UNIT-1

INTRODUCTION

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 a biological species in the air, water and soil and the effect of from human activity upon these.

Environment Explained

Literary environment means the surrounding external conditions influencing development or growth of people, animal or plants; living or working conditions etc. This involves three questions:

1. What is Surrounded

The answer to this question is living objects in general and man in particular.

2. By what Surrounded

The physical attributes are the answer to this question, which become environment. In fact, the concern of all education is the environment of man. However, man cannot exist or be understood in isolation from the other forms of life and from plant life. Hence, environment refers to the sum total of condition, which surround point in space and time. The scope of the term Environment has been changing and widening by the passage of time. In the primitive age, the environment consisted of only physical aspects of the planted earth' land, air and water as biological communities. As the time passed on man extended his environment through his social, economic and political functions.

3. Where Surrounded

The answer to this question. It is in nature that physical component of the plant earth, viz land, air, water etc., support and affect life in the biosphere. According to a Goudie

1

ENVIRONMENTAL SCIENCE

Environment is the representative of physical components of the earth where in man is an important factor affecting the environment.

(ii) **Scope of Environment:** The environment consists of four segments as under:

1. **Atmosphere:** The atmosphere implies the protective blanket of gases, surrounding the earth:

(a) It sustains life on the earth.

(b) It saves it from the hostile environment of outer space.

(c) It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.

(d) It transmits only here ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultraviolate waves below about 300 nm.

The atmosphere is composed of nitrogen and oxygen. Besides, argon, carbon dioxide,

and trace gases.

2. **Hydrosphere:** The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reserviour, polar icecaps, glaciers, and ground water.
(i) Nature 97% of the earth's water supply is in the oceans,
(ii) About 2% of the water resources is locked in the polar icecaps and glaciers.
(iii) Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit to be used for human consumption and other uses.
3. **Lithosphere:** Lithosphere is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil e.g. minerals, organic matter, air and water.
4. **Biosphere:** Biosphere indicates the realm of living organisms and their interactions with environment, viz atmosphere, hydrosphere and lithosphere.

Element of Environment

Environment is constituted by the interacting systems of physical, biological and cultural elements inter-related in various ways, individually as well as collectively. These elements
may be explained as under:

(1) Physical elements

Physical elements are as space, landforms, water bodies, climate soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.

(2) Biological elements

Biological elements such as plants, animals, microorganisms and men constitute the biosphere.

(3) Cultural elements

Cultural elements such as economic, social and political elements are essentially manmade features, which make cultural milieu.

ENVIRONMENT STUDIES: IMPORTANCE

Importance of Environment Studies: 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 and complexity day by day, threatening the survival of mankind on earth. We study about these issues besides and effective suggestions in the Environment Studies. Environment studies have become significant for the following reasons:

1. Environment Issues Being of International Importance

It has been well recognised that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.

2. Problems Cropped in The Wake of Development

Development, in its wake gave birth to Urbanization, Industrial Growth, Transportation

Systems, Agriculture and Housing etc. However, it has become phased out in the developed world. The North, to cleanse their own environment has, fact fully, managed to move 'dirty' factories of South. When the West developed, it did so perhaps in ignorance of the environmental impact of its activities. Evidently such a path is neither practicable nor desirable, even if developing world follows that.

3. Explosively Increase in Pollution

World census reflects that one in every seven persons in this planted lives in India.
Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soils health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

4. Need for An Alternative Solution

It is essential, specially for developing countries to find alternative paths to an alternative goal. We need a goal as under:
(1) A goal, which ultimately is the true goal of development an environmentally sound and sustainable development.
(2) A goal common to all citizens of our earth.
(3) A goal distant from the developing world in the manner it is from the over-consuming
wasteful societies of the "developed" world.

5. Need To Save Humanity From Extinction

It is incumbent upon us to save the humanity from exinction. Consequent to our activities
constricting the environment and depleting the biosphere, in the name of development.

6. Need For Wise Planning of Development

Our survival and sustenance depend. Resources withdraw, processing and use of the product have all to by synchronised with the ecological cycles in any plan of development our
actions should be planned ecologically for the sustenance of the environment and development.

7. Misra's Report

Misra (1991) recognized four basic principles of ecology, as under:
(i) Holism
(ii) Ecosystem
(iii) Succession
(iv) Conversation.

Holism has been considered as the real base of ecology. In hierarchical levels at which interacting units of ecology are discussed, are as under:
Individual<population<community<ecosystem<biome<biosphere.

Misra (1991) has recognised four basic requirements of environmental management as under:
(i) Impact of human activities on the environment,
(ii) Value system,
(iii) Plan and design for sustainable development,

(iv) Environment education.

Keeping in view the of goal of planning for environmentally sustainable development India contributed to the United Nations Conference on Environment and Development (UNCED), also referred to as "Earth Summit" held at Rio de Janciro, the Capital of Brazil, 3rd-14th June, 1992.

NEED FOR PUBLIC AWARENESS

It is essential to make the public aware of the formidable consequences of the Environmental Degradation, if not retorted and reformative measures undertaken, would result in the extinction of life. We are facing various environmental challenges. It is essential to get the country acquainted with these challenges so that their acts may be eco-friendly. Some of these challenges are as under:

1. Growing Population

A population of over thousands of millions is growing at 2.11 per cent every year. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does automatically lead to development, yet the development leads to a decrease in population growth rates. For this development of the women is essential.

2. Poverty

India has often been described a rich land with poor people. The poverty and environmental degradation have a nexus between them. The vast majority of our people are directly dependent on the nature resources of the country for their basic needs of food, fuel shelter and fodder. About 40% of our people are still below the poverty line. Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge environment degradation are two facets of the same challenge. The population growth is essentially a function of poverty. Because, to the very poor, every child is an earner and helper and global concerns have little relevance for him.

3. Agricultural Growth

The people must be acquainted with the methods to sustain and increase agricultural growth with damaging the environment. High yielding varities have caused soil salinity and damage to physical structure of soil.

4. Need to Ground water

It is essential of rationalizing the use of groundwater. Factors like community wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies as lakes is an important challenge. It so finding our suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean which are difficult challenges is essential.

5. Development And Forests

Forests serve catchments for the rivers. With increasing demand of water, plan to harness the mighty river through large irrigation projects were made. Certainly, these would submerge forests; displace local people, damage flora and fauna. As such, the dams on the river Narmada, Bhagirathi and elsewhere have become areas of political and scientific debate.

Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were once green, stand today as wastelands. These areas are to be brought back under vegetative cover. The tribal communities inhabiting forests respects the trees and birds and animal that gives them sustenance. We must recognize the role of these people in restoring and conserving forests. The modern knowledge and skills of the forest deptt. should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests should be evolved in a well planned way.

6. Degradation of Land

At present out of the total 329 mha of land, only 266 mha possess any potential for production. Of this, 143 mha is agricultural land nearly and 85 suffers from varying degrees of soil degradation. Of the remaining 123 mha, 40 are completely unproductive. The remaining 83 mha is classified as forest land, of which over half is denuded to various degrees. Nearly 406 million head of livestock have to be supported on 13 mha, or less than 4 per cent of the land classified as pasture land, most of which is overgrazed. Thus, our of 226 mha, about 175 mha or 66 per cent is degraded to varying degrees. Water and wind erosion causes further degradation of almost 150 mha This degradation is to be avoided.

7. Reorientation of Institutions

The people should be roused to orient institutions, attitudes and infrastructures, to suit conditions and needs today. The change has to be brought in keeping in view India's traditions for resources use managements and education etc. Change should be brought in education, in attitudes, in administrative procedures and in institutions. Because it affects way people view technology resources and development.

8. Reduction of Genetic Diversity

Proper measures to conserve genetic diversity need to be taken. At present most wild genetic stocks have been disappearing from nature. Wilding including the Asiatic Lion are facing problem of loss of genetic diversity. The protected areas network like sanctuaries, national parks, biosphere reserves are isolating populations. So, they are decreasing changes of one group breeding with another. Remedial steps are to be taken to check decreasing genetic diversity.

9. Evil Consequences of Urbanisation

Nearly 27 per cent Indians live in urban areas. Urbanisation and industrialisation has given birth to a great number of environmental problem that need urgent attention. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

10. Air and water Population

Majority of our industrial plants are using outdated and population technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas that have been identified as the worst in terms of air and water pollution. Acts are enforced in the country, but their implement is not so easy. The reason is their implementation needs great resources, technical expertise, political and social will. Again the people are to be made aware of these rules. Their support is indispensable to implement these rules.

VARIOUS TYPES OF ENVIRONMENT

According to Kurt Lewin, environment is of three types which influence the personality

of an individual as under:
(a) Physical Environment,
(b) Social and Cultural Environment, and
(c) Psychological Environment.
These may be explained as under:

1. Physical Environment

Physical environment, refers to geographical climate and weather or physical conditions wherein and individual lives. The human races are greatly influenced by the climate. Some examples are as under:
(a) In the cold countries i.e. European countries the people are of white colour. Likewise, in Asian and African countries, that is, in hot countries people are of dark complexion.
(b) The physique of an individual depends on climate conditions as the individual tries to adjust in his physical environment.
(d) The human working efficiency also depends on the climatic conditions.

2. Social Environment

Social Environment includes an individual's social, economic and political condition wherein he lives. The moral, cultural and emotional forces influence the life and nature of
individual behaviour. Society may be classified into two categories as under:
(i) An open society is very conductive for the individual developement.
(ii) A closed society is not very conductive for the developenment.

3. Psychological Environment

Although physical and social environment are common to the individual in a specific situation. Yet every individual has his own psychological environment, in which he lives.
Kurt Lewin has used the term 'life space' for explaining psychological environment. The Psychological environment enables us to understand the personality of an individual. Both the person and his goal form psychological environment.
If a person is unable to overcome the barriers, he can either get frustrated or completed to change his goal for a new psychological environment. But adopting this mechanism, the individual is helped in his adjustment to the environment.

STRUCTURE OF ENVIRONMENT

Environment is both physical and biological. It includes both living and non-living components.

(i) Physical Environment

The Physical Environment is classified into three broad categories viz.
(i) Solid,
(ii) Liquid
(iii) Gas.

These represent the following spheres:
(i) The lithosphere (solid earth)
(ii) The hydrosphere (water component) and
(iii) The atmosphere

As such, the three basic of physical environment may be termed as under:
(i) Lithospheric Environment

(*ii*) Hydrospheric Environment
(*iii*) Atmospheric Environment

The scientists have classified them into smaller units based on different spatial scales, *e.g.*
(*i*) Mountain Environment
(*ii*) Glacier Environment
(*iii*) Plateau Environment
(*iv*) Coastal Environment

(ii) Biological Environment

The biological of the environment consists of:
(*i*) Plants (flora)
(*ii*) Animals (fauna).
Thus, the biotic environment further be divided into floral environment and faunal environment. All the organisms work to form their social groups and organizations at several levels. Thus, the social environment is formed. In this social environment the organisms work to derive matter from the physical environment for their sustenance and development.

This process gives birth to economic environment. Man claims to be most skilled and civilized of all the organisms. This is the reason why his social organisation is most systematic. The three aspects of man, *e.g.* physical, social and economic, function in the biotic environment as under:

(i) The Physical Man

The 'Physical Man' is one of the organisms populations or biological community. He is in need of basic elements of the physical environment like habitat (space), air, water and food. Besides, like other biological populations, he releases wastes into the ecosystem.

(ii) The Social Man

The 'Social Man' performs the following functions:
(*a*) Establishing social institutions,
(*b*) Forming social organisations,
(*c*) Formulating laws, principles and policies,
(*d*) Taking steps to safeguard his existence, interest and social welfare.

(iii) The Economic Man

The economic man derives and utilises resources from the physical and biotic environment with his skills and technologies. The economic function makes the man an environment/ geomorphic process as he transports matter and energy from one component of the ecosystem to the other. There may be any following two situations:
(*a*) His exploitative functions may be in harmony with the natural environment. Such, functions do not necessarily involve change in the working of the ecosystem.
(b) These functions may exceed the critical limit. Consequently, the equilibrium of the environment/ecosystem is disturbed and a great number of environment and ecological problems crop up. These are determental to man him besides to whole population of human species in a given ecosystem.

RESOURCES

FOREST RESOURCES

'A nation that destroys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people'- **Franklin D. Roosevelt**

2.1 Introduction to Natural Resources

Any material which can be transformed in a way that it becomes more valuable and useful can be termed as resource. In other words, it is possible to obtain valuable items from any resources. Resource, therefore, are the means to attain given ends. The aspect of satisfaction is so important that we consider a thing or substance a resource, as so long it meets our needs. Life on this planet depends upon a large number of things and services provided by the nature, which are known as Natural Resources. Thus water, air, soil, minerals, coal, forests, crops and wild life are all examples of natural resources.

2.1.1 Classification of natural resources

Depending upon availability of natural resources can be divided into two categories such as (1) renewable and (2) Non renewable resources.

1.Renewable resources

Renewable resources are in a way inexhaustible resources. They have the ability to replenish themselves by means such as recycling, reproduction and replacement.Examples of renewable resources are sunlight, animals and plants,soil,water,etc.

2. Non-Renewable Resources

Non renewable resources are the resources that cannot be replenished once used or perished. Examples of non renewable resources are minerals, fossil fuels, etc.

Resources can also be classified as biotic or abiotic.

a)Biotic resources

These are living resources (e.g. forest, agriculture, fish and wild life) that are able to reproduce or replace them and to increase.

b)Abiotic resources

These are non-living resources (e.g. petrol, land, minerals etc.) that are not able to

replace themselves or do so at such a slow rate that they are not useful to consider them in terms of the human life times.

2.1.2 Problems associated with natural resources

1. The unequal consumption of natural resources

A major part of natural resources today are consumed in the technologically advanced or 'developed' world, usually termed 'the west'. The 'developing nations' of 'the east', including India and China, also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases.

2. Planning land use

Land is a major resource, needed for not only for food production and animal husbandry, but also for industry and growing human settlements. These forms of intensive land use are frequently extended at the cost of 'wild lands', our remaining forests, grasslands, wetlands and deserts. This demands for a pragmatic policy that analyses the land allocation for different uses.

3. The need for sustainable lifestyles

Human standard of living and the health of the ecosystem are indicators of sustainable use of resources in any country or region. Ironically, both are not in concurrence with each other. Increasing the level of one, usually leads to degradation of other. Development policies should be formulated to strike a balance between the two.

2.2 Forest Resources

Forest is important renewable resources. Forest vary in composition and diversity and can contribute substantially to the economic development of any country .Plants along with trees cover large areas, produce variety of products and provide food for living organisms, and also important to save the environment.
It is estimated that about 30% of world area is covered by forest whereas 26% by pastures. Among all continents, Africa has largest forested area (33%) followed by Latin America (25%), whereas in North America forest cover is only 11%. Asia and former USSR has 14% area under forest. European countries have only 3% area under forest cover. India's Forest Cover accounts for 20.6% of the total geographical area of the country as of 2005.

2.2.1 Significance of forests

Forest can provide prosperity of human being and to the nations. Important uses of forest can be classified as under

- Commercial values
- Ecological significance
- Aesthetic values
- Life and economy of tribal

2.2.1.1 Commercial values

- Forests are main source of many commercial products such as wood, timber, pulpwood etc. About 1.5 billion people depend upon fuel wood as an energy source. Timber obtained from the forest can used to make plywood, board, doors and windows, furniture, and agriculture implements and sports goods. Timber is also a raw material for preparation of paper, rayon and film.
- Forest can provide food , fibre, edible oils and drugs.
- Forest lands are also used for agriculture and grazing.
- Forest is important source of development of dams, recreation and mining.

2.2.1.2 Life and economy of tribal

Forest provide food, medicine and other products needed for tribal people and play a vital role in the life and economy of tribes living in the forest.

2.2.1.3 Ecological uses

Forests are habitat to all wild animals, plants and support millions of species. They help in reducing global warming caused by green house gases and produces oxygen upon photosynthesis.
Forest can act as pollution purifier by absorbing toxic gases. Forest not only helps in soil conservation but also helps to regulate the hydrological cycle.

2.2.1.4 Aesthetic values

All over the world people appreciate the beauty and tranquillity of the forest because forests have a greatest aesthetic value. Forest provides opportunity for recreation and ecosystem research.

2.2.2 Over exploitation of forests

Forests contribute substantially to the national economy. With increasing population increased demand of fuel wood, expansion of area under urban development and industries has lead to over exploitation of forest .At present international level we are losing forest at the rate of 1.7 crore hectares annually. Overexploitation also occurs due to overgrazing and conversion of forest to pastures for domestic use.

2.2.3 Deforestation

1. Forest are burned or cut for clearing of land for agriculture ,harvesting for wood and timber , development and expansion of cities .These economic gains are short term where as long term effects of deforestation are irreversible
2. Deforestation rate is relatively low in temperate countries than in tropics If present rate of deforestation continues we may losses 90% tropical forest in coming six decades
3. For ecological balance 33% area should be under forest cover but our nation has only 20.6% forest cover.

2.2.3.1 Causes of deforestation

Forest area in some developed area has expanded. However in developing countries area under forest is showing declining trend particularly in tropical region. Main causes of deforestation are

a) Shifting cultivation or jhum cultivation

This practise is prevalent in tribal areas where forest lands are cleared to grow subsistence crops. It is estimated that principle cause of deforestation in tropics in Africa, Asia and tropical America is estimated to be 70, 50, and 35% respectively. Shifting cultivation which is a practice of slash and burn agriculture are posses to clear more than 5 lakh hectares of land annually. In India, shifting cultivation is prevalent in northeast and to limited extent in M.P, Bihar and Andhra Pradesh and is contributing significantly to deforestation.

b) Commercial logging

It is a important deforestation agent. It may not be the primary cause but definitely it acts as secondary cause, because new logging lots permits shifting cultivation and fuel wood gatherers access to new logged areas.

c) Need for fuel wood

Increased population has lead to increasing demand for fuel wood which is also acting as an important deforestation agent, particularly in dry forest.

d) Expansion for agribusiness

With the addition of cash crops such as oil palm, rubber, fruits and ornamental plants, there is stress to expand the area for agribusiness products which results in deforestation.

e) Development projects and growing need for food

The growing demand for electricity, irrigation, construction, mining, etc. has lead

to destruction of forest. Increased population needs more food which has compelled for increasing area under agriculture crops compelling for deforestation.

f) Raw materials for industrial use

Forest provides raw material for industry and it has exerted tremendous pressure on forest. Increasing demand for plywood for backing has exerted pressure on cutting of other species such as fir to be used as backing material for apple in J&K and tea in northeast states.

2.2.3.2 Major effects of deforestation

Deforestation adversely and directly affects and damages the environment and living beings .Major causes of deforestation are

- Soil erosion and loss of soil fertility
- Decrease of rain fall due to affect of hydrological cycle
- Expansion of deserts
- Climate change and depletion of water table
- Loss of biodiversity ,flora and fauna
- Environmental changes and disturbance in forest ecosystems

2.2.5 Timber extraction

There has been unlimited exploitation of timber for commercial use. Due to increased industrial demand; timber extraction has significant effect on forest and tribal people.

2.2.5.1 Logging

- Poor logging results in degraded forest and may lead to soil erosion especially on slopes.
- New logging roads permit shifting cultivators and fuel wood gatherers to gain access to the logging area.
- Loss of long term forest productivity
- Species of plants and animals may be eliminated
- Exploitation of tribal people by contractor.

2.2.6 Mining

Major effects of mining operations on forest and tribal people are:

- Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. It leads to degradation of lands and loss of top soil. It is estimated that about eighty thousands hectare land is under stress of mining activities in India
- Mining leads to drying up perennial sources of water sources like spring and streams in mountainous area.

- Mining and other associated activities remove vegetation along with underlying soil mantle, which results in destruction of topography and landscape in the area. Large scale deforestation has been reported in Mussorie and Dehradun valley due to indiscriminating mining.
- The forested area has declined at an average rate of 33% and the increase in non-forest area due to mining activities has resulted in relatively unstable zones leading to landslides.
- Indiscriminate mining in forests of Goa since 1961 has destroyed more than 50000 ha of forest land. Coal mining in Jharia, Raniganj and Singrauli areas has caused extensive deforestation in Jharkhand.
- Mining of magnetite and soapstone have destroyed 14 ha of forest in hilly slopes of Khirakot, Kosi valley and Almora.
- Mining of radioactive minerals in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation.
- The rich forests of Western Ghats are also facing the same threat due to mining projects for excavation of copper, chromites, bauxite and magnetite.

2.2.7 Effects of dams on forests and tribal people

Pandit Jawaharlal Nehru referred dam and valley projects as "Temples of modern India". These big dams and rivers valley projects have multi-purpose uses. However, these dams are also responsible for the destruction of forests. They are responsible for degradation of catchment areas, loss of flora and fauna, increase of water borne diseases, disturbance in forest ecosystems, rehabilitation and resettlement of tribal peoples.

- India has more than 1550 large dams, the maximum being in the state of Maharashtra (more than 600), followed by Gujarat (more than 250) and Madhya Pradesh (130).
- The highest one is Tehri dam, on river Bhagirathi in Uttaranchal and the largest in terms of capacity is Bhakra dam on river Satluj in Himachal Pradesh. Big dams have been in sharp focus of various environmental groups all over the world, which is mainly because of several ecological problems including deforestation and socio-economic problems related to tribal or native people associated with them.
- The Silent valley hydroelectric project was one of the first such projects situated in the tropical rain forest area of Western Ghats which attracted much concern of the people.
- The crusade against the ecological damage and deforestation caused due to Tehri dam was led by Shri. Sunder Lal Bahaguna, the leader of Chipko Movement.
- The cause of Sardar Sarovar Dam related issues have been taken up by the environmental activitist Medha Patkar, joined by Arundhati Ray and Baba Amte. For building big dams, large scale devastation of forests takes place which breaks the natural ecological balance of the region.

- Floods, droughts and landslides become more prevalent in such areas. Forests are the repositories of invaluable gifts of nature in the form of biodiversity and by destroying them (particularly, the tropical rain forests), we are going to lose these species even before knowing them. These species could be having marvellous economic or medicinal value and deforestation results in loss of this storehouse of species which have evolved over millions of years in a single stroke.

2.2.8 Forest conservation and management

Forest is one of the most valuable resources and thus needs to be conserved. To conserve forest, following steps should be taken.

1. Conservation of forest is a national problem, thus it should be tackled with perfect coordination between concerned government departments.
2. People should be made aware of importance of forest and involved in forest conservation activities.
3. The cutting of trees in the forests for timber should be stopped.
4. A forestation programmes should be launched
5. Grasslands should be regenerated.
6. Forest conservation Act should be strictly implemented to check deforestation.
7. Awards should be instituted for the deserving.

WATER RESOURCES

'Water is the driver of Nature' - **Leonardo daVinci**

3.1 Introduction

Water is an indispensable resource for life on earth. Approximately 70.8 % surface of earth is covered with water in the form of oceans. Out of this, about 97% is not fit for human consumption, about 2% is locked as a glacier and only less than 1% available as fresh water that can be used for human consumption and other uses.

Fig. 3.1 Water resources in world

Water is a very important source and essential for life because it has very unique characteristic such as

1. Water exists as liquid over a wide range of temperature 0-100^{0}C with highest specific heat and latent heat of vaporization.
2. Water is excellent solvent and act as carrier of nutrient and helps to distribute them to the cells in the body, regulates the body temperature and support structure and can dissolve various pollutant and can act as carrier of large number of microorganisms

3. It is responsible for hydrological cycle which acts as resource of water to the earth. It is estimated that about 1.4 inch thick layer of water evaporates and majority of water returns to earth through hydrological cycle.

3.2 Water Use

More than 99% of earth water is unavailable for use; only 1% water is available for people, animal, plants and earth. There is an uneven distribution of water resources, tropical rain forest are receive maximum rainfall where as desert receive only little rainfall.

Due to its unique properties water is of multiple uses for all living organisms. Water is absolutely essential for all the living organisms. One can survive for weeks without food but cannot survive more than a few days without water. Since the earliest days of mankind water availability was the major factor to decide the place of human settlements. Water dissolves nutrients and distributes them in different parts of plants and regulates the temperature and removes the waste.

3.2.1 Fresh water crisis

On global scale water availability is not a problem itself, but it's availability in right form, right time and right place is a problem. Irregularities in duration and intensity of rainfall cause floods and droughts. Out of the total water reserves of the world, about 97% is salty water (marine) and only 3% is fresh water.

Due to increased demands overuse of groundwater for drinking, irrigation and domestic purposes has lead to rapid depletion of groundwater in various regions leading to lowering of water table.

Pollution of many of the groundwater aquifers has made them unfit for consumption. Rivers and streams have long been used for discharging the wastes. due to industrialization river water are being polluted because industrial residues are pushed into the river .Civilizations have grown and flourished on the banks of rivers, but being over populated due to fast growth are polluting the natural resources of water.

3.2.2 Problems associated with water resources

These are some problems associated with use of water

- **Water Scarcity** (precipitation/evapotranspiration balance, temporal availability, per capita availability)
- **Floods and droughts** (spatio-temporal distribution; regular floods related to heavy winter or spring rains, increasing damage level due to shifting land use (settlements in flood zones) recurrent summer droughts coinciding with peak demand periods for agriculture and tourism)
- **Groundwater availability and quality** (aquifer size and access, yield, saltwater intrusion, pollution of shallow aquifers)
- **Watershed degradation** (deforestation, land use, increasing impervious (sealed) areas due to urbanization the main concern here is land use change (primarily deforestation and urbanization) and its effects on runoff patterns (flooding) and water quality including erosion/sediments with subsequent problems such as reservoir siltation/capacity loss)
- **Coastal interaction** (salinity intrusion in groundwater and estuaries, coastal pollution due to pollution runoff)

3.3 Over-Exploitation of Water

3.3.1 Groundwater

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

Effects of extensive and reckless groundwater usage:

1. Subsidence
2. Lowering of water table
3. Water logging

3.3.2 Surface water

Surface water mainly comes directly from rain or snow covers. The various surface sources are natural lakes and ponds, rivers and streams, artificial reservoirs. Availability of surface water decides the economy of the country. On one side surface water availability affects the productivity, but on the other side water sources may cause floods and drought. Due to unequal distribution, water may lead to national (interstate) or international disputes. Sharing of surface water due to these disputes is affecting productivity of different agro eco-zone and creating problems for government.

3.5 Dams - Benefits and Problems

Water is a precious resource and its scarcity is increasing at global level. There is a pressure to utilise surface water resources efficiently for different purposes. According to World Commission on Dam Report -2001 there are 45000 large dams spread over 140 countries

3.5.1 Major benefits of dams

The major benefits of dams are

1. Hydroelectricity generation
2. Year round water supply to ensure higher productivity
3. Equal water distribution by transferring water from area of excess to area of deficit
4. Helps flood control and protects soil
5. Assure irrigation during dry periods
6. River valley projects provide inland water navigation ,employment opportunities and can be used to develop fish hatcheries and nurseries
7. River valley projects have tremendous potential for economic upliftment and will help to raise the standard of living and can help to improve the quality of life

3.5.2 Disadvantages/problems

Although dams have proved very useful over the centuries but recent past big dams has created lot of human as well as environmental issues

1. Submergence of large areas may lead to loss of fertile soil and displacement of tribal people
2. Salt left behind due to evaporation increase the salinity of river water and makes it unusable when reaches down stream
3. Siltation and sedimentation of reservoirs not only makes dams use less but also is responsible for loss of valuable nutrients
4. Loss of non-forest land leads to loss of flora and fauna
5. Changes in fisheries and the spawning grounds
6. Stagnation and water logging near reservoir leads to breeding of vectors and spread of vector-borne diseases
7. Growth of aquatic weeds may lead to microclimatic changes.

MINERAL RESOURCES

'God sleeps in the minerals, awakens in plants, walks in animals, and thinks in man' -**Arthur Young**

4.1 Introduction

Minerals are essential for the formation and functioning of organisms, plant animals and human beings. In the modern era, human life needs variety of minerals to sustain industry based civilization. Mineral resources are broadly defined as elements, chemical compounds, and mixtures which are extracted to manufacture sustainable commodity. India has rich mineral resource base to provide suitable base for industrial development in the country. Sufficient reserve of nuclear energy minerals is available in India.
India's reserves, as well as production are adequate in petroleum, ores of copper, lead, zinc, tin, graphite, mercury, tungsten, and in the minerals required for fertilizer industry such as sulphur, potassium and phosphorus.

4.2 Exploitation of Minerals

Depending on their use, mineral resources can be divided into several broad categories such as elements for metal production and technology, building materials, minerals for the chemical industry and minerals for agriculture. When

usually we think about mineral resources we often think of metals but the predominant mineral resources are not metallic. The picture of annual world consumption of some elements is as under:

- Sodium and iron are used at a rate of about 0.1 to 1.0 billion metric tons per year.
- Nitrogen, sulphur, potassium and calcium are primarily used as fertilizers at a rate of about 10 to 100 million metric tons per year.
- Zinc, copper, aluminium and lead are used at a rate of about 3 to 10 million metric tons per year;
- Gold and silver are used at a rate of about 10 thousand metric tons per year.
- Out of all the metallic minerals, iron consumption is 95% of the metals consumed

Thus, with the exception of iron, the non-metallic minerals are consumed at much greater rates than the elements used for their metallic properties.

4.3 Uses of Minerals

Due to increased population, there is increased demand of minerals by the industry, transport, agriculture and defence preparation. Depletion of almost all known and easily accessible deposits is anticipated in near future. Moreover, there may be shortage of some crucial elements such as mercury, tin, copper, gold, silver and platinum. The limited resource of phosphorus, which is an essential component of chemical fertilizers, is another area of concern.

4.4 Environmental Impacts of Mineral Extraction

Extracting and use of mineral resources can affect the environment adversely. Environmental affect may depend on factors such as mining procedures, ore quality, climate, size of operation, topography, etc. Some of major environmental impacts of mining and processing operations are as under

1. Degradation of land.
2. Pollution of surfaces and ground water resources.
3. Effect on growth of vegetation due to leaching out effect of minerals.
4. Surface water pollution and groundwater contamination lead to occupational health hazards etc.
5. Air pollution due to emission of gases.
6. Deforestation affects flora and fauna.

7. Rehabilitation of affected population.

4.5 Conservation of Minerals

Conservation of minerals can be done in number of ways and these are as follows,

- Industries can reduce waste by using more efficient mining and processing methods.
- In some cases, industries can substitute plentiful materials for scarce ones.
- Some mineral products can be recycled. Aluminum cans are commonly recycled. Although bauxite is plentiful, it can be expensive to refine. Recycling aluminum products does not require the large amounts of electric power needed to refine bauxite.
- Products made from many other minerals, such as nickel, chromium, lead, copper, and zinc, can also be recycled.
- Strict laws should be made and enforced to ensure efficient management of mining resources.

FOOD RESOURCES

'A house is not a home unless it contains food and fire for the mind as well as the body' **--Benjamin Franklin**

5.1 Introduction

Food is essential for growth and development of living organisms. These essential materials are called nutrients and these nutrients are available from variety of animals and plants. There are thousands of edible plants and animals over the world, out of which only about three dozen types constitute major food of humans.

5.1.1 Food sources

The majority of people obtain food from cultivated plants and domesticated animals. Although some food is obtained from oceans and fresh waters, but the

great majority of food for human population is obtained from traditional land-based agriculture of crops and livestock.

5.1.2 Food crops

It is estimated that out of about 2,50,000 species of plants, only about 3,000 have been tried as agricultural crops. Under different agro-climatic condition, 300 are grown for food and only 100 are used on a large scale.

Some species of crops provide food, whereas others provide commercial products like oils, fibres, etc. Raw crops are sometimes converted into valuable edible products by using different techniques for value addition .At global level, only 20 species of crops are used for food. These, in approximate order of importance are wheat, rice, corn, potatoes; barley, sweet potatoes, cassavas, soybeans, oats, sorghum, millet, sugarcane, sugar beets, rye, peanuts, field beans, chick-peas, pigeon- peas, bananas and coconuts. Many of them are used directly, whereas other can be used by changing them by using different techniques for enhancing calorific value.

5.1.3 Livestock

Domesticated animals are an important food source. The major domesticated animals used as food source by human beings are 'ruminants' (e.g. cattle, sheep, goats, camel, reindeer, llama, etc.).
Ruminants convert indigestible woody tissue of plants (cellulose) which are earth's most abundant organic compound into digestible food products for human consumption. Milk, which is provided by milking animals, is considered to be the complete food. Other domestic animals like sheep, goat, poultry and ducker can be used as meat.

5.1.4 Aquaculture

Fish and seafood contributes 17 million metric tonnes of high quality protein to provide balance diet to the world. Presently aquaculture provides only small amounts for world food but its significance is increasing day by day.

5.2 World Food Problems

As per estimates of Food and Agriculture Organization (FAO), about 840 million people remain chronically hungry and out of this 800 million are living in the developing world. In last decade, it is decreasing at the rate of 2.5 million per year, but at the same time world's population is increasing. Target of cutting half the number of world's chronically hungry and undernourished people by 2015 will difficult to meet, if the present trend continues. Due to inadequate purchasing power to buy food, it is difficult to fulfil minimum calorific requirement of human body per day. Large number of people are in India are poor which can be attribute to equitable distribution of income. Food insufficiency can be divided into two categories into under-nourishment and malnourishment. Both of these insufficiencies are global problems.

5.3 Changes Caused by Agriculture and Overgrazing

From centuries, agriculture is providing inputs to large number of industries involved in production, processing and distribution of food. Accordingly, agriculture has significant effect on environment. The effects of agriculture on environment can be classified as local, regional, and global level. The agriculture also makes impact on the usage of land generally as follows:

1. Deforestation
2. Soil Erosion
3. Depletion of nutrients
4. Impact related to high yielding varieties (HYV)
5. Fertilizers related problems include micronutrient imbalance, nitrite pollution and eutrophication.
6. Pesticide related problems include creating resistance in pests and producing new pests, death of non-target organisms, biological magnification.
7. Some other problems include water logging, salinity problems and such others.

The carrying capacity of land for cattle depends upon micro climate and soil fertility. If carrying capacity is exceeded than land is overgrazed. Because of overgrazing the agricultural land gets affected as follows,

- Reduction in growth and diversity of plant species
- Reduce plant cover leads to increased soil erosion
- Cattle trampling leads to land degradation

5.4 Effects of Modern Agriculture

For sustainable production modern techniques are used to enhance productivity of different cropping systems under different agro-eco-zones. Adoption of modern agricultural practises has both positive and negative effects on environment. Effects of modern agriculture are briefly discussed under different heads as under:

5.4.1 Soil erosion

Raindrops bombarding bare soil result in the oldest and still most serious problem of agriculture. The long history of soil erosion and its impact on civilization is one of devastation. Eroded fields record our failure as land stewards.

5.4.2 Irrigation

Adequate rainfall is never guaranteed for the dry land farmer in arid and semiarid regions, and thus irrigation is essential for reliable production. Irrigation ensures sufficient water when needed and also allows farmers to expand their acreage of suitable cropland. In fact, we rely heavily on crops from irrigated lands, with fully one-third of the world's harvest coming from that 17% of cropland that is under irrigation. Unfortunately, current irrigation practices severely damage the cropland and the aquatic systems from which the water is withdrawn.

5.4.3 Agriculture and the loss of genetic diversity

As modern agriculture converts an ever-increasing portion of the earth's land surface to monoculture, the genetic and ecological diversity of the planet erodes. Both the conversion of diverse natural ecosystems to new agricultural lands and the narrowing of the genetic diversity of crops contribute to this erosion.

5.4.4 Fertilizer-pesticide problems

For photosynthesis apart from water, sunshine and CO_2, plants need micro and macro nutrients for growth. These nutrients are supplied in the shape of fertilizers. There is lot of potential to increase food productivity by increasing fertilizer use. On one hand application of artificial chemical fertilizers increases the productivity at faster rate as compare to organic fertilizers, on the other hand application of fertilizers can be a serious problem of pollution and can create number of problems. Excessive level of nitrates in ground water has created problems in developed countries. These are:

a. Accumulated phosphorous as a consequence of use of phosphoric fertilizer are posing serious threat as residues in domestic water supply and for ecology of river and other water bodies. Increased level of phosphates in different water results in eutropication.
b. Effect of chemical fertilizer is long term, therefore leads to net loss of soil organic matter.

To control insects, pests, diseases and weeds which are responsible for reduction in productivity different chemicals are used as insecticides, pesticides and herbicides. Successful control of insects, pests and weeds increases productivity and reduces losses and provide security for harvest and storage. Applications of these synthetic chemicals have great economic values and at the same time cause number of serious problems such as:

a. Affects human health which includes acute poisoning and illness caused by higher doses and accidental exposes
b. As long term effect, cause cancer, birth defects, Parkinson's disease and other regenerative diseases.
c. Long term application of pesticides can affect soil fertility.
d. Danger of killing beneficial predators.
e. Pesticides resistance and pest resurgence

5.5 Water Logging

High water table or surface flooding can cause water logging problems .Water logging may lead to poor crop productivity due to anaerobic condition created in the soil. In India, deltas of Ganga, Andaman and Nicobar Islands and some areas of Kerala are prone to frequent water logging.

5.6 Salinity

Due to adoption of intensive agriculture practices and increased concentration of soluble salts leads to salinity. Due to poor drainage, dissolved salts accumulate on soil surface and affects soil fertility. Excess concentration of these salts may form a crust on the surface which may injurious to the plants. The water absorption process is affected and uptake of nutrient is disturbed. According to an estimate, in India, 7 million hectare of land is saline and area is showing in increasing trends due to adoption of intensive agriculture practises.

ENERGY RESOURCES

6.1 Growing Energy Needs

Energy consumption of a nation is usually considered as an index of its development, because almost all the development activities are directly or indirectly dependent upon energy. Power generation and energy consumption are crucial to economic development as economy of any nation depends upon availability of energy resources. There are wide disparities in per capita energy use of developed and the developing nations. With increased speed of development in

the developing nations energy needs are also increasing.

- The very original form of energy technology probably was the fire, which produced heat and the early man used it for cooking and heating purposes.
- Wind and hydropower has also been used. Invention of steam engineers replaced the burning of wood by coal and coal was further replaced by oil.
- The oil producing has started twisting arms of the developed as well as developing countries by dictating the prices of oil and other petroleum products.
- Energy resources are primarily divided into two categories viz. renewable and non-renewable sources.
- Renewable energy resources must be preferred over the non-renewable resources.
- It is inevitable truth that now there is an urgent need of thinking in terms of alternative sources of energy, which are also termed as non-conventional energy sources which include:
    1. Solar energy needs equipments such as solar heat collectors, solar cells, solar cooker, solar water heater, solar furnace and solar power plants .
    2. Wind energy
    3. Hydropower, Tidal energy, ocean thermal energy, geothermal energy, biomass, biogas, biofuels etc.
- The non renewable energy sources include coal, petroleum, natural gas, nuclear energy.

6.2 Energy Scenario

Energy is a key input in the economic growth and there is a close link between the availability of energy and the future growth of a nation. Power generation and energy consumption are crucial to economic development.

In India, energy is consumed in a variety of forms such as fuel wood; animal waste and agricultural residues are the traditional sources of energy. These non-commercial fuels are gradually getting replaced by commercial fuels i.e. coal, petroleum products, natural gas and electricity.

Out of total energy, commercial fuels account for 60% where as the balance 40% is coming from non-commercial fuels. Of the total commercial energy produced in the form of power or electricity,

- 69% is from coal (thermal power),
- 25% is from hydel power,
- 4% is from diesel and gas,
- 2% is from nuclear power, and
- Less than 1% from non- conventional sources like solar, wind, ocean, biomass, etc.

Petroleum and its products are the other large sources of energy. In a developing country like India, in spite of enhanced energy production, there is still shortage due to increased demand of energy. In spite of the fact that there is a phenomenal increase in power generating capacity, still there is 30% deficit of about 2,000 million units.

Policy makers are in the process of formulating an energy policy with the objectives of ensuring adequate energy supply at a minimum cost, achieving self-sufficiency in energy supplies and protecting environment from adverse impact of utilizing energy resources in an injudicious manner. The main features of this policy are

1. Accelerated exploitation of domestic conventional energy resources, viz., oil, coal, hydro and nuclear power;
2. Intensification of exploration to achieve indigenous production of oil and gas;
3. Efficient management of demand of oil and other forms of energy;
4. To formulate efficient methods of energy conservation and management;
5. Optimisation of utilisation of existing capacity in the country
6. Development and exploitation of renewable sources of energy to meet energy requirements of rural communities;
7. Organisation of training for personnel engaged at various levels in the energy sector.
8. Government private partnership to exploit natural energy resources

6.3 Renewable Resources

- The resources that can be replenished through rapid natural cycles are known as renewable resource.
- These resources are able to increase their abundance through reproduction and utilization of simple substances.
- Examples of renewable resources are plants (crops and forests),and animals who are being replaced from time to time because they have the power of reproducing and maintain life cycles.
- Some examples of renewable resources though they do not have life cycle but can be recycled are wood and wood-products, pulp products, natural rubber, fibres (e.g. cotton, jute, animal wool, silk and synthetic fibres) and leather.
- In addition to these resources, water and soil are also classified as renewable resources. Solar energy although having a finite life, as a special case, is considered as a renewable resource in as much as solar stocks is inexhaustible on the human scale.

6.4 Non-Renewable Resources

- The resources that cannot be replenished through natural processes are known as non-renewable resources.
- These are available in limited amounts, which cannot be increased. These resources include fossil fuels (petrol, coal etc.), nuclear energy sources (e.g.

uranium, thorium, etc). metals (iron, copper, gold, silver, lead, zinc etc.), minerals and salts (carbonates, phosphates, nitrates etc.).

- Once a non-renewable resource is consumed, it is gone forever. Then we have to find a substitute for it or do without it.
- Non-renewable resources can further be divided into two categories, viz. Recyclable and non-recyclable

6.4.1 Recyclable resources

These are non-renewable resources, which can be collected after they are used and can be recycled. These are mainly the non-energy mineral resources, which occur in the earth's crust (e.g. ores of aluminium, copper, mercury etc.) and deposits of fertilizer nutrients (e.g. phosphate sock and potassium and minerals used in their natural state (asbestos, clay, mica etc.)

6.4.2 Non-recyclable resources

These are non-renewable resources, which cannot be recycled in any way. Examples of these are fossil fuels and nuclear energy sources (e.g. uranium, etc) which provide 90 per cent of our energy requirements.

6.5 Use of Alternate Energy Sources

There is a need to develop renewable energy sources which are available and could be utilized (solar or wind) or the sources which could be created and utilized (bio-mass). The main renewable energy sources for India are solar, wind, hydel, waste and bio-mass. Bio-mass are resources which are agriculture related like wood, bagasse, cow dung, seeds, etc.

6.5.1 Hydel energy

India has a total hydro energy potential of about 1.5 lakh MW, of which only about 20 % is installed. Small hydro plant potential is about 15000 MW and most of it is in the northern and eastern hilly regions.

6.5.2 Wind energy

The wind power potential of India is about 45,000 MW out of which capacity of 8748 MW has been installed in India till 2008. India is one of the leading countries in generating the power through wind energy.

Gujarat, AP, Karnataka, MP and Rajasthan are states having more than 5000 MW potential each. These potentials could be improved if the technology of putting turbines in sea is embraced. There are wind farms on sea generating as high as 160 MW of power.

6.5.3 Geothermal energy

Geothermal energy is thermal energy generated and stored in the Earth. Thermal

energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

6.5.4 Ocean thermal energy conversion (OTEC)

Ocean Thermal Energy Conversion (OTEC) uses the difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity. A heat engine gives greater efficiency and power when run with a large temperature difference. In the oceans the temperature difference between surface and deep water is greatest in the tropics, although still a modest 20 to 25 °C. It is therefore in the tropics that OTEC offers the greatest possibilities. OTEC has the potential to offer global amounts of energy that are 10 to 100 times greater than other ocean energy options such as wave power

6.5.5 Biomass energy

Biomass is the oldest means of energy used by humans along with solar energy. As soon as the fire was discovered, it was used widely among humans mainly for heat and light. Fire was generated using wood or leaves, which is basically a biomass. The biomass could be used to generate steam or power or used as a fuel. Power is generated using rice husk in Andhra Pradesh, while several bagasse based plants are there. India has a potential of 3500 MW from bagasse. Other fast growing plants could be planned over a huge area, so that it provides biomass for generating power.

Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted by the anaerobic digestion or fermentation into a gaseous fuel called biogas. Biogas is a mixture of 65% methane (CH_4) and of 35% CO_2 and may have small amounts of hydrogen sulphide (H_2S), moisture and siloxanes. It is a renewable energy resulting from biomass. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, much like natural gas, and used to power motor vehicles.

6.5.6 Bio-fuels

India has more than 50 million hectare of wasteland, which could be utilized for cultivating fuel plants. Jatropha is one of the options which can be planted on arid lands and be used for production of bio fuels.

6.5.7 Solar energy

India being a tropical country has potential to use solar energy on commercial bases. According to estimates, 35 MW of power could be generated from one sq km. With such potential, solar energy has bright future as energy source for the development of the country. Initial cost is the biggest limitation which has led to the low realization of its potential. For solar energy to become one of the front runners, it will require lot of research, cheap technology and low capital.

6.6 Problems Relate To the Use of Energy Resources

6.6.1 Fossil fuel

- Global warming
- Acid rains
- Dangers posed by leaded fuels ,Oil spills
- Water pollution caused by poorly managed coal mines
- Air pollution.

6.6.2 Alternate energy resources

- The initial cost of establishment of alternate energy generation is costlier than conventional resources.
- Maintenance of these structures is difficult.
- It requires more space.
- Energy supply is unpredictable during natural calamities.

LAND RESOURCES

'A nation that destroys its soils destroys itself' - **Franklin D. Roosevelt**

7.1 Land as a Resource

Land area constitutes about 1/5 of the earth surface. To meet out the challenging demand of food, fibre and fuel for human population, fodder for animals and industrial raw material for agro based industries, efficient management of land resources will play critical role. Soil, water, vegetation and climate are basic natural resources for agricultural growth and development.

7.2 Land Degradation

Due to increasing population, the demands for arable land for producing food, fibre and fuel wood is also increasing. Hence there is more and more pressure on the limited land resources which are getting degraded due to over-exploitation. Nearly 56% of total geographical area of the country is suffering due to land resource degradation. Out of 17 million hectare canal irrigated area, 3.4 million hectare is suffering from water logging and salinity. Soil erosion, water logging, salinization and contamination of the soil with industrial wastes like fly-ash, press mud or heavy metals all cause degradation of land.

7.3 Soil Erosion

Soil erosion refers to loss or removal of superficial layer of soil due to the action of wind, water and human factors. In other words, it can be defined as the movement of soil components, especially surface-litter and top soil from one place to another. It has been estimated that more than 5000 million tonnes topsoil is being eroded annually and 30% of total eroded mass is getting loosed to the sea .It results in the loss of fertility. It basically is of two types, viz. geologic erosion and accelerated erosion. Various factors which affect soil erosions include soil type, vegetation cover, slope of ground, soil mismanagement and intensity and amount of rainfall. Wind is also responsible for the land erosion through saltation, suspension and surface creep.

In order to prevent soil erosion and conserve the soil the following conservation practices are employed,

- Conservational till farming, Contour farming and Terracing
- Strip cropping and alley cropping
- Wind breaks or shelterbelts

7.4 Salinization

It refers to accumulation of soluble salts in the soil. Concentration of soluble salts increases due to poor drainage facilities. In dry land areas, salt concentration increases where poor drainage is accompanied by high temperature. High concentration of salts affects the process of water absorption hence affects the productivity.

7.5 Water Logging

Excessive utilization of irrigation may disturb the water balance which can lead to water logging due to rise of water table .Anaerobic condition due to poor availability of oxygen in water logged soils may affect respiration process in plants which will ultimately affect the productivity of water logged soil.

7.6 Desertification

Desertification is a process whereby the productive potential of arid or semiarid lands falls by ten percent or more. Desertification is characterized by devegetation and depletion of groundwater, salinization and severe soil erosion.

7.6.1 Causes of desertification

- Deforestation
- Overgrazing
- Mining and quarrying

7.7 Shifting Cultivation

Shifting cultivation is a practice of slash and burn agriculture adopted by tribal communities and is a main cause for soil degradation particularly tropical and sub tropical regions. Shifting cultivation which is also popularly known as 'Jhum Cultivation' has lead to destruction of forest in hilly areas .It is responsible for soil erosion and other problems related to land degradation in mountainous areas.

7.8 Man Induced Landslides

Human race has exploited land resources for his own comfort by constructing roads, railway tracks, canals for irrigation, hydroelectric projects, large dams and reservoirs and mining in hilly areas. Moreover productive lands under crop production are decreasing because of development activities. These factors are affecting the stability of hill slopes and damage the protective vegetation cover. These activities are also responsible to upset the balance of nature and making such areas prone to landslides.

CONSERVATION AND EQUITABLE USE OF NATURAL RESOURCES

8.1 Role of an Individual

Natural resources like forests, water, soil, food, minerals and energy resources play an important role in the economy and development of a nation. Humans can play important role in conservation of natural resources. A little effort by individuals can help to conserve these resources which are a gift of nature to the mankind. Brief description of role of individual to conserve different types of natural resources is given below:

8.1.1 Roles to conserve water

- To minimise the evaporation losses irrigate the crops, the plants and the lawns in the evening, because water application during day time will lead to more loss of water due to higher rate of evapo-transpiration.

- Improve water efficiency by using optimum amount of water in washing machine, dishwashers and other domestic appliances, etc.
- Install water saving toilets which use less water per flush.
- Check for water leaks in pipes and toilets and repair them promptly.
- Don't keep water taps running while they are not in use.
- Recycle water of washing of cloths for gardening.
- Installing rainwater harvesting structure to conserve water for future use.

8.1.2 Energy conservation for future use

- Turn off all electric appliances such as lights, fans, televisions, computers, etc when not in use.
- Clean all the lighting sources regularly because dust on lighting sources decreases lighting levels up to 20-30%
- Try to harvest energy from natural resources to obtain heat for example drying the cloths in sun and avoid drying in washing machine.
- Save liquid petroleum gas (LPG) by using solar cookers for cooking.
- Design the house with provision for sunspace to keep the house warm and to provide more light.
- Avoid misuse of vehicles for transportation and if possible share car journey to minimise use of petrol/diesel. For small distances walk down or just use bicycles.
- Minimise the use air conditioner to save energy

8.1.3 Protect soil health

- Use organic manure/compost to maintain soil fertility
- To avoid soil erosion does not irrigate the plants by using fast flow of water.
- Use sprinkler irrigation to conserve the soil.
- Design landscape of lawn in large area which will help to bind soil to avoid erosion.
- Provide vegetation cover by growing of ornamental plant, herbs and trees in your garden.
- Use vegetable waste to prepare compost to use in kitchen gardening.

8.1.4 Promote sustainable agriculture

- Diversify the existing cropping pattern for sustainability of agriculture
- Cultivate need based crop
- Maintain soil fertility
- Make optimum use of fertilizers, pesticides and other chemicals for production and processing of agriculture products
- Save grains in storage to minimise the losses
- Improve indigenous breeds of milch animals for sustainable dairy production systems.
- Adopt post harvest technologies for value addition

8.2 Equitable Use of Resources for Sustainable Life Style

In last 50 years, the consumption of resource in the society has increased many folds. There is a big gap in the consumers lifestyle between developed and developing countries.Urbanisation has changed the life style of middle class population in developing countries creating more stress on the use of natural resources. It has been estimated that More Developed Countries (MDC) of the world constitute only 22% of world's population but they use 88% of natural resources. These countries use 73% of energy resources and command 85% of income and in turn they contribute very big proportion of pollution. On the other hand less developed countries (LDCs) have moderate industrial growth and constitute 78% of world's population and use only 12% of natural resources, 27% of energy and have only 15% of global income.

There is a huge gap between rich and poor. In this age of development the rich have gone richer and the poor is becoming more poorer.. This has lead to unsustainable growth. There is an increasing global concern about the management of natural resources. The solution to this problem is to have more equitable distribution of resources and income. Two major causes of unsustainability are over population in poor countries and over consumption of resources by rich countries. A global consensus has to be reached for balanced distribution of natural resources.

For equitable use of natural resources more developed countries/rich people have to lower down their level of consumption to bare minimum so that these resources can be shared by poor people to satisfy their needs. Time has come to think that it is need of the hour that rich and poor should make equitable use of resources for sustainable development of mankind.

ECOSYSTEM

What is an Ecosystem?

The ecosystem is the structural and functional unit of ecology where the living organisms interact with each other and the surrounding environment. In other words, an ecosystem is a chain of interaction between organisms and their environment. The term "Ecosystem" was first coined by A.G.Tansely, an English botanist, in the year 1953.

Read on to explore the types, structure, components, types and functions of the ecosystem in the ecosystem notes provided below.

Types of Ecosystem

An ecosystem can be as small as an oasis in a desert, or as big as an ocean, spanning thousands of miles. There are two types of ecosystem:

- Terrestrial Ecosystem
- Aquatic Ecosystem

Terrestrial Ecosystems

Terrestrial ecosystems are exclusively land-based ecosystems. There are different types of terrestrial ecosystems distributed around various geological zones. They are as follows:

1. Forest Ecosystems
2. Grassland Ecosystems
3. Tundra Ecosystems
4. Desert Ecosystem

Forest Ecosystem

A forest ecosystem consists of several plants, animals and microorganisms that live in coordination with the abiotic factors of the environment. Forests help in maintaining the temperature of the earth and are the major carbon sink.

Grassland Ecosystem

In a grassland ecosystem, the vegetation is dominated by grasses and herbs. Temperate grasslands, savanna grasslands are some of the examples of grassland ecosystems.

Tundra Ecosystem

Tundra ecosystems are devoid of trees and are found in cold climate or where rainfall is scarce. These are covered with snow for most of the year. The ecosystem in the Arctic or mountain tops is tundra type.

Desert Ecosystem

Deserts are found throughout the world. These are regions with very little rainfall. The days are hot and the nights are cold.

Aquatic Ecosystem

Aquatic ecosystems are ecosystems present in a body of water. These can be further divided into two types, namely:

1. Freshwater Ecosystem
2. Marine Ecosystem

Freshwater Ecosystem

The freshwater ecosystem is an aquatic ecosystem that includes lakes, ponds, rivers, streams, and wetlands. These have no salt content in contrast with the marine ecosystem.

Marine Ecosystem

The marine ecosystem includes seas and oceans. These have a larger salt content and greater biodiversity in comparison to the freshwater ecosystem.

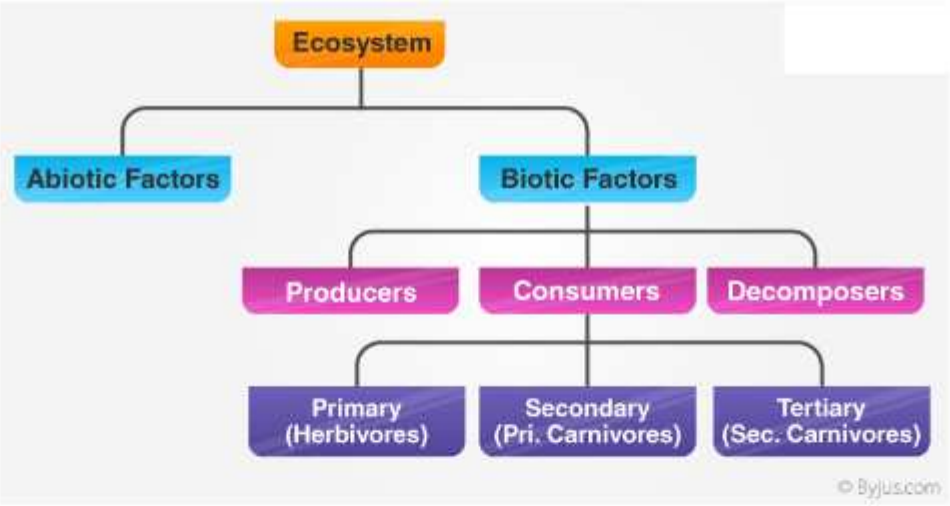
Structure of the Ecosystem

The structure of an ecosystem is characterised by the organisation of both biotic and abiotic components. This includes the distribution of energy in **our environment**. It also includes the climatic conditions prevailing in that particular environment.

The structure of an ecosystem can be split into two main components, namely:

- Biotic Components
- Abiotic Components

The biotic and abiotic components are interrelated in an ecosystem. It is an open system where the energy and components can flow throughout the boundaries.



Structure of Ecosystem highlighting the biotic and abiotic factors

Biotic Components

Biotic components refer to all life in an ecosystem. Based on nutrition, biotic components can be categorised into autotrophs, heterotrophs and saprotrophs (or decomposers).

- **Producers** include all autotrophs such as plants. They are called autotrophs as they can produce food through the process of photosynthesis. Consequently, all other organisms higher up on the food chain rely on producers for food.
- **Consumers** or heterotrophs are organisms that depend on other organisms for food. Consumers are further classified into primary consumers, secondary consumers and tertiary consumers.
    - ***Primary consumers*** are always herbivores that they rely on producers for food.

- ***Secondary consumers*** depend on primary consumers for energy. They can either be a carnivore or an omnivore.
- ***Tertiary consumers*** are organisms that depend on secondary consumers for food. Tertiary consumers can also be an omnivore.
- ***Quaternary consumers*** are present in some food chains. These organisms prey on tertiary consumers for energy. Furthermore, they are usually at the top of a food chain as they have no natural predators.

- **Decomposers** include saprophytes such as fungi and bacteria. They directly thrive on the dead and decaying organic matter. Decomposers are essential for the ecosystem as they help in recycling nutrients to be reused by plants.

Abiotic Components

Abiotic components are the non-living component of an ecosystem. It includes air, water, soil, minerals, sunlight, temperature, nutrients, wind, altitude, turbidity etc.

Functions of Ecosystem

The functions of the ecosystem are as follows:

1.
    1. It regulates the essential ecological processes, supports life systems and renders the stability.
    2. It is also responsible for the cycling of nutrients between biotic and abiotic components.
    3. It maintains a balance among the various trophic levels in the ecosystem.
    4. It cycles the minerals through the biosphere.
    5. The abiotic components help in the synthesis of organic components that involves the exchange of energy.

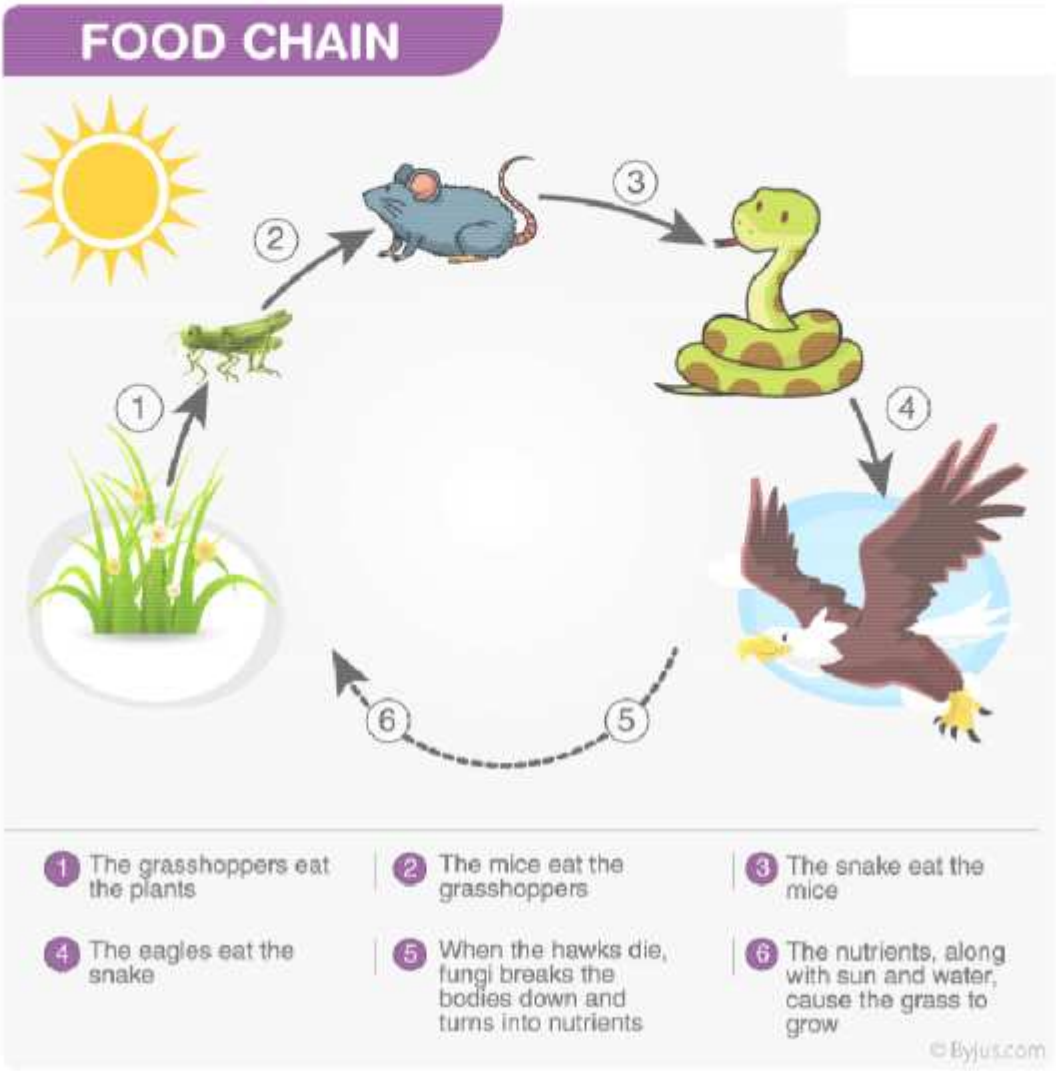
Important Ecological Concepts

1. Food Chain

The sun is the ultimate source of energy on earth. It provides the energy required for all plant life. The plants utilise this energy for the process of photosynthesis, which is used to synthesise their food.

During this biological process, light energy is converted into chemical energy and is passed on through successive levels. The flow of energy from a producer, to a consumer and eventually, to an apex predator or a detritivore is called the food chain.

Dead and decaying matter, along with organic debris, is broken down into its constituents by scavengers. The reducers then absorb these constituents. After gaining the energy, the reducers liberate molecules to the environment, which can be utilised again by the producers.



A classic example of a food chain in an ecosystem

2. Ecological Pyramids

An ecological pyramid is the graphical representation of the number, energy, and biomass of the successive trophic levels of an ecosystem. Charles Elton was a first ecologist to describe the ecological pyramid and its principals in the year 1927.

The biomass, number, and energy of organisms ranging from the producer level to the consumer level are represented in the form of a pyramid; hence, it is known as the ecological pyramid.

The base of the ecological pyramid comprises of the producers, followed by the primary and secondary consumers. The tertiary consumers hold the apex. In some food chains, the quaternary consumers are at the very apex of the food chain.

The producers generally outnumber the primary consumers, and similarly, the primary consumers outnumber the secondary consumers. And lastly, apex predators also follow the same trend as the other consumers; wherein, their numbers are considerably lower than the secondary consumers.

For example, Grasshoppers feed on crops such as cotton and wheat, which are plentiful. These grasshoppers are then preyed upon by common mice, which are comparatively less in number.

The mice are preyed upon by snakes such as cobras. Snakes are ultimately preyed on by apex predators such as the brown snake eagle.

In essence:

Grasshopper →Mice→ Cobra → Brown Snake Eagle

3. Food Web

Food web is a network of interconnected food chains. It comprises of all the food chains within a single ecosystem. It helps in understanding that plants lay the foundation of all the food chains.

Ecological Succession

"Ecological succession is a series of changes that occur in an ecological community over time."

Ecological succession is the steady and gradual change in a species of a given area with respect to the changing environment. It is a predictable change and is an inevitable process of nature as all the biotic components have to keep up with the changes in **our environment.**

The ultimate aim of this process is to reach equilibrium in the ecosystem. The community that achieves this aim is called a climax community. In an attempt to reach this equilibrium, some species increase in number while some other decreases.

Types of Ecological Succession

There are the following types of ecological succession:

Primary Succession

Primary succession is the succession that starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life.

When the planet was first formed there was no soil on earth. The earth was only made up of rocks. These rocks were broken down by microorganisms and eroded to form soil. The soil then becomes the foundation of plant life. These plants help in the survival of different animals and progress from primary succession to the climax community.

If this primary ecosystem is destroyed, secondary succession takes place.

Secondary Succession

Secondary succession occurs when the primary ecosystem gets destroyed. For eg., a climax community gets destroyed by fire. It gets recolonized after the destruction. This is known as secondary ecological succession. Small plants emerge first, followed by larger plants. The tall trees block the sunlight and change the structure of the organisms below the canopy. Finally, the climax community arrives.

Cyclic Succession

This is only the change in the structure of an ecosystem on a cyclic basis. Some plants remain dormant for the rest of the year and emerge all at once. This drastically changes the structure of an ecosystem.

Seral Community

"A seral community is an intermediate stage of ecological succession advancing towards the climax community."

A seral community is replaced by the subsequent community. It consists of simple **food webs** and food chains. It exhibits a very low degree of diversity. The individuals are less in number and the nutrients are also less.

There are seven different types of seres:

Types of Seres	Explanation
Hydrosere	Succession in aquatic habitat.
Xerosere	Succession in dry habitat.
Lithosere	Succession on a bare rock surface.
Psammosere	Succession initiating on sandy areas.
Halosere	Succession starting in saline soil or water.
Senile	Succession of microorganism on dead matter.
Eosere	Development of vegetation in an era.

Examples of Ecological Succession

Following are the important examples of ecological succession:

Acadia National Park

This national park suffered a huge wildfire. Restoration of the forest was left on to nature. In the initial years, only small plants grew on the burnt soil. After several years, the forest showed diversity in tree species. However, the trees before the fire were mostly evergreen, while the trees that grew after the fire were deciduous in nature.

Ecological Succession of Coral Reefs

Small coral polyps colonize the rocks. These polyps grow and divide to form coral colonies. The shape of the coral reefs attracts small fish and crustaceans that are food for the larger fish. Thus, a fully functional coral reef exists.

BIODIVERSITY

Biodiversity is a term which describes every living organism within a single ecosystem or habitat, including numbers and diversity of species and all environmental aspects such as temperature, oxygen and carbon dioxide levels and climate. Biodiversity can be measured globally or in smaller settings, such as ponds.

Ecological biodiversity is measured by looking at its three levels of genetic, species and ecosystem diversity.

Genetic Diversity

Genetic diversity refers to the differences in the **genetic make-up of a distinct species and to the genetic variations within a single species**. It concerns DNA (or RNA in some viruses) sequences. Humans, for example, have different eye and skin colors, hair textures, propensity for disease, reactions to pollutants, heights, hormone levels and so on. We are the same species but have genetic variations which make us diverse. This means that if one individual dies when stung by a bee, others will not and are able to carry on to ensure the success of the species.

Plants of the same species can diversify to be able to live in alternative habitats. Mangrove trees – a diverse group of around eighty different species – have diversified to successfully survive and reproduce in salt water. This change was due to genetic mutations which allowed them to move from aquatic into marine ecosystems, and so increase the biodiversity of a different region and ensure the survival of the species. As with humans, genetic diversity in other organisms can affect any aspect of that organism's make up. From size to color, to diet, to function, and everything in between.

Species Diversity

Species diversity relates to numbers and spread – how many different species live in an ecosystem and how are they distributed? When considering only the number of different species within an ecosystem we then talk of species richness. **Species richness only considers the number of different species in an ecosystem**, not their distribution.

There are approximately 391,000 different species of plant on the planet, although some are at risk of becoming extinct and many have not yet been discovered. Obviously, speaking of the distribution of every one of these plant species would take a long time. Unless as part of scientific research, global species diversity is usually described in the terms of species richness – how many species there are – although **the terms species diversity and species richness are not synonyms of one another**.

The South African gold mine mentioned earlier on has a species diversity of one which is (therefore) equally distributed. In the soil, the greatest biomass is composed of microorganisms, where fungi are by far the most common.

Ecosystem Diversity

The major habitat types from which all other smaller ecosystems derive are called terrestrial, marine and aquatic ecosystems. These three examples of ecosystem diversity contain further examples as subgroups. The marine ecosystem includes subgroups known as open marine, ocean floor, coral reef, estuary, saltwater wetland estuary, and mangrove systems. Terrestrial heads six subgroups: tundra, grasslands, taiga, deciduous forest, rainforest, and desert. The smallest ecosystem of the three main groups, the aquatic ecosystem, can be further split into estuaries, wetlands, ponds, lakes, and rivers.

However small or large a particular area of the planet, the number of ecosystems that can be found within it define its ecosystem diversity. Deserts are, on the whole, the least diverse terrestrial ecosystem but may be split into sand, rock, bush and even oasis with its own group of mini-ecosystems (aquatic, date palm, a small area of wetland at the water's edge). Tropical rainforests are the most diverse of the terrestrial ecosystems, but many of these are biodiversity hotspots. This means that an ecosystem must contain at least 1,500 species of plants found nowhere else on earth (endemic" species) but have also lost at least 70% of its primary native vegetation. Unfortunately, there are over 36 biodiversity hotspots at this moment in time, some of which have undergone up to 95% of native vegitation loss. There is an overwhelming need for conservation in the modern world.

Within these diverse ecosystems, one must also consider trophic levels, how species interact with that specific ecosystem, climate, pollution or human impact and every other variable that is part of that particular habitat.

Threats to Biodiversity

The greatest threat leading to the loss of biodiversity is the human race. As our population grows together with our need for food, water, industry, transportation, and home comforts, it takes over natural ecosystems and replaces them with unnatural ones. Even in these, other organisms can adapt and successfully reproduce, but the levels of biodiversity as compared to the replaced environment are significantly lower.

The Threat of Urbanization

The city of London, for example, is becoming home to increasingly more wildlife who have adapted to live in an urban environment. Fox populations

are large, feeding on rats, mice, and garbage. Plant life is not enough to support large populations of herbivores and in this unnatural ecosystem are in a group of their own. Instead of having a group of producers (plants) feeding primary consumers (herbivores) who feed secondary, tertiary and quaternary consumers (omnivores and carnivores), it is often human food waste that becomes the urban producer. Humans import their food from other agricultural ecosystems.

The Threat of Pollution

We have already discussed the dramatic effects of deforestation upon the climate and biodiversity. Global warming and pollution are the largest abiotic threats to biodiversity, but the cause of these abiotic threats is biotic – us. Heavy metals and plastics in the seas not only reduce the numbers of a species but can render an area completely uninhabitable. The industrial revolution of the mid-eighteenth to mid-nineteenth century in Europe turned skies black with smoke and poisoned rivers and plant life, killing consumers, too. Today, the fine dust from car exhausts largely replaces coal.

The Threat of Climate Change

Higher temperatures through climate change mean increased biodiversity in some regions (mangrove trees are moving to areas previously too cold, wine-making is taking off in areas previously unsuitable for growing grapes). In other regions, the higher temperatures cause destruction. In the winter months, for example, caribou scrape through the ice to reach plant life preserved in the equivalent of a natural refrigerator. As global temperatures rise, this extra food source decomposes and the caribou has no winter food source unless it moves much further north. Higher Arctic springtime temperatures also bring swarms of flying insects to the icy north much earlier than usual. Caribou are so distressed by these biting flies that they will even

change their migrating paths, meaning they also have to look for new sources of food instead of relying on familiar feeding grounds. In escaping from these flies, caribou also spend less time feeding. Furthermore, they also have to compete for the meager plant life when other herbivores, previously kept away by the cold, arrive and thrive through adaptive radiation.


Migrating caribou

The Threat of Invasive Species

Yet there are still many threats to biodiversity that may not (always) be the fault of the human being. The proliferation of an invasive species, for example, may be the result of an opportunistic move into another species' territory. Still, **human transportation systems are primarily to blame for the introduction of pests into other countries via air and sea**. Consider the American gray squirrel decimating red squirrel populations in England and the introduction of the Colorado beetle in Europe which caused countless potato crops to fail, for example.

The Threat of Overexploitation

Overexploitation is another threat to biodiversity, again a largely human threat. **Overfishing and overharvesting either remove competition for**

other species causes a huge shift in the stability of species richness and diversity. By removing too many of one species of fish, fishers allow other species to take over, perhaps upsetting the delicate balance between producer and consumer. Alternatively, fishers remove too many fish of a wide range of species, not immediately upsetting the balance of fish species but causing a drop in population and lower reproduction rates that allows certain types of plankton or algae to take over. The latter can cover large areas of fresh or salt water and remove the oxygen, causing a dead zone where nothing except anaerobic bacteria can survive. In agriculture, the **overharvesting of crops leads to a lack of nutrients in the soil**, where farmers then add nitrogen-containing fertilizers to make up for this loss. Nitrogen contributes greatly to global warming and climate change. A vicious circle of action and effect which slowly reduces biodiversity on first a local and finally a global scale.

Benefits of Biodiversity

Species can have instrumental or intrinsic (inherent) value. When of use to humans, either as a pleasing aspect (a pet dog) or a useful one (willow bark as a pain killer), they are instrumental. If a species has other value beyond its use to the human race, it has intrinsic value. This would include the fact that a species is part of the world's natural history. New discussions regarding the ethics of human effects upon biodiversity sway towards agreeing that every species has intrinsic value.

Without biodiversity, ecosystems would produce less. If one species of plant type produces one type of flower for one species bee, who produces honey for one species of honey badger who provides food for one cheetah, the balance is much too delicate. If a sudden heavy downpour kills most of the bees and drowns the flowers, the entire food chain is lost. **The higher the**

number of species that can be supported in an ecosystem, the higher the rate of survival for every organism inside that ecosystem. Including the human species.

Thanks to the planet's huge biodiversity we have been able to produce medicines for the sick, grow new types of crops in areas which used to suffer regular famine, enjoy the colors and scents of a fantastic range of flowers, eat a varied diet with no need for deficiencies, and explore the splendor of the world's different habitats as we travel. Biodiversity is not only necessary for survival, but it is also extremely beautiful.


Mangrove ecosystem

Pollution

Air Pollution

What Is Air Pollution?

Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole.

The Clean Air Act authorizes the U.S. Environmental Protection Agency (EPA) to protect public health by regulating the emissions of these harmful air pollutants. The NRDC has been a leading authority on this law since it was established in 1970.

What Causes Air Pollution?

"Most air pollution comes from energy use and production," says John Walke, director of the Clean Air Project, part of the Climate and Clean Air program at NRDC. "Burning fossil fuels releases gases and chemicals into the air." And in an especially destructive feedback loop, air pollution not only contributes to climate change but is also exacerbated by it. "Air pollution in the form of carbon dioxide and methane raises the earth's temperature," Walke says. "Another type of air pollution is then worsened by that increased heat: Smog forms when the weather is warmer and there's more ultraviolet radiation." Climate change also increases the production of allergenic air pollutants including mold (thanks to damp conditions caused by extreme weather and increased flooding) and pollen (due to a longer pollen season and more pollen production).

Effects of Air Pollution

"While we've made progress over the last 40-plus years improving air quality in the U.S. thanks to the Clean Air Act, climate change will make it harder in the future to meet pollution standards, which are designed to protect health," says Kim Knowlton, senior scientist and deputy director of the NRDC Science Center.

Smog and soot

These two are the most prevalent types of air pollution. Smog, or "ground-level ozone," as it is more wonkily called, occurs when emissions from combusting fossil fuels react with sunlight. Soot, or "particulate matter," is made up of tiny particles of chemicals, soil, smoke, dust, or allergens, in the form of gas or solids, that are carried in the air. The EPA's "Plain English Guide to the Clean Air Act" states, "In many parts of the United States, pollution has reduced the distance and clarity of what we see by 70 percent." The sources of smog and soot are similar. "Both come from cars and trucks, factories, power plants, incinerators, engines—anything that combusts fossil fuels such as coal, gas, or natural gas," Walke says. The tiniest airborne particles in soot—whether they're in the form of gas or solids—are especially dangerous because they can penetrate the lungs and bloodstream and worsen bronchitis, lead to heart attacks, and even hasten death.

Smog can irritate the eyes and throat and also damage the lungs—especially of people who work or exercise outside, children, and senior citizens. It's even worse for people who have asthma or allergies—these extra pollutants only intensify their symptoms and can trigger asthma attacks.

Hazardous air pollutants

These are either deadly or have severe health risks even in small amounts. Almost 200 are regulated by law; some of the most common are mercury, lead, dioxins, and benzene. "These are also most often emitted during gas or coal combustion, incinerating, or in the case of benzene, found in gasoline," Walke says. Benzene, classified as a carcinogen by the EPA, can cause eye, skin, and lung irritation in the short term and blood disorders in the long term. Dioxins, more typically found in food but also present in small amounts in the air, can affect the liver in the short term and harm the immune, nervous, and endocrine systems, as well as reproductive functions. Lead in large amounts can damage children's brains and

kidneys, and even in small amounts it can affect children's IQ and ability to learn. Mercury affects the central nervous system.

Polycyclic aromatic hydrocarbons, or PAHs, are toxic components of traffic exhaust and wildfire smoke. In large amounts, they have been linked to eye and lung irritation, blood and liver issues, and even cancer. In one recent study, the children of mothers who'd had higher PAH exposure during pregnancy had slower brain processing speeds and worse symptoms of ADHD.

Greenhouse gases

By trapping the earth's heat in the atmosphere, greenhouse gases lead to warmer temperatures and all the hallmarks of climate change: rising sea levels, more extreme weather, heat-related deaths, and increasing transmission of infectious diseases like Lyme. According to a 2014 EPA study, carbon dioxide was responsible for 81 percent of the country's total greenhouse gas emissions, and methane made up 11 percent. "Carbon dioxide comes from combusting fossil fuels, and methane comes from natural and industrial sources, including the large amounts that are released during oil and gas drilling," Walke says. "We emit far larger amounts of carbon dioxide, but methane is significantly more potent, so it's also very destructive." Another class of greenhouse gases, hydrofluorocarbons (HFCs), are thousands of times more powerful than carbon dioxide in their ability to trap heat. In October 2016, more than 140 countries reached an agreement to reduce the use of these chemicals—which are used in air conditioners and refrigerators—and find greener alternatives over time. David Doniger, director of NRDC's Climate and Clean Air program, writes, "NRDC estimates that the agreed HFC phase-down will avoid the equivalent of more than 80 billion tons of CO_2 over the next 35 years."

Pollen and mold

Mold and allergens from trees, weeds, and grass are also carried in the air, are exacerbated by climate change, and can be hazardous to health. They are not

regulated by the government and are less directly connected to human actions, but they can be considered air pollution. "When homes, schools, or businesses get water damage, mold can grow and can produce allergenic airborne pollutants," Knowlton says. "Mold exposure can precipitate asthma attacks or an allergic response, and some molds can even produce toxins that would be dangerous for anyone to inhale."

Pollen allergies are worsening because of climate change. "Lab and field studies are showing that the more carbon dioxide pollen-producing plants—especially ragweed—are grown in, the bigger they grow and the more pollen they produce," Knowlton says. "Climate change also extends the pollen production season, and some studies are beginning to suggest that ragweed pollen itself might be becoming a more potent allergen." That means more people will suffer runny noses, fevers, itchy eyes, and other symptoms.

How to Help Reduce Air Pollution

"The less gasoline we burn, the better we're doing to reduce air pollution and harmful effects of climate change," Walke says. "Make good choices about transportation. When you can, walk, ride a bike, or take public transportation. For driving, choose cars that get better miles per gallon of gas or choose an electric car." You can also investigate your power provider options—you may be able to request that your electricity be supplied by wind or solar. Buying your food locally cuts down on the fossil fuels burned in trucking or flying food in from across the country. And perhaps most important, "Support leaders who push for clean air and water and responsible steps on climate change," Walke says.

How to Protect Your Health

- "When you see in the newspaper or hear on the weather report that pollution levels are high, it may be useful to limit the time when children go outside or

you go for a jog," Walke says. Generally, ozone levels tend to be lower in the morning.

- When you do exercise outside, stay as far as you can from heavily trafficked roads. Then shower and wash your clothes to remove fine particles.
- If the air quality is bad, stay inside with windows closed.
- Wear sunscreen. When ultraviolet radiation comes through the weakened ozone layer, it can cause skin damage and skin cancer.

Water Pollution

What Is Water Pollution?

Water pollution occurs when harmful substances—often chemicals or microorganisms—contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment.

What Are the Causes of Water Pollution?

Water is uniquely vulnerable to pollution. Known as a "universal solvent," water is able to dissolve more substances than any other liquid on earth. It's the reason we have Kool-Aid and brilliant blue waterfalls. It's also why water is so easily polluted. Toxic substances from farms, towns, and factories readily dissolve into and mix with it, causing water pollution.

Categories of Water Pollution

Groundwater

When rain falls and seeps deep into the earth, filling the cracks, crevices, and porous spaces of an aquifer (basically an underground storehouse of water), it becomes groundwater—one of our least visible but most important natural resources. Nearly 40 percent of Americans rely on groundwater, pumped to the

earth's surface, for drinking water. For some folks in rural areas, it's their only freshwater source. Groundwater gets polluted when contaminants—from pesticides and fertilizers to waste leached from landfills and septic systems—make their way into an aquifer, rendering it unsafe for human use. Ridding groundwater of contaminants can be difficult to impossible, as well as costly. Once polluted, an aquifer may be unusable for decades, or even thousands of years. Groundwater can also spread contamination far from the original polluting source as it seeps into streams, lakes, and oceans.

Surface water

Covering about 70 percent of the earth, surface water is what fills our oceans, lakes, rivers, and all those other blue bits on the world map. Surface water from freshwater sources (that is, from sources other than the ocean) accounts for more than 60 percent of the water delivered to American homes. But a significant pool of that water is in peril. According to the most recent surveys on national water quality from the U.S. Environmental Protection Agency, nearly half of our rivers and streams and more than one-third of our lakes are polluted and unfit for swimming, fishing, and drinking. Nutrient pollution, which includes nitrates and phosphates, is the leading type of contamination in these freshwater sources. While plants and animals need these nutrients to grow, they have become a major pollutant due to farm waste and fertilizer runoff. Municipal and industrial waste discharges contribute their fair share of toxins as well. There's also all the random junk that industry and individuals dump directly into waterways.

Ocean water

Eighty percent of ocean pollution (also called marine pollution) originates on land—whether along the coast or far inland. Contaminants such as chemicals, nutrients, and heavy metals are carried from farms, factories, and cities by streams and rivers into our bays and estuaries; from there they travel out to sea. Meanwhile, marine debris—particularly plastic—is blown in by the wind or washed in via storm

drains and sewers. Our seas are also sometimes spoiled by oil spills and leaks—big and small—and are consistently soaking up carbon pollution from the air. The ocean absorbs as much as a quarter of man-made carbon emissions.

Point source

When contamination originates from a single source, it's called point source pollution. Examples include wastewater (also called effluent) discharged legally or illegally by a manufacturer, oil refinery, or wastewater treatment facility, as well as contamination from leaking septic systems, chemical and oil spills, and illegal dumping. The EPA regulates point source pollution by establishing limits on what can be discharged by a facility directly into a body of water. While point source pollution originates from a specific place, it can affect miles of waterways and ocean.

Nonpoint source

Nonpoint source pollution is contamination derived from diffuse sources. These may include agricultural or stormwater runoff or debris blown into waterways from land. **Nonpoint source pollution is** the leading cause of water pollution in U.S. waters, but it's difficult to regulate, since there's no single, identifiable culprit.

Transboundary

It goes without saying that water pollution can't be contained by a line on a map. Transboundary pollution is the result of contaminated water from one country spilling into the waters of another. Contamination can result from a disaster—like an oil spill—or the slow, downriver creep of industrial, agricultural, or municipal discharge.

The Most Common Types of Water Contamination

Agricultural

Not only is the agricultural sector the biggest consumer of global freshwater resources, with farming and livestock production using about 70 percent of the earth's surface water supplies, but it's also a serious water polluter. Around the world, agriculture is the leading cause of water degradation. In the United States, agricultural pollution is the top source of contamination in rivers and streams, the second-biggest source in wetlands, and the third main source in lakes. It's also a major contributor of contamination to estuaries and groundwater. Every time it rains, fertilizers, pesticides, and animal waste from farms and livestock operations wash nutrients and pathogens—such bacteria and viruses—into our waterways. Nutrient pollution, caused by excess nitrogen and phosphorus in water or air, is the number-one threat to water quality worldwide and can cause algal blooms, a toxic soup of blue-green algae that can be harmful to people and wildlife.

Sewage and wastewater

Used water is wastewater. It comes from our sinks, showers, and toilets (think sewage) and from commercial, industrial, and agricultural activities (think metals, solvents, and toxic sludge). The term also includes stormwater runoff, which occurs when rainfall carries road salts, oil, grease, chemicals, and debris from impermeable surfaces into our waterways

More than 80 percent of the world's wastewater flows back into the environment without being treated or reused, according to the United Nations; in some least-developed countries, the figure tops 95 percent. In the United States, wastewater treatment facilities process about 34 billion gallons of wastewater per day. These facilities reduce the amount of pollutants such as pathogens, phosphorus, and nitrogen in sewage, as well as heavy metals and toxic chemicals in industrial waste, before discharging the treated waters back into waterways. That's when all goes well. But according to EPA estimates, our nation's aging and easily

overwhelmed sewage treatment systems also release more than 850 billion gallons of untreated wastewater each year.

Oil pollution

Big spills may dominate headlines, but consumers account for the vast majority of oil pollution in our seas, including oil and gasoline that drips from millions of cars and trucks every day. Moreover, nearly half of the estimated 1 million tons of oil that makes its way into marine environments each year comes not from tanker spills but from land-based sources such as factories, farms, and cities. At sea, tanker spills account for about 10 percent of the oil in waters around the world, while regular operations of the shipping industry—through both legal and illegal discharges—contribute about one-third. Oil is also naturally released from under the ocean floor through fractures known as seeps.

Radioactive substances

Radioactive waste is any pollution that emits radiation beyond what is naturally released by the environment. It's generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that use radioactive materials for research and medicine. Radioactive waste can persist in the environment for thousands of years, making disposal a major challenge. Consider the decommissioned Hanford nuclear weapons production site in Washington, where the cleanup of 56 million gallons of radioactive waste is expected to cost more than $100 billion and last through 2060. Accidentally released or improperly disposed of contaminants threaten groundwater, surface water, and marine resources.

What Are the Effects of Water Pollution?

On human health

To put it bluntly: Water pollution kills. In fact, it caused 1.8 million deaths in 2015, according to a study published in *The Lancet*. Contaminated water can also

make you ill. Every year, unsafe water sickens about 1 billion people. And low-income communities are disproportionately at risk because their homes are often closest to the most polluting industries.

On the environment

In order to thrive, healthy ecosystems rely on a complex web of animals, plants, bacteria, and fungi—all of which interact, directly or indirectly, with each other. Harm to any of these organisms can create a chain effect, imperiling entire aquatic environments.

When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn reduces oxygen levels in the water. This dearth of oxygen, known as eutrophication, suffocates plants and animals and can create "dead zones," where waters are essentially devoid of life. In certain cases, these harmful algal blooms can also produce neurotoxins that affect wildlife, from whales to sea turtles.

What Can You Do to Prevent Water Pollution?

With your actions

It's easy to tsk-tsk the oil company with a leaking tanker, but we're all accountable to some degree for today's water pollution problem. Fortunately, there are some simple ways you can prevent water contamination or at least limit your contribution to it:

- Reduce your plastic consumption and reuse or recycle plastic when you can.
- Properly dispose of chemical cleaners, oils, and non-biodegradable items to keep them from ending up down the drain.
- Maintain your car so it doesn't leak oil, antifreeze, or coolant.
- If you have a yard, consider landscaping that reduces runoff and avoid applying pesticides and herbicides.
- If you have a pup, be sure to pick up its poop.

Soil Pollution

What is Soil Pollution?

Soil pollution refers to the contamination of soil with anomalous concentrations of toxic substances. It is a serious environmental concern since it harbours many health hazards. For example, exposure to soil containing high concentrations of benzene increases the risk of contracting leukaemia. An image detailing the discolouration of soil due to soil pollution is provided below.

It is important to understand that all soils contain compounds that are harmful/toxic to human beings and other living organisms. However, the concentration of such substances in unpolluted soil is low enough that they do not pose any threat to the surrounding ecosystem. When the concentration of one or more such toxic substances is high enough to cause damage to living organisms, the soil is said to be contaminated.

The root cause of soil pollution is often one of the following:

- Agriculture (excessive/improper use of pesticides)
- Excessive industrial activity
- Poor management or inefficient disposal of waste

The challenges faced in soil remediation (decontamination of soil) are closely related to the extent of soil pollution. The greater the contamination, the greater the requirement of resources for remediation.

What are the Pollutants that Contaminate Soil?

Some of the most hazardous soil pollutants are xenobiotics - substances that are not naturally found in nature and are synthesized by human beings. The term 'xenobiotic' has Greek roots - 'Xenos' (foreigner), and 'Bios' (life). Several xenobiotics are known to be carcinogens.

The different types of pollutants that are found in contaminated soil are listed in this subsection.

Heavy Metals

The presence of heavy metals (such as lead and mercury, in abnormally high concentrations) in soils can cause it to become highly toxic to human beings. Some metals that can be classified as soil pollutants are tabulated below.

Toxic Metals that Cause Soil Pollution		
Arsenic	Mercury	Lead
Antimony	Zinc	Nickel
Cadmium	Selenium	Beryllium
Thallium	Chromium	Copper

These metals can originate from several sources such as mining activities, agricultural activities, electronic waste (e-waste), and medical waste.

Industrial Waste

The discharge of industrial waste into soils can result in soil pollution. Some common soil pollutants that can be sourced to industrial waste are listed below.

- Chlorinated industrial solvents
- Dioxins produced from the manufacture of pesticides and the incineration of waste.
- Plasticizers/dispersants
- Polychlorinated biphenyls (PCBs)

The petroleum industry creates many petroleum hydrocarbon waste products. Some of these wastes, such as benzene and methylbenzene, are known to be carcinogenic in nature.

Pesticides

Pesticides are substances (or mixtures of substances) that are used to kill or inhibit the growth of pests. Common types of pesticides used in agriculture include:

- Herbicides - used to kill/control weeds and other unwanted plants.
- Insecticides - used to kill insects.
- Fungicides - used to kill parasitic fungi or inhibit their growth.

However, the unintentional diffusion of pesticides into the environment (commonly known as 'pesticide drift') poses a variety of environmental concerns such as water pollution and soil pollution.

What are the Processes that Cause Soil Pollution?

Soil pollution can be broadly classified into two categories -

- Naturally caused soil pollution
- Anthropogenic soil pollution (caused by human activity)

Natural Pollution of Soil

In some extremely rare processes, some pollutants are naturally accumulated in soils. This can occur due to the differential deposition of soil by the atmosphere. Another manner in which this type of soil pollution can occur is via the transportation of soil pollutants with precipitation water.

An example of natural soil pollution is the accumulation of compounds containing the perchlorate anion (ClO_4^-) in some dry, arid ecosystems. It is important to note that some contaminants can be naturally produced in the soil under the effect of certain environmental conditions. For example, perchlorates can be formed in soils containing chlorine and certain metals during a thunderstorm.

Anthropogenic Soil Pollution

Almost all cases of soil pollution are anthropogenic in nature. A variety of human activities can lead to the contamination of soil. Some such processes are listed below.

- The demolition of old buildings can involve the contamination of nearby soil with asbestos.
- Usage of lead-based paint during construction activities can also pollute the soil with hazardous concentrations of lead.
- Spillage of petrol and diesel during transportation can contaminate soils with the hydrocarbons found in petroleum.

- Activities associated with metal casting factories (foundries) often cause the dispersion of metallic contaminants into the nearby soils.
- Underground mining activities can cause the contamination of land with heavy metals.
- Improper disposal of highly toxic industrial/chemical waste can severely pollute the soil. For example, the storage of toxic wastes in landfills can result in the seepage of the waste into the soil. This waste can go on to pollute groundwater as well.
- Chemical pesticides contain several hazardous substances. Excessive and inefficient use of chemical pesticides can result in severe soil pollution.
- Sewage produced in urbanized areas can also contaminate soil (if not disposed of correctly). These wastes may also contain several carcinogenic substances.

Other forms of waste that can pollute soil include nuclear waste, e-waste, and coal ash.

Effects on Human Beings

Soil contaminants can exist in all three phases (solid, liquid, and gaseous). Therefore, these contaminants can find their way into the human body via several channels such as direct contact with the skin or through the inhalation of contaminated soil dust.

The short term effects of human exposure to polluted soil include:

- Headaches, nausea, and vomiting.
- Coughing, pain in the chest, and wheezing.
- Irritation of the skin and the eyes.
- Fatigue and weakness.

A variety of long-term ailments have been linked to soil pollution. Some such diseases are listed below.

- Exposure to high levels of lead can result in permanent damage to the nervous system. Children are particularly vulnerable to lead.
- Depression of the CNS (Central Nervous System).
- Damage to vital organs such as the kidney and the liver.
- Higher risk of developing cancer.

It can be noted that many soil pollutants such as petroleum hydrocarbons and industrial solvents have been linked to congenital disorders in humans. Thus, soil pollution can have several negative effects on human health.

Effects on Plants and Animals

Since soil pollution is often accompanied by a decrease in the availability of nutrients, plant life ceases to thrive in such soils. Soils contaminated with inorganic aluminium can prove toxic to plants. Also, this type of pollution often increases the salinity of the soil, making it inhospitable for the growth of plant life.

Plants that are grown in polluted soil may accumulate high concentrations of soil pollutants through a process known as bioaccumulation. When these plants are consumed by herbivores, all the accumulated pollutants are passed up the food chain. This can result in the loss/extinction of many desirable animal species. Also, these pollutants can eventually make their way to the top of the food chain and manifest as diseases in human beings.

Effects on the Ecosystem

- Since the volatile contaminants in the soil can be carried away into the atmosphere by winds or can seep into underground water reserves, soil pollution can be a direct contributor to air and water pollution.
- It can also contribute towards acid rain (by releasing huge quantities of ammonia into the atmosphere).
- Acidic soils are inhospitable to several microorganisms that improve soil texture and help in the decomposition of organic matter. Thus, the negative effects of soil pollution also impact soil quality and texture.
- Crop yield is greatly affected by this form of pollution. In China, over 12 million tons of grain (worth approximately 2.6 billion USD) is found to be unfit for human consumption due to contamination with heavy metals (as per studies conducted by the China Dialogue).

MARINE POLLUTION

Definition:

Marine pollution refers to direct or indirect introduction by humans of substances or energy into the marine environment (including estuaries), resulting in harm to living resources, hazards to human health, hindrances to marine activities including fishing, impairment of the quality of sea water and reduction of amenities.

Types of Ocean Pollution

Pollution of the earth's largest bodies of waters, oceans, can take several forms. Once contaminated by these eight pollution sources, many delicate ecosystems need a long time to recover.

There are various ways in which pollution enters the ocean. Some of them are:

1. Sewage

Pollution can enter the ocean directly. Sewage or polluting substances flow through sewage, rivers, or drainages directly into the ocean. This is often how minerals and substances from mining camps find their way into the ocean.

The release of other chemical nutrients into the ocean's ecosystem leads to reductions in oxygen levels, the decay of plant life, a severe decline in the quality of the seawater itself. As a result, all levels of oceanic life, plants and animals, are highly affected.

2. Toxic Chemicals From Industries

Industrial and agricultural waste is another most common form of wastes that are directly discharged into the oceans, resulting in ocean pollution. The dumping of toxic liquids in the ocean directly affects the marine life as

they are considered hazardous and secondly, they raise the temperature of the ocean, known as thermal pollution, as the temperature of these liquids is quite high. Animals and plants that cannot survive at higher temperatures eventually perish.

3. Land Runoff

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.
Often, this water picks up man-made, harmful contaminants that pollute the ocean, including fertilizers, petroleum, pesticides and other forms of soil contaminants. Fertilizers and waste from land animals and humans can be a huge detriment to the ocean by creating dead zones.

4. 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 once it entraps them. Crude oil is also extremely difficult to clean up, unfortunately meaning that when it is split; it is usually there to stay.
In addition, many ships lose thousands of crates each year due to storms, emergencies, and accidents. This causes noise pollution (excessive, unexpected noise that interrupts the balance of life, most often caused by modes of transportation), excessive algae, and ballast water. Often times, other species can also invade an ecosystem and do harm to it by interrupting the life cycles of other organisms, causing a clash of nature that has already been damaged by the overflow of pollution.

5. Ocean Mining

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 into the ocean.

While we have yet the gathering of scientific evidence to fully explain the harsh environmental impacts of deep-sea mining, we do have a general idea that deep sea mining causes damage to the lowest levels of the ocean and increase the toxicity of the region. This permanent damage dealt also causes leaking, corrosion and oil spills that only drastically further hinder the ecosystem of the region.

6. Littering

Pollution from the atmosphere is, believe it or not, a huge source of ocean pollution. This occurs when objects that are far inland are blown by the wind over long distances and end up in the ocean. These objects can be anything from natural things like dust and sand to man-made objects such as debris and trash. Most debris, especially plastic debris, cannot decompose and remains suspended in the ocean's current for years.

Animals can become snagged on the plastic or mistake it for food, slowly killing them over a long period of time. Animals who are most often the victims of plastic debris include turtles, dolphins, fish, sharks, crabs, sea birds, and crocodiles.
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 Co2 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.

Effects of Ocean Pollution

1. Effect of Toxic Wastes on Marine Animals

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

2. Disruption to the Cycle of Coral Reefs

Oil spill floats on the surface of the water and prevents sunlight from reaching to marine plants and affects the process of photosynthesis. Skin irritation, eye irritation, lung and liver problems can impact marine life over a long period of time.

3. Depletes Oxygen Content in Water

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. When oxygen levels go down, the chances of survival of marine

animals like whales, turtles, sharks, dolphins, penguins for a long time also goes down.

4. Failure in the Reproductive System of Sea Animals

Industrial and agricultural wastes include various poisonous chemicals that are considered hazardous for marine life. Chemicals from pesticides can accumulate in the fatty tissue of animals, leading to failure in their reproductive system.

5. Effect on Food Chain

Chemicals used in industries and agriculture get washed into the rivers and from there are carried into the oceans. These chemicals do not get dissolved and sink at the bottom of the ocean. Small animals ingest these chemicals and are later eaten by large animals, which then affects the whole food chain.

6. Affects Human Health

Animals from impacted food chain are then eaten by humans which affects their health as toxins from these contaminated animals get deposited in the tissues of people and can lead to cancer, birth defects or long term health problems.

Control Measures of Marine Pollution:

a. Introduction of sewage treatment plants to reduce BOD of final product before discharging into sea.

b. Cleaning oil from surface waters and contaminated beaches can be accelerated through the use of chemical dispersants which can be sprayed on the oil.

c. Load on top system reduce oil pollution cleaned with high pressures jets of water.

d. Crude oil washing: The clingage is removed by jets of crude oil while the cargo is being unloaded.

e. Skimming off the oil surface with a section device.

f. Spreading a high density powder over the oil spill, so that oil can I be sunk to the bottom.

Noise Pollution

What is Noise Pollution?

The word noise is derived from a Latin word 'Nausea' which means sickness in which one feels to vomit. Noise is the unpleasant and undesirable sound which leads to discomfort to human beings. **The intensity of sound is measured in decibels (dB)**. The faintest sound which can be heard by Human ear is 1 Db. Due to increasing noise around the civilizations; noise pollution has become a matter of concern. Some of its major causes are vehicles, aircraft, industrial machines, loudspeakers, crackers etc. Some other appliances also contribute to noise pollution like television, transistor, radio, etc. when used at high volume.

Types of Noise Pollution

Following are the three types of pollution:

- Transport Noise
- Neighbourhood Noise
- Industrial Noise

Transport Noise

It mainly consists of traffic noise which has increased in recent years with the increase in the number of vehicles. The increase in noise pollution leads to deafening of older people, headache, hypertension, etc.

Neighbourhood Noise

The noise from gadgets, household utensils etc. Some of the main sources are musical instruments, transistors, loudspeakers etc.

Industrial Noise

It is the high-intensity sound which is caused by heavy industrial machines. According to many researches industrial noise pollution damages the hearing ability to around 20%.

Causes and Sources of Noise Pollution

Following are the causes and sources of noise pollution:

- **Industrialization:** Industrialization has led to an increase in noise pollution as the use of heavy machinery such as generators, mills, huge exhaust fans, etc are used resulting in the production of unwanted noise.
- **Vehicles:** Increased number of vehicles on the roads are the second reason for noise pollution.
- **Events:** Weddings, public gatherings involve loudspeakers to play music resulting in the production of unwanted noise in the neighbourhood.
- **Construction sites:** Mining, construction of buildings, etc add to the noise pollution.

Noise Pollution Examples

Following are the examples of noise pollution:

- Unnecessary usage of horns
- Using loudspeakers either for religious functions or for political purposes
- Unnecessary usage of fireworks
- Industrial noise
- Construction noise
- Noise from transportation such as railway and aircraft

Effects of Noise Pollution on Human Health

Noise pollution can be hazardous to human health in the following ways:

- **Hypertension:** It is a direct result of noise pollution which is caused due to elevated blood levels for a longer duration.
- **Hearing loss:** Constant exposure of human ears to loud noise that are beyond the range of sound that human ears can withstand damages the eardrums resulting in loss of hearing.
- **Sleeping disorders:** Lack of sleep might result in fatigue and low energy level throughout day affecting everyday activities. Noise pollution hampers the sleep cycles leading to irritation and uncomfortable state of mind.
- **Cardiovascular issues:** Heart related problems such as blood pressure level, stress, and cardiovascular diseases might come up in a normal person and person suffering from any of these diseases might feel the sudden shoot up in the level.

Prevention of Noise Pollution

Some noise pollution preventive measures are provided in the points below.

- Honking in public places like teaching institutes, hospital, etc. should be banned.
- In commercial, hospital, and industrial buildings adequate soundproof systems should be installed.
- Musical instruments sound should be controlled to desirable limits.
- Dense tree cover is useful in noise pollution prevention.
- Explosives should be not used in forest, mountainous, and mining areas.

Thermal Pollution

An increase in the optimum water temperature by industrial process (steel factories, electric power houses and atomic power plants) may be called as "Thermal Pollution." Many industries generate their own power and use water to cool their generator.

This hot water is released into the system from where it was drawn, causing a warming trend of surface water. If the system is poorly flushed, a permanent increase in the temperature may result. However, if the water is released into the well flushed system, permanent increase in temperature does not occur.

Effects:

Many organisms are killed instantly by the hot water resulting into a high mortality. It may bring other disturbance in the ecosystem. The egg of fish may hatch early or fail to hatch at all. It may change the diurnal and seasonal behaviour and metabolic responses of organisms. It may lead to unplanned migration of aquatic animals.

Macro-phytic population may also be changed. As temperature is an important limiting factor, serious changes may be brought about even by a slight increase in temperature in a population. For minimising thermal pollution, hot water should be cooled before release from factories and removal of forest canopies and irrigation return flows should be prohibited.

Causes or Sources of Thermal Pollution:

The various causes of thermal pollution are as follows:

(1) Coal-fired Power Plants:

Some thermal power plants use coal as fuel. Coal-fired power plants constitute the major source of the thermal pollution.

(2) Industrial Effluents:

Industries generating electricity require large amount of Cooling water for heat removal. Other industries like textile, paper, and pulp and sugar industry also release heat in water, but to a lesser extent.

(3) Nuclear Power Plants:

Nuclear power plants emit a large amount of unutilized heat and traces of toxic radio nuclear into nearby water streams. Emissions from nuclear reactors and processing installations are also responsible for increasing the temperature of water bodies.

(4) Hydro Electric Power:

Generation of hydro-electric power also results in negative thermal loading of water bodies.

(5) Domestic Sewage:

Domestic sewage is often discharged into rivers, lakes, canals or streams without waste treatment. The municipal water sewage normally has a higher temperature than receiving water. With the increase in temperature of the receiving water the dissolved oxygen content (DO) decreases and the demand of oxygen increases and anaerobic conditions occur.

Control of Thermal Pollution:

Control of thermal pollution is necessary as its detrimental effects on aquatic ecosystem may be detrimental in the future. Viable solutions to chronic thermal discharge into water bodies are as follows:

(1) Cooling Ponds:

Cooling ponds or reservoirs constitute the simplest method of controlling thermal discharges. Heated effluents on the surface of water in cooling ponds maximize dissipation of heat to the atmosphere and minimize the water area and volume. This is the simplest and cheapest method which cools the water to a considerable low temperature. However, the technique alone is less desirable and inefficient in terms of air-water contact.

(2) Cooling Towers:

Using water from water sources for cooling purposes, with subsequent return to the water body after passing through the condenser is termed as cooling process. In order to make the cooling process more effective, cooling towers are designed to control the temperature of water. In-fact, cooling towers are used to dissipate the recovered waste heat so as to eliminate the problems of thermal pollution.

(3) Artificial Lake:

Artificial lakes are man-made bodies of water which offer possible alternative to once through cooling. The heated effluents may be discharged into the lake at one end and the water for cooling purposes may be withdrawn from the other end. The heat is eventually dissipated through evaporation.

These lakes have to be rejuvenated continuously. A number of methods have been suggested and developed for converting the thermal effluents from power plants into useful heat resources for maximing the benefits.

Definitions

Risk or danger to human health or the environment exposed by the radiation emanating from the atomic nuclei is called as nuclear hazard.
(OR)
Nuclear hazard is an actual or potential release of radioactive material at a commercial nuclear power plant or a transportation accident.

Sources

The sources of radioactivity include both natural and manmade.

Natural sources

- Cosmic rays from outer space
- Emissions from radioactive materials in the earth's crust (rocks, marine sediments etc) Man-made sources include the nuclear wastes produced during
- Mining and processing of radioactive ores
- Use of radioactive materials in power plants

- Use of radioactive isotopes in medical technology (x-ray machines, radioisotopes used in medicine)
- Industrial applications include wastes from nuclear reactors
- Research applications: radioactive fallouts during nuclear weapons testing.
- In a nuclear power plant, any leak or accident taking place emit nuclear radiation. In either case it results in nuclear hazard.
- Nuclear tests Conducted under the ground or under oceans which also release radiation.
- Uranium mining and milling, Nuclear reactors and reprocessing of nuclear fuel cause nuclear pollution.

Effects

Studies shown that the health effects due to radiation are dependent on the level of dose, kind of radiation, duration of exposure and types of cells irradiated. Radiation effects can be somatic or genetic. **Somatic affects** the function of cells and organs. It causes damages to cell membranes, mitochondria and cell nuclei resulting in abnormal cell functions, cell division, growth and death. **Genetic affects** the future generations. Radiations can cause mutations, which are changes in genetic make up of cells. These effects are mainly due to the damages to DNA molecules. People suffer from blood cancer and bone cancer if exposed to

doses around 100 to 1000 roentgens. Instantaneous deaths on exposure in the event if disasters are many.

Control measures

- Laboratory generated nuclear wastes should be disposed off safely and scientifically.
- Nuclear power plants should be located in areas after careful study of the geology of the area, tectonic activity and meeting other established conditions.
- Appropriate protection against occupational exposure
- Leakage of radioactive elements from nuclear reactors, careless use of radioactive elements as fuel and careless handling of radioactive isotopes must be prevented.
- Safety measure against accidental release of radioactive elements must be ensured in nuclear plants.
- Unless absolutely necessary, one should not frequently go for diagnosis by x-rays.
- Regular monitoring of the presence of radioactive substance in high risk area should be ensured.

Solid-waste management

Solid-waste management, the collecting, treating, and disposing of solid material that is discarded because it has served its

purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease—that is, diseases spread by rodents and insects. The tasks of solid-waste management present complex technical challenges. They also pose a wide variety of administrative, economic, and social problems that must be managed and solved.

Various Sources of Solid Waste

Everyday, tonnes of solid waste is disposed off at various landfill sites. This waste comes from homes, offices, industries and various other agricultural related activities. These landfill sites produce foul smell if waste is not stored and treated properly. It can pollute the surrounding air and can seriously affect the health of humans, wildlife and our environment. The following are major sources of solid waste:

Residential

Residences and homes where people live are some of the major sources of solid waste. Garbage from these places include food wastes, plastics, paper, glass, leather, cardboard, metals, yard wastes, ashes and special wastes like bulky household items like electronics, tires, batteries, old mattresses and used oil. Most homes have garbage bins where they can throw away their solid wastes in and later the bin is emptied by a garbage collecting firm or person for treatment.

Industrial

Industries are known to be one of the biggest contributors of solid waste. They include light and heavy manufacturing industries, construction sites, fabrication plants, canning plants, power and chemical plants. These industries produce solid waste in form of housekeeping wastes, food wastes, packaging wastes, ashes, construction and demolition materials, special wastes, medical wastes as well as other hazardous wastes.

Commercial

Commercial facilities and buildings are yet another source of solid waste today. Commercial buildings and facilities in this case refer to hotels, markets, restaurants, go downs, stores and office buildings. Some of the solid wastes generated from these places include plastics, food wastes, metals, paper, glass, wood, cardboard materials, special wastes and other hazardous wastes.

Institutional

The institutional centers like schools, colleges, prisons, military barracks and other government centers also produce solid waste. Some of the common solid wastes obtained from these places include glass, rubber waste, plastics, food wastes, wood, paper, metals, cardboard materials, electronics as well as various hazardous wastes.

Construction and Demolition Areas

Construction sites and demolition sites also contribute to the solid waste problem. Construction sites include new construction sites for buildings and roads, road repair sites, building renovation sites and building demolition sites. Some of the solid wastes produced in these places include steel materials, concrete, wood, plastics, rubber, copper wires, dirt and glass.

Municipal services

The urban centers also contribute immensely to the solid waste crisis in most countries today. Some of the solid waste brought about by the municipal services include, street cleaning, wastes from parks and beaches, wastewater treatment plants, landscaping wastes and wastes from recreational areas including sludge.

Treatment Plants and Sites

Heavy and light manufacturing plants also produce solid waste. They include refineries, power plants, processing plants, mineral extraction plants and chemicals plants. Among the wastes produced by these plants include, industrial process wastes, unwanted specification products, plastics, metal parts just to mention but a few.

Agriculture

Crop farms, orchards, dairies, vineyards and feedlots are also sources of solid wastes. Among the wastes they produce include agricultural wastes, spoiled food, pesticide containers and other hazardous materials.

Biomedical
This refers to hospitals and biomedical equipment and chemical manufacturing firms. In hospitals there are different types of solid wastes produced. Some of these solid wastes include syringes, bandages, used gloves, drugs, paper, plastics, food wastes and chemicals. All these require proper disposal or else they will cause a huge problem to the environment and the people in these facilities.

Effects of Poor Solid Waste Management

Due to improper waste disposal systems particularly by municipal waste management teams, wastes heap up and become a problem. People clean their homes and places of work and litter their surroundings which affects the environment and the community.
This type of dumping of waste materials forces biodegradable materials to rot and decompose under improper, unhygienic and uncontrolled conditions. After a few days of decomposition, a foul smell is produced and it becomes a **breeding ground for different types of disease** causing insects as well as infectious organisms. On top of that, it also spoils the aesthetic value of the area.
Solid wastes from industries are a source of toxic metals, hazardous wastes, and chemicals. When released to the environment, the solid wastes **can cause biological and physicochemical** problems to the environment and may affect or alter the productivity of the soils in that particular area. Toxic materials and chemicals **may seep into the soil and pollute the ground water**. During the process of collecting solid waste, the hazardous wastes usually mix with ordinary garbage and other flammable wastes making the disposal process even harder and risky.
When hazardous wastes like pesticides, batteries containing lead, mercury or zinc, cleaning solvents, radioactive materials, e-waste and plastics are mixed up with paper and other scraps are burned they produce dioxins and gasses. These **toxic gases have a potential of causing various diseases including cancer**.

Save

Methods of Solid Waste Management

There are different methods of solid waste management. The following are some of the recognized methods:

Sanitary Landfill

This is the most popular solid waste disposal method used today. Garbage is basically spread out in thin layers, compressed and covered with soil or plastic foam. Modern landfills are designed in such a way that the bottom of the landfill is covered with an impervious liner which is usually made of several layers of thick plastic and sand. This liner protects the ground water from being contaminated because of leaching or percolation. When the landfill is full, it is covered with layers of sand, clay, top soil and gravel to prevent seepage of water.

Incineration

This method involves burning of solid wastes at high temperatures until the wastes are turned into ashes. Incinerators are made in such a way that they do not give off extreme amounts of heat when burning solid wastes. This method of solid waste management can be done by individuals, municipalities and even institutions. The good thing about this method is the fact that it reduces the volume of waste up to 20 or 30% of the original volume.

Recovery and Recycling

Recycling or recovery of resources is the process of taking useful but discarded items for next use. Traditionally, these items are processed and cleaned before they are recycled. The process aims at reducing energy loss, consumption of new material and reduction of landfills.

Composting

Due to lack of adequate space for landfills, biodegradable yard waste is allowed to decompose in a medium designed for the purpose. Only biodegradable waste materials are used in composting. Good quality environmentally friendly manure is formed from the compost and can be used for agricultural purposes.

Pyrolysis

This is method of solid waste management whereby solid wastes are chemically decomposed by heat without presence of oxygen. This usually occurs under pressure and at temperatures of up to 430 degrees Celsius. The solid wastes are changed into gasses, solid residue and small quantities of liquid.

In summary, proper solid waste management is an integral part of environmental conservation that should be observed by individuals and companies globally. This will keep the environment clean and reduce health and settlement problems.

ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

Over population and pollution are potent ecological forces impinging upon man by affecting the quality of the environment. All efforts aimed at bringing more and more people above the poverty line actually increase the pressure on natural resources. Unmindful exploitation of the finite resources of the biosphere has a severe ecological backlash because no development is sustainable unless it is environmentally compatible. Environmental compatibility demands that the economic and social development should be linked with environmental management.

Articles 48.A and 51.A of our constitution provide for environmental protection. According to the National Committee of Environment-Planning and Co-ordination, the framework for environmental protection aims at:

(a) Control of environmental pollution

(b) Conservation of natural resources

(c) Land management

(d) Development of non polluting sources of energy

(e) Environmental education

(f) Environmental laws.

Pollution is the burning issue of the day at the global level. A combined effort to control pollution has to be made by all government agencies, technologists, industrialists, agriculturists and last but not the least the common man.

Several measures were recommended by the scientists participating in the conference, e.g.:

(a) The first step should be to identify those causes of pollution that have global implications, and to devise protective measures to be adopted.

(b) The second step should be to find out the carrying capacity of the environment and reduce the emission of the major sources of pollution.

(c) The third step should be to find a neutralizer for each type of pollutant.

(d) The fourth step should be to ensure that anti-pollution measures are adopted by all industries.

(e) The fifth step should be the identification of areas where the cause of pollution is poverty and lack of environmental education. Contamination of food and water are the basic causes of pollution in such areas.

(f) Most important is initiation of adequate research to devise measures for controlling pollution.

Environmental monitoring is urgently required for controlling pollution. This involves:

(a) Careful scrutinisation of the environmental characteristics.

(b) Laying down the standards of environmental quality

(c) Regular assessment of the above mentioned environmental characteristics.

(d) Keeping track of the changes in the environmental characteristics and educating people about the pollution due to these changes.

(e) Devising measures to combat the menace of pollution.

(f) Enacting environmental laws and taking legal action against environmental offenders.

Efforts are required to be made by each individual to control pollution. These efforts include:

(a) Installation of proper sewage disposal methods.

(b) Dumping of non biodegradable wastes in low lying areas.

(c) Installation of gobar gas plants in areas of high availability of cow dung.

(d) Reduction of smoke emission and treatment of chimney smoke to remove solid carbon particles.

(e) Judicious use of fertilisers, pesticides and detergents (Detergents of low- level phosphate content are less harmful).

DISASTER MANAGEMENT

Geological processes like earthquakes, volcanoes, floods and landslides are normal natural events which have resulted in the formation of the earth that we have today. They are however disastrous in their impact when they affect human settlements.

Types of Disasters:

There are two types of disasters:

(i) Natural Disasters:

The disasters that are caused by nature are termed as natural disasters e.g., earthquake, cyclone etc.

(ii) Man-made Disaster:

The disasters which are caused as a result of human activities are termed as Man-Made Disasters e.g., Road accident, terrorist attack.

Natural Disasters:

1. Earthquake:

Earthquake is a sudden and violent shaking of ground causing great destruction as a result of movement of earth's crust. An earthquake has the potential to tsunami or volcanic eruption.

Earthquake of magnitude 9.2 on the Richter's scale in 2004 in Indonesia is the second largest earthquake ever recorded. The deadliest earthquake happened in Central China, killing over 800,000 in 1556. People during that time and region lived in caves and died from the caves collapsing.

Earthquake mitigation strategies:

a. Existing critical facilities built on reclaimed land should be inspected and retrofitted if necessary to ensure earthquake resistance.

b. Future critical facilities should not be located on reclaimed land because of the high potential for liquefaction.

c. Older unreinforced masonry buildings should be inspected and retrofitted if necessary to increase earthquake resistance.

d. Older unreinforced masonry buildings should not be used for critical functions.

2. Cyclone:

Cyclones (or more properly called Tropical Cyclones) are a type of severe spinning storm that occurs over the ocean near the tropics.

Cyclone mitigation strategies:

a. Future critical facilities should not be located in areas of accelerated winds.

b. The most significant aspect of structural damage to buildings by high velocity wind results from roof damage. The roofs of existing

buildings should be inspected and if necessary retrofitted to adequate standards.

c. The roofs of existing critical facilities should be retrofitted to a higher standard to ensure wind resistance.

d. Building openings such as windows and doors also suffer damage from high velocity winds. These openings if not constructed of wood or metal should be protected with shutters or temporary covers of adequate design.

5. Floods:

Flooding is the unusual presence of water on land to a depth which affects normal activities. Flooding can arise from: overflowing rivers (river flooding), heavy rainfall over a short duration (flash floods), or an unusual inflow of sea water onto land (ocean flooding). Ocean flooding can be caused by storms such as hurricanes (storm surge), high tides (tidal flooding), seismic events (tsunami) or large landslides.

Flood mitigation strategies:

a. Watercourses which pass through significant settlement areas should be properly configured and lined with concrete.

b. Existing bridges should be inspected to determine which ones are too low or which have support pillars within the watercourse channel. Where possible these should be replaced as these features restrict water flow and cause the channels to be easily blocked with debris.

c. Future bridges should not be built with these undesirable features.

d. Buildings constructed adjacent to watercourses should be elevated by at least one meter to prevent potential flood inundation.

e. Critical facilities should not be located adjacent to watercourses.

Landslides

Landslides are simply defined as the mass movement of rock, debris or earth down a slope and have come to include a broad range of motions whereby falling, sliding and flowing under the influence of gravity dislodges earth material. They often take place in conjunction with earthquakes, floods and volcanoes. At times, prolonged rainfall causing heavy block the flow or river for quite some time. The formation of river blocks can cause havoc to the settlements downstream on it's bursting. In the hilly terrain of India including the Himalayas, landslides have been a major and widely spread natural disaster the often strike life and property and occupy a position of major concern

The two regions most vulnerable to landslides are the Himalayas and the Western Ghats. The Himalayas mountain belt comprise of tectonically unstable younger geological formations subjected to severe seismic activity. The Western Ghats and nilgiris are geologically stable but have uplifted plateau margins influenced by neo- tectonic activity. Compared to Western Ghats region, the slides in the Himalayas region are huge and massive and in most cases the overburden along with the underlying litho logy is displaced during sliding particularly due to the seismic factor.

Landslides Zonation Mopping is a modern method to identify landslides prone areas and has been in use in India since 1980s The major parameters that call for evaluation are as follows:

1. Slope-Magnitude, length and Direction
2. Soil thickness
3. Relative relief
4. Land use
5. Drainage- pattern and density
6. Landslide affected population

Causes of Landslides

Landslides can be caused by
1. Poor ground conditions
2. Geomorphic phenomena
3. Natural physical forces
4. Quite often due to heavy spells of rainfall coupled with impeded drainage.

A Checklist of Causes of Landslides Ground Causes

1. Weak, sensitivity, or weathered materials

2. Adverse ground structure (joints, fissures etc.)
3. Physical property variation (permeability, plasticity etc)

Morphological Causes

- Ground uplift (volcanic, tectonic etc)
- Erosion (wind, water)
- Scour4. Deposition loading in the slope crest.
- Vegetation removal (by forest fire, drought etc)

Physical Causes

- Prolonged precipitation
- Rapid draw- down
- Earthquake
- Volcanic eruption
- Thawing
- Shrink and swell
- Artesian pressure

Man- made Causes

- Excavation (particularly at the toe of slope
- Loading of slope crest
- Draw -down (of reservoir)
- Deforestation
- Irrigation
- Mining
- Artificial vibrations
- Water impoundment and leakage from utilities

Man-made Disasters:

1. Road Accidents:

Road accidents are common in India due to reckless driving, untrained drivers and poor maintenance of roads and vehicles. According to Lifeline Foundation, the Ahmedabad based organization working for road safety, India accounts for 13 per cent of road accident fatalities worldwide.

With 130,000 deaths in 2007, India tops in the number of people killed in road accidents, surpassing China's 90,000. Most of these

deaths occurred due to bad road designs and lack of proper traffic management systems to separate different streams of traffic.

2. Building and Bridge Collapse:
Building collapses are frequent in India where construction is often hastily done, with little regard for safety regulations, particularly in the western part of the country.

3. Terrorist Attack:
Devastating acts such as the terrorist attacks on the World Trade Centre and the Pentagon have left many concerned about the possibility of future incidents in the United States and their potential impact. Terrorism may involve devastating acts using weapons of mass destruction ranging from chemical agents, biological hazards, a radiological or nuclear device, and other explosives.

Mitigation strategies for man-made disasters:
a. For road accidents, traffic rules and regulations need to be followed strictly.

b. For building and bridge collapse, standard building materials should be used.

c. Moreover, more and more public awareness should be made to minimize the effects of man-made disasters.

UNIT-6 (Ch-4)

SOCIAL ISSUES AND THE ENVIRONMENT

A-) From Unsustainable to Sustainable development

Man as part of the nature is bound to obey the laws of nature. He depends on his environment for food, water, air, space and shelter. His intervention has made more significant changes in natural environments for his developmental activities like agriculture, urbanisation, industrialisation, mining, transportation, technology, etc. More developmental activities are adopted in order to increase the quality of life, for this purpose human uses the available resources.

WCED (World Commission on Environment and Development) understand the necessity of development a linkage between meeting the needs of people for natural resources and protecting/conserving these resources and environment. This linkage has been identified and named as "Sustainable Development".

Sustainable Development defined as "the development to meet the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development must balance the needs of society, the economy and the environment.

The developed and most easily accessible renewable water resources are streams, lakes, rivers and aquifers that recharge quickly. The process of developing less accessible fresh water resource will be costly & time consuming.

The three main components of sustainable development are:-

1) economic development (industrial, creating job opportunities, utilisation of natural resources for developing quality of life)

2) Community development (providing food, shelter, cloth, education, other essential things for human beings)

3) Environment protection (provide clear air, water & environment for present and future generations, utilisation of resources in a sustainable manner)

The framework for the integration of developmental strategies with environmental protection is provided by the concept of sustainable development. It includes:-

1) use of excessive resources are to be reduced with increasing resources conservation

2) Waste minimisation to be adopted with more recycling & reusing materials.

3) Enhance scientific management of renewable resources.

Examples of unsustainable developmental activities and their effects:-

1) In Egypt:- Aswan Dam was constructed for producing more electrical energy and providing multiple benefits to the farmers & others. But the catchment area of this dam covered priceless archeological sites and buildings. It destroyed valuable ecosystems and fishing grounds. It damaged nutrient and sediment balances of the ecosystem.

2) In China:- Govt. of China has planned to construct 3 Gorges Dam on the Yangtze river. Even though the benefits are more, it affected more than 2 million farmers and villagers of the catchment area of that dam. Hence the govt. has accepted to pay compensation amount and place to resettle the displaced people.

3) In US:- In US, it was decided to transport water to water poor states from the rivers in Wester Canada and Alaska. But this project was dropped due to its excessive cost, technological interruptions and environmental risks.

4) In India:- The Narmada Valley Project if and when completed, will be ranked as the largest irrigation project ever planned and implemented as a single unit anywhere in the world. It has been planned to construct 31 major dams, 135 medium dams and 3000 minor dams in this project by the year 2040. But it affect more agricultural area and more wild animals & species in that area.

Sustainable Development Indicators (SDI)

SDI are various statistical values that collectively measures the capacity to meet present and future needs. SDI will provide info crucial to decisions on national policy and to the general public.

The indicators are used by decision makers and the policy makers at all levels. It is needed to monitor the progress towards attaining sustainable development. These are also used to increase focus on the sustainable development.

Based on a working list of 134 indicators, a core set of 58 indicators & methodology sheets are available for all countries to use.

Sustainability:-

It can be defined as the ability of a society or ecosystem to continue functioning into the indefinite future without being forced into decline through complete loss of its strength or overloading of key resources on which that system depends.

Stability has 2 aspects which are almost opposite in nature:-

i) Resistance Stability

ii) Resilience Stability.

Resistance Stability is the ability of a system to remain stable in the face of stresses. Resilience stability is the ability of the system to recover from disturbances occured due to the activities happened.

Characteristics of Sustainable Society:-

1) All the material processes will be designed to be of cycle nature
2) There will not be any waste material or pollution of air, water, land and environment.
3) The output from one system will be used as inputs to other systems.
4) Only renewable energy will be used in the society, either directly or in the forms of hydro-power, wind power, solar power and biomas
5) Human population will be either stable in size or gradually declining.

4.2 Urban Problems related to Energy

Urbanisation is defined as the process of movement of human population from rural area to urban area in search of better economic interests with better education, health, communication, civic facilities and other day-to-day needs. Nowadays, migration of people has become a major trend. The movement and migration of people depends on many factors. The most important problems or discomforts in rural area are:-

- lack of modernisation of agricultural sector
- lack of job opportunity
- Poor lifestyle
- Poor health facility
- Poor education facility
- Poor transport facility
- Poor energy available

- Urban problems related to energy:-

Energy is important where required for almost all developmental activities in a society. The level of development of a country depends on the amount of energy it produced and used.

The increase in population in urban area tends to use more amount of energy for their daily needs. Today this is the main problem arises in the urban areas. The energy consumption increase about 40% of that was in about 40 year's ago.

Some of the problems faced during power failure are:-

→ causes full darkness in the area
→ Unable to operate financial transactions/ATMs
→ Affect transportation system (lift, petrol pump, train, traffic signals)
→ Affect life style greatly.
→ Water supply.
→ Education

Energy requirement for Sustaining Urban life:

① Industrial activity & Energy:-

Industrial activities consumes about 37% of worlds energy. Big markets, shopping complexes, residential buildings are gradually developed around the industrial area. Thus increasing population & industrialisation needs more conventional & non-conventional energy

② Transportation and Energy:-

Transportation consumes about 30% of world. Out of this, 82% is consumed in roads. Energy requirement for transportation varies with urban forms. Industrial activities require excellent transport communication, which requires greater energy resources in the form of fossil fuel or some other means.

③ Urban water supply & Energy:-

Water alway play an important role. Due to increase urbanisation and industrialisation, the surface water quality and quantity of surface water decreases. Therefore people is focused shifted towards the use of ground water.

Use of pumping stations, transport of water from water source to urban area, water treatment, supply of water in municipal area, etc. requires great energy. Hence all the activities from the source of water to distributing needs more energy for safe and proper distribution of water.

④ Energy use for Buildes:-

In residential & commercial area, most energy is used for water heating, space heating/cooling, lifts, cooking, etc. These are consumes more than 80% of all energy used for residential buildings. The main factors influencing building energy use are:-

- Type of building construction
- Materials required for building
- Shape & orientation of the building
- Internal climate
- Internal activities.

(5) Energy required for Clean up Drive :-

The rapid growth of urbanisation and industrialisation produces more liquid, solid and gaseous pollutants into the environment.

Untreated wastes were discharged into the river/lake/ocean. But now-a-days, the wastes are to be pretreated before discharge them into any water body. Energy is essential to operate treatment plants or machineries. It is estimated that one sewage treatment plant (STP) utilise energy which is equivalent required for a town.

(6) Essential services & Energy :-

Urban areas need excellent services such as hospitals, educational institutions, research institutions, traffic signals, telephone exchange, recreational places, water supply system, electric & non-electric media services, tem street lights, etc. In order to operate these centres, reliable and efficient energy is required.

Solutions to the urban problems related to Energy:-

The problems related to energy can be minimised and avoided by proper management and development of industrial and urban areas. Some of the solutions to these problems are:-

- mass movement of rural area can be stopped by providing them better facilities & opportunities at their own places.
- Energy can be saved by proper utilisation
- Other economical & eco-friendly energy resources are to be identified.
- Sub-urban development & controlled population is to be promoted.
- Adopt pooling system where use personal transport.
- more energy to be generated from sustainable form of sources.
- Gap between generation point and consumption point is to be minimised.

4.3 Water Conservation:-

Most living tissue is composed of a very high percentage of water (upto 90%). Human body consists of 65% (appx) of water. Without water living organisms can not survive.

The water available on Earth may occur in all three stages as gas, liquid and solid. The total quantity of water present on Earth is around 2.66×10^{20} kg. About 97% of water is salt water, 2% is locked up in polar region as ice and 1% is available as ground water.

The production, development and efficient management of water resources for beneficial use is called water conservation. Some of the techniques for water conservation are:-

1. Rain water harvesting
2. Watershed management
3. Construction of storage reservation
4. Reuse of industrial ~~waste~~ wastewater
5. Better agricultural practices.

① Rain Water Harvesting:-

The process of collection of rainwater directly or recharging it into the ground to improve ground water storage in the aquifier is called "rainwater harvesting".

Necessity:-

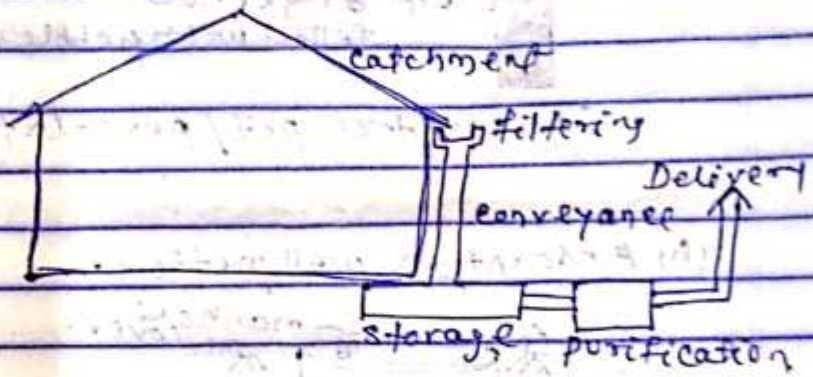
During rainy season, the storm water runs over the fields and lands. Finally it reaches the sea. It caused soil erosion. Steps should be taken to direct the rain water into the ground, which results more benefit to people as well as to environment. It also increase the ground water level and decrease the water problem during summer season.

Components for rainwater Harvesting:-

1. Catchment - The surface upon which rain falls
2. Filtering - To filter and remove debris and contaminants from water
3. Conveyance - Transport channel / pipes from catchment to storage
4. Storage - Tanks where collected rainwater is stored

5. Purification – Includes filtering equipments, distillation, additives to settle, help filter and disinfect the collected rainwater

6. Distributors – System that deliver the rain water.



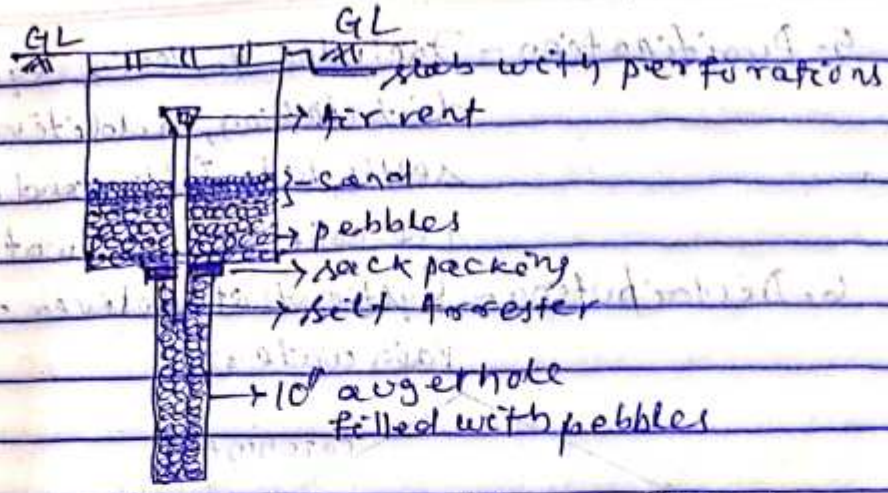
Methods:-

The rainwater harvesting can be done in individual houses and in grouped houses. Methods for rainwater harvesting are:-

(a) Absorption pit method
(b) Absorption well method
(c) well-cum-bore method

(a) Absorption pit method:-

In this method, a hand bore made in the soil is used to harvest the rainwater. This structure is suitable for gravelly soil. The absorption pit (percolation) is made to a size of about 10' in diameter and 4 to 8 meter in length. It is filled with pebbles or broken bricks at bottom and sand at top. A square/circular chamber is fitted with silt arrester is provided at the top to collect & feed the pit. At the ground level, a perforated slab is used to cover the pit.



(Absorption pit / percolation)

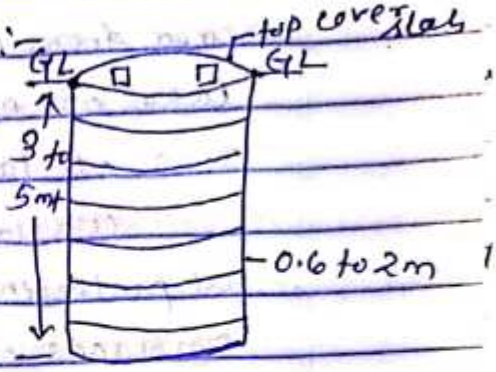
(b) Absorption well method :-

This type of structure is suitable where the soil is likely to be clayey upto 5m and more. A well upto 3 to 5m depth and then bore upto a depth of 3 to 5m height within the well is suitable for this structure. Usually the hand bore to a depth upto the reach of sandy bed is done. Then a pipe of 150mm diameter is inserted into the bore for the entire length. The well is filled with pebbles

and sand and the pipe is filled with pebbles.

(c) well-cum-bore method:-

These wells are generally constructed to a diameter of 0.6 to 2m. These are made up of cement rings.



Size depends on type of soil strata and the number of collection pipe lines. Generally in this type of wells, no filtering medium is filled inside. The top portion is covered with RCC slab.

Advantages:-

1) Integrated with house which makes the water easily accessible.
2) Increase ground water level
3) Decreases salt content in the ground water
4) Decrease drinking water deficiency
5) Prevent soil erosion and flood
6) Reduce the reliability on water storage dams
7) Require less space
8) Does not require major constructing work
9) Require very little maintenance
10) Simple to install and operate.

Disadvantages:-

1) Water supply is very limited
2) Uncertainty of rainfall does not effectively use this system throughout the year.

② Watershed Management :-

A watershed is defined as the geographic area from which water in a particular stream, lake, or estuary originates. It includes entire area of land that drains into the water body.

Watershed management is a process aimed at protecting and restoring the habitat and water resources of a watershed incorporating the needs of multiple stakeholders.

Impacts of human on watershed :-

- Altering water flow :-

The water course is altered by changing the boundary of the land and adding storm water system.

- Adding Pollution Sources :-

Another way of impact is by adding potential pollution sources to the watershed. When the storm water flows a parking area, it might pick up litter, road salt, motor oil, etc. It carry these pollutants to a local stream. Fertilisers & pesticides are also pollute the water.

- Urbanisation :-

It has more effects on local water resources. It changes the flow of water as well as constituents of water that flows on watershed.

In urban areas trees, shrubs & other plants are replaced with impervious (Not allowing fluids to pass through) surfaces like : roads, rooftops, parking plots etc. These impervious surfaces do not allow storm water to soak into ground.

without plants, these rainwater runoff is increased. This leads to flood situation. The reduced amount of infiltrating water can lower ground water level.

- Cleaning of Channels:-

In the stream, more erosion of stream banks and scouring (cleaning) of channels will occure due to volume increase. The sediment settles to fill in stream channels, lakes and reservoirs. This also increase flooding and the need for dredging to clear stream or lakes for boating.

Controlling Storm water flow:-

To reduce the impact of development of local watershed and aquifers, it is important to control the storm water flow. It can be controlled by both quality and quantity by minimising the disturbances developed in natural flow of water. The storm water flow can be controlled by the following ways:-

(a) Minimise the development of impervious surface

(b) Maximise the natural areas of dense vegetation

(c) Reduce the possibility of pollution of storm water

(d) Use structural storm water control like:- storm water management basins.

4.4 Resettlement and Rehabilitation of People: Problems and concerns:-

Resettlement and rehabilitation is one of the most serious problems posed by the developmental activities. Among other developmental activities, Dam construction have so far ousted 30 million people across the world. Most of them are poor or indigenous who leave behind productive farms and ancestral homes, though these groups pay the social & environmental costs of dam construction, they don't receive the benefit.

The overall objective of resettlement and rehabilitation is to ensure that the affected production base will be restored, the affected labour force will be re-employed, income and livelihood of affected people will be improved or at least restored to their previous levels before resettlement.

Causes of Relocation:-

Many factors contribute to displacement and relocation of human settlements on a large scale. Some of the major factors are:-

- **Developmental Activities:-**

  Activities like: construction of dams, roads, railway tracks, airports, ports, irrigation canals, urban expansion, erection of towers, irrigation, and etc cause relocation of people.

• Disasters:-

It may be natural or man made. Natural disasters includes earthquake, floods, droughts, landslides, volcanic eruptions, forest fires etc. Man made includes industrial accidents, nuclear accidents, dam burst, shelling, etc.

• Conservation initiatives:-

It includes protection of wildlife, forest, water bodies, pollution control from urban & industrial areas or around STP, etc.

Resettlement:-

Resettlement is defined as the process of simple relocation or displacement of human beings without considering their individual, community or social needs. This process focuses/ ensures their safety and social community such as: receive education, find employment, health care, retain their culture and society identity.

Rehabilitation:-

Rehabilitation is defined as the process of replacing the lost economic assets, rebuilding the community systems that have been weakened by displacement, attending to the psychological trauma (event) of forced separation from livelihood.

Resettlement and Rehabilitation (R&R) is a dynamic process. Its implementation and execution have necessarily to remain flexible and answer to the call of foreseen and unforeseen situations.

4.5 Environmental Ethics:-

Inquiry is defined as the attempt to discover truths about the world.

Philosophy is defined as the area of inquiry that attempts to discover truths.

Ethics is a branch of philosophy that primarily discuss issues dealing with human behaviour and character.

Environmental ethics is the branch of ethics which analyze about use of Earth's resources by human beings. Environmental ethics tries to answer the questions of how human being should relate to their environment, how to use Earth's resources and how to treat other species, both plants and animals.

Issues and Possible Solutions:-

Natural sciences and engineering are important forces shaping our future. They exert both positive and negative influences upon the world. We all contribute to these changes. Humanity now faces following inter-related problems.

i) Environmental pollution
ii) Over population
iii) Over exploitation & increased consumption of non-renewable resources
iv) Prejudice of people on class, culture, religion, etc
v) War land
vi) Non-peaceful use of power
vii) Various problems due to improper distribution money, food, housing, education, work, recreational opportunities & facilities, etc.

The above problems are resulting from our individual actions and reactions. Therefore, we are responsible for these problems.

∴ Consequently, one could argue that our current ethical system is not functioning adequately. This causes immediate need to re-examine our values and the ways in which these problems influence our lives.

4.6 Climate Change:-

Climate represents sum of all statistical weather information of the atmospheric elements, with specified area over a long period of time. Climate never remains static. It is dynamic process, greater or lesser degree, it is changing. Climate change is common deviating from the average as well as extreme conditions.

The lower part of atmosphere and the Earth's surface have warmed upon average by about 0.6°C during the last 100 years. If the climate change is at the same rate as now, global average surface temperature could be anywhere between 1.4 and 5.8°C higher than in 1990 by 2100. Sea level rise is projected to be between 9 and 88cm by 2100.

Causes of Climate Change:-

1) Variation in earth's orbital characteristics
2) Atmospheric carbon dioxide variation
3) Volcanic eruptions
4) Variations in solar output.

Effects of climate change:-

The climate change has more effects on every parts of the earth. It affects both living and non-living components of the ecosystem in the world. Some of the effects of climate change are:-

- Mean sea level is increased on an average of around 1.8mm per year.
- Many ecosystems of the world have to adapt to the rapid change in global temperature
- The rate of species extinction will be increased
- Human agriculture, forestry, water resources and health will be affected.
- Climate change and changing rate of precipitation and evapo-transpiration will influence the hydrological (water) cycle
- The frequency and intensity of extreme weather events is possible and it makes unexpected flooding and drought.
- The societies currently facing existing social, economic and climatic stresses will be both worst affected and least able to adapt.

4.7 Global Warming:-

Global warming is defined as the increase in temperature of earth which causes more changes in climate.

Industrial, agricultural and other human activities release more green house gases into the atmosphere. It causes to increase heat energy at earth's surface

and makes the planet warmer than usual. Even a little extra warming may cause problems for humans, plants and animals.

The average global temperature is now 1°C higher than in 1900. It is assumed that, by the middle of the next century the earth's global temperature may be 1°C to 3°C higher than today.

The International Red Cross and Red Crescent analysed the past 33yrs of natural disasters - 90% of which are weather related. It is found that the number of these has increased in the past 3decades.

Effects of Global Warming :-

1) more heat waves
2) Expansion of desert area
3) Natural fires in forest land
4) more evaporation of water
5) Melting of ice in Arctic & Antarctical area
6) more cloud formation in atmosphere
7) Shorter & warmer winter
8) Longer & hotter summer
9) Changes in rainfall pattern
10) Rise in sea level
11) Flooding & submergence of low laying coastal area
12) Disruption in farming
13) More drought
14) More impacts on plants, animals & humans
15) Impact on cultivation.

Control and Remedies of Global Warming:-

1) Reduce the consumption of fossil fuel such as coal & petroleum.
2) Use of biogas plant
3) Use of nuclear power plants
4) Increasing forest cover
5) Use unleaded petrol in automobile
6) Install polluting control devices in automobiles and industries.

Acid Rain:-

Acid rain was discovered in the 1850 in Great Britain. Acid rain can be precised as Acid deposition.

Wet deposition and dry deposition are two parts of acid deposition. Wet deposition refers to acid rain, fog, snow, etc. As the's acidic water flows over & through the ground, it affect plants and animals in many ways.

Dry deposition refers to the acidic gases and particles. About half of the acidity in the atmosphere falls back to earth through dry deposition.

Sulphuric acid (H_2SO_4) and Nitric acid (HNO_3) are the two principal acids present in acid rain.

Until the atmospheric release of pollutants is stopped, acid rain will continue to fall and it become one of the greatest destructive behaviour of mankind.

Measuring Acid Rain:-

Acid rain can be measured using pH scale. Less value of pH indicates more acidity. Pure water has a pH value of 7.0. Normal rain is slightly acidic due to carbon dioxide dissolved in it.

Mechanism of formation of Acid Rain:-

$S + O_2 \rightarrow SO_2$
$2SO_2 + O_2 \rightarrow 2SO_3$
$SO_3 + H_2O \rightarrow H_2SO_4$ } formation of Sulphuric acid

formation of Nitric acid:
$O_3 + NO_2 \rightarrow NO_3 + O_2$
$NO_3 + NO_2 \rightarrow N_2O_5$
$N_2O_5 + H_2O \rightarrow 2HNO_3$

Sources of Acid Rain:-

Sulphur dioxide and oxides of nitrogen are the primary sources of acid rain. These developed due to natural activities and anthropogenic activities.

Natural Sources:-

- Quantity of pollutants - Small percentage of pollutants are released from natural sources
- SO_2 - Volcanic eruptions and decomposition of organic materials
- NO_x - Bacterial reaction in soil and chemical reactions in the upper atmosphere.

Manmade Sources:-

- Quantity of Pollutants - About 90% of sulphur emmissions and 95% of nitrogen emission are from man-made sources.
- SO_2 - Combustion of coal from electric power plants, oil refineries, natural gas wells, etc.

• NO_x – Burning of fuels at high temperature.
  * About 40% are from trains/vehicles
  * About 95% are from industrial combustion process
  * About 25% are from thermo electric generating plants

Impacts of Acid Rain

1) Both dry & wet deposition of sulphur dioxide increases the rate of corrosion of lime stone, sand stone and marble.
2) Forest tree population is affected and decreased by acid rain
3) It changes the characteristics of soil and pollute the streams & lakes
4) It reduces the decomposition of dead plants and animals.
5) Calcium deficiency in fishes can lead for bone malformation
6) Chemicals found in acid rain can cause paint to peel and stone statues to begin to appear old & worn down, which reduces their value & beauty.
7) By combinating with ozone, it may damage the waxy coating on leaves and needles.

8) Control of Acid Rain:-
The formation of acid rain can be minimised by using the following methods:-
1) By reducing pollution from industries
2) By using other source of energy
3) By using cleaner automobiles

1) By reducing pollution from industries:-
The release of sulpur dioxide is reduced from the coal burning power plants by:
a) using less sulphur coal
b) washing the coal to remove some of the sulphur
c) installing pollution controling devices like: scrubbers to remove sulphur dioxide.

2) By using other source of energy:-
By producing energy without using fossil fuels, more possibility of acid rain can be minimised. Use of fossil fuel can be reduced by using use of renewable energy sources such as: solar, wind power, etc.

3) By using cleaner automobiles:-
Automobiles are the major sources of the acid rain pollutants. By using pollution control devices like: catalytic converter or by using natural gas (CNG) in automobiles, etc. acid rain formation can be minimised.

4.9 Ozen Layer Depletion:-

Ozen is an odorless & colorless gas composed of three(3) atoms of oxygen(O_3). The normal oxygen we breathe is 2 atoms. Ozone has the same chemical structure whether it is at ground level or miles above the earth. It can be good or bad depending on its location in the atmosphere.

It is naturally formed by short wavelength ultraviolet radiation in the upper stratosphere. Wavelength less than 240nm are absorbed by normal oxygen molecules, which dissociate

to give O atoms. The O atoms in combination with other oxygen molecules produce ozone.

$O_2 + (\text{Short wavelength} \leq 240\,nm) \rightarrow O + O$

$O + O_2 \rightarrow O_3$

CFC (Chlorofluorocarbon):-

CFC is the short form of Chlorofluorocarbon. These are man made chemicals which comprise Chlorine, Fluorine and carbon atoms. It was developed in the early 1930s & used in various industries, commercial & household applications. These substances are:-

1) Non-toxic
2) Non-flammable
3) Non-reactive with other chemical compounds.

These safety characteristics along with stable thermodynamic properties make them ideal for many applications as coolants for commercial and home refrigeration units, aerosol propelants, solvent in electronic industries and blowing agents in fire extinguishers.

Types of CFC for ozone depletion are:-

a) Trichlorofluoromethane $CFCl_3$ (CFC-11)
b) Dichlorofluoromethane, CF_2Cl_2 (CFC-12)
c) 1,1,2 Trichlorotrifluoromethane, $CF_2ClCFCl_2$ (CFC-113)

Ozone Layer Depletion Process:-

Between 19 and 30 km above Earth's surface at stratosphere, ozone is constantly produced and destroyed naturally. This process makes the stratosphere with ozone layer. It is used to filter the UV radiations from Sun and protects life on the Earth.

But manmade chemicals called CFC (Chlorofluorocarbons) are destroy the ozone molecules in ozone layers. CFC themselves do not destroy molecules. They decay the ozone molecules at the low temperature. A small amount of chlorine atom (Cl) and Chole chlorine monoxide (ClO) are functioned as catalyst (a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change) in the process of the destruction of ozone.

Ozone Depletion Potential (ODP)

The ozone depletion potential (ODP) of a compound is defined as the measure of its ability to destroy the stratospheric ozone.

In other words it is defined as the ratio of the total amount of ozone destroyed by a particular agent to the amount of ozone destroyed by the same mass of CFC-11.

$$ODP(A) = \frac{\text{Amount of ozone destroyed by (A)}}{\text{Amount of ozone destroyed by CFC-11}}$$

ODP of CFC-11 is always taken as 1.0.

Factors affecting ODP :-

a) The nature of halogen (bromine-containing halocarbons usually have much higher ODPs than chlorocarbon because Br is a more effective ozone-destruction catalyst than Cl)

b) The number of chlorine or bromine atoms in a molecule

c) Molecular Mass (since ODP is defined by comparing equal masses rather than equal numbers of moles.

d) Atmospheric lifetime (CH_3CCl_3 has a lower ODP than CFC-11, because much of the CH_3CCl_3 is destroyed in the troposphere)

Dobson Units:-

Dobson unit (DU) is the scale for measuring the total amount of ozone occupying a column overhead.

One DU unit is defined as 0.01mm at 0°C and 1 atmospheric pressure.

If the ozone layer thickness is compressed to 0°C and 1 atmosphere pressure, is about 5mm thick, then the average thickness of the ozone layer would be about 500 DU

In absolute terms, 1DU is about

2.7×10^{16} molecules/cm^2

Harmful effects of Ozone layer depletion:-

The ozone layer is protecting all the living beings on the earth from Sun's UV radiation. Any decrease in ozone layer would result in an increase in the amount of UV radiation. It leads to an increase in harmful effect for human beings and all other lives.

Human Health:-

1) Reddening of skin in sunshine (sun burn)
2) Skin cancer
3) Reduction in body's immunity to disease
4) Eye disorders like: cataracts & Blindness

Other living things:-

1) The UV rays are harmful to other living beings, particularly small plants & animals living in sea called 'Plankton'.
2) The UV ray can damage certain crops like: rice, which many people in the world rely on for food
3) These can damage polymers used in plants, clothing and other materials

4.10 Waste Land Reclamation:- x (N.I.S)

4.11 Consumerism and Waste Products:- x (N.I.S)

4.12 Nuclear Accidents:-

In recent time, the use of nuclear energy has been increased to meet the requirement instead of use of fuels (oil, coal, gas). Nuclear power plants are always producing some dangerous element pollutants to the environment.

The main danger is release of intense radioactivity generated by fission into the environment in the gaseous form, radioactive water, or contaminated steam

The two important nuclear accidents are:-

1) Chernobyl nuclear power plant disaster in USSR in 1986
2) Three mile island ~~new~~ nuclear power plant disaster in US in 1979

Three Mile Island Accident :-

3 mile island is in middle town, on the bank of Susquehanna river and about 16km from Harrisburg, the capital of Pennsylvania. Several small towns, dairy and other farms are common in the area, which

On 28 March 1979, at about 4:00 am, a series of events that led to a loss of control of the nuclear chain reaction in the TMI Unit-2 reactor. For several days, it was not clear how or when the reactor could be shut-down.

Lack of knowledge about the plant condition, lack of experience with this type of situation, and non-functional radiation monitors gave rise to conflicting reports about the severity of the accident & its threat to the public.

Consequences :-

- Hundreds of local residents reported metalic taste, erythema, nausea, vomiting, diarrhea, hair loss, deaths of pets and farms & wild animals and damage to plants
- There was the psychological effect on the nation.
- Before accident, appx. 70% of the general public approved of nuclear power. But after the accident, support for nuclear power across the country fell to about 50%, where it has remained.

4.13 The Environment Protection Act 1986 :- X (NIS)

A.14 Air Act 1981 (Prevention and Control of Pollution) :-

Objective :-

i) Prevention, control and abatement of decrease air pollution

ii) maintaing the quality of air

iii) Establishment of Boards for the prevention and control of air pollution.

Definitions :-

a) Air pollution means any solid, liquid or gaseous substances present in the atmosphere of such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

b) Emission means any solid or liquid or gaseous substance coming out of any chimney duct, or flue or any other outlet.

c) Industrial plant means, any plant used for any industrial or trade purposes and emitting any air pollutant into the atmosphere

d) Control equipment means, any apparatus, devices, equipment or system to control the quality and manner of emission of any air pollutant and includes any device used for securing the efficient operation of any industrial plant.

Powers & Functions of Central Board:-

a) Plan & cause to be executed a nation-wide program for the prevention, control and decrease abatement of air pollution.

b) Co-ordinate the activities of the State and resolve disputes among them

c) Organise through mass media a comprehensive program regarding the prevention, control and abatement of air pollution.

d) Lay down standards for quality of air

e) Collect and disseminate spread information in respect of matters relating to air pollution

f) ~~Perform~~ Collect, compile & publish technical and statistical data relating to air pollution and the measures devised for its effective prevention, control/abatement and prepare manuals, codes or guides relating to prevention, control/abatement of air pollution.

Functions of State Board:-

1) To plan a comprehensive program for the prevention, control or abatement of air pollution and to secure the execution there of.

2) To collect and spread info relates to air pollution

3) To collaborate with central board in organising the training of persons engaged/to be engaged in programs relating to prevention, control of air pollution and to organise mass-education

4) 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 of air pollution.

5) To inspect air pollution control areas at such interval as it may think necessary, assess the quality of air therein and take steps for the prevention, control of air pollution in such area.

4.5 Water (Prevention and Control of pollution) Act, 1974:-

Definition:-

'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 (directly/indirectly) as may or is likely to create a nuisance or render such water harmful or injurious to public health or safety, or to the life and health of animals or plants or of aquatic organisms.

"Sewage effluent" means effluent from any sewerage system or sewage disposal works and includes sullage from open drains.

"Sewer" means any conduit pipe or channel, open or closed carrying sewage or trade effluent.

Objectives:-

1) To prevent & control of water pollution
2) To maintain or restore the wholesomeness of water
3) To establish boards for the prevention & control of water pollution
4) To confer on and assign to the Boards powers and functions relating to the above purpose.

Features:-

1) Establishment of Central and State Board for pollution control
2) Provision of Joint Boards for two or more states
3) Prohibition of the use of streams and wells for the disposal of polluting matters
4) Consent of Pollution Control Board to open new outlets and discharges into streams or wells.

Population: Definition, Growth and Variation among Nations

Population Growth:

Each population has a characterized pattern of increase which is termed as its growth form. It increases in size in a characteristic S-Shaped or sigmoid fashion. When a population starts growing, first the growing is slow, and then it becomes rapid and finally slows down until equilibrium is reached.

If we plot time on n-axis and number of organisms any-axis, on a graph paper, we should get a s-shaped sigmoid curve. Human population shows a s-shaped growth. However, if the growth stops abruptly, a J-shaped growth curve is obtained.

There are 5 main concepts that our students struggle with when learning about population growth and the relationship of population to geological resource use:

1. overpopulation is a leading environmental problem,
2. exponential population growth and development leads to faster depletion of resources,
3. population grows exponentially,
4. why population prediction is difficult,
5. population is not evenly distributed throughout the world.

A leading environmental problem: Overpopulation

Students do not understand that overpopulation is the cause of many other environmental problems. To help students understand this, one of my colleagues asks her students to list three important local and global environmental issues as part of a survey on the first day of class. During this lecture, we will present overpopulation as the top environmental problem:

1. Pollution (unspecified):14.7%
2. Global warming:14.5%
3. Air pollution:13.5%
4. Habitat destruction:13.1%
5. Resource depletion/degradation:11.8%
6. Population growth/Overpopulation:7.9%
7. Natural disasters:6.2%
8. Water pollution:6.6%
9. fossil fuels (oil spills/ANWR):6.0%

10. Waste management:3.5%

Effects of population explosion

The effect of population explosion is numerous with far reaching consequences. Some of them are enumerated as under:

- Unemployment,
- Low living standard of people,
- Hindrance in the process of development of economy
- Pressure on agriculture land,
- Low per capital income,
- Lack of basic amenities like water supply and sanitation, education, health, etc.,
- High crime rate
- Environmental damage,
- Migration to urban area in search of job,
- Energy crisis,
- Overcrowding of cities leading to development of slums.

Population explosion in Indian context

The population explosion, though a worldwide phenomenon, poses a serious threat to India as it has to maintain 16.9% of world's population on only 2.4%of the world's area. The present growth rate of 1.7% is much higher than the world population growth rate of 1.3%, which is of great concern.
In order to overcome this problem of population explosion, a sound Population Policy is required with the following objectives:

1. Quick economic development and raising the per capital income.
2. Significant reduction in birth rate, which is more fundamental and important than the first, by providing legal and fiscal motivations like raising age of marriage, legalization abortion etc.
3. The planning of population must not aim merely at controlling the rate of multiplication but it should also include the improvement of the quality of the population as well by providing better facilities in education, health, etc.
4. (iv) The death rate should be brought down further, as high death rate results in waste of human energy and resources.
5. Integrating population planning with economic planning.