birth defects and certain cancers.

7.Thermal pollution is defined as sudden increase or decrease in temperature of a natural body of water which may be ocean, lake, river or pond by human influence. This is caused by **:**

1. Water as Cooling Agent in Power, Manufacturing and Industrial plants :

2. Soil Erosion : 3. Deforestation: 4. Runoff from Paved Surfaces 5. Natural Causes.

Effects of Thermal Pollution are : 1. Decrease in DO (Dissolved Oxygen) Levels 2. Increase in Toxins 3. Loss of Biodiversity 4. Ecological Impact 5. Affects in Reproductive Systems 6. Increase in metabolic rate.

Marine Pollution : Marine pollution, is the spreading of harmful substances such as oil, plastic, industrial and agricultural waste and chemical particles into the ocean. Causes of Ocean Pollution are : **1. Sewage 2. Toxic Chemicals From Industries 3. Industrial and agricultural waste 4. Land Runoff 5. Large Scale Oil Spills 6. Ocean Mining and 7. Littering Effects of Ocean Pollution** are Animals like turtles, dolphins, fish, sharks, crabs, sea birds, and crocodiles are slowly killed over a long period of time.

7.6 GLOSSARY

BOD –Amount of oxygen required by microbes to degrade organic matter in one litre of water in five days at 20^{o} C.

Eutrophication – Enrichment of lakes with nutrients

Sewage –Waste water of domestic and community units

Biodiversity –Vast array of plants animals and microbes in area.

7.7 Short ans. Questions / sample paper

1. Blue baby syndrome' disease is caused due to

   a. Phosphate pollution b. Sulphate pollution

   c. Chloride pollution d. Nitrate pollution

Ans. D

2. The itai-itai or ouch-ouch disease is caused due to:

a. Mercury b. Oxygen

c. cadmium d. Nitrogen gas

Ans. c

3. Eutrophication results in the reduction of

a. mineral salts b. dissolved O_2

c. . dissolved H_2 d. None

Ans. b.

4. BOD is connected with

a. organic matter b. microbes

c. both a& b d. None

Ans. a

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Unit : 2 **Lesson VIII**

(SOIL, NOISE AND RADIATION POLLUTION)

8.1 INTRODUCTION

8.2 OBJECTIVES

8.3 SOIL POLLUTION

8.3.1 CAUSES OF SOIL POLLUTION

8.3.2 EFFECTS OF SOIL POLLUTION

8.3.3 CONTROL MEASURES OF SOIL POLLUTION:

8.4 NOISE POLLUTION

8.4.1 CAUSES OF NOISE POLLUTION

8.4.2 EFFECTS OF NOISE POLLUTION

8.4.3 CONTROL MEASURES:

8.5 RADIOACTION POLLUTION

8.5.1 CAUSES OF RADIATION POLLUTION

8.5.2 EFFECTS OF RADIOACTIVE POLLUTION

8.5.3 CONTROL OF RADIOACTIVE POLLUTION

8.6 SUMMARY

8.7 GLOSSORY

8.8 SHORT ANS. QUESTIONS / SAMPLE PAPER

8.9 REFERENCES / SUGGESTED READINGS

8.1 INTRODUCTION

Urbanization and industrialization has also resulted **soil, noise and radiation** pollution which has direct impact on quality of human life . Polluted soil due to discharge of industrial effluents and disposal of all types of wastes and invisible noise and radiation pollution are associated with current environmenta issues.

8.2 OBJECTIVES

The main objective of this lesson is to acquaint the students with effects, causes and control measures of Soil, Noise and Radiation pollution so that they can educate the common masses to protect the good quality of environment.

8.3 SOIL POLLUTION

Any qualitative as well as quantitative change in normal composition of soil that make it unfit for agriculture is called **soil pollution.**

8.3.1 CAUSES OF SOIL POLLUTION

1. Industrial Activity : Industrial activity has been the biggest contributor to the problem in the last century due to increase in mining and manufacturing activity. Most of the industries are dependent on extracting minerals like iron ore or coal from the Earth, and the industrial wates are disposed off in a unmanaged way thereby making soil unsuitable for use.

2. Agricultural Activities : Chemical utilization has gone up tremendously since technology provided us with modern chemical pesticides and fertilizers which cannot be broken down by microbes in soil. As a result, they seep into the ground after they mix with water and slowly reduce the fertility of the soil. Other chemicals damage the composition of the soil and make it easier to erode by water and air. Plants absorb many of these pesticides and when they decompose, they cause soil pollution since they become a part of the land.

3. Solid Waste Disposal : Solid waste generated in residential area, commercial area and institutional area is disposed off openly on land therby making it unfit for use.Besides this every human being produces a certain amount of personal waste

products like urine and feaces the disposal of which is done in sewer system which ends at the landfill, where the biological waste pollutes the soil and water There is also a large amount that is dumped directly into landfills in the form of diapers causing pollution of the soil.

4. Accidental Oil Spills : Oil leaks can happen accidently during storage and transport of chemicals and oil like petroleum and diesel which deteriorates the quality of soil and make it unsuitable for cultivation. These chemicals can enter into the groundwater through soil and also make the water undrinkable.

6. Acid Rain : Acid rain is caused when pollutants like oxides of nitrogen and sulphur present in the air mixes up with the rain and fall back on the ground. The polluted water could dissolve away some of the important nutrients found in soil and change the structure of the soil.

8.3.2 EFFECTS OF SOIL POLLUTION

1. Effect on Health of Humans : Crops and plants grown on polluted soil absorb much of the pollutants and then pass these on to us. Long term exposure to such soil can affect the genetic make-up of the body, causing congenital illnesses and chronic health problems that cannot be cured easily. In fact, it can sicken the livestock to a considerable extent and cause food poisoning over a long period of time. The soil pollution can even lead to widespread famines if the plants are unable to grow in it.

2. Effect on Growth of Plants : The ecological balance of any system gets affected due to the widespread contamination of the soil. Most plants are unable to adapt when the chemistry of the soil changes so radically in a short period of time. Fungi and bacteria found in the soil that bind it together begin to decline, which creates an additional problem of soil erosion. The fertility slowly diminishes, making land unsuitable for agriculture and any local vegetation to survive. The soil pollution causes large tracts of land to become hazardous to health. Polluted land cannot support most forms of life.

3. Decreased Soil Fertility: The toxic chemicals present in the soil can decrease soil fertility and therefore decrease in the soil yield. The contaminated soil is then

used to produce fruits and vegetables which lacks quality nutrients and may contain some poisonous substances to 'cause serious health problems in people consuming them.

4. Toxic Dust: The emission of toxic and foul gases from landfills pollutes the environment and causes serious effects on health of some people. The unpleasant smell causes inconvenience to other people.

5. Changes in Soil Structure: The decay and death of many soil organisms in the soil can lead to alteration in soil structure.

8.3.3 CONTROL MEASURES OF SOIL POLLUTION :

A number of ways have been suggested to curb the current rate of pollution. Industries have been given regulations for the disposal of hazardous waste, which aims at minimizing the area that becomes polluted. Organic methods of farming are being supported, which do not use chemical laden pesticides and fertilizers. Use of plants that can remove the pollutants from the soil is being encouraged. However, the road ahead is quite long and the prevention of soil pollution will take many more years

1. Soil erosion can be controlled by a variety of forestry and farm practices .e.g. Planting trees on barren slopes Contour cultivation and strip cropping may be practiced instead of shifting cultivation. Terracing and building diversion channels may be undertaken. Reducing deforestation and substituting chemical manures by animal wastes also helps arrest soil erosion in the long term.

2. Proper dumping of unwanted materials : Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.

3. Production of natural fertilizers : Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Eg.: Organic wastes in animal dung may be

used to prepare compost manure instead of throwing them wastefully and polluting the soil.

4. Proper hygienic condition : People should be trained regarding sanitary habits. Eg.: Lavatoriesshould be equipped with quick and effective disposal methods.

5. Public awareness : Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education. Eg.: Mass media, Educational institutions and voluntary agencies can achieve this.

6. Recycling and Reuse of wastes : To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc should be recycled and reused. Eg.: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

7. Ban on Toxic chemicals: Ban should be imposed on chemicals and pesticides like DDT, BHC, etc which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.

8.4 NOISE POLLUTION

Noise is defined as, "the unwanted, unpleasant or disagreeable sound that causes discomfort to all living beings". Sound intensity is measured in decibels (dB), that is the tenth part of the longest unit Bel. One dB is the faintest sound that a human ear can hear.

8.4.1 CAUSES OF NOISE POLLUTION

Industrial Noise : It is sound with a high intensity sound caused by industry machines. Sources of such noise pollution are caused by machines in various factories, industries and mills. Noise from mechanical saws and pneumatic drills is unbearable and a nuisance to the public.The Indian Institute of Oto-Rino Laryngology, Chennai reported that increasing industrial pollution damages the hearing ability by atleast 20%.Workers in steel industry, who

work close to heavy industrial blowers are exposed to 112dB for eight hours suffer from occupational pollution.

Transport Noise : Transport noise mainly consists of traffic noise from road, rail and aircraft. The number of automobiles on roads like motors, scooters, cars, motor cycles, buses, trucks and diesel engine vehicles have increased enormously in the recent past further aggravating the problem of transport noise. Noise levels in most residential areas in metropolitan cities is hovering around the border line due to increased vehicular noise pollution. This high level of noise pollution leads to deafening in the elderly.

Neighbourhood Noise : This type of noise includes disturbance from household gadgets and community. Common sources being musical instruments, TV, VCR, Radios, Transistors, Telephones, and loudspeakers etc. Statistically, ever since the industrial revolution, noise in the environment has been doubling every ten years.

8.4.2 EFFECTS OF NOISE POLLUTION

Noise pollution affects both human and animal health. **1**.It leads to a..contraction of blood vessels, b. making skin pale, c.excessive adrenalin in the blood stream which is responsible for high blood pressure,d.Blaring sounds are known to cause mental distress,e.Heart attacks, neurological problems birth defects and abortion, **2**. Muscle contraction leading to nervous breakdown, tension, etc **3**.The adverse reactions are coupled with a change in hormone content of blood, which in-turn increases heart beat, digestive spams and dilation of the pupil of the eye.**4**.Noise affects health, work efficiency and behaviour..**5**.The most immediate and acute effect of noise is impairment of hearing that diminishes some part of the auditory system. Prolonged exposure to noise of certain frequency pattern leads to chronic damage to the inner ear**.6**.Impulsive noise may cause psychological and pathological disorders

8.4.3 CONTROL MEASURES :

Source control : This includes source modification such as acoustic treatment to machine surface, design changes, limiting operational timings, etc

Transmission path intervention : This includes taking the source inside a sound insulating enclosure, constructing a noise barrier or provision of sound absorbing materials along the path.

RECEPTOR CONTROL : This includes protection of the receiver by altering the work schedule or provision of personal protection devices such as ear plugs for operating noisy machinery. The measure may include dissipation and deflection methods.

OILING : Proper oiling reduces noise from the machine.

Preventive measures:

1. Prescribing noise limits for vehicular traffic
2. Ban on honking (usage of horns) in certain areas
3. Creation of silence zones near schools and hospitals
4. Redesigning buildings to make them noise proof
5. Reduction of traffic density in residential areas
6. Giving preference to mass public transport system.
7. Providing ear muffs or plugs to workers in industries
8. Growing plants in three tiers(Green mufflers) along road side

8.5. RADIOACTION POLLUTION

The pollution of air ,water and soil with radioactive materials is called Radioactive Pollution.

8.5.1 Causes of Radiation Pollution

(i) Natural (Background) Radiation: This includes cosmic rays that reach the surface of the earth from space and terrestrial radiations from radioactive elements present in the earth's crust. Many radioactive elements such as radium 224, uranium 235, uranium 238, thorium 232, radon 222, potassium 40 and carbon 14 occur in rocks, soil and water.

(ii) Man-made Radiation : a. This includes mining and refining of plutonium and thorium ,production and explosion of nuclear weapons, nuclear power plants, nuclear fuels and prepa-ration of radioactive isotopes.Production of nuclear weapons involves the tests of nuclear arms. These tests produce large amount of radioactive elements into the environment and make other materials also radioactive. They include strontium 90, cesium 137, iodine 131 and some others.The radioactive materials are transformed into gases and fine particles which are carried to distant places by wind. When rain drops, the radioactive particles fall on the ground, it is called nuclear fallout. From the soil radioactive substances are taken by plants, thence they reach humans and animals through food chains. The radioactive materials are washed from land to water bodies where the aquatic organisms absorb them. From these organisms radioactive materials may reach man through food chains.3

(b) Atomic Reactors and Nuclear Fuels : The operation of a nuclear power plant releases large amounts of energy. This energy is used in large turbines, which produce electricity. Both the fuel elements and coolants contribute to radiation pollution. Wastes from atomic reactors also contain radioactive materials. The biggest problem is the disposal of these radioactive wastes. If these wastes are not properly disposed off, can harm the living organisms wherever they may be dumped. Inert gases and halogens escape as vapours and cause pollution as they settle on land or reach surface waters with rain.

(c) Radio Isotopes : Many radioactive isotopes such as ^{14}C. ^{125}I, ^{32}P and their compounds are used in scientific research. Waste waters containing these radioactive materials reach water sources like rivers through the sewers. From water they enter human body through food chains.

(d) X-rays and Radiation Therapy : Human beings also voluntarily receive radiation from diagnostic X-rays and radiation therapy for cancer. People working in power plants, nuclear reactors, fuel processors or living nearby are vulnerable to radiation exposure.

8.5.2 Effects of Radioactive Pollution:

Harmful Effects:

The effects of radiation were first noted in 1909 when it was found that uranium miners suffer from skin burn and cancer due to radiations from the radio-active mineral. Different organisms show different sensitivity to ionising radiations. For example, tests have shown that pine trees are killed by radiations in which oak trees continue to thrive comfortably.It has also been reported that high altitude plants have developed polyploidy as a protective mechanism against radiations. Parts of coastal areas in South India have a high degree of background radiation which was formerly considered to be quite harmful to human beings.

The cells which actively grow and divide are quickly damaged. This category includes the cells of skin, intestinal lining, bone marrow, gonads and embryo. Radiations have both immediate or short-range and delayed or long-ranged effects.

(i) Short Range (Immediate) Effects:

They appear within days or a few weeks after exposure. The effects included loss of hair, nails, subcutaneous bleeding, change in number and proportion of blood cells, changed tabolism, and proportion of blood cells, etc.

(ii) Long Range (Delayed) Effects:

They appear several months or even years after the exposure. The effects are caused by development of genetic changes, mutations, shortening of life span, formation of tumour, cancers, etc. The effect of mutations can persist in the human race. Iodine 131 damages white blood corpuscles, bone marrow, spleen, lymph nodes, skin cancer, sterility and defective eye sight and may cause lung tumours. Strontium 90 accumulates in the bones and may cause bone cancer and tissue degeneration in most animals and man.

All organisms are affected by radiation pollution. Some organisms preferentially accumulate specific radioactive materials. For example, oysters accumulate ^{65}Zn, fish accumulate ^{55}Fe, marine animals accumulate ^{90}Sr.

8.5.3 Control of Radioactive Pollution :

The following preventive measures should be followed to control radioactive pollution.

(i) Leakage of radioactive materials from nuclear reactors, industries and laboratories using them should be totally stopped.

(ii) Radioactive wastes disposal must be safe. They should be changed into harmless form or stored in safe places so that they can decay in a harmless manner. Radioactive wastes only with very low radiation should be discharged into sewerage.

(iii) Preventive measures should be taken so that natural radiation level does not rise above the permissible limits.

(iv) Safety measures should be taken against accidents in nuclear power plants.

8.6 SUMMARY

Urbanization and industrialization has also resulted **soil, noise and radiation** pollution which has direct impact on quality of human life . Any qualitative as well as quantitative change in normal composition of soil that make it unfit for agriculture is called **soil pollution.** This is caused by **1. Industrial Activity: 2. Agricultural Activities: 3. Solid Waste Disposal: 4. Accidental Oil Spills: 6. Acid Rain:** Effects of Soil Pollution are **1. Effect on Health of Humans: 2. Effect on Growth of Plants: 3. Decreased Soil Fertility: 4. Toxic Dust: 5. Changes in Soil Structure** A number of ways have been suggested to curb the current rate of pollution. Industries have been given regulations for the disposal of hazardous waste, which aims at minimizing the area that becomes polluted. Organic methods of farming are being supported, which do not use chemical laden pesticides and fertilizers. Use of plants that can remove the pollutants from the soil is being encouraged. **.Soil erosion can be controlled** by a variety of forestry and farm practices .. **Proper dumping of unwanted materials: Production of natural fertilizers. .Proper hygienic condition, Public awareness**: **Recycling and Reuse of wastes. Noise** is defined as, "the unwanted, unpleasant or disagreeable sound that causes discomfort to all living beings". This is caused by **Industrial Noise, Transport Noise**,**Neighbourhood noise**: It leads to a..contraction of blood vessels, b. making skin pale, c.excessive adrenalin in the

blood stream which is responsible for high blood pressure,d.Blaring sounds are known to cause mental distress,e.Heart attacks, neurological problems birth defects and abortion, **2**. Muscle contraction leading to nervous breakdown, tension, etc **3**.The adverse reactions are coupled with a change in hormone content of blood, which in-turn increases heart beat, digestive spams and dilation of the pupil of the eye.**4**.Noise affects health, work efficiency and behaviour..**5**.The most immediate and acute effect of noise is impairment of hearing that diminishes some part of the auditory system. Prolonged exposure to noise of certain frequency pattern leads to chronic damage to the inner ear**.6**.Impulsive noise may cause psychological and pathological disorders. Noise is controlled by Prescribing noise limits for vehicular traffic banning honking (usage of horns) in certain areas, Creation of silence zones near schools and hospitals, Redesigning buildings to make them noise proof,Reduction of traffic density in residential areasGiving preference to mass public transport system.,Providing ear muffs or lugs to workers in industries,Growing plants in three tiers(Green mufflers) along road side.

Radioaction Pollution **The pollution of air ,water and soil with radioactive materials is called Radioactive Pollution..** This is caused by **(i) Natural (Background) Radiation: (ii) Man-made Radiation** , **Atomic Reactors and Nuclear Fuels:(c) Radio Isotopes:(d) X-rays and Radiation Therapy.**This has **Short Range (Immediate) Effects:**

Which appear within days or a few weeks after exposure. The effects included loss of hair, nails, subcutaneous bleeding, change in number and proportion of blood cells, changed metabolism, and proportion of blood cells, etc.and **(ii) Long Range (Delayed) Effects** which appear several months or even years after the exposure. The effects are caused by development of genetic changes, mutations, shortening of life span, formation of tumour, cancers, etc. The effect of mutations can persist in the human race. Iodine 131 damages white blood corpuscles, bone marrow, spleen, lymph nodes, skin cancer, sterility and defective eye sight and may cause lung tumours. Strontium 90 accumulates in the bones and may cause bone cancer and tissue degeneration in most animals and man.All organisms are affected by radiation pollution. Some organisms preferentially accumulate specific radioactive materials. For example, oysters accumulate ^{65}Zn, fish accumulate ^{55}Fe, marine animals accumulate ^{90}Sr.

Radioactive Pollution is controlled by stopping leakage of radioactive materials from nuclear reactors, industries and laboratories and Radioactive wastes disposal must be safe. They should be changed into harmless form or stored in safe places so that they can decay in a harmless manner. Radioactive wastes only with very low radiation should be discharged into sewerage. Preventive measures should be taken so that natural radiation level does not rise above the permissible limits. and Safety measures should be taken against accidents in nuclear power plants.

8.7 GLOSSORY

Soil - loose weathered rock layer different in composition from parent rock

Decibel (dB) - It is the unit of noise measurement

Green Muffer-Plantation in three tiers along road sides to noise pollution.

8.8 SHORT ANSWER QUESTIONS / SAMPLE PAPER

1. Eroded soils are

   a. Devoid of plant nutrients b. Richer in plant nutrients

   c. Unaltered in plant nutrients d. Fit for agriculture

Ans. a

2. Terracing is an effective method of soil conservation in

   a. Desert areas b. Hilly areas

   c. Plain areas d. None of above

Ans. b.

3. A bone seeker nuclear fallout is:

   a. Sr^{90} b. $C^{14}O_2$

   c. P^{35} d. Sr^{85}

Ans. a

4. Deforestation is the major cause of

a. Depletion of natural resources b. environmental pollution

c. Desertification of habitat **d.** All above

Ans. d

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Unit : 2 **Lesson IX**

SOLID WASTE MANAGEMENT: CAUSES , EFFECTS AND CONTROL MEASURES OF URBAN AND INDUSTRIAL WASTE

9.1 INTRODUCTION

9.2 OBJECTIVES

9.3 SOLID WASTE

9.3.1 SOURCES OF SOLID WASTE

9.3.2 EFFECT OF IMPROPER SOLID WASTE MANAGEMENT

9.3.3 CONTROL MEASURES

9.4 SUMMARY

9.5 GLOSSARY

9.6 SHORT ANS. QUESTIONS / SAMPLE PAPER

9.7 REFERENCES / SUGGESTED READINGS

9.1 INTRODUCTION

Rapid population growth and urbanization in developing countries has led to people generating enormous quantities of solid waste and consequent environmental degradation. The waste is normally disposed in open dumps creating nuisance and environmental degradation. Solid wastes cause a major risk to public health and the environment. Management of solid wastes is important in order to minimize the adverse effects posed by their indiscriminate disposal. Solid waste management is a polite term for garbage management. As long as humans have been living in settled communities, solid waste, or garbage, has been an issue, and modern societies generate far more solid waste than early humans ever did.

9.2 OBJECTIVES

The main objective of this lesson is to acquaint the students with effects, causes and control measures of urban and industrial waste so that they can educate the common masses to protect the good quality of environment.

9.3 SOLID WASTE

Any solid form of matter that is of no use is called solid waste. Solid waste management is the disposal of solid waste at reasonable cost with least impact on environment.

9.3.1 SOURCES OF SOLID WASTE

Depending on the nature of origin, solid wastes are classified into

1. URBAN OR MUNICIPAL WASTES
2. INDUSTRIAL WASTES and
3. HAZARDOUS WASTES

SOURCES OF URBAN WASTES

Urban wastes include the following wastes:

Domestic wastes containing a variety of materials thrown out from homes Ex: Food waste, Cloth, Waste paper, Glass bottles, Polythene bags, Waste metals, etc. **Commercial wastes**: It includes wastes coming out from shops, markets, hotels, offices, institutions, etc .Ex: Waste paper, packaging material, cans, bottle, polythene bags, etc. **Construction wastes**: It includes wastes of construction materials. Ex: Wood, Concrete, Debris, etc. **Biomedical wastes:** It includes mostly waste organic materials Ex: Anatomical wastes, Infectious wastes, etc.

Classification of urban wastes : Urban wastes are classified into :

Bio-degradable wastes : Those wastes that can be degraded by micro organisms are called bio-degradable wastes Ex: Food, vegetables, tea leaves, dry leaves, etc.

Non-biodegradable wastes : Urban solid waste materials that cannot be degraded by micro organisms are called non-biodegradable wastes .Ex: Polythene bags, scrap materials, glass bottles etc.

SOURCES OF INDUSTRIAL WASTES

The main source of industrial wastes are chemical industries, metal and mineral processing industries. E.g.: Nuclear plants which generates radioactive wastes.

Thermal power plants which produces fly ash in large quantities.

Chemical Industries which produces large quantities of hazardous and toxic materials.

Other industries produces packing materials, rubbish, organic wastes, acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

9.3.2 EFFECT OF IMPROPER SOLID WASTE MANAGEMENT

1. Due to improper disposal of municipal solid waste on the roads and immediate surroundings, biodegradable materials undergo decomposition producing foul smell and become a breeding ground for disease vectors.

2. Industrial solid wastes are the source for toxic metals and hazardous wastes that affect soil characteristics and productivity of soils when they are dumped on the soil.

3. Toxic substances may percolate into the ground and contaminate the groundwater.

4. Burning of industrial or domestic wastes (cans, pesticides, plastics, radioactive materials and batteries) produce furans, dioxins and polychlorinated biphenyls that are harmful to human beings.

9.3.3 Control Measures :

Solid waste management involves waste generation, mode of collection, transportation, segregation of wastes and disposal techniques. Two important steps involved in solid waste management are: a.**Reduce, Reuse and Recycle** of Raw Materials. and b. **Discarding wastes**

Reduce - If usage of raw materials is reduced, the generation of waste also gets reduced.

Reuse - Refillable containers that are discarded after use can be reused.

Rubber rings can be made from discarded cucle tubes and this reduces waste generation during manufacture of rubber bands

Recycle- Recycling is the reprocessing of discarded materials into new useful products. Ex : Old aluminium cans and glass bottles are melted and recast into new cans and bottles.

Preparation of cellulose insulation from paper Preparation of automobile body and construction material from steel cans This method (**Reduce, Reuse & Recycle**), i.e, **3R's** help save money, energy,raw materials and reduces pollution.

Discarding wastes : The following methods are adopted for discarding wastes.

1. LANDFILL : Solid wastes are placed in a sanitary landfill in which alternate layers of 80 cm thick refuse is covered with selected earth-fill of 20 cm thickness. After 2-3 years solid waste volume shrinks by 25-30% and land is used for parks, roads and small buildings. This is the most common and cheapest cheapest method of waste disposal and is mostly employed in Indian cities. **Advantages:** It is simple and economical. Segregation of wastes is not required Landfilled areas can be reclaimed and used for other purposes.

Converts low-lying, marshy waste-land in to useful areas. Natural resources are returned to soil and recycled. **Disadvantages:** Large area is required. Land availability is away from the town, tansportation costs are high. Leads to bad odour if landfill is not properly managed.

Land filled areas are sources of mosquitoes and flies requiring application of insecticides and pesticides at regular intervals.Causes fire hazard due to formation of methane in wet weather.

2. INCINERATION : It is a hygenic way of disposing solid waste. It is suitable if waste contains more hazardous material and organic content. It is a thermal process and very effective for detoxification of all combustible pathogens. It is expensive when compared to composting or land-filling. In this method municipal solid wastes as well infectious biomedical wastes are burnt in a furnace called incinerator. Combustible substances such as rubbish, garbage, dead organisms and non-combustibe matter such as glass, porcelain and metals are separated before feeding to incinerators. The non-combustible materials can be left out for recycling and reuse. The leftover ashes and clinkers may account for about 10 to 20% which need further disposal by sanitary landfill or some other means.

The heat produced in the incinerator during burning of refuse is used in the form of steam power for generation of electricity through turbines. Municipal solid waste is generally wet and has a high calorific value. Therefore, it has to be dried first before burning. Waste is dried in a preheater from where it is taken to a large incinerating furnace called "destructor" which can incinerate about 100 to 150 tonnes per hour. Temperature normally maintained in a combustion chamber is about 700^0 C which may be increased to 1000^0 C when electricity is to be generated. **ADVANTAGES** Residue is only 20-25% of the original and can be used as clinker after treatment Requires very little space Cost of transportation is not high if the incinerator is located within city limits Safest from hygienic point of view An incinerator plant of 3000 tonnes per day capacity can generate 3MW of power.

DISADVANTAGES Its capital and operating cost is high.

Operation needs skilled personnel Formation of smoke, dust and ashes needs further disposal and that may cause air pollution.

3. COMPOSTING : It is another popular method practiced in many cities in our country. In this method, bulk of organic waste is converted into fertilizer by biological action.

Separated compostible waste is dumped in underground trenches in layers of 1.5m and finally covered with earth of 20cm and left for decomposition.

Sometimes, actinomycetes are introduced for active decomposition. Within 2 to 3 days biological action starts. Organic matter is destroyed by actinomycetes and lot of heat is liberated increasing the temperature of compost by 75^0C and the refuse is finally converted into powdery brown coloured odourless mass called humus that has a fertilizing value and can be used in agriculture. Humus contains lot of Nitrogen essential for plant growth apart from phosphates and other minerals. Vermi-composting has become very popular in the last few years. In this method, earthworms are added to form the compost. These help to break the waste and the added excreta of the the earthworms makes the compost very rich in nutrients ADVANTAGES Manure added to soil increases water retention and ion-exchange capacity of soil.

This method can be used to treat several industrial solid wastes.

Manure can be sold thereby reducing cost of disposing wastes.

Recycling can be done.

DISADVANTAGES Non-consumables have to be disposed separately The technology has not caught-up with the farmers and hence does not have an assured market.

4. PYROLYSIS : This is a form of incineration that chemically decomposes organic materials by heat in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures above 430 °C (800 °F).In practice, it is not possible to achieve a completely oxygen-free atmosphere. Because some oxygen is present in any pyrolysis system, a small amount of oxidation occurs. If volatile or semi-volatile materials are present in the waste, thermal desorption will also occur.

Organic materials are transformed into gases, small quantities of liquid, and a solid residue containing carbon and ash. The off-gases may also be treated in a secondary thermal oxidation unit. Particulate removal equipment is also required. Several types of pyrolysis units are available, including the rotary kiln, rotary hearth furnace, and fluidized bed furnace. These units are

similar to incinerators except that they operate at lower temperatures and with less air supply.

LIMITATIONS AND CONCERNS :

i. The technology requires drying of soil prior to treatment.

ii. Limited performance data are available for systems treating hazardous wastes containing polychlorinated biphenyls (PCBs), dioxins, and other organics. There is concern that systems that destroy chlorinated organic molecules by heat have the potential to create products of incomplete combustion, including dioxins and furans. These compounds are extremely toxic in the parts per trillion ranges. The MSO process reportedly does not produce dioxins and furans.

iii. The molten salt is usually recycled in the reactor chamber. However, depending on the waste treated (especially inorganics) and the amount of ash, spent molten salt may be hazardous and require special care in disposal.

iv. Pyrolysis is not effective in either destroying or physically separating in organics from the contaminated medium. Volatile metals may be removed as a result of the higher temperatures associated with the process, but they are not destroyed. By-products containing heavy metals may require stabilization before final disposal.

v. When the off-gases are cooled, liquids condense, producing an oil/tar residue and contaminated water. These oils and tars may be hazardous wastes, requiring proper treatment, storage, and disposal

9.4 SUMMARY

Rapid population growth and urbanization in developing countries has led to people generating enormous quantities of solid waste and consequent environmental degradation. **Solid waste:** Any solid form of matter that is of no use is called solid waste. Solid waste management is the disposal of solid waste at reasonable cost with least impact on environment.Depending on the nature of origin, solid wastes are classified into urban or municipal wastes,industrial wastes

and hazardous wastes **Urban wastes include Domestic wastes** containing a variety of materials thrown out from homes Ex: Food waste, Cloth, Waste paper, Glass bottles, Polythene bags, Waste metals, etc.**Commercial wastes**: It includes wastes coming out from shops, markets, hotels, offices, institutions, etc.Ex: Waste paper, packaging material, cans, bottle, polythene bags, etc.**Construction wastes**: It includes wastes of construction materials.Ex: Wood, Concrete, Debris, etc. n**Biomedical wastes:** It includes mostly waste organic materials Ex: Anatomical wastes, Infectious wastes, etc Urban wastes are classified into: **Bio-degradable wastes** - Those wastes that can be degraded by micro organisms are called bio-degradable wastes Ex: Food, vegetables, tea leaves, dry leaves,etc.**Non-biodegradable wastes**: Urban solid waste materials that cannot be degraded by micro organisms are called non-biodegradable wastes .Ex: Polythene bags, scrap materials, glass bottles,etc.

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Thermal power plants which produces fly ash in large quantities

Chemical Industries which produces large quantities of hazardous and toxic materials.

Other industries produces packing materials, rubbish, organic wastes, acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

Due to improper disposal of municipal solid waste on the roads and immediate surroundings, biodegradable materials undergo decomposition producing foul smell and become a breeding ground for disease vectors.Industrial solid wastes are the source for toxic metals and hazardous wastes that affect soil characteristics and productivity of soils when they are dumped on the soilToxic substances may percolate into the ground and contaminate the groundwater.Burning of industrial or domestic wastes (cans, pesticides, plastics, radioactive materials and batteries) produce furans, dioxins and polychlorinated biphenyls that are harmful to human beings.

Solid waste management involves waste generation, mode of collection, transportation, segregation of wastes and disposal techniques.Two important steps involved

in solid waste management are: a.**Reduce, Reuse and Recycle** of Raw Materials. and b. **Discarding wastes.**

Reduce - If usage of raw materials is reduced, the generation of waste also gets reduced.

Reuse - Refillable containers that are discarded after use can be reused.

Rubber rings can be made from discarded cucle tubes and this reduces waste generation during manufacture of rubber bands.

Recycle- Recycling is the reprocessing of discarded materials into new useful products. Ex : Old aluminium cans and glass bottles are melted and recast into new cans and bottles.

Preparation of cellulose insulation from paper Preparation of automobile body and construction material from steel cans This method (**Reduce, Reuse & Recycle**), i.e, **3R's** help save money, energy ,raw materials and reduces pollution.

Discarding wastes : The following methods are adopted for discarding wastes:

1. landfill 2.incineration 3.composting 4. pyrolysis

9.5 GLOSSARY

Management –Judious use of means

Biodegradable. - which can be easily degraded in soil by microbes.

Non- biodegradable - which cannot be easily degraded in soil by microbes.

Pesticides – The chemicals that kill the pests

Pests – any organism that damages the crop and crop products

Pyrolysis It is burning without oxygen. It consumes large amount of energy

9.6 Short ans. Questions / sample paper

1. Vermicomposting uses which of following

a. virus b. earthworms c. algae d. fungi

Ans. b.

2. Which of following is biodegradable waste

a. glass b. Plastic c. paper d. thermo coal

Ans. c.

3. During incineration desired temperature is

a. 100^{o} C b. 300^{o} C c. 500^{o} C **d.**700^{o}C

Ans. d.

4. Anatomical waste is part of

a. Domestic waste **b.** Biomedical waste

c. Commercial waste d. Construction waste

Ans. b.

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Unit : 2 **Lesson : X**

ACID RAIN, OZONE DEPLETION AND GLOBAL WARMING

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10.1 INTRODUCTION

Environmental pollution besides having short term effects is also having long term effects at global level which seems to be illusive for the time being but going to have disastrous effects on nature and biodiversity including human being .These long term effects are Acid Rain, Ozone depletion and Global warming which are current environmental issues responsible for climate change.

10.2 OBJECTIVES

The main objective of this lesson is to acquaint the students with effects, causes and control measures of Acid Rain, Ozone depletion and Global warming so that they can educate the common masses to protect the good quality of environment

10.3 ACID RAIN

Acid Rain was discovered way back in 1800s during the Industrial Revolution. A Scottish chemist, Robert Angus Smith, was first to discover this phenomenon in 1852 as a relationship between acid rain and atmospheric pollution in Manchester, England. But it gained public attention mainly in 1960s. The term was coined in 1972 when the NY Times published reports about the climate change effects which started arising due to the occurrence of acid rain in the Hubbard Brook Experimental Forest in New Hampshire.

Acid rain refers to a mixture of deposited material, both wet and dry, coming from the atmosphere containing more than normal amounts of nitric and sulfuric acids. Normal rain water is slightly acidic with a pH range of 5.3-6.0, because carbon dioxide and water present in the air react together to form carbonic acid, which is a weak acid. When the pH level of rain water falls below this range, it becomes acid rain.Simply put, it means rain that is acidic in nature due to the presence of certain pollutants in the air due to cars and industrial processes. It is easily defined as rain, fog, sleet or snow that has been made acidic by pollutants in the air as a result of fossil fuel and industrial combustions that mostly emits Nitrogen Oxides (NO_x) and Sulfur Dioxide (SO_2

There are two forms in which acid deposition occurs – wet and dry.

Wet Deposition : When the wind blows the acidic chemicals in the air to the areas where the weather is wet, the acids fall to the ground in the form of rain, sleet, fog, snow or mist. It removes acid from the atmosphere and deposits them on the earth's surface. When this acid flows through the ground, it affects large number of plants, animals and aquatic life. The water from drain flows into rivers and canals which is them mixed up with sea water, thereby affecting marine habitats.

Dry Deposition : If the wind blows the acidic chemicals in the air to the areas where the weather is dry, the acidic pollutants slip into dust or smoke and fall to the ground as dry particles. These stick to the ground and other surfaces such as cars, houses, trees and buildings. Almost 50% of the acidic pollutants in the atmosphere fall back through dry deposition. These acidic pollutants can be washed away from earth surface by rainstorms.

10.3.1 CAUSES OF ACID RAIN

Both natural and man-made sources are known to play a role in the formation of acid rain. But, it is mainly caused by combustion of fossil fuels which results in emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x).

1. Natural Sources

The major natural causal agent for acid rain is volcanic emissions. Volcanoes emit acid producing gases to create higher than normal amounts of acid rain or any other form of precipitation such as fog and snow to an extent of affecting vegetation cover and health of residents within the surrounding. Decaying vegetation, wildfires and biological processes within the environment also generate the acid rain forming gases. Dimethly sulfide is a typical example of a major biological contributor to sulfur containing elements into the atmosphere. Lighting strikes also naturally produces nitric oxides that react with water molecules via electrical activity to produce nitric acid, thereby forming acid rain.

2. Man-made sources

Human activities leading to chemical gas emissions such as sulfur and nitrogen are the primary contributors to acid rain. The activities include air pollution sources emitting sulfur and nitrogen gases like factories, power generations facilities, and automobiles. In particular, use of coal for electrical power generation is the biggest contributor to gaseous emissions leading to acid rain. Automobiles and factories also release high scores of gaseous emissions on daily basis into the air, especially in highly industrialized areas and urban regions with large numbers of car traffic. These gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds such as sulfuric acid, ammonium nitrate, and nitric acid. As a result, these areas experience exceedingly high amounts of acid rain.The existing winds blow these acidic compounds over large areas across borders and they fall back to the ground in the form of acid rain or other forms of precipitation. Upon reaching the earth, it flows across the surface, absorbs into the soil and enters into lakes and rivers and finally gets mixed up with sea water.The gases i.e. sulfur dioxide (SO_2) and nitrogen oxides (NO_x) are primarily gases occurring from electric power generation by burning coal and responsible for acid rain.

10.3.2 EFFECTS OF ACID RAIN

Acid rain has significant effects on the world environment and public health.

Effect on Aquatic Environment: Acid rain either falls directly on aquatic bodies or gets run off the forests, roads and fields to flow into streams, rivers and lakes. Over a period of time, acids get accumulated in the water and lower the overall pH of the water body. The aquatic plants and animals need a particular pH level of about 4.8 to survive. If the pH level falls below that the conditions become hostile for the survival of aquatic life. Acid rain tendency of altering pH and aluminum concentrations greatly affects pH concentration levels in surface water, thereby affecting fish as well as other aquatic life-forms. At pH levels below 5.0, most fish eggs cannot hatch. Lower pHs can also kill adult fish. Acid rain runoff from catchment areas into rivers and lakes has also reduced biodiversity as rivers and lakes become more acidic.

Species including fish, plant and insect types in some lakes, rivers and brooks have been reduced and some even completely eliminated owing to excess acid rain flowing into the waters.

Effect on Forests : It makes trees vulnerable to disease, extreme weather, and insects by destroying their leaves, damaging the bark and arresting their growth. Forest damage due to acid rain is most evident in Eastern Europe – especially Germany, Poland and Switzerland.

Effect on Soil: Acid rain highly impacts on soil chemistry and biology. It means, soil microbes and biological activity as well as soil chemical compositions such as soil pH are damaged or reversed due to the effects of acid rain. The soil needs to maintain an optimum pH level for the continuity of biological activity. When acid rains seep into the soil, it means higher soil pH, which damages or reverses soil biological and chemical activities. Hence, sensitive soil microorganisms that cannot adapt to changes in pH are killed. High soil acidity also denatures enzymes for the soil microbes. On the same breadth, hydrogen ions of acid rain leach away vital minerals and nutrients such as calcium and magnesium.

Vegetation Cover and Plantations: The damaging effects of acid rain on soil and high evels of dry depositions have endlessly damaged high altitude forests and vegetation cover since they are mostly encircled by acidic fogs and clouds. Besides, the widespread effects of acid rain on ecological harmony have lead to stunted growth and even death of some forests and vegetation cover.

Effect on Architecture and Buildings: Acid rain on buildings, especially those constructed with limestone, react with the minerals and corrode them away. This leaves the building weak and susceptible to decay. Modern buildings, cars, airplanes, steel bridges and pipes are all affected by acid rain. Irreplaceable damage can be caused to the old heritage buildings.e.g Taj Mahal has been damaged by acid rains due emission of SO_2 from the thermal power plants and Mathura refineries.

Effect on Public Health: When in atmosphere, sulfur dioxide and nitrogen oxide gases and their particulate matter derivatives like sulfates and nitrates, degrades visibility and can cause accidents, leading to injuries and deaths. Human health is not directly affected by acid rain because acid rain water is too dilute to cause serious health problems. However, the dry depositions also known as gaseous particulates in the air which in this case are nitrogen oxides and sulfur dioxide can cause serious health problems when inhaled. Intensified levels of acid depositions in dry form in the air can cause lung and heart problems such as bronchitis and asthma.

Other Effects: Acid rain leads to weathering of buildings, corrosion of metals, and peeling of paints on surfaces. Buildings and structures made of marble and limestone are the ones especially damaged by acid rain due to the reactivity of the acids in the rain and the calcium compounds in the structures. The effects are commonly seen on statues, old grave stones, historic monuments, and damaged buildings. Acid rain also corrodes metals like steel, bronze, copper, and iron.

10.3.3 SOLUTIONS TO ACID RAIN

Cleaning up Exhaust Pipes and Smokestacks Most of the electric power supporting the modern-day energy requirements comes from combusting fossil fuels such as oil, natural gas, and coal that generate nitrogen oxides (NOx) and sulfur dioxide (SO2) as the chief contributors to acid rain. Burning coal largely accounts for SO2 emissions while NOx emissions are mostly from fossil fuel combustions.

Washing coal, use of coal comprised of low sulfur, and use of devices known as "scrubbers" can provide technical solution to SO2 emissions. "Scrubbing" also called flue-gas desulfurization (FGD) typically work to chemically eliminate SO2 from the gases leaving smokestacks. It can eliminate up to 95% of SO2 gases. Power generation facilities can also shift to using fuels that emit much less SO2 such as natural gas instead of burning coal. These methods are simply called emission reduction strategies.

Similarly, NOx emissions from automobile fossil fuel combustions are mitigated upon by use of catalytic converters. Catalytic converters are fixed on the exhaust pipe system to reduce NOx emission. Improvement of gasoline that combusts cleaner is also a strategy for reducing emission of NOx gases.

2. Restoring Damaged Environments : Use of limestone or lime, a process called liming, is a practice that people can do to repair the damage caused by acid rain to lakes, rivers and brooks. Adding lime into acidic surface waters balances the acidity. It's a process that has extensively been used, for instance in Sweden, to keep the water pH at optimum. Even though, liming is an expensive method and has to be done repeatedly. Furthermore, it only offers a short-term solution at the expense of solving the broader challenges of SO2 and NOx emissions and risks to human health. Nevertheless, it helps to restore and allow the survival of aquatic life forms by improving chronically acidified surface waters.

3. Alternative Energy Sources : Besides fossil fuels, there is a wide range of alternative energy sources that can generate electrical power. These include wind energy, geothermal energy, solar energy, hydropower, and nuclear power. Harnessing these energy sources can offer effective electrical power alternatives instead of using fossil fuels. Fuel cells, natural gas, and batteries can also substitute use of fossil fuel as cleaner energy sources. As of today, all energy sources have environmental and economic costs as well as benefits. The only solution is using sustainable energy that can protect the future.

4. Individual, National/State, and International Actions : Millions of people directly and indirectly contribute to SO2 and NOx emissions. Mitigation of this challenge requires individuals to be more informed about energy conservation and ways of reducing emissions such as: turning off lights or electrical appliances when not using them; use public transport; use energy efficient electrical appliances; and use of hybrid vehicles or those with low NOx emissions.

10.4 OZONE DEPLETION

Ozone layer is a deep layer in earth's atmosphere that contain ozone which is a naturally occurring molecule containing three oxygen atoms. These ozone molecules form a gaseous layer in the Earth's upper atmosphere called stratosphere. This lower region of stratosphere containing relatively higher concentration of ozone is called Ozonosphere. The Ozonosphere is found at 25 km. above the surface of the earth. The concentration of ozone in the ozone layer is usually under 10 parts per million while the average concentration of ozone in the atmosphere is about 0.3 parts per million. The thickness of the ozone layer differs as per season and geography. The highest concentrations of ozone occur at altitudes from 26 to 28 km (16 to 17 miles) in the tropics and from 12 to 20 km (7 to 12 miles) towards the poles.

The ozone layer forms a thick layer in stratosphere, encircling the earth, that has large amount of ozone in it. The ozone layer protects life on earth from strong ultraviolet radiation that comes from the sun. Ultraviolet rays are harmful rays that can drive up the risk of deadly disorders like skin cancer, cataracts and damage the immune system. Ultraviolet rays are also capable of destroying single cell organism, terrestrial plant life, and aquatic ecosystems. The ozone layer was discovered in 1913 by the French physicists Charles Fabry and Henri Buisson. The ozone layer has the capability to absorb almost 97-99% of the harmful ultraviolet radiations that sun emit and which can produce long term devastating effects on humans beings as well as plants and animals.

10.4.1 CAUSES OF OZONE LAYER DEPLETION

Credible scientific studies have substantiated that the cause of ozone layer depletion is human activity, specifically, human-made chemicals that contain chlorine or bromine. These chemicals are widely known as ODS, an acronym for Ozone-Depleting Substances. The scientists have observed reduction in stratospheric ozone since early 1970's. It is found to be more prominent in Polar Regions. Ozone-Depleting Substances have been proven to be eco-friendly, very stable and non-toxic in the atmosphere below. This is why they have gained popularity over the years. However, their stability comes at a price; they are able to float and remain static high up in the stratosphere. When up there, ODS are comfortably

broken down by the strong UV light and the resultant chemical is chlorine and bromine. Chlorine and bromine are known to deplete the ozone layer at supersonic speeds. They do this by simply stripping off an atom from the ozone molecule. One chlorine molecule has the capability to break down thousands of ozone molecules.

Ozone-depleting substances have stayed and will continue to stay in the atmosphere for many years. This, essentially, implies that a lot of the ozone-depleting substances human have allowed to go into the atmosphere for the previous 90 years are still on their journey to the atmosphere, which is why they will contribute to ozone depletion.

The chief ozone-depleting substances include chlorofluorocarbons (CFCs), carbon tetrachloride, hydrochlorofluorocarbons (HCFCs) and methyl chloroform. Halons, sometimes known as brominated fluorocarbons, also contribute mightily to ozone depletion. However, their application is greatly restricted since they are utilized in specific fire extinguishers. The downside to halons is they are so potent that they are able to deplete the ozone layer 10 times more than ozone-depleting substances.

Scientists in this age are working around the clock to develop Hydrofluorocarbons (HFCs) to take the place of hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs) for use in vehicle air conditioning. Hydrochlorofluorocarbons are powerful greenhouse gases, but they are not able to deplete ozone. Chlorofluorocarbons, on the other hand, significantly contribute to climate change, which means Hydrofluorocarbons continue to be the better alternative until safer alternatives are available.

There are two regions in which the ozone layer has depleted.

- In the mid-latitude, for example, over Australia, ozone layer is thinned. This has led to an increase in the UV radiation reaching the earth. It is estimated that about 5-9% thickness of the ozone layer has decreased, increasing the risk of humans to over-exposure to UV radiation owing to outdoor lifestyle.

- In atmospheric regions over Antarctica, ozone layer is significantly thinned, especially in spring season. This has led to the formation of what is called 'ozone hole'. Ozone holes refer to the regions of severely reduced ozone layers. Usually ozone holes form over the Poles during the onset of spring seasons. One of the largest such hole appears annually over Antarctica between September and November.

Natural causes of depletion of ozone layer : Ozone layer has been found to be affected by certain natural phenomena such as Sun-spots and stratospheric winds. But this has been found to cause not more than 1-2% depletion of the ozone layer and the effects are also thought to ly temporary. It is also believed that the major volcanic eruptions (mainly El Chichon in 1983 and and Mt. Pinatubo in 1991) has also contributed towards ozone depletion.

Man-made causes of depletion of ozone layer : The main cause for the depletion of ozone is determined as excessive release of chlorine and bromine from man-made compounds such as chlorofluorocarbons (CFCs). CFCs (chlorofluorocarbons), halons, CH_3CCl_3 (Methyl chloroform), CCl_4 (Carbon tetrachloride), HCFCs (hydro-chlorofluorocarbons), hydrobromofluorocarbons and methyl bromide are found to have direct impact on the depletion of the ozone layer. These are categorized as ozone-depleting substances (ODS).

The problem with the Ozone-Depleting Substances (ODS) is that they are not washed back in the form of rain on the earth and in-fact remain in the atmosphere for quite a long time. With so much stability, they are transported into the stratosphere. The emission of ODS account for roughly 90% of total depletion of ozone layer in stratosphere. These gases are carried to the stratosphere layer of atmosphere where ultraviolet radiations from the sun break them to release chlorine (from CFCs) and bromine (from methyl bromide and halons).

The chlorine and bromine free radicals react with ozone molecule and destroy their molecular structure, thus depleting the ozone layer. One chlorine

atom can break more than 1, 00,000 molecules of ozone. Bromine atom is believed to be 40 times more destructive than chlorine molecules.

Main Ozone Depleting Substances (ODS)

Chlorofluorocarbons (CFCs) It's billed as the most extensively utilized ozone-depleting substance because it attributes to more than 80% of overall ozone depletion. It was utilized as a coolant in home appliances like freezers, refrigerators and air conditioners in both buildings and cars that were manufactured prior to 1995. This substance is usually contained in dry cleaning agents, hospital sterilants, and industrial solvents. The substance is also utilized in foam products like mattresses and cushions and home insulation.

Hydrofluorocarbons (HCFCs) Hydrofluorocarbons have over the years served in place of Chlorofluorocarbons. They are not as harmful as CFCs to ozone layer.

Halons It's especially used in selected fire extinguishers in scenarios where the equipment or material could be devastated by water or extinguisher chemicals.

Carbon Tetrachloride Also used in selected fire extinguishers and solvents.

Methyl Chloroform Commonly utilized in industries for cold cleaning, vapor degreasing, chemical processing, adhesives and some aerosols.

10.4.2 EFFECTS OF OZONE DEPLETION

1. Damage to human health

If the ozone layer is depleted, it means humans will be overly exposed to strong UV light. Overexposure to strong UV light causes skin cancer, cataracts, sunburns, weakening of immune system and quick aging.

2. Devastation to environment

Many crops species are vulnerable to strong UV light and overexposure may well lead to nimal growth, photosynthesis and flowering. Some of the crop species vulnerable to UV light include barley, wheat, corn, oats, rice,

broccoli, tomatoes, cauliflower just to name a few. Forests equally bear the brunt of ozone depletion.

3. Threat to marine life

Certain marine life, especially planktons, is greatly impacted by exposure to strong ultraviolet rays. In the aquatic food chain, planktons appear high up. If planktons decrease in number due to ozone layer destruction, the marine food chain would be disrupted in many ways. Also, overexposure of sun rays could reduce the fortunes of fishers. On top of that, certain species of marine life have been greatly affected by overexposure to ultraviolet radiation at their early stage.

4. Effect on animals

In domesticated animals, too much Ultraviolet radiation could also lead to skin and eye cancer.

5. Impacts certain materials

Materials like plastics, wood, fabrics, rubber are massively degraded by too much ultraviolet radiation.

10.4.3 SOLUTIONS TO OZONE DEPLETION

1. Desist from using pesticides

Pesticides are great chemicals to rid your farm of pests and weeds, but they contribute enormously to ozone layer depletion. The surefire solution to get rid of pests and weeds is to apply natural methods. Just weed your farm manually and use alternative eco-friendly chemicals to alleviate pests.

2. Discourage driving of private vehicles

The easiest technique to minimize ozone depletion is to limit the number of vehicles on the road. These vehicles emit a lot of greenhouse gases that eventually form smog, a catalyst in the depletion of ozone layer.

3. Utilize environmentally friendly cleaning products

Most household cleaning products are loaded with harsh chemicals that find way to the atmosphere, eventually contributing to degradation of the ozone layer. Use natural and environmentally friendly cleaning products to arrest this situation.

4. Prohibit the use of harmful nitrous oxide

The Montreal Protocol formed in 1989 helped a lot in the limitation of Chlorofluorocarbons (CFCs). However, the protocol never covered nitrous oxide, which is a known harmful chemical that can destroy the ozone layer. Nitrous oxide is still in use today. Governments must take action now and outlaw nitrous oxide use to reduce the rate of ozone depletion.

10.5 GLOBAL WARMING :

Introduction and meaning: The rise in earth's surface temperature as a consequence of greenhouse effect is called Global Warming..The greenhouse gases such as carbon-dioxide and other pollutants absorbs more heat from the sun then it radiates back. This causes an increase in the intensity of heat in atmosphere..The thickening of earth atmosphere because of presence of increased carbon dioxide and other greenhouse gases is called greenhouse effect.

10.5.1 CAUSES AND EFFECT FOR GLOBAL WARMING

Cause of global warming

Almost 100% of the observed temperature increase over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapour, carbon dioxide (CO_2), methane and ozone. Greenhouse gases are those gases that contribute to the greenhouse effect (see below). The largest contributing source of greenhouse gas is the burning of fossil fuels leading to the emission of carbon dioxide.

The greenhouse effect

When sunlight reaches Earth's surface some is absorbed and warms the earth and most of the rest is radiated back to the atmosphere at a longer wavelength

than the sun light. Some of these longer wavelengths are absorbed by greenhouse gases in the atmosphere before they are lost to space. The absorption of this longwave radiant energy warms the atmosphere. These greenhouse gases act like a mirror and reflect back to the Earth some of the heat energy which would otherwise be lost to space. The reflecting back of heat energy by the atmosphere is called the "greenhouse effect".

The major natural greenhouse gases are water vapor, which causes about 36-70% of the greenhouse effect on Earth (not including clouds); carbon dioxide CO_2, which causes 9-26%; methane, which causes 4-9%, and ozone, which causes 3-7%. It is not possible to state that a certain gas causes a certain percentage of the greenhouse effect, because the influences of the various gases are not additive. Other greenhouse gases include, but are not limited to, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, perfluorocarbons and chlorofluorocarbons.

Global warming causes by greenhouse effect

Greenhouse gases in the atmosphere act like a mirror and reflect back to the Earth a part of the heat radiation, which would otherwise be lost to space. The higher the concentration of green house gases like carbon dioxide in the atmosphere, the more heat energy is being reflected back to the Earth. The emission of carbon dioxide into the environment mainly from burning of fossil fuels (oil, gas, petrol, kerosene, etc.) has been increased dramatically over the past 50 years, see graph below. Besides this 1. Deforestation and industrial emissions result to an **increase greenhouse gases** (such as carbon-dioxide) around earth's atmosphere.2. These **greenhouse gases traps and absorbs atmospheric heat** and ultimately causes Global warming (an increase earth's surface temperature).

10.5.2 EFFECTS / IMPACT OF GLOBAL WARMING

If Global warming continues the world would be in danger. The major effects and impacts of Global Warming are:

1. Climate Change: Global warming is causing climate change. The world's is becoming warmer and warmer. There is also prediction of regional climate changes along the ecosystem.

2. Sea Level Change: One major consequence of global warming arising out of greenhouse effect is the rise in sea level. Four major changes take place prior to this. They are: Thermal expansion, mountain glacier melting, Greenland ice sheet melting and Polar (Arctic and Antarctic) ice sheet melting. Thus, the coastal cities and ports may be submerged under sea-water. Many islands may vanish from the earth surface as well as from the world map.

3. Water Balance: Although changes in sea-level have received much publicity, problems of water availability are likely to be more serious and perhaps more expensive to solve. In future, warmer world will face water crisis in some parts while in other regions it will be wetter than it is now.There is uncertainty regarding regional forecasts of future precipitation as warming of globe makes it difficult to predict. Also, pattern of agricultural changes, or effects on ecosystems in general are fairly unpredictable.

4. Human Health: The human health is put at risk because of Global warming. In recent years, there have been newer reports of spread of major tropical diseases with changing climate. As the earth becomes warmer, more and more people are likely to be affected by tropical diseases.

10.5.3 PREVENTION OF GLOBAL WARMING

The problem of Global Warming can be controlled by minimizing the emission of greenhouse gases into the environment. The following preventive steps would help save the earth from the harmful effects of Global Warming.

1. **Laws.** The Laws that governs pollution and greenhouse gases should be followed.

2. Reduction in thermal power generating stations. Reduced dependence on thermal power for our electricity need would help towards reducing the quantity if carbon dioxide in the environment. The use of fossil fuels for generating conventional energy is a major of greenhouse gases.

3. We should not waste paper. We can save paper by keeping documents in electronic format and by not printing emails.

4. Planting Trees. Trees absorb carbon dioxide and releases oxygen. Trees are helpful in reducing the problem of global warming.

1. **Sharing our car.** We can share our car while going to office or performing other scheduled activities. On one hand, we will save money, and on the other, we will emit less greenhouse gases.

10.6 SUMMARY

Environmental pollution besides having short term effects is also having long term effects like Acid Rain, Ozone depletion and Global warming which are current environmental issues responsible for climate change.

Acid rain refers to a mixture of deposited material, both wet and dry, coming from the atmosphere containing more than normal amounts of nitric and sulfuric acids. Normal rain water is slightly acidic with a pH range of 5.3-6.0, because carbon dioxide and water present in the air react together to form carbonic acid, which is a weak acid. When the pH level of rain water falls below this range, it becomes acid rain..Simply put, it means rain that is acidic in nature due to the presence of certain pollutants in the air due to cars and industrial processes. It is easily defined as rain, fog, sleet or snow that has been made acidic by pollutants in the air as a result of fossil fuel and industrial combustions that mostly emits Nitrogen Oxides (NO_x) and Sulfur Dioxide (SO_2). Acidity is determined on the basis of the pH level of the water droplets. When these gases react with water molecules and oxygen among other chemicals found in the atmosphere, mild acidic chemical compounds such as sulfuric and nitric acid are formed resulting to acid rain. Acid rain generally leads to weathering of buildings, corrosion of metals, and peeling of paints on surfaces. Erupting volcanoes contains some chemicals that can cause acid rain. Apart from this, burning of fossil fuels, running of factories and automobiles due to human activities are few other reasons .There are two forms in which acid deposition occurs – wet and dry. Acid rain has significant effects on the world environment and public health..Acid rain **effect aquatic environment: forests, soil vegetation cover and plantations, architecture and buildings and public health:**

Ozone depletion : Ozone layer is a deep layer in earth's atmosphere that contain ozone which is a naturally occurring molecule containing three oxygen atoms. These ozone molecules form a gaseous layer in the Earth's upper atmosphere called stratosphere. This lower region of stratosphere containing relatively higher concentration of ozone is called Ozonosphere. The Ozonosphere is found at 25 km. above the surface of the earth. An essential property of ozone molecule is its ability to block solar radiations of wavelengths less than 290 nanometers from reaching Earth's surface. In this process, it also absorbs ultraviolet radiations that are dangerous for most living beings. UV radiation could injure or kill life on Earth. Though the absorption of UV radiations warms the stratosphere but it is important for life to flourish on planet Earth. Research scientists have anticipated disruption of susceptible terrestrial and aquatic ecosystems due to depletion of ozone layer.

Credible scientific studies have substantiated that the cause of ozone layer depletion is human activity, specifically, human-made chemicals that contain chlorine or bromine. These chemicals are widely known as ODS, an acronym for Ozone-Depleting Substances. The scientists have observed reduction in stratospheric ozone since early 1970's. It is found to be more prominent in Polar Regions. Ozone-Depleting Substances have been proven to be eco-friendly, very stable and non-toxic in the atmosphere below. Main Ozone Depleting Substances (ODS) are **Chlorofluorocarbons (CFCs),Hydrofluorocarbons (HCFCs),Halons Carbon Tetrachloride and Methyl Chloroform**

Global warming - The rise in earth's surface temperature as a consequence of greenhouse effect is called Global Warming.The greenhouse gases such as carbon-dioxide and other pollutants absorbs more heat from the sun then it radiates back. This causes an increase in the intensity of heat in atmosphere.The thickening of earth atmosphere because of presence of increased carbon dioxide and other greenhouse gases is called greenhouse effect.Almost 100% of the observed temperature increase over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapour, carbon dioxide (CO_2), methane and ozone.

Greenhouse gases are those gases that contribute to the greenhouse effect (see below). The largest contributing source of greenhouse gas is the burning of fossil fuels leading to the emission of carbon dioxide.

When sunlight reaches Earth's surface some is absorbed and warms the earth and most of the rest is radiated back to the atmosphere at a longer wavelength than the sun light. Some of these longer wavelengths are absorbed by greenhouse gases in the atmosphere before they are lost to space. The absorption of this long wave radiant energy warms the atmosphere. These greenhouse gases act like a mirror and reflect back to the Earth some of the heat energy which would otherwise be lost to space. The reflecting back of heat energy by the atmosphere is called.

The major effects and impacts of Global Warming are :

1. Climate Change **2. Sea Level Change**
3. Water Balance **4. Human Health.**

10.7 GLOSSARY

pH –Potentia hydrogen

Acid rain -term was introduced by Robert Augus in 1872

Dobson units –Thickness of ozone layer is measured in Dobson units

Montreal Protocol –On 16th Sept. 1987 27 indutrialised countries signed an agreement to limit the production and use of ozone depleting substances .

Kyoto Protocol – an international conference on global warming held in july 2001 at Kyoto (Japan)To cut down emission of green house gases

10.8 SHORT ANSWER QUESTIONS / SAMPLE PAPER

1. Which of following is not involved in global warming

a. CH_4 b. CO_2 c. CFC d. SO_2

Ans. d

2. Acid rain is due to

a. H_2SO_4 only b HNO_3 only c. HCL d. both a. and b

Ans. d.

3. Ozone depletion is due to

a. H_2SO_4 only b HNO_3 only c. CFC d. All of them

Ans. c

4. World ozone day is celebrated on

a. 5th June b. 16th September c. 22nd April d. 3rd December

Ans. b

10.9 REFERENCES / SUGGESTED READINGS

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Unit : 3 **Chapter: XI**

ENVIRONMENTAL LAWS

11.1 INTRODUCTION

11.2 OBJECTIVES

11.3 SALIENT FEATURES OF FOLLOWING ACTS

11.3.1 WILDLIFE PROTECTION ACT, 1972

11.3.2 WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

11.2.3 FOREST CONSERVATION ACT, 1980

11.2.4 AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

11.2.5 ENVIRONMENTAL PROTECTION ACT, 1986

11.4 SUMMARY

11.5 GLOSSARY

11.6 SAQ/CYP/POSSIBLE ANSWERS

11.7 SUGGESTED READING/REFERENCES

11.1 INTRODUCTION

In order to protect ourselves, the animal and plant life and the environment from destruction, numerous laws have been enacted at the national and international levels. In this lesion, we will discuss these laws relating to environment. The coverage includes common law rules applicable to environment issues, legation on water and air pollution and the comprehensive Environment (Protection) Act of 1986.

11.2 OBJECTIVES

After reading this unit, you will be able to:

- Explain the need for the environment legation
- Discuss various Acts enacted for the protection of environment
- Explain the difficulties in the enforcement of the environment legislation

11.3 SALIENT FEATURES OF FOLLOWING ACTS

The salient features of various Acts are as under :-

11.3.1 THE WILD LIFE PROTECTION ACT, 1972

The objective of this enactment was three-fold, i. e., to have a uniform legislation on wild life throughout the country, to establish a network of protected areas, i. e., national parks and sanctuaries and to regulate illicit trade in wild life and its products.

The Wild Life Protection Act, 1972 has 66 Sections and has been divided into seven chapters and has six schedules.

Definitions:

Animal: Includes mammals, birds, reptiles, amphibians, fish, other chordates and invertebrates and also includes their young and eggs.

Animal Article: Means an article made from any captive animal or wild animal, other than vermin, and includes an article or object, in which the whole or any part of such animal has been used, and ivory imported into India and an article made there from.

Hunting: With its grammatical variations & cognate expressions hunting, includes :

a) killing or poisoning of any wild animal or captive animal and every attempt to do so.

b) capturing, coursing, snaring, trapping, driving or baiting any wild or captive animal and every attempt to do so.

c) injuring or destroying or taking any part of the body of any such animal or, in the case of wild birds or reptiles, disturbing the eggs or nests of such birds or reptiles.

Protected Area: Means a National Park, a sanctuary, a conservation reserve or a community reserve notified under this Act.

Specified Plant: Means any plant specified in Schedule VI.

Trophy: It is the whole or any part of any captive animal or wild animal, other than vermin, which has been kept or preserved by any means, whether artificial or natural, and includes –

- rugs, skins, and specimens of such animal mounted in whole or in part through a process of taxidermy, and

- antler, bone, carapace, shell, horn, rhinoceros horn, hair, feather, nail, tooth, tusk, musk, eggs, nests and honeycomb.

Vermin: is any wild animal specified in Schedule V

Wild Animal: means any animal specified in Schedules I to IV and found in wild in nature.

Wild Life: means any animal, aquatic or land vegetation which forms part of any habitat.

Authorities to be Appointed or Constituted under the Act:

The Central Government may, for the purposes of this Act, appoint, a director of Wild Life Preservation, and such other officers and employees as may be necessary. The State Government may, for the purposes of this Act, appoint, Chief Wild Life Warden, Wild Life Wardens, Honorary Wild Life Wardens and such other officers and employees as may be necessary.

National Board for Wildlife: It is constituted by the Central Government, within three months from the date of commencement of Wild Life (Protection) Amendment Act, 2002. The Prime Minister acts as the Chairperson, and the Minister in-charge of Forests and Wild Life as Vice-Chairperson. It shall be the duty of the National Board for Wild Life to promote the conservation and development of wild life and forests by such measures as it thinks fit.

State Board for Wildlife: The State Government shall, within a period of six months from the date of commencement of Wild Life (Protection) Amendment Act, 2002 constitute a State Board for Wild Life with the Chief Minister of the State and in case of the Union Territory, either Chief Minister or Administrator, as the case may be as the Chairperson and the Minister in-charge of Forests and Wild Life as Vice-Chairperson.

It shall be the duty of the State Board for Wildlife to advice the State Government, in the election and management of areas to be declared as protected areas, in the formulation of the policy for protection and conservation of the wild life and specified plants, in any matter relating to the amendment of any Schedule, in relation to the measures to be taken for harmonising the needs of the tribal other dwellers of the forest with the protection and conservation of wild life, and in any other matter connected with the protection of wild life, which may be referred to it by the State Government.

Hunting of Wild Animals:

Section 9 : Prohibits hunting of wild animals specified in Schedules I, II, III, and IV.

Section11 : This section permits hunting of wild animals in certain cases which subject to the provisions of Chapter IV-

1. The Chief Wild Life Warden may permit hunting, it he satisfies that any wild animal specified in Schedule I has become dangerous to human life or is as disabled or diseased as to be beyond recovery, by order in writing and stating the reasons therefore. But no animal shall be ordered to be killed if the

Chief Wild Life Warden satisfies that such animal can be captured, tranquilised or translocated.

2. The Chief Wild Life Warden or the authorised officer may permit hunting, if he is satisfied that any wild animal specified in Schedule II, III, or IV, has become dangerous to human life (including standing crops on any land) or is as disabled or diseased as to be beyond recovery, by order in writing and stating the reasons therefore.

3. The killing or wounding in good faith of any wild animal in defence of oneself or of any other person shall not be an offence. But nothing in this sub-section shall exonerate any person who, when such defence becomes necessary, was committing any act in contravention of any provision of this Act or any rule or order made there under.

4. Any wild animal killed or wounded in defence of any person shall be Government Property.

Section 12: of this Act empowers the Chief Wild Life Worden, to grant a permit for special purposes, by an order in writing stating the reasons therefore, to any person, on payment of such fee as may be prescribed, which shall entitle the holder of such permit to hunt, subject to such conditions as may be specified therein, any animal specified in such permit, for the purpose of, education, scientific research, scientific management, collection of specimens for recognised zoo and derivation, collection or preparation of snake venom for the manufacture of life-saving drugs.

Section 17: Provides that no person shall wilfully pick, uproot, damage, destroy, acquire or collect any specified plant from any forest land and any area specified, by notification, by the Central Government, possess, sell, offer for sale, transfer by way of gift or otherwise, or transport any specified plant, whether alive or dead, or part or derivative thereof.

But, nothing in this Section shall prevent a member of scheduled tribe, subject to the provisions of Chapter IV, from picking collecting or possessing

in the district he resides any specified plant or part or derivative thereof for his bona fide personal use.

Protected Areas: Under Section 18, the State Government may, by notification, declare its intention to constitute any area other than an area comprised within any reserved forest or the territorial waters as a sanctuary if it considers that such area is of adequate ecological, faunal, floral, geo-morphological, natural or zoological significance, specifying, as nearly as possible, the situation and limits of such area for the purpose of protecting, propagating or developing wild life or its environment.

Prohibition of Trade or Commerce in Trophies, Animal Articles, Etc, derived from Certain Animal:

Section 49-B prohibits every person to commence or carry on the business as-

i) a manufacturer of, or dealer in, scheduled animal articles, or a dealer in ivory imported into India or articles made there from or a manufacturer of such articles, or

ii) a taxidermist with respect to any scheduled animals or any parts of such animals, or

iii) a dealer in trophy or uncured trophy derived from any scheduled animal, or

iv) dealer in any captive animals being scheduled animals, or

v) a dealer in meat derived from any scheduled animal, or cook or serve meat derived from any scheduled animal in any eating-house.

Wild Life Crimes and Punishments:

The offences under the Wild Life (Protection) Act, 1972 and subsequent penalties are based on three aspects.

First, for contravention of any provision (e. g. destruction in a sanctuary) and for breach of any licence or permit: imprisonment up to three years or a fine up to twenty-five thousand rupees, or both.

Second, for offence committed in relation to any Schedule I or Part II of Schedule II or meat of such wild animal or altering boundaries of Protected Areas: not less than three years imprisonment, which may extend to seven years. In addition there is a fine of not less than ten thousand rupees.

Thirdly, for the offences relating to trade or commerce in Scheduled animals, i. e., Part I of Schedule I or Part II of Schedule II of the Wild Life (Protection) Act, 1972: not less than three years imprisonment, which may extend to seven years. In addition, there is a fine of not less than ten thousand rupees.

Any weapon, tool, vehicle that is used or even suspected to have been used in the commission of any wild life related offence, if seized, becomes Government Property as per the provisions of the Wild Life (Protection) Act, 1972 (Section 39).

11.3.2 THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

It is an Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards Powers and functions relating thereto and for matters connected therewith. This act has 64 Sections and has been divided into eight chapters relating to i) Preliminary, ii) Central and State Boards for the Prevention and Control of Water Pollution, iii) Joint Boards, iv) Powers and Functions of Boards, v) Prevention and Control of Water Pollution, vi) Funds, Accounts and Audit, vii) Penalties and Procedures, and viii) Miscellaneous.

Definitions:

Occupier: In relation to any factory or premises, it means the person who has control over the affairs of the factory or the premises, and includes, in relation to any substance, the person in possession of the substance.

Pollution: Means such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharge of any sewage or trade effluent or of any other liquid, gaseous or solid substance into water (whether directly or indirectly) as may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or of aquatic organisers.

Stream: Includes(i) river; (ii) Water course (whether flowing or for the time being dry);(iii) inland water (whether natural or artificial); (iv) subterranean waters; (v) sea or tidal waters to such extent or, as the case may be, to such point as the State Government modified in the Official Gazette.

The central & state boards for prevention and control of water pollution:

Central Board: The Central Government shall constitute by notification in the Official Gazette, a Central Board to be called the [Central Pollution Control Board] to exercise the powers conferred on and perform the functions assigned to that Board under this Act.

The Central Board shall consist of the following members, namely:-

(a) A full-time chairman, being a person having special knowledge or practical experience in respect of matters relating to environmental protection or a person having knowledge and experience in administering institutions dealing with the matters aforesaid, to be nominated by the Central Government;

(b) Officials, not exceeding five to be nominated by the Central Government to represent that Government;

(c) persons, not exceeding five to be nominated by the Central Government, from amongst the members of the State Boards,

(d) non-officials, (not exceeding three) to be nominated by the Central Government, to represent the interests of agriculture, fishery or industry or trade or any other interest which, in the opinion of the Central Government, ought to be represented;

(e) two persons to represent the companies or corporations owned, controlled or managed by the Central Government, to be nominated by that Government;

(f) a full-time member-secretary, possessing qualifications, knowledge and experience of scientific, engineering or management aspects of pollution control, to be appointed by the Central Government.

The Central Board shall have power, subject to the provisions of this Act, to acquire, hold and dispose of property and to contract, and may, by the aforesaid name, sue or be sued.

Functions of Central Board: The main function of the Central Board shall be to promote cleanliness of streams and wells in different areas of the States.

The Central Board may perform all or any of the following functions, namely:

(a) advise the Central Government on any matter concerning the prevention and control of water pollution;

(b) co-ordinate the activities of the State Boards and resolve disputes among them;

(c) provide technical assistance and guidance to the State Boards, carry out and sponsor investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;

(d) plan and organise the training of persons engaged or to be engaged in programs for the prevention, control or abatement of water pollution on such terms and conditions as the Central Board may specify;

(e) organise through mass media a comprehensive programme regarding the prevention and control of water pollution;

(f) collect, compile and publish technical and statistical data relating to water pollution and the measures devised for its effective prevention and control and prepare manuals, codes or guides relating to treatment and disposal of sewage and trade effluents and disseminate information connected therewith;

(g) lay down, modify or annul, in consultation with the State Government concerned, the standards for a stream or well: Provided that different standards may be laid down for the same stream or well or for different streams or wells, having regard to the quality of water, flow characteristics of the stream or well and the nature of the use of the water in such stream or well or streams or wells;

(h) plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water pollution;

(i) perform such other functions as may be prescribed.

The Board may establish or recognise a laboratory or laboratories to enable the Board to perform its functions efficiently, including the analysis of samples of water from any stream or well or of samples of any sewage or trade effluents.

State Boards: The State Government shall, with effect from such date as it may, by notification in the Official Gazette, appoint, constitute a [State Pollution Control Board] under such name as may be specified in the notification, to exercise the powers conferred on and perform the functions assigned to that Board under this Act.

A State Board shall consist of the following members, namely:

(a) a chairman, being a person having special knowledge or practical experience in respect of matters relating to environmental protection]or a person having knowledge and experience in administering institutions dealing with the matters aforesaid, to be nominated by the State Government.

(b) officials (not exceeding five) to be nominated by the State Government to represent that Government;

(c) persons, (not exceeding five) to be nominated by the State Government from amongst the members of the local authorities functioning within the State;

(d) non-officials, (not exceeding five) to be nominated by the State Government to represent the interest of agriculture, fishery or industry or trade or any other interest which, in the opinion of the State Government, ought to be represented;

(e) two persons to represent the companies or corporations owned, controlled or managed by the State Government, to be nominated by that Government;

(f) a full-time member-secretary, possessing qualifications, knowledge and experience of scientific, engineering or management aspects of pollution control, to be appointed by the State Government

Every State Board shall be a body corporate with the name specified by the State Government in the notification under sub-section (1), having perpetual succession and a common seal with power, subject to the provisions of this Act, to acquire, hold and dispose of property and to contract, and may, by the said name, sue or be sued.

No State Board shall be constituted for a Union territory and in relation to a Union territory, the Central Board shall exercise the powers and perform the functions of a State Board for that Union territory.

Functions of State Board: The functions of a State Board shall be

(a) to plan a comprehensive programme for the prevention, control or abatement of pollution of streams and wells in the State and to secure the execution thereof;

(b) to advise the State Government on any matter concerning the prevention, control or abatement of water pollution;

(c) to collect and disseminate information relating to water pollution and the prevention, control or abatement thereof;

(d) to encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;

(e) to collaborate with the Central Board in organising the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of water pollution and to organise mass education programmes relating thereto;

(f) to inspect sewage or trade effluents, works and plants for the treatment or sewage and trade effluents

(g) lay down, modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving waters (not being water in an inter-State stream) resulting from the discharge of effluents and to classify waters of the State;

(h) to evolve economical and reliable methods of treatment of sewage and trade effluents,

(i) to evolve methods of utilisation of sewage and suitable trade effluents in agriculture;

(j) to lay down effluent standards to be complied with by persons while causing discharge of sewage or sullage or both and to lay down, modify or annul effluent standards for the sewage and trade effluents;

(k) to advice the State Government with respect to the location of any industry the carrying on of which is likely to pollute a stream or well;

(l) to perform such other functions as may be prescribed or as may, from time to time be entrusted to it by the Central Board or the State Government.

Penalties: The Water (Prevention and Control of Pollution) Act, 1974 is of considerable importance in practice. It provides for penalties and punishments for non-compliance of the directions given by the State Board, for certain acts and for contravention of provisions of the Act. The punishment under the Act may be imprisonment for a term varying from

three months to seven years and / with- a fine which may extend to ten thousand rupees, with an additional fine which may extend to five thousand rupees for every day during which such failure continues after the conviction for the first such failure.- If the failure continues beyond a period of one year after the date of conviction, the offender shall, on conviction, be punishable with imprisonment for a term which shall not be less than two years but which may extend to seven years and with fine.

The Act provides for enhanced penalty if any person who has been convicted of any offence under Section 24 (Prohibition on use of stream or well for disposal of polluting matter, etc.) or Section 25 (Restrictions on new outlets and new discharges) or Section 26 (Provision regarding existing discharge of sewage or trade effluent) is again found guilty of an offence involving a contravention of the same provision, he shall, on the second and on every subsequent conviction, be punishable with imprisonment for a term which shall not be less than one and half years but which may extend to six years and with fine. No cognisance shall be taken of any conviction made more than two years before the commission of the offence which is being punished.

Under the Act, when an offence under this Act has been committed by a company, every person at the time the offence was committed who was in-charge of, and was responsible to the company for the conduct of, the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly. But the person held guilty proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such an offence, in such situation he is not liable for punishment provided under the Act.

A Board shall meet at least once in every three months and shall observe such rules of procedure in regard to the transaction of business at its meetings as may be prescribed. If, in the opinion of the chairman, any business of an urgent nature is to be transacted, he may convene a meeting of the Board at such time as he thinks fit for the purpose.

11.3.3 THE FOREST (CONSERVATION) ACT, 1980:

The Parliament has enacted the Forest (Conservation) Act, 1980, to check further deforestation and conserve forests and to provide for matters connected therewith or ancillary or incidental thereto.

This Act has five Sections which deal with conservation of forests.

Objectives: The Act was enacted with the twin objectives under Section 2 of restricting the use of forest land for non-forest purposes, and preventing the de-reservation of forests that have been reserved under the Indian Forest Act, 1927. However, in 1988 the Act was further amended to include two new provisions under Section 2, where it sought to restrict leasing of forest land to private individuals, authority, corporations not owned by the Government, and to prevent clear felling of naturally grown trees.

Provisions:

The Act empowers the Central Government to constitute a committee to advise the Government with a grant of approval under Section 2, as also on any other matter connected with the conservation of forest and referred to it by the Central Government.

The Act provides for the punishment of imprisonment, extendable to fifteen days for the contravention of the provisions of the Act.

The Act provides for punishment of offenders from the Government Departments, including Head of the Departments and authorities. However, these persons can escape criminal liabilities if they can prove that:

- The offence was committed without their knowledge,

- They had exercised all due diligence to prevent the committing of such offence.

11.3.4 THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981:

It is an act for the prevention, control and abatement of air pollution and for the establishment of Boards and for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

Definitions:

Air pollutant: means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

Air pollution: Means the presence in the atmosphere of any air.

Automobile: Means any vehicle powered either by internal combustion engine or by any method of generating power to drive such vehicle by burning fuel.

Emission: Means any solid or liquid or gaseous substance coming out of any chimney, duct or flue or any other outlet.

Central Board and State Boards for the Prevention and Control of Air Pollution.

The Central Board for the Prevention and Control of Water Pollution constituted under section 3 of the Water (Prevention and Control of Pollution) Act, 1974 shall, without prejudice to the exercise and performance of its powers and functions under this Act, exercise the powers and perform the functions of the Central Board for the Prevention and Control of Air Pollution under this Act.

State Boards for the Prevention and Control of Water Pollution to be the State Boards for the Prevention and Control of Air Pollution.

Functions of Central Board.

(i) Subject to the provisions of this Act, and without prejudice to the performance, of its functions under the Water (Prevention and Control of Pollution) Act, 1974 the main functions of the Central Board shall be to

improve the quality of air and to prevent, control or abate air pollution in the country.

(ii) In particular and without prejudice to the generality of the foregoing functions, the Central Board may-

(a) advise the Central Government on any matter concerning the improvement of the quality of air and the prevention, control or abatement of air pollution;

(b) plan and cause to be executed a nation-wide programme for the prevention, control or abatement of air pollution;

(c) co-ordinate the activities of the State and resolve disputes among them;

(d) provide technical assistance and guidance to the State Boards, carry out and sponsor investigations and research relating to problems of air pollution and prevention, control or abatement of air pollution;

(e) plan and organise the training of persons engaged or to be engaged in programmes for the prevention, control or abatement of air pollution on such terms and conditions as the Central Board may specify;

(f) organise through mass media a comprehensive programme regarding the prevention, control or abatement of air pollution;

(g) collect, compile and publish technical and statistical data relating to air pollution and the measures devised for its effective prevention, control or abatement and prepare manuals, codes or guides relating to prevention, control or abatement of air pollution;

(h) lay down standards for the quality of air.,

(i) collect and disseminate information in respect of matters relating to air pollution;

(j) perform such other functions as may be prescribed.

The Central Board may establish or recognise a laboratory or laboratories to enable the Central Board to perform its functions under this section efficiently.

Functions of State Boards:

(1) subject to the provisions of this Act, and without prejudice to the performance of its functions, if any, under the Water (Prevention and Control of Pollution) Act, 1974 (Act 6 of 1974), the functions of a State Board shall be-

(a) to plan a comprehensive programme for the prevention, control or abatement of air pollution and to secure the execution thereof-,

(b) to advise the State Government on any matter concerning the prevention, control or abatement of air pollution;

(c) to collect and disseminate information relating to air pollution;

(d) to collaborate with the Central Board in organising the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of air pollution and to organise mass-education programme relating thereto;

(e) to inspect, at all reasonable times, any control equipment, industrial plant or manufacturing process and to give, by order, such directions to such persons as it may consider necessary to take steps for the prevention, control or abatement of air pollution;

(f) to inspect air pollution control areas at such intervals as it may think necessary, assess the quality of air therein and take steps for the prevention, control or abatement of air pollution in such areas;

(g) to lay down, in consultation with the Central Board and having regard to the standards for the quality of air laid down by the Central Board, standards for emission of air pollutants into the atmosphere from industrial plants and automobiles or for the discharge of any air pollutant into the atmosphere from any other source whatsoever not being a ship or an aircraft.

(h) to advise the State Government with respect to the suitability of any premises or location for carrying on any industry which is likely to cause air pollution;

(i) to Perform such other functions as may be prescribed or as may, from time to time, be entrusted to it by the Central Board or the State Government;

(j) to do such other things and to perform such other acts as it may think necessary for the proper discharge of its functions and generally for the purpose of carrying into effect the purposes of this Act.

A State Board may establish or recognise a laboratory or laboratories to enable the State Board to perform its functions under this section efficiently.

Penalties:

The persons managing industry are to be penalized if they produce emissions of air pollutants in excess of the standards laid down by the State Board. The Board also makes applications to the court for restraining persons causing air pollution.

Whoever contravenes any of the provision of the Act or any order or direction issued is punishable with imprisonment for a term which may extend to three months or with a fine of Rs. 10,000 or with both, and in case of continuing offence with an additional fine which may extend to Rs 5,000 for every day during which such contravention continues after conviction for the first contravention.

11.3.5 THE ENVIRONMENTAL (PROTECTION) ACT, 1986:

The environmental protection act, 1986 was enacted in response to united Nations conference on the human Environment held in Stockholm in 1972. India has participated in that conference and resolved to protect its environment. This act extends to whole of india and came into force on 19 Nov. 1986.The genesis of the Environmental (Protection) Act, 1986, is in Article 48A (Directive Principles of State Policy) and Article 51A (g) (Fundamental Duties) of the Indian Constitution.

The Environment (Protection) Act, 1986 has 26 Sections and it has been divided into four chapters relating to i) Preliminary, ii) General Powers of the Central Government, iii) Prevention, Control, and Abatement of Environmental Pollution, iv) Miscellaneous

Definitions:

Environment: Includes water, air and land and the inter- relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property.

Environmental pollutant: Means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment.

Environmental pollution: Means the presence in the environment of any environmental pollutant.

Handling: In relation to any substance, means the manufacture, processing, treatment, package, storage, transportation, use, collection, and destruction, conversion, offering for sale, transfer or the like of such substance.

Hazardous substance: Means any substance or preparation which, by reason of its chemical or physico-chemical properties or handling, is liable to cause harm to human beings, other living creatures, plant, micro-organism, property or the environment.

Occupier: In relation to any factory or premises, means a person who has, control over the affairs of the factory or the premises and includes in relation to any substance, the person in possession of the substance.

Provisions of the act:

The Act empowers the Central Government to take all appropriate measures to prevent and control pollution and to establish effective machinery for the purpose of protecting and improving the quality of the environment and protecting controlling and abating environmental pollution.

The Central Government or any other person duly authorised is empowered to collect the samples of air, water, soil or other substances as evidence of the offences under the Environment (Protection) Act, 1986.

The Act prescribes a special procedure for handling hazardous substances and the concerned person has to handle the hazardous substances according to the procedure of the Act.

The Environment (Protection) Act, 1986 has relaxed the rule of "Locus Standi" and because of such relaxation even a common citizen can approach the Court provided he has given a notice of sixty days of the alleged offence and his intention to make a complaint to the Central Government or any other competent authority.

In the commission of the offence under this Act by Government Department, the Act holds the Head of the Department as guilty of the offence unless the head of the Department proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

This Act also empowers and authorises the Central Government to issue directions for the operation or process, prohibition, closure, or regulation of any industry. The Central Government is also authorised to stop, regulate the supply of electricity or water or any other service directly without obtaining the order of the Court in this regard.

The Environment (Protection) Act, 1986 grants immunity to the officers of the Government for any act done under the provisions of this Act or under the powers vested in them or functions assigned to them under this Act.

The Central Government is also empowered to enter and inspect any place through any person or through any agency authorised by Central Government.

The Act debars the Civil Courts from having any jurisdiction to entertain any suit or proceeding in respect of an action, direction, order issued by Central Government or other statutory authority under this Act.

Under the Act, there will be supremacy of provision. In other words, the provisions of this Act and the rules or orders made under this Act shall have effect and supremacy over anything inconsistent contained in any enactment other than this Act.

Penalties: The Act consists of and deals with more stringent penal provisions. The minimum penalty for contravention or violation of any provision of the law is an imprisonment for a term which may extend to five years or fine up to one lakh rupees, or both. The Act also provides for the further penalty if the failure or contravention continues after the date of conviction. It is Rs. 5000/ - per day. If the failure of contravention continues beyond the period of one year, then the offender is punished with imprisonment for a term which may extend to seven years.

11.4 SUMMARY

You have read in the lesion that:

- Regulatory measures in the form of legislation are needed to check the degradation of the environment.
- Both at national and international levels laws were introduced to stop pollution
- The constitution of India has provisions to make environment legislations. One of the primary duties of the states and citizens is the obligation to protect and improve the environment. The union government utilised this provision to pass various Acts in order to protect the environment from destruction.
- Legislation is not perfect. It has some drawbacks which come in the way of its effective enforcement.

Although the legislative measures are taken and the administrative set-up is satisfactory, it is difficult to enforce the legislation due to shortage of funds, lack of expertise and non-cooperation of the public

11.5 GLOSSARY

Abatement : Reducing the degree or intensity of, or eliminating, pollution.

Disseminate : To spread or give out something

Hazardous waste : Waste which can pose a substantial or potential hazard to human health or the environment when improperly managed.

Parts per billion (ppb): A unit of measure used to describe levels or concentrations of contamination.

11.6 SAQ / CYP / POSSIBLE ANSWERS

1. Discuss, in brief, the salient features of the Air (Prevention and control of pollution) Act, 1981.

2. Discuss the salient features of Wild Life Protection Act, 1972.

3. Discuss the merits and limits of the Wildlife sanctuary and national parks?

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Unit : 3 **Lesson XII**

DISASTER MANAGEMENT AND WASTELAND RECLAMATION

DISASTER MANAGEMENT : FLOOD, EARTHQUAKE, CYCLONES, LANDSLIDES, DROUGHTS.

12.1 INTRODUCTION

12.2 OBJECTIVES

12.3 DISASTER MANAGEMENT

- 12.3.1 FLOODS
- 12.3.2 EARTHQUAKES
- 12.3.3 CYCLONES
- 12.3.4 LANDSLIDES
- 12.3.5 DROUGHTS

12.4 WASTELAND RECLAMATION

- 12.4.1 STATUS OF WASTELAND
- 12.4.2 CLASSIFICATION OF WASTELAND
- 12.4.3 METHODS OF WASTELAND RECLAMATION

12.5 SUMMARY

12.6 GLOSSARY

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12.1 INTRODUCTION

In nature catastrophes such as floods, drought, earth quake, tsunami, happen from time to time causing immense damage to life and property. It is important to devise means and methods to manage and minimise from natural disasters as far as possible. Disasters caused by human activities such as fires, accidents, epidemics are no less sudden than natural disasters and may be equally devastating. In this lesson you shall learn about causes, effects, prevention and management of natural as well as human made disaster.

Wasteland is briefly defined as that land, which is degraded and is presently lying uncultivated except current fallow due to different constraints. Land degradation due to increasing biotic interferences has resulted in salinity and alkalinity, water logging, gully and ravenous erosion, deforestation, encroachment of deserts, etc. converting productive lands into wasteland. This has resulted in dependence on the improved yield from the limited land rather than expanding the area for agriculture production.

Increasing demand for food, fodder and fuel has leads to adoption of various scientific methods or measures for increasing land productivity and buying more areas under cultivation/forests. At the same time land degradation due to desertification, soil salinity, water logging ,excessive soil erosion due to deforestation, unscientific agricultural practices etc .,has resulted in the creation of vast stretches of wastelands and a decrease in per capita cultivable land besides ecological imbalance.

12.2 OBJECTIVE

- After completing this lesson, you will be able to:
- explain how ecological balance is maintained in nature;
- classify disasters into natural and man-made;
- explain the causes, effects and management of flood, cyclone, drought (water and climate related disasters);
- explain the causes, effects and management of earthquake (geologically related disasters);

- explain the role of community and government in disaster management.
- To identify and assess the typology and extension of wastelands in different regions of the country.
- To identify various environmental and anthropogenic factors which may be responsible for the formation of different types of wasteland?
- To suggest suitable remedies and the reclamation of each type of wasteland along with socially and economically appropriate technology for the wasteland development and to suggest measures for their reclamation into cropland, pastureland, energy plantation etc.

12.3 DISASTERS MANAGEMENT

The Indian sub continent is highly prone to natural disasters. Floods, droughts, cyclones and earthquakes are recurrent phenomena in India. Susceptibility to disasters is compounded by frequent occurrences of man-made disasters such as fire. The changing topography (topo = land) due to environmental degradation also increasing vulnerability to natural disasters. In 1988, 11.2%of total land area was flood prone, but in 1998 floods inundated 37% geographical area. Four major disasters that India has experienced in the recent past are the earthquake in Latur (Maharashtra in 1993), super cyclone in Orissa (1999), the earthquake in Gujarat (2001) and Tsunami in Tamilnadu and Andhra Pradesh in December 2004. Frequent disasters lead to enormous loss of life and property. Physical safety-especially that of the vulnerable groups is routinely threatened by hazards. Natural disasters can not be prevented but their damaging impact can be reduced through better forecast, and preparedness to take up effective rescue measures. The four major disasters mentioned above have very clearly illustrated that we need multi-hazard prevention, response and recovery plans for natural hazards so that threat to human life and property is minimized. Disaster risk management is essentially a development problem. Preparedness and planning for disaster management have to be taken up along with environmental concerns that the country is facing today.

Type of disasters

There are two types of disasters namely natural disasters and man made disasters. For example: fire, accidents (road, rail or air), industrial accidents or epidemics are some of the examples of man-made disasters, both natural and man-made disasters which have devastating input resulting loss of human life, loss of livelihoods, property and environmental degradation.

Disasters disrupt normal functioning of society and leave long lasting impact. Earth quake, cyclone, flood, landslides and drought are examples of natural disasters.

12.3.1 FLOODS

Floods are sudden and temporary inundation of a large area as an overflowing of rivers or reservoirs**.**

Causes : Floods are caused by rains, high winds, cyclones, tsunami, melting snow or dam burst. Flood can happen gradually or can happen suddenly due to heavy rains, breach of the water storage and control structures, spillover. Siltation of the rivers and reservoirs, and this can enhance the incidence and magnitude of floods.

Effects :

- Casualties Human and livestock death due to drowning, serious injuries and outbreak of epidemics like diarrhoea, cholera, jaundice or viral infections are common problems faced in flood affected areas. Even wells, other source of drinking water get submerged resulting in acute shortage of safe drinking water during floods. Consequently often people are forced to drink the contaminated floodwater, which may cause serious diseases.
- Structural damage during floods mud huts and buildings built on weak foundations collapse endangering human lives and property. Damage may also be cause to roads, rail, dams, monuments, crops and cattle. Floods may uproot trees and may cause landslides and soil erosion.
- Material loss Household articles including eatables, electronic goods, beds, clothes, furniture get submerged in water and get spoilt all materials mounted

on ground e.g. food stock, equipment, vehicles, livestock, machinery, salt pan and fishing boats can be submerged and spoilt.

- Utilities damage Utilities such as water supply, sewerage, communication lines, power-lines, transportation network and railways are put at risk.
- Crop loss Apart from the loss of human and cattle life, floods cause severe devastation of standing agricultural crops. Floods water spoils the stored food-grains or harvested crop. Floods may affect soil characteristics and may turn them infertile due to the erosion of the top soil or in coastal areas agricultural lands may turn saline due to flooding by sea water.

Flood control :

Flood control can be achieved through various means. The floodwater can be reduced by reducing the run-off water through afforestation. Forests promote rainwater percolation in the ground, thus recharging the groundwater and reducing the run-off water. Construction of dams also reduces flood water through storage. Dams can store water, which can not be accommodated in the river downstream may cause floods. Water can be released in a controlled manner from the dam. Desilting, deepening and increasing embankment increase the capacity of a river/ channel/drain.

Management :

The flood damage can be considerable reduced and loss of human lives can prevented through proper planning of flood control and management measures.

- Identification of flood prone areas

A rational planning for flood management involves identification the flood prone areas and frequency and magnitude of flooding in these areas.

- Flood forecasting

Normally there is a reasonable timely warning by alerting people and moving them to safer area well in time. Measurement of intensity of rainfall in the catchment area provide sufficient clue to hydrology engineers to calculate the possible submergence area along a river well before the flooding occurs. Accordingly expected run-off volume people can be warned to evacuate the likely areas to be flooded and advise to go to safer places along with their belongings including livestock. In India has a large network of rain measuring stations, flood warnings are issued by the Central Water Commission (CWC), Irrigation and Flood Control Department and Water Resources Department.

- Land use planning

Land use planning is very important for all the developmental activities. No major development should be permitted in flood prone areas.

If construction is unavoidable it should be able to withstand the flood forces. Buildings should be constructed on elevated areas. Afforestation should be encouraged. Deforestation in the catchments areas should be discouraged because deforestation results in excessive run-off water and causes soil erosion, which is the main cause of river siltation resulting in floods. Any construction, which causes obstruction in drainage flow, should not be permitted. Encroachment of the storm water drains should not be allowed.

This reduces the risk of floods. Some precautionary measures are as follows –

- Build houses away from flood prone area.
- Keep yourself alert and updated to weather and flood forecasting information.
- In case evacuation warnings are issued, immediately go to the shelters provided.
- When you are moving to a shelter, move your valuable articles to safer elevated places so that they are not destroyed by flood water.
- Store extra food, such as rice, pulses etc. for emergency.

- Do not touch any loose electric wire to avoid electrocution.
- Do not spread rumours or listen to them.
- Make provision for adults and children who need special diet.
- After the flood is over, get yourself and your family members inoculated against diseases and seek medical care for injured and sick.
- Clear the house and dwellings of debris.
- Report any loss to the revenue authorities

12.3.2 EARTHQUAKE

Earthquake is a sudden release of energy accumulated in deformed rocks of earth crust causing the ground to tremble or shake. Earthquake can occur suddenly any time of the year without any warning causing severe loss of life and property. We are aware of the severe damage caused by earthquakes of Latur (1993) and Bhuj (2002).

The intensity of an earthquake is related to the amount of energy released when rocks give way to the forces within the earth. It is measured with the help of an instrument known as seismograph. The intensity is measured on Richter scale (after inventor C.F. Richter). Following values indicate degree of damage.

Causes: Earthquakes are natural ways of releasing energy by earth. An earthquake occurs in certain pockets of the earth which has geological faults. Such areas have already been identified.

Effects :

- Structural damage-

Earthquakes may cause physical damage to the buildings, roads, dams and monuments. High rise buildings or building built on weak foundations are especially susceptible to earthquake damage. Household articles including electronic goods and furniture get damaged. Human and livestock deaths or

serious injuries from collapsing of building are common followed by outbreak of epidemics like cholera, diarrhoea, and infectious diseases. Utilities such as water supply, sewerage, communication lines, power-lines, transportation network, and railways get damaged.

Management :

The effects can be minimized if some of the following measures are taken :-

Design of buildings-

The buildings should be designed especially in earthquake prone areas in such a manner that they can withstand the stress of earthquake. Physical characteristics of soil should be analysed in order to ensure the strength to withstand the earthquake. Bureau of Indian Standards has formulated building designs and guidelines for constructions that withstand against earthquakes. Generally building design is approved by the concerned municipal authorities according to build by laws and safety requirements. Training of the builders, architects, contractors, designers, house owners and government officials is important.

Some of the precautionary measures in the event of an earthquake are as follows

- Move out in the open;
- Keep calm, do not rush and panic, never use lift, keep away from windows, mirrors and furniture;
- Stand under strong beams that may not fall or creep under the dining table or a strong bed;
- If you are under a building and unable to move, cover your head and body with your arms, pillows, blankets to protect yourself from falling objects;
- If in a multi storey building stay on the same floor. Do not use elevators or run towards the staircase;

- If travelling stop the vehicle away from building, walls, bridge, trees, electricity poles and wires;
- Check for structural damage and clear the blockage;
- Check for injuries. Apply first aid. Help others;
- If your home is badly damaged by earthquake, come out immediately. Collect all emergency supplies like food, water, first aid kit, medicines, flash light or torch, candles, matchbox, clothes etc; if possible;
- Keep away from buildings especially old and tall ones, electricity poles, wires and walls.

12.3.3 CYCLONE

Cyclones are violent storms, often of vast extent, characterised by strong and high winds rotating about a calm centre of low atmospheric pressure. This centre moves onwards, often with velocity of around 50 km/h. Cyclones strike suddenly though it takes time for them to build up. Cyclone is generally followed by heavy rains causing floods. Satellite tracking can predict on possible affected areas and inhabitants fore-warned can be made for warning. Warning and evacuation is done along the projected path.

Effects : Light weight structures built of mud, wood, old buildings with weak walls and structure without proper anchorage to the foundation are at risk. The settlements located in low lying areas of coastal regions are directly vulnerable. Settlements in adjacent areas are vulnerable to floods, mudslide or landslide due to heavy rain. Telephone and electricity poles and wires, fences, light building structures such as thatched, tin sheds roofs, signboards, hoardings, fishing boats and trees are most vulnerable to cyclone damages. Due to heavy rains people and their property might be washed away in floods or blown away by cyclone itself. The cyclone along in the coastal areas may cause sea waves to enter on land and flood it. This may cause saline water contamination of soil and water in the affected area, affecting water supply and severely affecting agricultural crops.

Management : It is important to identify the cyclone prone areas. No development should be permitted in cyclone – prone areas. The building should be designed to withstand forces of wind and floods. All the elements holding the structures need to be properly anchored to resist the uplift. Coastal green belt has been found very effective in minimizing the effects of cyclones. Such green belts (trees growing along the coast) need to be developed along the coasts.

12.3.4 LANDSLIDES

A landslide, sometimes known as landslip, slope failure or slump, is an uncontrollable downhill flow of rock, earth, debris or the combination of the three. Landslides stem from the failure of materials making up the hill slopes and are beefed up by the force of gravity. When the ground becomes saturated, it can become unstable, losing its equilibrium in the long run. That's when a landslide breaks loose. When people are living down these hills or mountains, it's usually just a matter of time before disaster happens.

Causes : Although the causes of landslides are wide ranging, they have 2 aspects in common; they are driven by forces of gravity and result from failure of soil and rock materials that constitute the hill slope:

Natural Causes of Landslides

Climate : Long-term climatic changes can significantly impact soil stability. A general reduction in precipitation leads to lowering of water table and reduction in overall weight of soil mass, reduced solution of materials and less powerful freeze-thaw activity. A significant upsurge in precipitation or ground saturation would dramatically increase the level of ground water. When sloped areas are completely saturated with water, landslides can occur. If there is absence of mechanical root support, the soils start to run off.

Earthquakes : Seismic activities have, for a long time, contributed to landslides across the globe. Any moment tectonic plates move, the soil covering them also moves along. When earthquake strike areas with steep slopes, on numerous

occasion, the soil slips leading to landslides. In addition, ashen debris flows instigated by earthquakes could also cause mass soil movement.

Weathering : It is the natural procedure of rock deterioration that leads to weak, landslide-susceptive materials. Weathering is brought about by the chemical action of water, air, plants and bacteria. When the rocks are weak enough, they slip away causing landslides.

Erosion : It caused by sporadic running water such as streams, rivers, wind, currents, ice and waves wipes out latent and lateral slope support enabling landslides to occur easily.

Volcanoes : It can trigger landslides. If an eruption occurs in a wet condition, the soil will start to move downhill instigating a landslide. Strato volcano is a typical example of volcano responsible for most landslides across the globe.

Gravity : Steeper slopes coupled with gravitational force can trigger a massive landslide.

HUMAN CAUSES OF LANDSLIDES

Mining : Mining activities that utilize blasting techniques contribute mightily to landslides. Vibrations emanating from the blasts can weaken soils in other areas susceptible to landslides. The weakening of soil means a landslide can occur anytime.

Clear cutting: Clear cutting is a technique of timber harvesting that eliminates all old trees from the area. This technique is dangerous since it decimates the existing mechanical root structure of the area.

Effects of Landslides:

(1).Lead to economic decline.
(2) Decimation of infrastructure.
(3) Loss of lifE
(4). Affects beauty of landscapes.
(5) Impacts river ecosystems

Management:

The landslides can be reduced by avoiding construction on steep slopes and existing landslides, or by stabilizing the slopes. Stability increases when ground water is prevented from rising in the landslide mass by

(1) covering the landslide with an impermeable membrane, (2) directing surface water away from the landslide, (3) draining ground water away from the landslide, and (4) minimizing surface irrigation. Slope stability is also increased when a retaining structure and/or the weight of a soil/rock berm are placed at the toe of the landslide or when mass is removed from the top of the slope.

12.3.5 DROUGHT

Drought is an event that results from lower than normal expected rainfall over a season or period. The low rainfall is insufficient to meet the needs of human beings, plants, animals and agriculture. Short fall in rain results in drying of rivers, lakes, reservoirs and drying of wells due to excessive withdrawal and poor recharge of ground water and loss of crop yield due to shortage of water are some of the main indicators of drought.

Causes : Drought occurs due to shortage of rainfall. As per Meteorological Department if rainfall is deficient by more than 10% of the annual average rainfall, the condition is said to be that of drought. The severity of drought is determined by the extent of deviation of rainfall from the average. In the recent past frequency of periods of drought have increasing due to deforestation and environmental degradation.

Effects : Drought has severe effects on agriculture. To start with drought affects mostly rainfed crops and subsequently the irrigated crops. The herdsman, landless labours, subsistence farmers, women, children and farm animals are most affected.

- Crop failure or food shortage leading to large scale starvation and death.
- Affects dairy activities, timber and fisheries.
- Increases unemployment.

- Depletion of ground water.
- increases energy consumption for pumping water from deep aquifers.
- Reduces energy production in hydro-electric power plants.
- Loss of biodiversity; and reduced landscape quality.
- Causes health problems, increased poverty, reduced quality of life and social unrest leading to migration.3

Management :

The adverse effects of drought can be minimised if some measures are taken. A regular monitoring of rainfall, water availability in reservoirs, lakes and rivers as well as in comparison it with the demand. When water availability decreases than demand, water consumption need to be reduced by adopting various water conservation measures. These include economizing water consumption, by increasing water use efficiency, reducing wastage, reusing the wastewater for inferior uses. Use of efficient methods of irrigation and sowing low water-consuming crops are some important measures to overcome drought. Rain water harvesting increases water availability. Water harvesting is done by either allowing the run-off water from all the catchment areas to a common point and storing it in a reservoir or allowing it to percolate into the ground so far recharging groundwater.

Community Level Disaster Management:

At the time of disaster, various agencies such as government, NGOs and community plays an important role for disaster management.

These are preparedness, response, recovery and prevention details are on follows:

Disaster management has four basic components:

Preparedness : Measure to ensure that communities and services are capable of coping with the effect of disaster. It has the following main elements:

(•) Community awareness and education; (•) Preparation of disaster management plans for community, school, individual; (•) Mock drill, training and practice; (•) Inventory of resources both material resources and human skill resources; (•) Proper warning systems;

(•) Mutual aid arrangement; (•) Identifying the vulnerable groups;

Response : Measures taken in anticipation of, during and immediately after a disaster for minimizing its adverse impact. It has following main elements:

(•) Activate the emergency operation centres (control room); (•) Deployment of search and rescue teams. (•) Issuing updated warning; (•) Setting up community kitchens using local groups; (•) Set up temporary living accomodation and toilet faciliites; (•) Set up medical camps; (•) Mobilising resources;

Recovery : Measures are initiated to undertake reconstruction of the physical infrastructure and restoration of economic and emotional well being. The main elements are as follows:

(•) Community awareness on health and safety measures; (•) Counselling programme for those who have lost the near and dear ones; (•) Restoring the essential services -roads, communication links, electricity etc.; (•) Providing shelters; (•) Collecting usable materials for construction from rubble; (•) Providing financial support (•) Finding employment opportunities; (•) Reconstructing new buildings

Prevention : Measures to eliminate or reduce the incidence of severity.

(•) Land use planning; (•) Preventing habitation in risk zones; (•) Disaster resistant buildings;

(•) Finding ways to reduce risk even before the disaster strikes; (•) Community awareness and education.

The first few hours before and after a disaster are critical and precious for saving lives and reducing further injury. Often external help may take time to reach the disaster site. In any disaster, often the neighbours are first to respond. The first

responders are people who act first in a disaster situation, usually lack basic response skills to deal medical or other emergencies. The aim of community level management is to train the individuals and the members of local community to deal with emergency situation effectively. Trained community members are life saving assets in such situations. Thus community level management involves people's participation.

Government initiatives on Disaster Management

The Government of India has set up a National Committee on Disaster Management (NCDM) under the Chairmanship of the Prime Minister. The recommendations of this National Committee would form the basis of national disaster risk management programme and strengthening the natural disaster management and response mechanisms. United Nations Development Programmes (UNDP) has also been supporting various initiatives of the government to strengthen disaster management capacities.

The programme components would include the following:-

- Development of state and district disaster management plans.
- Development of disaster risk management and response plans at Village/ Ward, Gram Panchayat, Block/Urban Local Body levels.
- Constitutions of Disaster Management Teams and Committees at all levels with adequate representation of women in all committees and team. (Village/ Ward, Gram Panchayat, Block/Urban local body, District and State.)
- Capacity Building of Disaster Management Teams at all levels. Special training for women in first aid, shelter management, water and sanitation, rescue and evacuation, etc.
- Capacity Building in cyclone and earthquake resistant features for houses in disaster prone districts, training in retrofitting, and construction of technology demonstration units.

- Integration of disaster management plans with development plans of local self governments.

12.4 WASTELAND RECLAMATION

Reclaiming lands that have been laid waste in an extraction or industrial process is "wasteland reclamation."

12.4.1 STATUS OF WASTELAND

Land is a precious resource, since it is put to diverse use by man. India with a land area 32, 88000 km- which is about 2.4% of the world supports 15% of the world's population. The precipitate land resource available now in India is less than 0.4 hectares, in comparison to more than 0.9 hector in China.

About 44% of our land is used for agriculture, 23% is covered with forests, and 4% is used pastures and grazing fields, 8% for housing, agro forestry, industrial areas, and roads arid so on. The 14% is barren and about 8% is used for miscellaneous purposes. The rapid increase of urbanisation migration of population to towns and cities has created many problems. All this has led to the utilization of agricultural land for housing construction, industries etc.

The rational use of land resource is possible by adopting and integrated land-use policy which involves prevention of land misuse and reclamation of degraded and under-utilised land, wastelands fallows, etc. Reclamation of abandoned mines and brick kilns may yield some much required land. Few agricultural lands should not be sacrificed for non-agricultural purposes, such as road building, development of industries or construction of water reservoirs.

Urban areas should not be developed on agriculture lands. Waste lands arc lands which are unproductive, unfit for cultivation grazing and other economic uses due to rough terrain and eroded soils. The lands which are water-logged and saline are also term as waste lands.

The geomorphic processes become active in the absence of land management practices. As these processes erode and transport soil layers making those lands infertile, stony and useless.

The deforestation leads to soil erosion and the eroded soils exhibit droughty tendency. Further, falling trees aggravate the lowering of water table and dry conditions. The loss of fertility followed erosion also leads to the transformation of marginal forest lands into wastelands.

Waste lands are broadly categorized under two groups: barren and uncultivable waste land cultivable wasteland. The first category includes lands which cannot be brought under cultivation economic use except at a very high cost whether they exist as isolated pockets or within cultivar holdings. They are mostly lands such as hilly slopes, rocky exposures, stony or leached or gully land sandy deserts.

The second category lands are cultivable but not cultivated for more than five years. It comprise lands available for cultivation, but not taken up for cultivation. Next to 'fallow' lands, cultivable w lands are important for agricultural purposes because they can be reclaimed through conservation practices for cultivation or grazing or agro-forestry.

12.4.2 CLASSIFICATION OF WASTELANDS :

The wastelands are broadly classified into two categories:

1. Barren and uncultivable wastelands

These lands cannot be brought under cultivation or economic use except at a very high cost, whether they exist as isolated pockets or within cultivated holdings. Such lands are sandy deserts, gully land, stony or leached land, lands on hilly slopes, rocky exposures etc.

2. Cultivable wastelands :

These lands are not cultivated for five years or more. It consists of lands available for cultivation, but not used for cultivation. Next to fallow lands, cultivable

wastelands are important for agricultural purposes, because they can be reclaimed through conservational methods for cultivation, grazing or Agroforestry.

Maximum wasteland areas in our country lie in Rajasthan anthropogenic activities leading to wasteland formation are deforestation, overgrazing, mining and intensive agricultural practices.

12.4.3 WASTELAND RECLAMATION :

Various methods are used for wasteland reclamation;

Reclamation of waste land means re-claiming it or to use it for productive purposes.

1. Afforestation : It means growing the forest over culturable wasteland.

2. Reforestation : Growing the forest again over the lands where they were existing and was destroyed due to fires, overgrazing, and excessive cutting. Reforestation checks water logging, floods, soil erosion and increase productivity of land.

3. Providing surface cover : The easiest way to protect the land surface from soil erosion is of leave crop residue on the land after harvesting.

4. Mulching : Here also protective cover of organic matter and plants like stalks, cotton stalks, tobacco stalks etc. are used which reduce evaporation, help in retaining soil moisture and reduce soil erosion.

5. Changing Ground Topography on Downhill's : Running water erodes the hill soil and carries the soil along with it. This can be minimized by following alternation in ground topography:

(a) Strip farming:

Different kinds of crops are planted in alternate strip along the contour.

(b) Terracing:

In this arrangement, the earth is shaped in the form of levelled terraces to hold soil and water. The terrace edges are planted with such plant species which anchor the soil.

(c) Contour ploughing:

In this arrangement, the ploughing of land is done across the hill and not in up and down style.

6. Leaching : In salt affected land, the salinity can be minimized by leaching them with more water.

7. Changing agricultural practices :

Like mixed cropping, crop rotation and cropping of plants are adopted to improve soil fertility.

8. Ecological Succession : This refers to the natural development or redevelopment of an ecosystem which help in reclaiming the minerally deficient soil of wasteland.

12.5 SUMMARY

The Indian sub continent is highly prone to natural disasters. Floods, droughts, cyclones and earthquakes are a recurrent phenomenon in India**.** Four major disasters that India has experienced in the recent past are the Earthquake in Latur (Maharashtra in 1993), Super cyclone in Orissa (1999), the Earthquake in Gujarat (2001) and Tsunami in Tamil Nadu and Andhra Pradesh in December, 2004. Floods are temporary inundation of large region as a result of increase in level of river or reservoir due to heavy rains, high winds, cyclones, tsunami, melting snow or dam burst. Floods cause heavy toll on life of people, livestock and materials.. Earthquake is a sudden release of energy accumulated in deformed rocks of earth crust causing the ground to tremble or shake. If proper mass awareness programmes are conducted for the people. A majority of them can be avoided. Community level participation in disaster management is very useful as they are the first responders. Government of India is conducting several initiatives in order to involve public at various levels in order to implement the disaster management plan effectively.

Wastelands are lands which are unproductive, unfit for cultivation, grazing and other economic uses due to rough terrain and eroded soils. The lands which are waterlogged and saline are also termed as wastelands. The loss of fertility followed by erosion also leads to the conversion of marginal forest lands into wastelands.

12.6 GLOSSARY

Catastrophes: A sudden event that cause very great trouble or destruction

Encroachment: a gradual advance beyond usual or acceptable limits.

Wasteland: an ugly often devastated or barely inhabitable place or area

Topography: the arrangement of the natural and artificial physical features of an area.

Devastating: highly destructive or damaging

Spill-over: an instance of overflowing or spreading into another area

12.7 SAQ/CYP/Possible Answer

Q1. Why do floods occur?

Q2. How can the ill effects of drought overcome?

Q3. What arc the advantages of involving the community in disaster managements?

Q4. Define the term wasteland?

Q5. Name the different types of Wasteland?

Q6. Differentiate between barren and wasteland and culturable wasteland.

Q3. Write an essay on Disaster Management.

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UNIT : 3 **LESSON NO. XIII**

RESETTLEMENT AND REHABILITATION OF PEOPLE AND ENVIRONMENTAL ETHICS

13.1 INTRODUCTION

13.2 OBJECTIVES

13.3 RESETTLEMENT AND REHABILITATION OF PEOPLE

13.3.1 ACTIVITIES LEADING RESETTLEMENT

13.3.2 REHABILITATION

13.3.3 PROBLEM FACED DURING RESETTLEMENT AND REHABILITATION

13.3.4 LAWS REGARDING RESETTLEMENT AND REHABILITATION

13.4 ENVIRONMENTAL ETHICS

13.4.1 RESOURCE CONSUMPTION PATTERNS AND THE NEED FOR THEIR EQUITABLE UTILISATION

13.4.2 EQUITY – DISPARITY IN THE NORTHERN AND SOUTHERN COUNTRIES

13.4.3 URBAN – RURAL EQUITY ISSUES

13.4.4 THE NEED FOR GENDER EQUITY3

13.4.5 PRESERVING RESOURCES FOR FUTURE GENERATIONS

13.4.6 THE RIGHTS OF ANIMALS

13.4.7 THE ETHICAL BASIS OF ENVIRONMENT EDUCATION AND AWARENESS

13.4.8 THE CONSERVATION ETHIC AND TRADITIONAL VALUE SYSTEMS OF INDIA

13.5 SUMMARY

13.6 GLOSSARY

13.7 SAQ/CYP/POSSIBLE ANSWERS

13.8 REFERENCES/SUGGESTED READING

13.1 INTRODUCTION:

Human beings have been interacting with the environment since time immemorial. Human interaction with the environment has been growing exponentially all along. This has led to over exploitation of the ecology in a number of ways, resulting in environmental degradation. Overwhelming environmental degradation is the prime cause for various natural calamities like landslides, earthquakes, floods, tsunamis, cyclones, avalanches, etc. Simultaneously, rapid industrialization and globalization during the last few years has resulted in repurposing of land use. Major economic transformation has been possible only by changing the use of land for various purposes.

On the other hand, attempts at environmental conservation, by creating national reserves & parks, has also led to a change in land use practices. All such activities have been responsible for forcing communities to move out of their traditional homes and localities to new areas where they are forced to start life afresh. This has created a major problem of resettlement and rehabilitation of people around the globe.

13.2 OBJECTIVE

By the end of the session, the students will be able to know:

1. Know more about resettlement and rehabilitation

2. Understand the connection between resettlement and rehabilitation

3. Learn about the laws that govern resettlement and rehabilitation in India and around the world.

13.3 RESETTLEMENT AND REHABILITATION OF PEOPLE

Construction of large development projects involve acquisition of land and other immovable properties and necessitate relocation of its inhabitants. Among other things, displacement affects the socio-economic and cultural life of those getting relocated. Yet, displacement becomes unavoidable as the inhabited land is required for a development purpose which holds promise to prosperity and progress for the area, its residents and the nation at large.

The family getting displaced thus makes a sacrifice at the cost of its sentiments and identity for the sake of other members of the community. It undergoes intense hardship and faces an uncertain future so that others might live in happiness and better economic conditions. It therefore becomes imperative to formulate measures and implement the programmes for their smooth resettlement and rehabilitation (R&R) with least of inconvenience and hardship in the aftermath of their displacement.

13.3.1 ACTIVITIES LEADING TO RESETTLEMENT

Resettlement of people is needed due to two major reasons:

(a) Natural Reasons

(b) Manmade Reasons

(a) <u>Natural Reasons for Resettlement</u>:

Natural reasons for needing resettlement of populations are various kinds of natural calamities, like landslides, floods, earthquakes, tsunami, avalanche, etc. These are usually a result of over exploitation of natural resources, leading to an erosion & destruction of the ecology.

As a result of natural calamities, homes and lifestyles of the affected populace are destroyed and the people are forced to move to new areas to start life afresh.

(b) <u>Manmade Reasons for Resettlement</u>:

Today's economic growth has been possible only by repurposing the use of land. Growing industrialization has led to an increase in the number of factories, etc, being set up. Globalization has led to the setting up of Special Economic Zones or SEZ in most countries, especially in the Third World, for the setting up of industries of various kinds, with all the modern amenities and infrastructure being provided to the industries concerned. This needs a lot of land to be set aside for the development of such areas with the necessary infrastructure – roads, transportation, ports, warehouses, electricity, water, etc. As a result cities are expanding, with the villages being moved into forest areas and forest cover being reduced. The original inhabitants of the area, therefore, need to be resettled in new areas.

The infrastructure needs of urban and industrial areas has increased manifold during the last few decades. This has led to an increase in the exploitation of the various resources of energy, renewable and non-renewable. A number of dams, power plants, etc., have come up to fulfill these needs. The construction of dams requires evacuation of all the villages that come in the area which will be flooded by the dam waters. As a result massive resettlement needs to be undertaken throughout the course of the river wherever dams are being built on it.

Industrialization also needs plenty of raw materials. Mining has been the source for a lot of the raw materials needed by industries. The issuing of mining permits in areas rich in resources means that the local populace has to be evacuated, to ensure that the mining activities can be performed unhindered.

Another manmade cause responsible for large scale resettlement is the declaration of various areas as national reserves, in an attempt to conserve existing wildlife. The history of human civilization has always been set in areas where natural resources abound. This has usually meant river banks and forests. Early settlers lived in harmony with the flora and fauna around, knowing that conserving them was essential for their survival. With industrialization came greed for individual development, resulting in over exploitation of species and at times its extermination. The drastic imbalance today has made governments realize that they need to conserve

the ecology of their various forests. In this attempt forests have been declared as national reserves and the indigenous people residing in them have been moved out of their traditional homes.

Manmade disasters like Bhopal-gas tragedy, derailment of trains, etc., also create situations demanding resettlement of large populations.

13.3.2 REHABILITATION:

Resettlement is not just about moving people from one home and environment to another. It also entails ensuring that they are able to provide for and fulfill their families' needs, specially food, clothing and shelter. It, thus, falls on the authorities concerned to make sure that adequate arrangements are made to ensure this in the new area that the community shifts to.

13.3.3 PROBLEMS FACED DURING RESETTLEMENT & REHABILITATION:

Various problems are faced during the process of resettlement and rehabilitation, mostly by the people who are being resettled.

Loss of arable land: A lot of land has been acquired for building dams. This means that thousands of acres of fertile, arable farm land which was used for cultivation have now been submerged and are not available for cultivation. Alternative land provided is usually on barren land which needs decades of tilling for it to become profitably productive. Similar is the case with land acquired for industries.

Loss of forests, flora & fauna: Where the construction of various dams is concerned, large tracts of forest areas have been flooded and have now disappeared. The entire flora and fauna and the associated ecologies of these regions have been destroyed.

Extinction of indigenous populations: The displacement of indigenous communities from their ancestral lands has led to a destruction of

their traditional lifestyles, cultures, customs and traditions. As a result indigenous populations are rapidly diminishing and heading towards extinction.

Quality of land/area of resettlement: It has been found that the resettlement area is usually such that the quality of land given in compensation is much lower than the original land that the displaced people possessed. As a result, it becomes very difficult for these oustees to grow crops on this land to feed their families.

Water facilities: In India, most acquisition of land so far has been for building big dams. The people living along the rivers are used to free availability of water. Though the authorities are supposed to keep in mind the water requirements of the communities that are to be moved, especially drinking water facilities, more often than not this has not been done.

Loss of means of livelihood: In India, even today, most professions are inherited, especially in the rural areas and the poorer segments of society. When a population moves to a new area they are forced to take up new professions which they are not trained for or skilled in. As a result they are unable to feed their families, leading to deepening poverty.

Multiple displacements: People are moved from one area to another due to a new development project. A few years later another new project is envisaged in the area where they have now been resettled. As a result they have to move yet again. This has repeated effects on their lifestyles and livelihoods, leading to a further deepening of their poverty.

Project Beneficiaries Vs Project Affected: It has generally been found that project affected do not end up being project beneficiaries. The fruits of developmental projects are directly enjoyed by the affluent residing in urban areas, rather than those who have sacrificed their homes for the so-called development of the country. Result is that the displaced find themselves doubly exploited – loss of homes, cultures, traditional livelihoods on the one hand and continued deepening poverty on the other, since they are not trained for the jobs that are available.

13.3.4 LAWS REGARDING RESETTLEMENT & REHABILITATION.

A. International policies regarding Resettlement and Rehabilitation

The World Bank, Asian Development Bank, International Finance Corporation, United Nations Development Program, as well as most multilateral and private agencies, including commercial banks, require some kind of prior social impact assessment and some form of resettlement and rehabilitation provisions for all the projects that they finance. The World Bank was the first lending agency to adopt a policy on resettlement and rehabilitation through its 'Operative Policy (OP) 4.30 – Involuntary Resettlement', in June 1990. Its 'Operative Policy 4.01 – Environmental Assessment', Oct. 1991, is also applicable to all projects. These two, in conjunction, have now forced governments round the world to bring environmental assessment and resettlement into the development process.

B. Land Acquisition Act, 1894 (Amended 1984)

The Land Acquisition Act is the only legal instrument available in the country to address the issue of development induced displacement. Compensation and rehabilitation benefit for the project affected/displaced people in the project is determined on the basis of ownership to land as per the said Act. A serious weakness of the Act is that it only offers cash compensation for the land being acquired in the project. The resettlement and rehabilitation of affected/displaced people does not fall within the scope of the Act. The Act recognises only the individuals, not collective or community rights and hereditary usufruct/usage rights. Again the Act recognises only the legal records of rights. Thus, those who are living upon government land for generations but do not have any records of rights, or traditionally depended on the common property resources, or have survived by rendering services to the village community as a whole, are not entitled to get any compensation according to the present legislation.

C. Coal Mining Bearing Act, 1957

The Coal Mining Bearing Act, 1957, was established in the economic interest of the Government to gain greater public control over the coal mining industry and its development by providing for the acquisition by the State of unworked land containing or likely to contain coal deposits or of rights in or over such land. However, though this Act speaks of financial compensation for the owners of such land, it does not mention anything about any compensation or resettlement and rehabilitation of those whose livelihoods will be affected by such an acquisition.

D. Resettlement and Rehabilitation law in the country

Till date there is no national legislation or policy in India for comprehensive resettlement and rehabilitation for development-induced displacement across the country. However, National Thermal Power Corporation (NTPC) and Coal India Limited (CIL), both Public Sector Undertakings of Central Government, have their own resettlement and rehabilitation policies prepared in 1993 and 1994 respectively, for the rehabilitation of displaced people for the execution of their projects.

In the absence of a central law or even a central policy that governs resettlement and rehabilitation or lays down guidelines, resettlement and rehabilitation of displaced people has been based on ad hoc plans, resolutions and orders, adopted for specific States or even projects, as and when the need arises. Thus, resettlement and rehabilitation has been ad hoc and piecemeal. As a result, different State governments have formulated different resettlement and rehabilitation policies

(COMMENTARY)

In most States there is no uniform policy on resettlement and rehabilitation even for different kinds of development projects. Maharashtra and Karnataka have legislations on resettlement and rehabilitation for displaced people for all kinds of projects. Madhya Pradesh has legislation on resettlement and rehabilitation for the displaced people for irrigation projects only; the law may be applicable to other projects at the discretion of the Government. Orissa has resettlement and

rehabilitation policy for the water resource development projects. Gujarat has passed several Government Orders for resettlement and rehabilitation of displaced people of Sardar Sarovar Project but the State is yet to come out with a comprehensive resettlement and rehabilitation policy for displaced people of other development projects. Andhra Pradesh, Tamil Nadu and Rajasthan have passed several Government Orders for resettlement and rehabilitation of people displaced by development projects, most of them funded by the World Bank (Thangraj, 1996 quoted in Fernandes and Paranjpe, 1997). Other states have Government Orders or policy forms for resettlement and rehabilitation of displaced people due to different kinds of development projects.

Lack of legal framework for resettlement & rehabilitation of those affected by natural calamities: There is no law which speaks of the need for resettlement and rehabilitation of victims of natural calamities like floods, earthquakes, cyclones, famines, etc.

E. Draft Land Acquisition, Resettlement & Rehabilitation Bill, 2011

The Draft Land Acquisition, Resettlement & Rehabilitation Bill was placed before the Indian Parliament for discussion by the Ministry of Rural Development, Government of India, on July 27 2011. Various versions of this Bill have been seen in the Parliament over the years. This Bill is an attempt to scrap the old Land Acquisition Act, 1894 altogether. It proposes to combine land acquisition and resettlement and rehabilitation together, so that resettlement and rehabilitation becomes an essential part of the land acquisition process. This will ensure that the interests of project affected families are not neglected. It also seems to reflect international requirements by lending agencies like the World Bank, in this regard.

The Draft makes it mandatory for a social impact assessment report to be prepared before the project begins. It proposes a comprehensive compensation plan for those affected, including those whose lands are to be acquired and others who live & work in the area. It envisages the setting up of a National Monitoring Committee for Resettlement and

Rehabilitation to monitor the speedy implementation of resettlement and rehabilitation. It also proposes the establishment of Land Acquisition Rehabilitation and Resettlement Dispute Settlement Authority at the Centre and the States to deal with any disputes that may arise under the proposed Act. The Draft Bill makes it mandatory to give employment to at least one member of each project affected family. However, the Draft Bill too does not specifically mention that the rehabilitation and resettlement provisions listed here are in any way applicable to those who are displaced by natural calamities.

13.4 ENVIRONMENTAL ETHICS: ISSUES AND POSSIBLE SOLUTIONS

Environmental ethics deals with issues related to the rights of individuals that are fundamental to life and well being. This concerns not only the needs of each person today, but also those who will come after us. It also deals with the rights of other living creatures that inhabit our earth.

13.4.1 Resource consumption patterns and the need for their equitable utilisation:

Environmental ethics deals with issues that are related to how we utilise and distribute resources. Can individuals justifiably use resources so differently that one individual uses resources many times more lavishly than other individuals who have barely enough to survive? In a just world, there has to be a more equitable sharing of resources than we encounter at present. The just distribution of resources has global, national and local concerns that we need to address. There are rich and poor nations. There are rich and poor communities in every country. And there are rich and poor families. In this era of modern economic development, the disparity between the haves and have-nots is widening. Our human environments in the urban, rural and wilderness sectors, use natural resources that shift from the wilderness (forests, grasslands, wetlands, etc.) to the rural sector, and from there to the urban sector. Wealth also shifts in the same direction. This unequal distribution of wealth and access to land and its resources is a serious environmental concern. An equitable sharing of resources forms the basis of sustainable development for urban, rural and wilderness dwelling communities. As the political power base is in

the urban centers, this itself leads to inequalities and a subsequent loss of sustainability in resource management in the rural and even more so for forest dwelling people.

In 1985, Anil Agarwal published the first report on the Status of India's Environment. It emphasized that India's environmental problems were caused by the excessive consumption patterns of the rich that left the poor poorer. It was appreciated for the first time that tribals, especially women and other marginalized sectors of our society, were being left out of economic development. There are multiple stakeholders in Indian society who are dependent on different natural resources which cater directly or indirectly to their survival needs. Anil Agarwal brought forth a set of 8 propositions which are of great relevance to the ethical issues that are related to environmental concerns. These include:

1. Environmental destruction is largely caused by the consumption of the rich.
2. The worst sufferers of environmental destruction are the poor.
3. Even where nature is being 'recreated', as in afforestation, it is being transformed away from the needs of the poor and towards those of the rich.
4. Even among the poor, the worst sufferers are the marginalised cultures and occupations, and most of all, women.
5. There cannot be proper economic and social development without a holistic understanding of society and nature.
6. If we care for the poor, we cannot allow the Gross Nature Product to be destroyed any further. Conserving and recreating nature has become our highest priority.
7. Gross Nature Product will be enhanced only if we can arrest and reverse the growing alienation between the people and the common property resources. In this we will have to learn a lot from our traditional cultures.

8. It is totally inadequate to talk only of sustainable rural development, as the World Conservation Strategy does. We cannot save the rural environment or rural people dependent on it, unless we can bring about sustainable urban development.

Who pays for the cost of environmental degradation? Most sections of society do not feel the direct effects of degradation of the environment till it is too late. Those who suffer most are the poor, especially rural women, and tribal people who are dependent on forests. Traditional fishermen who are dependent on streams and rivers, and coastal people who fish and catch crustacea, are seriously affected by the degradation of aquatic ecosystems. Fuelwood gatherers from different types of forests, and pastoralists who are dependent on common grazing lands suffer when their resources are depleted. Several marginalised sectors of society are most affected by deforestation, or the loss of grassland tracts, or the deterioration of perennial water sources. All these effects can be linked to unsustainable increasing pressures on land and natural resources.

The well to do educated urban dweller consumes much larger quantities of resources and energy, than the traditional rural individual. Urban dwellers who are far removed from the source of natural resources that sustain their lives thus require exposure to a well-designed environment education program to appreciate these issues. While the rural people have a deep insight on the need for sustainable use of natural resources and know about methods of conservation, there are however several newer environmental concerns that are frequently outside their sphere of life experiences. Their traditional knowledge of environmental concerns cannot be expected to bring about an understanding of issues such as global warming, or problems created by pollution, pesticides, etc. These people thus require a different pattern of environment education that is related to their gaps in information. With the rapidly changing rural scenario the development that is thrust on unsuspecting rural communities needs to be addressed through locale specific environment awareness programs designed specifically for rural school children and adults. This must also use their local traditional knowledge systems as a base on which

modern concepts can be built, rather than by fostering concepts that are completely alien to their own knowledge systems. Common property resources in India once included vast stretches of forests, grazing lands and aquatic ecosystems. When the British found that they were unable to get enough wood for ship building and other uses they converted forest areas into Government 'Reserved Forests' for their own use to grow timber trees. This alienated local people from having a stake in preserving these resources. This in turn led to large-scale losses in forest cover and the creation of wasteland. In the past, in traditional villages that were managed by local panchayats, there were well defined rules about managing grazing lands, collecting forest resources, protecting sacred groves, etc. that supported conservation. There was a more or less equitable distribution that was controled by traditional mechanisms to prevent misuse of common property resources. Any infringement was quickly dealt with by the panchayat and the offender was punished. Common property resources were thus locally protected by communities. As landuse patterns changed, these mechanisms were lost and unsustainable practices evolved, frequently as a result of an inadequately planned development strategy.

13.4.2 EQUITY – DISPARITY IN THE NORTHERN AND SOUTHERN COUNTRIES

Environmental ethics are concerned with, who owns resources and how they are distributed. This can be looked upon at different levels. At the global level it deals with the great North – South divide between the rich industrialized nations of North America and Europe, as against the needs of developing countries of the South such as in South and Southeast Asia and South America. People living in the economically advanced nations use greater amounts of resources and energy per individual and also waste more resources. This is at the cost of poor people who are resource dependant and live in developing nations. The economically advanced West has exploited their own natural resources to such an extent that they have exhausted them nearly everywhere. They now buy their resources from resource rich but economically deprived nations at a low cost. This depletes the developing nations of natural resources on which their poor depend for their livelihood. Changing

this unfair economic practice to a more just and fair way in managing trade would require a new thinking on the part of people who live in the super rich countries.

13.4.3 URBAN – RURAL EQUITY ISSUES

The common property of rural communities has increasingly been used to supply the needs of the urban sector. Land itself that was once held as a common property resource of villages is being taken over by the urban and industrial sectors as it expands. The rural sector not only supplies food, but also a part of the energy needs (mainly fuelwood) to most towns and cities in India, at a pittance. As a result, the commons of the rural sector are being depleted of their resources. Thus while the cities get richer, the rural sector, especially the landless, get poorer. The urban rich must appreciate where their resources are derived from and be willing to pay a fair price for using them.

13.4.4 THE NEED FOR GENDER EQUITY

All over India, especially in the rural sector, women work on the whole longer hours than men. The life of a woman is enmeshed in an inextricable cycle of poverty. In attempting to eke out a living from their environment, they must constantly collect fuelwood for their homes and for sale to nearby urban areas. They laboriously collect fodder for their cattle. They have to trudge several kilometers to reach a reasonably clean water source. And finally must cook meals in a smoky unhealthy atmosphere on crop waste or other inefficient sources of energy. All this can take 10 to 12 hours a day of very hard work, every day of the year. There is thus the question of who should control the environmental resources of a rural community. Unfortunately it is the men who play a decisive role in managing the village commons and its resources whereas it should be the local women whose lives are deeply linked with the utilisation and conservation patterns of natural resources, who should be decision makers at the local level. Unfortunately women have not been given an equal opportunity to develop and better their lot. This begins with the lack of attention given to girls whose education is always given less attention than the boys in the family. Unless society begins to see that

development cannot be planned by a male dominated society from the male perspective alone, will we be able to create a better living environment for women and their children.

The great divide between women and men is most apparent in communities that live near forests and have by tradition made the woman play a greater role than men in collection of natural resources. Women fetch water, collect fuelwood, fruit, medicinal products, etc. day in and day out, while the men work only sporadically in the fields. This disparity in the lives of women and men has also led to a lower access to education and health care for girl children.

This has deep implications for the rate of utilization of natural resources and its conservation. Rural women who are intimately connected to resources, appreciate the value of conserving natural resources more deeply than men. Thus several environmental movements such as Chipko have been more strongly supported by local women folk rather than men.

13.4.5 PRESERVING RESOURCES FOR FUTURE GENERATIONS

Can we use up all the resources of the world, leaving nothing for our future generations? This ethical issue must be considered when we use resources unsustainably. If we overuse and misuse resources and energy from fossil fuels, our future generations would find survival much more difficult. A critical concern is to preserve species and natural undisturbed ecosystems that are linked with bioresources, which must be protected for the use of future generation. Just as our ancestors have left resources for us, it is our duty to leave them behind for our future generations.

13.4.6 THE RIGHTS OF ANIMALS

Can man, a single species, use and severely exploit the earth's resources which we share with billions of other plant and animal species? Within our world there are a variety of living beings. The plants and animals that share the earth with us too have a right to live and share our earth's resources and living space. We have no right to push a species that has

taken millions of years to evolve towards extinction. Not only do wild and domesticated animals have a right to life, but have the right to a dignified existence. Cruelty to an animal is no different ethically from cruelty to another human being.

Human beings are one small cog in the wheel of life on earth. We frequently forget that man has learned to exploit nature and other species well beyond what we should use justifiably. Every plant and animal has a right to life as a part of our earth's community of living things. Whilenature by itself has natural prey-predator relationships, left to itself, nature maintains a balance in each ecosystem. While evolution has developed a system whereby species become extinct and new ones evolve to fill the world's ecosystems with new plant and animal species, it is man alone that has been responsible for the recent rapid decline in the number of species on earth. Much more important man is now reducing the abundance levels of so many species that in the near future we will in all probability create a major extinction spasm on earth that will seriously endanger the existence of mankind. Thus endangering the existence of wild plants and animals and bringing them close to the brink of extinction is not only unfair to a species but also to future generation of people who may find them of great use. Quite apart from the use of these species, there is a strong ethical basis for the rights of animals and plants to exist on earth. Every individual, human or animal, that is living has feelings and emotions. Cruelty to animals is a crime that must be regarded seriously and action must be taken against offenders. Animals have a right to a dignified existence, and their life, well-being and liberty must be respected. While dominating over the animal world due to his superior intelligence, man cannot remain unfeeling to the right to life and well being of other species. There is a growing awareness of animal rights in our country and cruelty to animals is being increasingly regarded as a criminal offence

13.4.7 THE ETHICAL BASIS OF ENVIRONMENT EDUCATION AND AWARENESS

Perhaps the most important concern is related to creating an ethos that will support a sustainable lifestyle in society. This brings us to the

need for environmental education. The Honorary Supreme Court of our country has thus ordered that every young individual at school and college level be exposed to a course on environment. It is not to create only an awareness of environmental issues, but also to bring about pro environmental action. Among the variety of tools that can bring home the ethical issues of the environment, no solution is as powerful as real life experiences in nature. Creating a love for nature brings about strong pro environmental action. Our current educational processes at school and college level are being reoriented to bring this about.

There are two aspects that are closely connected with ethical issues that are related to our environment. These are based on valuing nature and appreciating the beauty of nature and treasuring the magnificence of the wilderness.

Valuing nature as a resource: It is essential that a value system that is based on environmental concern becomes a part of the thinking that we as responsible citizens of our country and our earth need to bring into our own daily lives. For our ancestors, Nature was considered to be like a mother. This has been essentially forgotten. In ancient India, forests were considered sacred. We now know that forests clean up our air, and act like a sponge that can hold water for the dry season. In the Hindu scriptures, Buddhist philosophy and especially in the Jain religion, each and every species on earth is supposed to have a place in the scheme of life. Many species were not only valued, but also venerated.

In today's world where many of us are far removed from nature, we need to remind ourselves that everything we use, if tracked back to its source, has come from nature. We depend on an intact unpolluted world which is based on nature's goods and services. No life is possible without this. If we as citizens begin to again respect Nature and all its varied species forming a complex web of life, and appreciate Nature's functions and services, it will continue to support our lives. If we disrespect nature one cannot expect her to continue to support our well being. Nature's resources that we all use and depend on can only be optimized if they are equitably shared by all of us. If the disparity is too great it can only result

in anarchy. The 'have not's' cannot be expected to remain in abject poverty, making a bare minimum living from the meager resources they can get, while the 'haves', who are already rich become richer through unsustainable consumer oriented, short-term economic development strategies. Bringing back an ethic for nature conservation requires environment education and conservation awareness. The best way to do so is to expose young people not only to our dependence on natural resources from the wilderness, but by bringing about an appreciation of the beauty and wondrous aspects of nature. This forms a sharp contrast to the sad plight of degraded areas and polluted sites in which most of humanity now lives in the developed and developing world.

Appreciating the beauty of Nature and treasuring the magnificence of the Wilderness: We often take Nature for granted. We rarely take the opportunity to gaze at a scenic sunset, or spend the time to sit in the incredible silence of the forest, or listen to the songs of birds and the sound of the wind rustling through the leaves. Or take the trouble to watch the magic of a seed germinating from the ground and gradually growing into a seedling over several days. Or observe a tree through a round of seasons as it gets new leaves, flowers, fruit and seeds. Or reflect on the incredibly large number of linkages between all the different animals and birds that depend on the seasonal changes in their habitat. It is the beauty of Nature that gives it an intrinsic value which we tend to ignore. These are not mundane day to day events, they are magical and mystical aspects of nature's clock that is ticking silently all around us. They are part of our living throbbing earth. If we fail to enjoy these wondrous aspects of Nature our lives will always remain empty.

Once we realise that the wilderness has a value all its own, this puts man in his rightful role as a custodian of nature rather than an exploiter. Visit a wilderness area, a forest, lakeside, waterfall, or seashore where man's hand has not made drastic changes to the ecosystem and one begins to value its beauty. It is there to heal the human soul and elevate his spirit. Without the wilderness, the earth would be a sad bleak human dominated landscape. The problem is how much of the wilderness can we preserve

in the presence of an ever-growing hunger for land and resources for its utilitarian values. Unless we begin to see the ecological values of the wilderness, an ethic for its conservation cannot become part of our daily lives. And without the wilderness the earth will eventually become unlivable.

The concept of 'Karma' is based on a thinking that the soul moves from man to animal and in reverse depending on ones actions. This itself brings about a concept of the oneness of all forms of life. Ahimsa or non-violence towards life which includes all plants and animals provides India with its basic philosophy which early Hindu philosophers and later sages such as Buddha, Mahavir and Mahatma Gandhi spoke of. Buddhist and Jain philosophy is intrinsically woven around non-violence and the great value of all forms of 'life'. It brings in the notion that animals are not to be viewed purely for their utility value but are a part of the earth's oneness which is linked with our own lives as well. In Hindu philosophy the earth itself is respected and venerated. In contrast, in Western thought Nature is to be subjugated and used. These are basic differences in thinking processes. Several modern philosophers in the West have now begun to see these eastern patterns of thought as a new basis for human development. This shift however, from a purely utilitarian or scientific exploitation of Nature, to one of harmony with Nature, can only occur if each of us loves and respects nature's great 'oneness'.

13.4.8 THE CONSERVATION ETHIC AND TRADITIONAL VALUE SYSTEMS OF INDIA

In ancient Indian traditions people have always valued mountains, rivers, forests, trees and several animals. Thus much of nature was venerated and protected. Forests have been associated with the names of forest gods and goddesses both in the Hindu religion as well as in tribal cultures. 'Tree' goddesses have been associated with specific plant species. Ficus religiosa, the peepal tree, is venerated and is thus not to be cut down. The Banyan tree in some regions such as Maharashtra is venerated once a year by tying a thread around it as a symbol of respect. The Tulsi plant is grown on the doorstep outside every home.

Patches of forest have been dedicated to a deity in many Indian cultures especially in tribal areas. These traditionally protected forest patches depict the true nature of undisturbed vegetation and have a large number of indigenous plant species as their exploitation has been controlled through local sentiments.

Certain species of trees have been protected as they are valued for their fruit or flowers. The mango tree is protected for its fruit around most farms even when wood becomes scarce. The Mohua tree (Madhuca indica) is protected by tribal people as it provides edible flowers, oil from its seeds and is used to make a potent alcohol. Many plants, shrubs and herbs have been used in Indian medicines which were once available in the wild in plenty. These are now rapidly vanishing. Many species of animals are venerated as being the 'vahan' or vehicle of different gods on which they are said to travel through the cosmos.

In Indian mythology, the elephant is associated with Ganesha. The elephant headed Ganesha is also linked to the rat. Vishnu is associated with the eagle. Rama is linked to monkeys. In mythology, Hanuman, the monkey god, rendered invaluable help to Rama during his travels to Lanka. The Sun god, Surya, rides a horse and has a superb chariot on which he moves through the sky. The lion is linked to Durga and the blackbuck to the moon godess. The cow is associated with Krishna. Vishnu's incarnations have been represented as taking various animal forms which serially include, fish, tortoise, a boar and a dwarf, and a half man half lion form.

The associations to various plants that have been given a religious significance include Tulsi, which is linked to Lakshmi and Vishnu. The Tulsi plant is also linked to the worship of ones own ancestors. The peepal tree is said to be the tree under which Buddha attained enlightenment. It is also associated with Vishnu and Krishna. Several trees are associated with the goddess Laxmi, including Amalaki, Mango and the Tulsi shrub.

Traditions also held that these species, which were considered as an important aspect of Nature, were the basis of local life support systems and were integral to bringing about a harmonious life. In traditional societies of

the past, these examples were all a part of ethical values that protected nature. As modern science based on the exploitation on nature spread into India, many of these traditions began to lose their effectiveness as measures that led to conserving nature.

Concepts that support nature's integrity must thus become a part of our modern educational systems. This constitutes a key solution to bring about a new ethic of conserving nature and living sustainable lifestyles.

13.5 SUMMARY

It is a well-known fact that both natural and human made disasters force peo-ple to move out of their land. For example. Tsunami in South Asia in December 2004, Latur and Gujarat earthquake, the Orissa super-cyclone and scores of floods and droughts in other parts of our country have rendered thousands of people homeless and jobless. Disasters, like the Bhopal gas tragedy in Union carbide factory, derailment of trains, are examples of human made disaster. It is a well-known fact that both natural and human made disasters force peo-ple to move out of their land. For example. Tsunami in South Asia in December 2004, Latur and Gujarat earthquake, the Orissa super-cyclone and scores of floods and droughts in other parts of our country have rendered thousands of people homeless and jobless. Disasters, like the Bhopal gas tragedy in Union carbide factory, derailment of trains.

The strategies formulated for resettlement and rehabilitation of those displaced by development projects can of course be equally applied to those displaced by natural and human made calamities. As far as our country's preparation for coping with the impact of natural and human made calamities is concerned, we have begun to feel a little aware of negative impacts of such events because they are now occurring at frequent intervals.

Environmental ethics is the study of normative issues and principles relating to human interactions with the natural environment. It comprises an increasingly significant field of applied ethics, crucial for the guidance of individuals, corporations and governments in shaping the principles affecting their lifestyles, their actions and their policies across the entire range of environmental issues. Debates include theories of normative ethics and of

meta ethics, and the adequacy of individualist, holist and ecofeminist stances. It is characteristically concerned with the good of future generations and of nonhuman species as well as that of contemporary human beings. Its scope includes the interpretation and application of the precautionary principle and of policies of sustainable development, grounds and policies for biodiversity preservation, and the nature and basis of obligations to assist adaptation to global warming, and to mitigate the anthropogenic greenhouse gas emissions widely recognised to constitute one of its principal sources.

13.6 GLOSSARY

Resettlement: the settlement of people in a different place

Rehabilitation: the action of restoring someone to former privileges or reputation after a period of disfavour.

Relocated: move to a new place and establish one's home or business there

Involuntary: done without will or conscious control

Indigenous: originating or occurring naturally in a particular place

Development projects: is the process that takes transportation, improvement from concept through construction.

Acquisition: an asset or object bought or obtained

Ethics: moral principles that govern a person's behaviour or the conducting of an activity.

Equity: the quality of being fair and impartial.

13.7 SAQ/CYP/POSSIBLE ANSWERS

Q1. Write the causes of Displacement.

Q2. What are Environmental Ethics? List them

Q3. Discuss various measures to rehabilitate the displaced people.

13.8 SUGGESTED READING / REFERENCES

Sharma, P.D.2012 Ecology and Environment. Rastogi Publications Meerut.

Santra,S.C. 2011 Environmental Sciences. New Central Book Agency s(P) Ltd.

Tiwari D. N. & Mishra A. 2012., Environmental Ethics: Indian Perspectives, Banaras Hindu University, India,

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