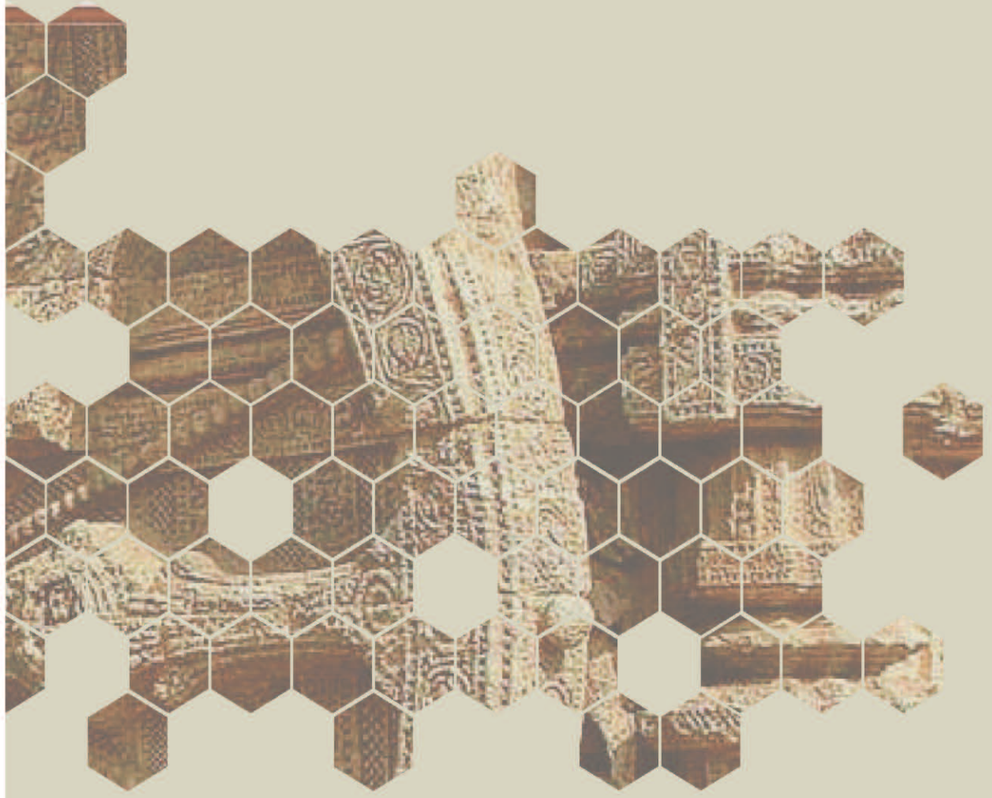

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Environmental Study-II

Institute of **Open** and **Distance Education**

Faculty of Arts

Environmental Study-II

4BA2

DR. C.V. RAMAN UNIVERSITY
Chhattisgarh, Bilaspur
A STATUTORY UNIVERSITY UNDER SECTION 2(F) OF THE UGC ACT

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UNIT 1 ENVIRONMENTAL EDUCATION

The Chapter Covers :

Learning Objectives :

After going through this unit, You would be able to -

- Environment education,
- Natural resources
- Forest resource
- Water resources
- Food resources
- Energy resources

NOTES

1.1 INTRODUCTION

Eco-education/environmental education is not a new concept. It has been in existence since the origin of humankind, as all human knowledge is derived out of interaction with nature and learning from nature.

As human society evolved and progressed, human being involved themselves in pursuit that made our living more and more conducive and comfortable. During the process, history also witnessed the emergence of various problems, both from the natural and social environment. The earth is getting polluted. The soil, minerals, water, fuel, plant and animal resources are getting depleted. Chemical contamination caused by synthetic fertilizers, pesticides, food additives, effluents/pollution, dams are causing havoc to plant, animal and human life. Climate changes, desertification and floods are becoming drastic.

The human population is glowing faster and creating pressure on the environment. Today over one billion people of the globe are living in absolute poverty (according to the World Bank) and about 600 million are completely starving. Annually, about 15-20 million deaths occur directly due to hunger. Little to wonder, 28 people die every moment due to hunger globally.

Studies have proved that human beings are found to be unable to adjust themselves to changes in the environment. What really happens is that there is a very slow adaptation of human to the environmental changes that take place drastically. This is known as bio-social disadaptation, and it leads to numerous ill effects - the most glaring of which is the high risk of being contaminated with diseases, both psychological and physiological. It is important to note that Homo sapiens (human beings) were not created by nature for a highly industrialized, petrochemical environment/ society. These concerns warrant an inquiry into the problems of human beiug in relation to the environment coupled with societal analysis.

1.2 ENVIRONMENTAL SCIENCE OR STUDIES ?

Environmental science in its broadest sense is the science of complex interactions that occurs among the terrestrial, atmospheric, living and anthropological environments. It includes all the disciplines, such as chemistry, biology, sociology and government that affect or describe these interactions. In broadest sense, environmental science may be defined as the study of the earth, air, water and living environments and the effects of technology thereon. To a significant degree, environmental science has evolved from investigations of the ways by which, and place in which living organisms carry out their life cycles. This is the discipline of natural history, which in recent time has evolved into ecology, the study of environmental factors that affect organisms and how organisms interact with these factors and with each other. Traditionally, environmental science is divided among the study of the atmosphere, the hydrosphere, the geosphere and the biosphere.

Environmental science is now a mature, viable discipline. The past three decades have witnessed a growing awareness of the affects of human activity upon our earth's resources and during this period environmental study has emerged as a

multi-disciplinary field of study to examine the interaction of the people and their environments.

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1. Environmental Studies and Chemistry:

This relation is known as environmental chemistry. It may be defined as the study of the sources, reactions, transport, effects, and fates of chemical species in water, soil, and air environments and the effects of technology thereon. One of environmental chemistry's major challenges is the determination of the nature and quantity of specific pollutants in the environments.

2. Environmental

Studies and Biology:

The ultimate environmental concern is that of life itself. The discipline that deals specifically with the effects of environmental chemical species on life is environmental biochemistry. Biological processes not only are profoundly influenced by chemical species in the environment, they largely determine the nature of these species, their degradation, and even their syntheses, particularly in the aquatic and soil environments. The study of such phenomena forms the basis of environmental biochemistry.

3. Environmental Studies and Economics

Economic environment refers to all these factors or forces which contribute to economic impact on the man, his activities and his region. Resources, industrial production, population, agriculture, infrastructure and the various stages in the economic development like economic conditions, economic policies, economic planning, economic philosophy, economic system and trade cycle- are major internal and external factors which make up the total economic environment. Availability of resources and the technology to exploit them plays most significant role in economic development or economic environment of a region. As the distribution of natural resources, due to geographical factor is uneven, the resources have become concentrated in some specific regions only. These gifted regions have exploited these resources for their economic developments and have come to be known as developed countries. Examples of such countries are USA, France, UK etc. Whereas the other regions which had poor resource concentration and which are still in developing stage have come to be known as developing countries. So it is economic environment of a region or country that decides its status i.e. developed or developing.

A population factor has its own say as regards economic environment of a region, as more resources are needed to feed more mouths. This requires more exploitation of resources which not only hampers the resource reserves but also affects the ecosystem of that region. However, a stable economic environment does not always help the mankind. The main disadvantage of it being its impact on the physical environment. It could be said as both economic and political are interdependent on each other. Both East Germany and West Germany serve as best example of interdependence of political and economic environment. The East Germany with her

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poor economic environment was left with no other alternative other than merging with West Germany which had strong and stable economic environment.

Every human activity necessary for economic development affects the local, regional or global environment. The effects may be of short term or long term in nature. In the present situation, the problems like depletion of forests, the extinction of rare species of flora and fauna, the global warming, epidemics such catrina, rita cyclones in USA, earthquakes in Jammu and Kashmir, heavy rainfalls, floods etc. are some of the major environmental problems the world is facing on various levels today.

The industrialization, the agricultural development, the extraction of various energy and other resources etc. which contribute to economic environment of the region, are some of the main factors responsible for deteriorating the quality of the physical environment.

4. Cultural Environment:

It is the manmade environment or manmade landscape. It may also be called as humanized landscape. The cultural environment is the imprint of man's activities, his occupation and utilization of the physical resources for his own benefit. All manmade features such as buildings, settlements, roads, plantation etc. are called cultural features. We may call this cultural environment as a social environment or socio-cultural environment or even social heritage. As per the passage of time man has acquired technical and scientific knowledge. Through this powerful tool he is changing fast the physical environment into cultural landscape.

Cultural environment have their tools in the natural environment and in the cultural level of the different human groups. As the natural environment differs place to place, cultural environment also should differ from place to place, hence human activities and achievements depend not only upon natural environment also upon manmade environment.

Culture develops on nature; it means it has its roots in nature. Cultural environment is only human adaptation and adjustment to natural or physical environment. In other words, man as per his knowledge and capacity super-imposes culture on nature. It goes on piling one after another, and grows in size and importance. Sometimes it becomes difficult to trace back the link with the physical base. As an example we have changes in many villages in India.

Cultural environment is simple and more directly connected with physical base in the early stages, but becomes more complex and indirect as the human society grows up in knowledge and size. At this stage the natural environment quality starts degrading and the question of ecological disorders and natural imbalance crops up. Ecological disorder is the direct result of human action, partly through his numbers and partly through his skills. All actions of men are not wise or far-sighted and hence it leads to environmental crises. The various ecosystems are showing signs of progressive deterioration because of man's hasty, negligent, unplanned actions which ultimately leads to environmental degradation.

Environmental degradation is greater in advanced rather than in primitive societies,

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more in the industrial and urban than rural, agricultural or pastoral interiors.

5. Population and Environment:

Population factors play a most momentous role in socio-economic environment of a country, specially the size or density of the population. It has its impact on natural environment also. Majority of the population being poor causes more environmental damage due to mutually reinforcing effect between poverty and environmental damage. The poor being both the victim and the agent of environmental damage.

The world population, which is growing at the rate of 1.7 per cent per year, is highly alarming. If this trend continues, there will be addition of another 3.7 billion (1 billion = 1000 million) or more to tbe present population level in another three to four decades. This rapid growth will affect both economic and physical environments at regional as well as global level. Traditional land and resources will be subjected to more and more overuse. Even the government will not be in a position to keep up with the infrastructural and human need of the growing population.

6. Environment and political set up:

Political environment refers to the influence exerted by the three main political institutions viz. legislature, executive and judiciary. It helps to shape, direct, develop and control many of the human activities including his business antipollution laws. The executives also called as government, implements whatever is decided by legislature and the executive, function in public interest and within the boundaries of the constitution.

A stable and dynamic political environment is a must for the development of mankind. The type of government plays a significant role in political environment of a country as it is guided by certain firm policies of its own.

The type or the form government may be democratic, communist, dictatorial, monarchy etc. Any change in the form may be counter-productive and may affect the nation from several angles i.e. economic, business, socio-cultural, physical etc. as all these segments are interdependent.

SCOPE:

A study of environmental studies is getting lot of attention not only in the field of pollution control but also to sustain the life and nature. It helps us to understand the nature of environment and its components, nature of disturbing factors and the various methods to overcome disturbing factors. The disturbing factors pressurize sustainability and natural living.

The scope of environmental studies and its management has increased from manufacturing pollution control equipment, sewage and effluent treatment plants, biomedical waste treatment and fly ash management. The subject is multidisciplinary in nature. It unfolds environmental issues for those wbo are directly or indirectly concerned with this discipline. The corporate leaders, the students of universities and colleges and the student-managers realize that environmental protection and resource conservation have to be considered as a normal part of conducting business

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and understanding nature. Similarly environmental concern has to a part of policy for the various governmental organizations. And same is true for public leaders whose sensitization is vital in this regard. Issues of environmental protection and "Right for Clean Environment" have already trickled down from educated and affluent people to the general public. Those who are not economically well off are equally affected, if not more due to environmental problems. Thus environmental concerns have to be on the agenda of all organizations.

In India, we have been witnessing significant environmental degradation during the last few decades. Increasing industrialization, high-intensity agriculture, (use of fertilizers and pesticides) deforestation, soil erosion, urbanization, transportation and population growth are the major environmental problems and these are likely to increase. If the desire to lead higher living standard also increases, then problem would be too acute to be manageable. Industry has significant role in environmental protection. More and more business executives have now identified environment as issue that affect their companies.

It is believed by the scientists and the leaders in industry that if we do not come to grip with environmental issues, irreversible process would have been set in that would ultimately lead to human suffering not in the countries of South but also the North. Most of the environmental problems are well known though we may not have found solution for all.

The problems are both global and national and all these pose serious challenges not only to our planet but also to our way of life. Human beings are not separate entity. They are part of the surrounding, our ecosystem- air, water, land, not only that but one cannot think of human survival if the services provided by the environment don't become available. Without a suitable habitat neither animals nor plants nor human can survive. If the habit is degraded / damaged, life would be adversely affected.

Since the environment provides all the resources that are used in the process of production of goods or services, the responsibility of industry is of paramount consideration. Industry not only has to consider issues like profit, quality standards, legislation and regulatory controls but has to go a step beyond. Our natural resources are either renewable or non-renewable, the later have to be conserved and the use of former to be judicious. Besides the issue of resources, our living style, rate of consumption and disposal of waste have created problems for manufacturing, marketing and management of landfills for wasters, air quality, water table and many other environmental problems.

In short scope of environmental studies is broad based and it encompasses a large number of areas and aspects, broadly listed below:

•Natural Resources- their conservation and management

•Ecology and biodiversity

•Environmental pollution and control

•Social issues in relation to development and environment

1.3 ENVIRONMENTAL STUDIES: IMPORTANCE

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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 recognized 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.

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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.

1.4 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

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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 dep't. 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 Urbanization

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Nearly 27 per cent Indians live in urban areas. Urbanization and industrialization has given birth to a great number of environmental problems 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 rule.

To sum up:

Today everybody talks of environment, but only a few have clear ideas about what needs to be done and still fewer have the actual experience or expertise in the field. Unfortunately, environmental awareness campaigns have very often been exploited for political propaganda rather than being an integral part of our educational programmes in theory and practice.

"Environment" is very wrongly taken as a "fashion" by all walks of life, hardly realizing that it is our "real-life-situation" and our sustenance and security are at stake. "What is the use of a beautiful house if you don't have a decent planet to put it on?" Even if we begin today, the restoration is expected in the next 40-50 years. The complex link between human activities and the loss of biodiversity is rapidly coming to light. Loss of habitats and poaching of wildlife is more obvious now a days. But more complex and unsuspected links are being thrown up as scientists go deeper into the subject.

The recent rapid decline of species of vultures in South Asia could be result of a veterinary drug give to cattle which is eventually passed on to vultures when they feed one of the carcasses of these animals. The study therefore requires number of disciplines to establish this relationship.

Similarly, while atmospheric science and chemistry may seem distantly related subjects, it was the study of CFCs and their impact on ozone that finally led to an understanding of the ozone 'hole' and the Montreal Protocol (a commitment by governments to phase out the use of CFCs), which has been one of the success stories of a global response to a global problem.

Questions:

Q.1: What is the need for studying environment issues?

Q.2: What is the scope of environmental education?

Q.3: How would environmental awareness help to protect our environment?

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1.5 NATURAL RESOURCES

Life on this planet earth depends upon a variety of goods and services provided by the nature, which are known as Natural resources. Simply stated, a resource is any useful information, material or service. Within this broad generalization, we can differentiate between natural resources' and 'human resources'.

Natural resources are the components of the environment *(i.e.* atmosphere, hydrosphere and lithosphere), which can be drawn upon for supporting life. These include energy, mineral, land (soil), food, forest, water, atmosphere (air), plants and animals.

Human resources refer to human wisdom, experience, skill, labour and enterprise.

1.6 CLASSIFICATION OF NATURAL RESOURCES

These are the components of our environment. These resources can be renewable or non-renewable:

(1) **Renewable Resources (Inexhaustible Resources) :** Inexhaustible resources have the inherent ability to reappear or replenish themselves by recycling, reproduction or replacement. These renewable sources include sunlight, plants, animals, soil, water and living organisms. Biological organisms are self-renewing. The rate at which their renewal occurs varies.

(2) **Non-renewable Resources (Exhaustible Resources):** The non-renewable resources are the earth's geologic endowments, *i.e.,* minerals, fossil fuels, non-mineral resources and other materials which are present in fixed amounts in the environment. Unlike renewable resources, non-renewable resources are finite in quantity and cannot be re-made, re-grown or regenerated. in a short period of time .

(3) **Intangible resources (abstract resources):** These are the resources which can be both exhaustible and inexhaustible such as, open space, information, diversity, satisfaction, serenity and beauty. There is no upper limit to the amount of knowledge, information, or beauty. But at the same time these can be destroyed easily. For example, a single and small piece of trash can destroy the beauty of any place. It is important to note here that the two most powerful and largest industries of the world—tourism and information management are based on the intangible resources.

It is very important to protect and conserve our natural resources and use them in a judicious manner so that we do not exhaust them. It does not mean that we should stop using most of the natural resources .Rather, we should use the resources in such a way that we always save enough of them for our future generations. In this unit we shall discuss the major natural resources:

- Forest Resources
- Water Resources
- Mineral Resources

- Food Resources
- Energy Resources
- Land Resources

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1.7 NATURAL RESOURCES AND ASSOCIATED PROBLEMS

Human population is growing day-by-day. Continuous increase in population caused an increasing demand for natural resources. Due to urban expansion, electricity need and industrialization, man started utilizing natural resources at a much larger scale. Non-renewable resources are limited.

They cannot be replaced easily. After some time, these resources may come to an end. It is a matter of much concern and ensures a balance between population growth and utilization of resources.

This overutilization creates many problems. In some regions there are problems of water logging due to over irrigation. In some areas, there is no sufficient water for industry and agriculture. Thus, there is need for conservation of natural resources.

There are many problems associated with natural resources:

Forest resources and associated problems

1. Use and over-exploitation.
2. Deforestation.
3. Timber extraction.
4. Mining and its effects on forest.
5. Dams and their effects on forests and tribal people.

Water resources and associated problems

1. Use and overutilization of water.
2. Floods, droughts etc.
3. Conflicts over water.
4. Dams and problems.

Mineral resource and associated problems

1. Use and exploitation.
2. Environmental effects of extracting and using minerals.

Food resources and associated problems

1. World food problems.
2. Changes caused by agriculture and over grazing.
3. Effects of modern agriculture.
4. Fertilizer-pesticide problems.
5. Water logging and salinity.

Energy resources and associated problems

1. Growing energy needs.

1. Land degradation.
2. Man-induced landslides.
3. Soil erosion and desertification.

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1.8 FOREST RESOURCE

Forest are one of the most important natural resources on this earth. They are renewable resources. A forest is a biotic community, predominantly of trees, shrubs or any other woody vegetation usually with a closed canopy. Forests vary a great deal in composition and density and are distinct from meadows and pastures. Forests contribute substantially to the economic development of a country. They are the vast natural resources for man that has been providing a broad array of commodities, amenities and environmental services. Fuel wood, timber, wildlife habitat, pasture for livestock, industrial forest products, animal products, recreation, soil moisture retention, climate regulation, production of atmospheric oxygen, a source of new agricultural or grazing land and spiritual renewal are a few examples.

Forest cover and distribution

According to the FAO Global Forest Resources Assessment 2000, forests cover almost one-third of the world's land area or 3869 million hectares, of which 95% is natural forest and 5% is planted forest. Forests are distributed unevenly across the globe with 17% in Africa, 14% in Asia, 27% in Europe, 14% in North and Central America, 23% in South America and 5% in Oceania.

Types of Forests in India

India has a diverse range of forests: from the rainforest of Kerala in the south to the alpine pastures of Ladakh in the north, from the deserts of Rajasthan in the west to the evergreen forests in the north-east. Forests are classified according to their nature and composition, the type of climate in which they thrive, and its relationship with the surrounding environment .India has six types of forests.

(a) **Every Green (Tropical Forests)** – is found in areas with 200cm to 300cm rainfall; av. Annul temp. 200C to 270C; av. Annual humidity > 80%.

(b) **Deciduous (Monsoon Forests)**- found in places with lesser rainfall between 150 to200 cm; mean annual temp between 240C and 280C; humidity 75%.

(C) **Dry Forest** are found rainfall is scanty between 75 to 100cm; mean annual temp 230C to 290C; humidity 50 to 60%.

(D) **Hill forest** are common in south India and Himalayas

(E) **Tidal forests** (Mangrove), Godavari (Sundarbans), Mahanadi, Godavari and Kerala .

(F) **Grasslands** (hilly lowlands-as in Punjab, Haryana, UP, Bihar, NW Assam and riverine grasslands-found along rivers.

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IMPORTANCE OF FORESTS

Forests are of immense value to the life and prosperity of human beings and also for rural economic growth. They provide a rich variety of goods useful both to the industrial societies and the rural poor. They offer huge potential for reducing poverty while also conserving their valuable key resources. The importance uses of forests include:

Commercial uses: Forest provides us a large number of commercial goods which includes

(i) **Wood:** Wood is the major forest produce. In developing countries, the heaviest demand on forest is of fuel wood for cooking and heating. Fuel wood, in fact, accounts for almost half of all wood harvested worldwide. About 1.5 billion people depend on fuel wood as their primary energy source. The world consumption of fuel wood is estimated to be more than 1,000 million cubic meters and is expected to increase to 2,600 million cubic meters in 2025.

(ii) **Timber :** Industrial timber and round wood (unprocessed logs) obtained from forests are used to make lumber, plywood, veneer, boards, doors, windows, furniture, carts, ploughs, tool handles, sports goods, etc. It is also a raw material for the manufacture of paper, rayon and film.

(iii) **Bamboo:** Bamboos (also called the poor man's timber) are used in rafters, roofing, walling, flooring, scaffolding, matting, basketry and cart wood; and also used as a raw material in paper and rayon industry.

(iv) **Canes:** Canes are used for making furniture, ropes, walking sticks, umbrella handles and sports goods.

(v) **Minor forest products:** I t contribution of minor forest produce to economy is not negligible. Forests provide resins, thatch, rattan, fruits, nuts, herbs, medicinal plants, pharmaceuticals, oil, forage, commercial flowers, spices and syrups. Oils obtained from a variety of forest plants such as' sandalwood, rosha grass and khas are used in the manufacture of cosmetics, soaps, pharmaceuticals, tobacco, confectionery and incense. Several types of tanning materials, dyes, gums and resins obtained from forest plants are utilized in many industries. Lac/honey, wax and silk are items of economic value obtained from forest insects. Forest plants also provide hundreds of drugs, spices, insecticides and poisons. Other forest products of economic value include—Tendu leaves for wrapping *bidis* (Indian.cigar), *Ritha* and *Shikakai* as soap substitutes. *Rudraksha is* important commercial forest products

Ecological significance: The ecological services provided by our forests may be summed up as follows :

- Maintain biological diversity
- Provide wildlife habitat

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- Cycling nutrients
- Produce oxygen
- Reduce atmospheric pollution by collecting the suspended particulate matter and by absorbing carbon dioxide
- Reduce global warming
- Maintain temperature of the earth
- Affect regional rainfall patterns
- They also regulate stream flow
- Reduce flooding
- Store water
- Controll wind erosion
- Reclaim degraded land
- Forests prevent erosion of soil by wind and water
- Provide shade which prevents the soil from becoming too dry and friable (easily crumbled) during the summer
- Further, they improve the quality of soil by increasing its porosity and fertility by contributing humus to it.

Vital role in the life and economy of Tribals: Forests play a vital role in the life and economy of forest dwellers and tribes living in forests. Forests provide food (fruits, roots, tubers and leaves of plants and meat from animals), medicines and many other commercial products.

Aesthetic and other values: Forests have a great aesthetic value. There is hardly any part of the earth where people do not appreciate the beauty of forests. Additionally, forests provide areas for ecosystem research; provide opportunities for recreation, spiritual renewal and inspire literature, music, religion and art.

OVER EXPLOITATION OF FORESTS:

Since time immemorial, humans have depended heavily on forests for food, medicine, shelter, wood and fuel. With growing civilization the demands for raw material like timber, pulp, minerals, fuel wood etc. shooted up resulting in large scale logging, mining, road-building and clearing of forests. Our forests contribute substantially to the national economy. The international timber trade alone is worth over US $ 40 billion per year. Excessive use of fuel wood and charcoal, expansion of urban, agricultural and industrial areas and overgrazing have together led to over exploitation of our forests leading to their rapid degradation.

1.9 DEFORESTATION

The total forest area of the world in 1990 was estimated to be 7000 million hectares

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which was reduced to 2890 million hectares in 1975 and fell down to just 2300 million hectares by 2000. Deforestation rate is relatively less intemperate countries, but it is very alarming in tropical countries where it is as high as 40-50 percent and at the present rate is it estimated that in the next 60years we would lose more than 90 percent of our tropical forests.

The forested area in India seems to have stabilized since 1982 with about 0.04%decline annually between 1982-90. FAO (1983) estimated that about 1.44 m hectares of land were brought under afforestation during this period leading to stabilization. As per FAO estimates, the deforestation rate per unit population in India is the lowest among the major tropical countries, despite the fact that we have a huge population size and very low per capita forest area (0.075 ha per capita). However, we are still far behind the target of achieving 33% forest areas, as per our National Forest Policy, as we are still having only 19.27% of our land area (63.38m ha) covered by forests based on satellite data (MOFF, 1998).

Deforestation is defined as the reckless felling of trees by human beings for their use. Forests are burned or cut down for various reasons, like clearing of land for agriculture, harvesting of timber, expansion of cities, and many more; but the aim behind all these reasons is 'economic gains'. But we forget,that these economic gains are short- lived, while the long-term damaging effects of deforestation are disastrous and irreversible. At present we are losing forests at the rate of 1.7crores hectares annually worldwide.

Causes of Deforestation :

Although the forest area in some developed regions has expanded (For example, former USSR, North and Central America and Europe) as economic development has encouraged the reversion of agricultural lands to forest. However, in developing countries, the trend is toward deforestation, particularly in tropical forests. Although broad issues of poverty, rapidly increasing population pressures, unequal political power, lack of opportunities to make a living, landlessness and inadequate knowledge and means to exploit the tropical forest without destroying it are at the root of deforestation, but there are more specific causes too. Such as :

(i) **Shifting cultivation,**(also known as 'Jhum Cultivation'), that is slash and burn agriculture, practices by landless indigenous people or tribals who clear trees to grow crops. Because of low productivity of most tropical forest soils, the farmers move to new sites after few years leading behind abandoned patches (called 'forest fallows').

These forest fallows may revert back to forest if left undisturbed; however, because rising populations and the ensuing. competition for land are forcing farmers to return to these fallows at increasingly shorter intervals. As a result, little of this is allowed to revert to forest. According to an estimate, about 500 million people (nearly 1@% of the world population) and 240 million hectares of closed forest are involved in shifting cultivation, which is increasing at an annual average rate of 1.25%.

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(ii) **Overgrazing:** Deforestation also occurs due to overgrazing and conversion of forest to pasture for domestic animals.

(iii) **Fuel requirement:** Increasing demands for fuel wood by the growing population thereby increase the pressure on forest .

(iv) **Commercial logging:** It is another deforestation agent, It may not be a primary cause of deforestation in the tropics (except in parts of.West Africa) because the number of trees left after logging may be sufficient to classify the areas and fell the remaining trees. Further, if logging is performed poorly, it results in a degraded forest.

(v) **Development projects:** Massive deforestation also occurs due to mining, quarrying, irrigation ,road construction, big dams and industrial projects which are various developmental projects.

(vi) **Agribusiness:** Expansion of agribusiness that grows oil palm, rubber, fruit trees and ornamental plants has also resulted in deforestation.

(vii) **Forest fires:** These may be natural or man made and cause huge forest loss.

(viii) **Government-sponsored Programmes:** Finally, government-sponsored programmes that resettle landless farmers on forested sites have contributed to deforestation all around the world.

(ix) **Raw material for industries:** Wood for making boxes, furniture, railway-have exerted tremendous pressure on forest.

EFFECTS OF DEFORESTATION

Deforestation adversely affects and damages the environment and humans both. It has far reaching consequences, which may be outlined as follows:

(i) **Soil Erosion.** In the absence of forests/trees, especially on slopes, the soil gets washed away with rain water.

(ii) **Expansions of deserts.** Denuded land mass gradually gets converted into sand deserts due to the action of strong winds laden by fragmented rock dust. This effect is more pronounced in rain scarced areas.

(iii) **Decrease in rainfall.** Forests bring rains due to high rate of transpiration and precipitation. In the absence of forests, rainfall declines considerably due to considerable effect on hydrological cycle.

(iv) **Effect on climatic temperature:** The climate of a region is mainly controlled by the rainfall, snowfall, etc. Deforestation causes decrease in rainfall, which in turn increases the climatic temperature.

(v) **Lowering of water table.** Decrease in rainfall results into lowered water table due to lack of recharging of underground reservoirs.

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(vi) **Economic losses.** Deforestation will cause loss of industrial timber and non-timber products, and loss of long-term productivity on the site.

(vii) **Loss of habitat:** Certain species of flora and fauna are getting extinct from the face of planet, mainly due to deforestation.

(viii) **Loss of biodiversity.** Loss of flora and fauna has resulted into loss of biodiversity, leading to disturbances in ecological balance worldwide.

(ix) **Loss of medicinal plants.** There are many species of plants which have medicinal and other advantages, like Neem *(Azadiaratha Indica)* which has been used in India for centuries as insecticide, fungicide, in medicine and in biofertilizers. Deforestation, may lead to the extinction of such types of valuable plants.

(xii) **Global Warming**: The air we breathe is purified by forests. So, deforestation will lead to increase in carbon dioxide and other air pollutants. This will lead to global warming, which is a serious effect as well as threat.

(xiii) **Threats of Flood Havocs:** Human life and downstream structures may be endangered by floods that may be intensified by clearing forests on upstream watersheds.

(xiv) Disturbance of forest ecosystems in a particular location may result in important changes in other ecosystems that may be separated by great distances.

1.10 MAJOR ACTIVITIES IN FOREST

TIMBER EXTRACTION: Logging for valuable timber, such as teak and mahogany not only involves a few large trees per hectares but about a dozen more trees since they are strongly interlocked with each other .

Effects of Timber Extraction

There has been unlimited exploitation of timber for commercial use. Commercial/ industrial demand could out-strip supply leading to decimation of forests, particularly the wood.

The major effects of timber extraction on forests and tribal people include:

- Poor logging results in a degraded forest.
- Soil erosion, especially on slopes.
- Sedimentation of irrigation systems.
- Floods may be intensified by cutting of trees on upstream watersheds.
- Loss of biodiversity.
- Climatic changes, such as lower precipitation.

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- New logging roads permit shifting cultivators and fuelwood gatherers to gain access to logged areas and fell the remaining trees.
- Loss of non-timber products and loss of long-term forest productivity on the site affect the subsistence economy of the forest dwellers.
- Forest fragmentation, the reduction of a large block of forest to many smaller tracts, promotes loss of biodiversity because some species of plants and animals require large continuous areas of similar habitat to survive.
- Species of plants and animals, which may occupy narrow ecological niches and whose potential value to humans is unknown, may be eliminated.
- Indigenous people may be forced into a new way of life for which they are unprepared.
- Exploitation of tribal people by the contractors as in the case of North Estern States.
- cutting of more trees than permitted in a particular area by the greedy contractors.

MINING : Mining is the extraction of valuable minerals or other geological materials from the earth which includes base metals, precious metals, iron, uranium, coal, diamonds, limestone, oil shale, rock salt and potash .

Effects of Mining

The major effects of mining operations on forests and tribal people include:

- degradation of lands.
- loss of top soil due to deforestation.
- pollution of surface and ground water resources due to-the discharge of highly mineralized mine waters.
- lowering of ground water table.
- air pollution due to release of greenhouse gases and other toxic gases during mining, *e.g.* release of CH^ during coal mining.
- deforestation including loss of flora and fauna.
- sediment production and discharge.
- ore transport hazards.
- fire hazards.
- subsidence above and near mine areas can change local hydraulic, gradients and drainage basin limits, and create numerous ponds.
- drying up of the perennial sources of water like springs and streams in hilly areas.

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- vast tribal people may be forced into a new way of life for which they are unprepared,
- migration of tribal people from mining areas to other areas in search of land and food.

Effect of Dams/River Valley Projects

Big dams and river valley projects have multi-purpose uses and have been referred to as "Temples of modern India". However, these dams are also responsible for the destruction of vast areas of forest.

The major impacts of dams/river valley projects on forests and ibal people which need consideration are:

- degradation of catchment areas.
- command area development.
- reservoir induced seismicity.
- deforestation and loss of fauna and flora including gene pool reserves due to submergence.
- increased incidence of water-borne diseases like malaria, filaria, schistosomiasis, etc.
- disturbance of the dam (or reservoir) site forest ecosystem may result in important changes in the neighboring and other ecosystems that may be separated by great distances.
- acute scarcity of fuel wood and other forest products for tribal people.
- rehabilitation and resettlement of those affected.

1.11 WATER RESOURCES

Water is, literally, the source of life on earth. It is the major constituent of. the hydrosphere that consists of the oceans, seas, rivers, streams, glaciers, lakes, reservoirs, polar ice caps and the shallow ground- water bodies that interflow with the surface water. Approximately 70.8% of the earth's surface is covered with water mainly in the form of oceans. It is estimated that the hydrosphere contains about 1,360 million cubic km of water. Of this about 97% is in the oceans and inland seas, where the high salt content does not permit its use for human consumption. About 2% of the water resource is locked in the glaciers and ice caps; while the rest (less than 1%) is available as fresh water, for human consumption and other uses, in surface water sources (such as rivers, streams, lakes and reservoirs) and ground water sources .

The total stock of ocean water and fresh water has been fairly constant throughout geological history. But the ratio between ocean water and fresh water has always changed according to climatic conditions. When the climate is very cold, much of

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the sea water is absorbed by glaciers and ice caps and fresh water increases at the expense of the sea water. When the climate is hot, glaciers and ice caps melt and sea water gains at the cost of fresh water. Sea level observations during the last ten decades or so indicate that the sea level is rising slowly. Which means, the global climate is getting warmer and warmer?

Water is characterized by certain unique features which make it a marvelous resource:

- It exists as a liquid over a wide range of temperature i.e. from 0 to 100 C.
- It has the highest specific heat, due to which it warms up and cools down very slowly without causing shocks of temperature jerks to the aquatic life.
- It has high latent heat of vaporization. Hence, it takes huge amount energy for getting vaporized. That's why it produces a cooling effect as it evaporates.
- It is in an excellent solvent for several nutrients. Thus, it can serve as a very good carrier of nutrients, including oxygen, which are essential for life. But it can also easily dissolve various pollutants and become a carrier of pathogenic microorganisms.
- Due to high surface tension and cohesion it can only easily rise through great heights through the trunk even in the tallest of the trees like Sequoia.
- It has anomalous expansion behavior i.e. as it freezes; it expands instead of contracting and thus becomes lighter. It is because of this property that even in extreme cold, the lakes freeze only on the surface. Being lighter the ice keeps floating, whereas the bottom waters remain at a higher temperature and therefore, can sustain aquatic organisms even in extreme cold.

The water we use keeps on cycling endlessly through the environment, which we call as Hydrological Cycle. We have enormous resources of water on earth amounting to 1404 million km^3. The water from various moist surfaces evaporates and fall again on the earth in the form of rain or snow and passes through living organisms and ultimately returns to oceans. Every year about 1.4inch thick layer of water evaporates from the oceans more than 90% of which returns to the oceans through the hydrological cycle. Solar energy drives the water cycle by evaporating it from various bodies, which subsequently return through rainfall or snow.

Plants too play a very vital role by absorbing the groundwater from the soil and releasing it into the atmosphere by process of transpiration. Global distribution of water resources is quite uneven depending upon several geographic factors. Tropical rain forest areas receive maximum rainfall while the major world deserts occur in zones of dry, descending air (20-40 N and S) and receive very little rainfall.

WATER USE AND OVER-EXPLOITATION:

Due to its unique properties water is of multiple uses for all living organisms. Water is absolutely essential for life. Most of the life processes take place in water in water

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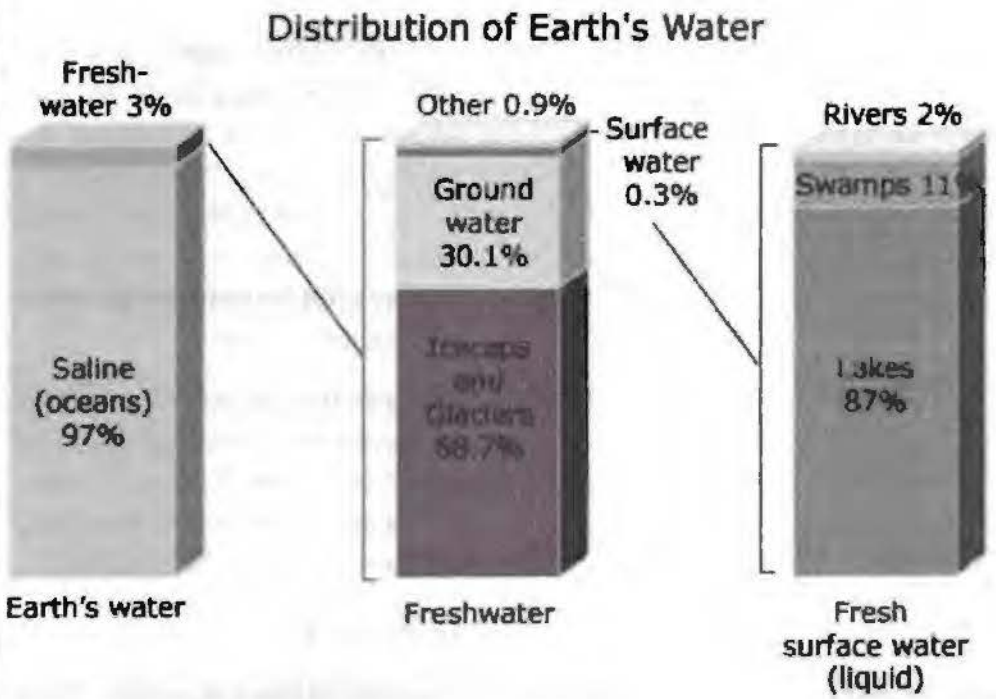
contained in the body. Uptake of nutrients, their distribution in the body, regulation of temperature, and removal of wastes are all mediated through water. Water use by humans is of two types:

1. Water withdrawal: taking water from groundwater or surface water resource and
2. Water consumption: the water which is taken up but not returned for reuse.

World water distribution

Location	Volume, in Million cubic km	% of total
Land Area		
Fresh water lakes	0.125	0.009
Saline lakes and inland seas	0.104	0.008
Rivers	1.25×10^{-3}	0.0001
Soil moisture	0.067	0.005
Ground water	8.3	0.61
Glaciers and ice caps	29.2	2.14
Total land area water (approx.)	37.0	2.8
Atmosphere (as water vapour)	0.013	0.001
Oceans	1,320	97.3
Total world water (approx.)	1,360	100



Check Your Progress:

1. What do you understand by deforestation?
2. What do you understand by water recourses?

Importance of Water

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Water is indispensable natural resource on this earth. It is essential for life not only human life but all life, animal and vegetation. About 97% of earth surface is covered with water and most of the animals and plants have 60-70% water in their body. Water has occupied an important position in man's life. Since the earliest days of mankind, the availability of water has determined where human settlements were built and what food human beings could raise. Without it, neither the individual nor the community can survive.

Water is the most critical limiting factor for many aspects of life, such as

economic growth, environmental stability, biodiversity conservation, food security and health care. In most cases there is no substitute for water. An energy source can be replaced by another, but water as a resource is largely irreplaceable.

Yet man's assessment of the value of this marvellous substance is very low until he finds himself without it.

Use of fresh water can be categorized as-

- It is a part of life itself, since it is the a medium in which all living processes occur.
- It dissolves nutrients and distributes them regulates body temperature,
- supports structures and removes waste products.
- It is estimated that 69% of world wide water (fresh water) is used for irrigation purposes.
- It is estimated that 15% of world wide consumptive water is used in various industries such as power plants, pulp and paper industries, distilleries, tanneries, ore and oil refineries.
- It is estimated that 15% of world wide consumptive water is used for household purposes. These include drinking, bathing, cooking, sanitation and gardening.
- Water is also used for recreation purpose such as boating, water skiers, swimming, fishing, navigation.
- Environmental use of water includes making of artificial wetlands, and artificial lakes to create wild life habitat

Since every 'activity of man involves some use of water, he is in the search of pure sparkling and palatable water from time immemorial. Man needs water not only for drinking purpose but also for bathing, washing, heating, air-conditioning; agriculture, livestock raising, industrial purposes, hydro power generation, steam power, fire protection, fishing, swimming, navigation, recreation, wild life habitat, and for disposal of wastes. Lack of water of required quality is a barrier to development also. A community with a limited water supply is a community with a limited growth—because the overall food production and large-scale generation of electricity still very much depend on the availability of water and also there is an increasing

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demand of water by industries. Human water use, in fact, has been increasing about twice as fast as population growth over the past century. And as the world's population and industrial production of goods increase, the use of water will also accelerate.

Water, thus, is an important pre-requisite for development.

FRESHWATER CRISIS

Due to its great abundance, water is generally a very inexpensive resource. Compared with other natural resources, water is used in tremendous quantities. In recent years the total mass (or weight) of water used on earth per year has been approximately 1,000 times the global total production of minerals (including coal, petroleum, metal ores and non-metals).

On a global scale, total water abundance is not the problem ; the problem is water's availability in the right place at the right time in the right form. Global water is unequally distributed.' Precipitation is seasonal and, therefore, the amount of water in inland bodies (surface and ground water sources) is variable. Irregularity in the duration and intensity of rainfall often causes floods or droughts. Scarcity of freshwater results in serious regional disparities. Arid regions suffer perennially from water shortage.

Freshwater is the biggest crisis facing the world today. Globally, on an annual basis, it is estimated that 12.5 to 14 billion cubic meters water is available for human use. As per estimation in 1989, there were 9,000 cubic meters of freshwater available for human use per person; and by 2000, this amount reduced to 7,800 cubic meters per person due to rise of global population. If this population growth continues, it is expected that by 2025 the per capita water use will come down to about 5,000 cubic meters. Even this amount of freshwater per capita would be enough to meet human needs, if it were properly distributed. But equitable distribution is not possible because—firstly, two-third of the global population lives in areas receiving only a quarter of the global annual rainfall; and secondly, there is no systematic rainfall throughout the seasons or from year to year.

According to an estimate, about 2 billion people, more than one-third of the global population, lack access to safe drinking water or sanitation; and about six thousand children die every day from diseases associated with unsafe water and lack of sanitation. About 40 countries in the world fall below the 2000 cubic meters of good water per person per year, the minimum quantity of freshwater needed for a healthful life according to WHO. The highest percentage of people in water-poor countries are in Africa and the Middle East.

Seeing the dimensions of the crisis, the United Nations declared the 1980s the decade to provide clean water and adequate sanitation to everyone. It was estimated that a total of $ 300 billion would bring clean water to everyone in the world. Unfortunately, growing populations and stagnant economies meant that most countries only kept even or fall behind in the proportion of their people with acceptable water supplies. Again, in its renewed efforts, UN celebrated year-2003 as the 'International Year of Freshwater'.

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Conflicts over water:

A country's economy is largely dependent upon its rivers. The problems arising out of water resources are floods, droughts. Apart from these there are conflicts over water. Indispensability of water and its unequal distribution has often led to inter-state or international disputes. Issues related to sharing of river water have been largely affecting our farmers and also shaking our governments.

Some major water conflicts are-

a) Water conflict in the Middle East- countries involved as Sudan, Egypt, Turkey- it also affects countries who are water starved viz. Saudi Arabia, Kuwait, Syria, Israel and Jordan.

b) The Indus Water treaty-is dispute between India and Pakistan,

c) The Cauvery water dispute- involves two major southern states of India viz. Tamilnadu, Karnataka similarly The Sutlej-Yamuna link canal Dispute also involves two Northern states viz. Punjab and Haryana. Affected states also include UP, Rajasthan as well as Delhi. In traditional water management, innovative arrangements ensure equitable distribution of water, which are democratically implemented. The 'gram sabhas"approve these plans publicly. While water disputes between states and nations often resume battle like situations, our traditional water managers in villages prove to be quite effective.

OVER-UTILIZATION OF WATER SOURCES

As mentioned earlier, more than 99% of Earth's wa.er in its natural state is unavailable or unsuitable for beneficial human use. Thus, the amount of freshwater for which all the people, animals and plants on Earth compete is even less than 1% of the total. This little fraction of water that is available as fresh water comes from inland surface water sources (such as rivers, streams, lakes and reservoirs) and ground water sources.

(1) **Surface water sources.** Most surface water originates directly from precipitation in the form of rainfall or snow. Groundwater from springs and seeps also contributes to flow of most of the streams. The various surface water sources along with their characteristics are discussed as under:

Natural Lakes and Ponds: Lakes are inland depressions that hold standing fresh water throughout the year. Ponds are generally small temporary or permanent shallow water bodies. As their water is much more accessible than groundwater or glaciers, they are considered as an important (though minor) source of freshwater supply. Water from these sources is more uniform in quality than water from flowing rivers and streams.

Artificial Impounding Reservoirs: These are formed by constructing hydraulic structures (like dams) across river valleys. The deeper and narrower the valley is, the easier it is to construct the dam. The water quality is similar to that of natural lakes and ponds.

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Rivers and Streams: Precipitation that does not evaporate or infiltrate, runs off over the surface towards the sea, in the form of streams and rivers. Rivers and streams are important sources of water supply, even though the water from these sources is generally more variable in quality as well as less satisfactory than the water from lakes and impounded reservoirs. The quality of water in rivers and streams depends on various factors like the character and area of the watershed, its geology and topography, seasonal variations and weather conditions, disposal of sewage and industrial effluents.

Sea Water: Though the oceans contain about 97% of the total water in the world, but as ocean waters contain high concentration of salts (approx. 3.5%) in solution, it becomes uneconomical to make this water potable. Still in places, where sea water is the only source available, potable water is obtained from sea water by carrying out desalting or demineralising. For example in ships on the high seas.

Effects of surface water usage

Inland surface water is the major source of fresh water for agricultural, domestic and industrial use throughout the world. The major environmental issue regarding inland surface water sources is the degradation of these sources by the disposal of sewage and industrial effluents without treatment. Though, the sustaining and assimilative capacity *(i.e.* self-purification process) of natural waters is tremendous but it is not infinite. The system is in operation for millions of years but now it has begun to show signs of stress.

2. Ground Water Sources. After glaciers, ice caps and snowfields, groundwater is the next largest fresh water reservoir. Precipitation that does not evaporate back into the air or run off over the surface percolates through the soil and either accumulates in an underground basin or flows underground in sub-surface streams. The quality of ground water is generally of uniform quality. As a result, groundwater is the major source of fresh water for agricultural and domestic use in many areas of the world, particularly areas having insufficient surface water sources.

Effects of ground water usage

Overuse of groundwater sources can cause several kinds of problems if groundwater is being withdrawn from aquifers faster than natural recharge can replace it, such as:

- A heavily pumped well can lower the local water table as a result of which shallower wells go dry.
- Heavy pumping, on a broader scale, can deplete a whole aquifer.
- Excessive pumping of groundwater causes porous formations to collapse, resulting in subsidence or settling of the above- surface.
- Overuse of freshwater reservoirs along coastlines often allows saltwater to intrude into aquifers used for domestic and agricultural purposes.

Then, there are many aquifers that have slow recharge rates which will take thou-

sands of years to refill them once they are emptied. In a sense, it is 'fossil water'. When water is pumped out from such a reservoir that cannot be refilled in our lifetime, we essentially are mining a non-renewable resource.

1.12 BIG DAMS – BENEFITS AND PROBLEMS

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Big dams are often regarded as a symbol of national development. However, there are several issues and problems related to these.

Benefits of Dams

The various benefits of dams are :

- Hydroelectricity generation.
- Ensuring a year-round water supply.
- Transfer of water from areas of excess to areas of deficit using canals.
- Flood control and soil protection.
- Irrigation during dry periods.
- Multi-purpose river valley projects also provide for inland water navigation, and can be used to develop fish hatcheries and nurseries.

Problems of Dams

Though dams have been useful over the centuries; but in recent years tapping of rivers through big dams has created lot of human as well as environmental issues. In many cases, they reduce water availability and destroy both natural and human values. Some of the disadvantages/problems of dams are as under:

- some dams loose so much water through evaporation and seepage into porous rock beds that they waste more water than they make available.
- salts left behind by evaporation increase the salinity of the river and make its water unusable when it reaches the downstream cities.
- accumulating sediments in the storage reservoir not only makes dams useless but also represents a loss of valuable nutrients to the downstream agricultural lands.
- growth of snail populations in the shallow permanent canals that distribute water to fields may lead to an epidemic of *schistosomiasis*.
- the enormous weight of water behind the dam could trigger seismic activity that might crack the dam and unleash a flood of biblical proportions.
- submergence of large areas of land that might include fertile fields and human settlements.
- resettlement and rehabilitation of displaced people.
- loss of free-flowing rivers that are either drowned by reservoir impoundments or turned into linear, sterile irrigation canals.

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- A number of water-related diseases have been casually linked with the creation of reservoirs and the resettlement of populations when dams are built. The greatest concern has been significant increase in the transmission of *schistosomiasis* and *malaria,* particularly where water impoundments provide breeding-sites for the vectors..
- Dam projects can also lead to lowered nutritional status when highly productive fields are flooded.

1.12.1 MINERAL RESOURCES

A mineral is a substance that is naturally present in the Earth's crust and is not formed from animal or vegetable matter. These are inorganic, crystalline solids having a definite chemical composition and characteristics physical properties. There are thousands of minerals occurring in different parts of the world.

Uses and exploitation of Minerals

Minerals find use in a large number of ways in everyday use in domestic, agriculture, industrial and commercial sectors and thus form a very important part of any nation's economy. The main uses of minerals are as follows:

(i) Development of industrial plants and machinery.

(ii) Generation of energy e.g. coal, lignite, uranium.

(iii) Construction, housing, settlements.

(iv) Defence equipments- weapons, armaments.

(v) Transportation means.

(vi) Communication- telephone wires, cables, electronic devices.

(vii) Medicinal system- particularly in Ayurvedic system.

(viii) Formation of Alloys e.g. steel

(ix) Agriculture- as fertilizers, pesticides etc.

(x) Jewellary-e.g. gold, silver, platinum, diamond

Some mineral elements are essential for the formation and functioning of the body of all organisms, plants as well as animals, including human beings. But the humans. Modern society depends on 'the availability of mineral resources, which can be considered a non-renewable heritage from the geologic past. Although new deposits are still forming from earth processes, but these processes are producing new mineral deposits too slowly to be of use to us today. Unlike forestry or agriculture (biological resources), where crops can be grown over and over again, mining is a robber industry. However large the deposit of a given mineral is, continuous mining will exhaust the ores. Hence minerals are thus a finite and declining resource.

CLASSIFICATION OF MINERALS

A. Based on their properties, minerals are of two types:

(i) Metallic minerals-e.g.bauxite, laterite, haematite etc.

(ii) Non metallic minerals-e.g. graphite, diamond, quartz, feldspar.

B. Minerals are sometimes classified on the basis of how much important they are to the nation:

(i) Critical minerals-are essential for the economy of nation e.g. iron, aluminum, copper, gold etc.

(ii) Strategic minerals –are those required for the defence of a country e.g. manganese, cobalt, platinum, chromium etc.

C.Based on their use , minerals are :

(i) Energy generating minerals – e.g. Coal, lignite, and uranium.

(ii) Commercially used minerals- e.g. .iron, aluminum, copper etc.

DISTRIBUTION OF MINERAL RESOURCES

The finite stock of minerals on earth is non-renewable; and, not only that, the geographical distribution of essential minerals is unequal.

India is fairly rich in minerals and has sufficiently large reserves of ferrous metals, coals and mica, manganese, bazuxite and thorium. India has very little reserves of mercury, tungsten, molybdenum, silver, cobalt, nickel, tin and Zinc. The production of petroleum, phosphate and sulphur falls short of its requirements. The minerals of India is unevently distributed and are localised in few areas. More than 90% of our mineral wealth is concentrated in the chottanagpur plateau region.

The geographical distribution of mineral resources is very uneven in India. Broadly, it can be said that with few exceptions, the peninsular rocks east of a line from Mangatore to Kanpur have the major reserves of metallic minerals, coal, mica and many other non-metallic minerals. The sedimentary rocks on the eastern and western flanks of the peninsular formations in Assam and Gujarat respectively have most of the reserves of petroleum ; while Rajasthan, with the rock system of the peninsula, has reserves of many non-ferrous minerals. Outside this area, most of the states including Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Tripura, Nagaland and Gangetic West Bengal are very poor in mineral resources.

According to Geological Survey of India (GSI), there are fifty important mineral occurrences and four hundred maior sites where these minerals occur.

Efforts are thus urgently required to .check the wasteful and injudicious use of minerals. Some of the suggested measure in this direction are:

- recycling;
- developing more efficient technologies;
- designing smaller equipments;
- exploiting untapped deposits, such as deep sea-mining; and

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- finding new uses for glass, ceramics, plastics and synthetic fibers and using them as substitutes for exhaustible minerals.

- Important Minerals and their Uses

S.No.	Mineral	Uses
	METALLIC	
(i)	Aluminium	Building material, electrical wiring, utensils, aircraft rockets
(ii)	Beryllium	Refractories copper alloys
(iii)	Chromium	Refractory, Metallurgy, chemicals
(iv)	Cobalt	Alloys, radiography , catalysts, therapectics
(v)	Columbium	Stainless steel, nuclear reactors
(vi)	Copper	Alloys, electrical products
(vii)	Gold	Monetary Purposes , jewellery, dentistry
(viii)	Iron	Steelbuilding materials, numerous industrial uses
(ix)	Lead	Batteries, Paints, alloys public health fittings, gasoline
(x)	Magnesium	Structural refractories
(xi)	Manganese	Alloy steels, , disinfectants
(xii)	Molbdenum	Alloy steels
(xiii)	Nickel	Used in over 3,000 alloys
(xiv)	Thorium	Nuclear bombs, electricity generation
(xv)	Tin	Slodering, chemicals, tin plates
(xvi)	Tungsten	Alloys, chemicals
(xvii)	Titanium	Alloys, pgments, aircraft
(xviii)	Uranium	Nuclear bombs, electricity generation tinting glass
(xix)	Vanadium	Alloys
(xx)	Zinc	Galvanising, chemicals, soldering, die-casting
	NON- METALLIC	
(XXI)	Asbestos	Roofing, insuletion , ceramics, textiles, gasolin solid propellants
(xxii)	Corundum	Abrasives
(xxiii)	Fluorlspar	Ceramic flux, artificial teeth
(xxiv)	Fluorspar	Flux, refrigerants, Propellants, acid
(xxv)	Nitrates	Fertilizers, chemicals

ENVIRONMENTAL EFFECTS OF EXTRACTING AND USING MINERAL RESOURCES

The issues related to the limits of mineral resources in our earth's crust or in the ocean is not so significant. More important environmental concern arises from the impacts of extraction and processing of the minerals during mining, smelting etc.

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Indian scenario:

India is the producer of 84 minerals the annual value of which is about Rs. 50,000 crore. At least six major mines need a mention here which are known for causing severe problem :

1. Jaduguda uranium mine ,Jharkhand
2. Jharia coal mines ,Jharkhand
3. Sukinda chromite mines, Orissa
4. Kudremukh iron ore mines, Karnataka
5. East coast bauxite mine, Orissa
6. North- Eastern Coal Fields, Assam

The environmental effects of extracting and using mineral resources depend on such factors as ore quality, mining procedures, local hydrological conditions, climate, rock types, size of operation, topography and several other related factors. The environmental impact varies with the stage of development of the resource, viz., exploration, mining, processing and dereliction stages. For instance, exploration and testing stages cause considerably less impact on environment than do the mining, processing and dereliction stages. In addition, the use of mineral resources has a significant social impact.

The mining and processing of mineral resources usually have considerable impact on land, water, air and biological resources ; they also have a social impact because of the increased demand for housing and services in mining areas. Some of the major environmental impacts of mining and processing operations are:

- Degradation of land.
- Pollution of surface and ground water resources due to the release of harmful trace elements (cadmium, cobalt, copper, lead, and others) by leaching, even if drainage is controlled.
- Serious adverse impact on the growth of vegetation due to leaching out of trace elements and minerals.
- Air pollution due to emission of dust and gases.
- Deforestation including loss of fauna and flora.
- Adverse impact on historical monuments and religious places.
- Physical changes in the land, soil, water and air associated with mining directly and indirectly affect the biological environment: kills caused by mining activity or contact with toxic soil or water are examples of direct impacts, whereas indirect impacts include changes in nutrient cycling, total biomass, species diversity, and ecosystem stability due to alterations in groundwater or surface water availability or quality.
- Accidental or periodic discharge of low-grade pollutants through failure of barriers, or water diversions or through breach of barriers during earthquakes, floods,

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etc. also cause damage to local ecological systems.

- Rehabilitation of affected population including tribals. Social impacts associated with large-scale mining results from a rapid influx of workers into areas unprepared for growth. This may cause:
- Stress on local services, such as water supplies, sewage and solid waste disposal systems, schools, and housing;
- Land use shifts from open range, forest, and agriculture to urban patterns.
- Construction activities and urbanization affect local streams / rivers through sedimentation, reduced water quality and increased runoff.
- Air pollution due to more vehicles, dust from construction and generation of power.

DERELICTION:

(closing or abandoning mines, i.e. deserting and left to fall into ruin) results from the ruthless exploitation of natural resources without consideration for the future. In fact, most dereliction is the result of thoughtless and uncontrolled mineral extraction and processing. Dereliction arises because mining operators are unwilling to spend money on rehabilitation which will give them no direct financial return. The harmful effects of dereliction include :

- Waste of agricultural and industrial land.
- Ugliness.
- Health and accident hazards: land over underground mines may subside, causing houses to collapse or creating hummocky ground unsuitable for any use and often full of pools of polluted water.
- Shafts that are not filled-in may lead to accidents.
- Old quarries and open-cast pits may also be dangerous.
- Permanent damage to landscape.

Unlike biological resources, minerals are difficult to produce a sustainable yield because the supply is finite. Therefore, recycling and conservation can only help, but eventually the supply will be exhausted.

1.13 FOOD RESOURCES

Food is any substance consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals. The substance is ingested by an organism and assimilated by the organism's cells in an effort to produce energy, maintain life, and/or stimulate growth.

Historically, people secured food through two methods: hunting and gathering, and agriculture. Today, most of the food energy consumed by the world population is supplied by the food industry, which is operated by multinational corporations that

use intensive farming and industrial agriculture to maximize system output.

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WORLD FOOD PROBLEMS

During the last 50 years world grain production has increased almost three times, thereby increasing per capita production by about 50%. But , at the same time population growth increased at such a rate in LDCs (less developed countries) that it outstripped food production.

The Food and Agriculture Organization (FAO) estimates that about 840 million people remain chronically hungry, nearly 800 million of them in the developing world. Though the number has been decreasing 2.5 million per year over the last eight years, but the world's target of cutting half the number of world's chronically hungry and undernourished people by 2015 will be met 100 years late if the present trend continues. In India alone, more than 300 million people are food insecure and poverty stricken. This means that they do not possess adequate purchasing power to buy food which could fulfill the minimum calorie requirement of a human body per day. The main reason for such kind of insecurity can be attributed to inequitable distribution of income with a minority of population possessing majority of wealth of that nation.

The World Food Summit, 1996 has set the target to reduce the number of undernourished to just half by 2015, which still means 410million undernourished people on earth.

There are two kinds of food insufficiency—undernourishment and malnourishment. Both of these food insufficiencies are global problems:

1. **Undernourishment:** Undernourishment is the lack of sufficient calories in available food, so that one has little or no ability to move or work. The FAO estimates that the average minimum daily caloric intake over the whole world is about 2,500 calories per day. People who receive less than 90% of their minimum dietary intake on a long-term basis are considered undernourished. While not starving to death, they tend not to have enough energy for an active, productive life. Lack of energy and nutrients makes them more susceptible to infectious diseases. Because of poor diet people are weak or sick and can't work; without an adequate income, they can't afford good food. This cycle doesn't stop here, it extends from one generation to the next. Parents who can't work can't buy food for their children, fail to grow their children properly as a result the. children are likely to be impoverished when they become adults.

   Those who receive less than 80% of their minimum daily caloric intake requirements are considered 'seriously' undernourished. Children in this category are likely to suffer from permanently stunted growth, mental retardation, and other social and developmental disorders. Further, infectious diseases that are only an inconvenience for well-fed individuals become lethal to those who are poorly nourished.

2. **Malnourishment:** Malnourishment is the lack of specific component of

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food, such as proteins, vitamins or essential chemical elements. It is possible to have excess food and still suffer from malnourishment due to nutritional imbalance caused by a lack of specific dietary components or an inability to absorb or utilize essential nutrients. People in richer countries often eat too much meat and fat and too little fiber, vitamins, trace minerals and other components lost from highly processed foods. In poorer countries, on the other hand, people often lack specific nutrients because they cannot afford more expensive food such as meat, fruits and vegetables that would provide a balanced diet. Malnourishment is long-term and insipidly. Although people may not die outright, yet they are less productive than normal and can suffer permanent brain damage. Some of the major problems of malnourishment are:

- *marasmus-* caused by lack of protein and calories
- *kwashiorkor-* due to lack of sufficient protein in the diet
- *anemia-* caused by an inability to absorb iron from food
- *goiter and hypothyroidism-* an iodine deficiency in the diet in early childhood
- *pellagra-* which occurs due to the deficiency of tryptophan and lysine vitamins
- *chronic* hunger- which occurs when people have enough food to stay alive but not enough to lead satisfactory and productive lives.

Over nutrition: In the richer countries, the most common dietary "problem is too many calories. For instance, the average daily caloric intake in North America and Europe is above 3,500 calories, nearly one- third more than is needed for adequate nutrition. Over nutrition contributes to overweight, high blood pressure, heart attack, and other cardiovascular diseases that rave become the leading causes of death in most developed countries.

BALANCED DIET

How can we avoid malnutrition and the ill effects of affluence such as obesity and cardiovascular diseases . Generally, it is as easy as consuming a balanced and varied diet with plenty of whole grains, fruits and vegetables. Cereals, like rice or wheat which form the staple food of mankind, supply us only with a fraction of our nutritional requirements. We have to supplement cereals with other food that provide plenty of fats and proteins and minor quantities of a number of vitamins and minerals. This means that the larger our diet sheet, the better our health will be.

In order to obtain adequate amounts of each of the different nutrients, the daily diet should include appropriate quantities of a variety of different foodstuff. A diet in which various foodstuffs are mixed-in suitable proportions to carry out adequately

CHANGES CAUSED BY AGRICULTURE

In the early years of human existence on this earth, man was just a hunter gatherer

and was quite like other animal species. Some 10,000 to 12,000 years ago he took to agriculture by cultivating plants of his own choice . He used the practice of Slash and burn cultivation or shifting cultivation, which is still prevalent in many tribal areas.

Undoubtedly, agriculture is the world's oldest and largest industry; more than half of all the people in the world still live on farms. Because the production, processing and distribution of food all changes the environment and because of the size of the industry, larger effects on the environment are unavoidable. Agriculture has both primary and secondary environmental effects.

A primary effect is an effect on the area where the agriculture takes place, *i.e.* on-site effect.

A secondary effect, also called an off-site effect, is an effect on an environment away from the agricultural site, typically downstream and downwind.

The effects of agriculture on the environment can be broadly classified into three groups, viz. local, regional and global:

1. Local changes: These occur at or near the site of farming. These changes/effects include-

1 Soil erosion and increase in sedimentation downstream in local rivers.

2 Fertilizers carried by sediments can cause eutrophication of local water bodies.

3 Polluted sediments can also transport toxins and destroy local fisheries.

2. Regional changes: They generally result from the combined effects of farming practices in the same large region. Regional effects include

1 Deforestation.

2 Desertification.

3 large scale pollution.

4 increases in sedimentation in major rivers and in the estuaries at the mouths of the rivers.

5 changes in the chemical fertility of soils over large areas.

6 In tropical waters, sediments entering the ocean can destroy coral reefs that are near the shore.

3. Global changes : These include climatic changes as well as potentially extensive changes in chemical cycles.

1.14 CHANGES CAUSED BY OVERGRAZING

Livestock wealth plays a crucial role in the rural life of our country. India leads in livestock population in the world. The huge population of livestock needs to be fed and grazing lands or pasture areas are not adequate.

The carrying capacity of land for cattle depends on the fertility of the soil and the

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rainfall. When the carrying capacity is exceeded, the land is overgrazed. The impact of overgrazing includes:

- Land degradation
- reduction in the diversity of plant species;
- reduction in the growth of vegetation;
- dominance of plant species that are relatively undesirable to the cattle;
- increased soil erosion as the plant cover is reduced; and
- damage from the cattle trampling on the land. For example, paths made by cattle develop into gullies, which erode rapidly in the rain.

1.15 EFFECT OF MODERN AGRICULTURE

It is based on high input technique using hybrid seeds of high yielding variety and frequent irrigation water, higher doses of chemical fertilizer and pesticide to get a higher yield.

Modern agricultural practices have both positive and negative effects on environment. For example, modern pesticides have created a revolution in agriculture in the short-term, but the long-term effects of these chemicals have proved extremely undesirable. The major problems that have arised due to the modern agricultural practices are related to fertilizers, pesticides, water logging and salination, and are briefly discussed as under:

1. Fertilizers:

Besides water, sunshine and carbon dioxide, plants need small amounts of inorganic nutrients for their growth. The most important elements required by plants are nitrogen, potassium and phosphorus along with calcium, magnesium and sulphur. Adding these elements in fertilizer stimulates growth and greatly increases crop yields.

Chemical fertilizers (particularly N-fertilizers) have played a key role in increasing crop production. There is considerable potential for increasing world food supply by increasing fertilizer use, particularly in low-production countries. India, for instance, has a relatively low average fertilizer level of only 30 Kg/ha. It has been estimated that the developing countries could at least triple their production by raising fertilizer use to the world average. Other increases are possible by using currently idle land, by introducing high-yield crop varieties and by investing in irrigation where water is available.

The world's food and commodity production is clearly dependent on chemical fertilizers, and their use is likely to increase, but unfortunately they can be a serious source of pollution and cause a number of problems which are discussed as under:

- If they are not applied with caution, artificial fertilizers cause contamination and fail to give their full potential.

- Excessive levels of nitrates (NO_3) in groundwater and surface water are increasingly a problem in Europe, USA and other, parts of the world. The indications are that it is nitrogenous fertilizers which are responsible for a good deal of contamination, which may also be caused by more deep ploughing; use of detergents, sewage pollution or land drainage.
- Phosphates have been accumulating in soils, river and lake sediments for decades, as a consequence of the use of phosphatic fertilizers, disposal of sewage and leaching of poorly sealed landfill sites. This poses a serious threat for domestic water supply and for the ecology of rivers, lakes and other water bodies. Increased levels of phosphates in water bodies (particularly lakes) are responsible for eutrophication.
- In addition, there are uncertainties about the long-term impact of chemical fertilizers on farmland. There is some indication that where year-round use of mono-crops and fertilizers has replaced crop rotation and use of livestock manure, fertility problems arise, in particular a net loss of organic matter from the soil.

There are ways of controlling fertilizer use:

- removal of subsidy on chemical fertilizers.
- reduction of price supports for crops.
- regulation of crops grown.
- set-aside—the withdrawal of land from production.
- costly slow-release liming treatment can be done.
- interplanting or rotating some leguminous crop (plants in whose root nodules live nitrogen-fixing bacteria) with such crops as wheat and corn.
- in temperate climates, planting winter wheat with white clover might help to reduce nitrate leaching, and would cut costs of fertilizer inputs and discourage pests.

2. Pesticides:

Thousands of types of pesticides are used in agriculture. All types of agriculture suffers from pests. Pests are undesirable competitors/parasites or predators. The modern era of chemical pest control began with the discovery of DDT (Dichloro-Diphenyl-Trichloroethane), initially synthesized in 1874, rediscovered in 1939 and adopted for louse and mosquito control during the Second World War and from the 1950s for agricultural use.

The major agricultural pests are insects (feed mainly on leaves and stems of funal plants) ; nematodes (small worms that feed on roots and other plant tissues) ; bacteria and viruses which cause diseases; weeds (flowering plants that compete with the crops); and vertebrates (mainly birds and rodents that feed on fruit or grain).

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Pesticides are compounds used to kill, deter or disable pests, for one or more of the following purposes :

- to maximize crop or livestock yields;
- to reduce post-harvest losses to rodents, fungus, etc.
- to improve appearance of crops or livestock ;
- for disease control (human health and veterinary use);
- for preservation and maintenance of buildings, clothing, furniture/etc.;
- to control weeds;
- for aesthetic reasons, lawn-care, garden flower and; golf-courses.

The benefits claimed for pesticides are considerable, in terms of improved harvest, reduced storage losses, human and livestock disease control. Successful pest control commonly reduces crop and produce losses by 20% or more and improves security of harvest and storage. But It is difficult to quantity the benefits and risks of pesticide use. While synthetic chemical pesticides have brought us great economic and social benefits, they **also cause a number of serious problems which are summarized as under:**

- effects on non-target species.
- poor selectivity of compounds (i.e. not very specific in terms of what is killed or injured).
- over-use.
- toxicity and slow breakdown.
- pesticide resistance and pest resurgence.
- tendency to be concentrated by foodweb.
- misuse or unsafe methods of application.
- creation of new pests due to the killing of beneficial predators that previously kept a number of pests under control.
- the effect of long-term usage of pesticides on soil fertility cannot be ruled out.
- the qualities that make synthetic organic pesticides so effective—stability, solubility and high toxicity—make them environmental nightmare due to their persistence and mobility in the environment.

Remedy:

- banning dangerous compounds;
- developing alternatives like application of biological control agents biological pesticides or integrated pest management;
- restricting trade of pesticide-contaminated produce;
- controlling pesticide usage by monitoring, inspection and licensing to ensure

sensible procedures;

- developing less persistant pesticides;
- controlling prices of pesticides to discourage excessive use;
- education to discourage unsound strategies;
- rotation of crops to upset pest breeding and access to food;
- hand weeding or non-chemical weeding;
- encouraging agencies to cut funds for pesticides; and
- treating drinking water to remove pesticides.

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3. Water logging:

The problem of water logging arises either due to surface flooding or due to high water table. The productivity of water-logged soils is very poor due to less oxygen availability for respiration of plants sown over such soils/areas. Though construction of canals has improved irrigation and increased the crop yield in many areas, but excessive use of canal irrigation in some areas has disturbed the water balance. This has created water logging problem as a result of seepage or rise in the water table.

In India, the areas which are frequently waterlogged include estuarine Deltas of Ganges, areas of Kerala and Andaman & Nicobar Islands. In Punjab and Haryana, extensive areas have become water- logged where adequate water supply or tube well water encouraged the farmers to use it over- enthusiastically leading to water –logging problem.

Preventing excessive irrigation, sub- surface drainage technology and biodrainage with trees like Eucalyptus are some of the remedial measures to prevent water logging.

4.Salinity:

At present one third of the total cultivable land area of the world is affected by salts. In India, there is about 6-7 million hectares of saline land and thousands of hectares of good agricultural land is turning saline every year due to intensive agricultural practices.

Salinity refers to increased concentration of soluble salts in the soil. Saline soils are characterized by the accumulation of soluble salts like sodium chloride, sodium sulphate, calcium chloride, magnesium chloride etc in the soil profile. It results due to intensive agricultural practices. Due to poor drainage of irrigation and flood waters, the dissolved salts in these waters accumulate on the soil surface. In arid areas with low rainfall, poor drainage and high temperatures, water evaporates quickly from the soil leaving behind the salts in high concentrations. Excess of these salts (mainly carbonates, chlorides and sulphates of sodium and traces of calcium and magnesium) form a crust on the soil surface and are injurious to the survival of plants. The water absorption process of the plant is severely affected. Even if

Check Your Progress:

3. How many types of minerals are there?
4. what do you understand by balanced diet?

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sufficient water is available in the soil, it is not available to the plants due to higher concentrations of the soil solution.

Salinity can be checked by:

- Improving the drainage;
- Salinated land can be reclaimed by leaching them with plenty of waters (*i.e.* heavy irrigation).
- Laying under ground network of perforated drainage pipes for flushing out the salts slowing. This sub- surface drainage system has been tried in the experimental station of CSSRI at Sampla, Haryana.

1.16 ENERGY RESOURCES

Energy powers the modern world. It is essential to the way we live, work and move today.

Though energy is present in a number of forms (mechanical, thermal, chemical, biological energy and energy in the matter), which differ basically from one another ; but together constitute the physical reality of our universe. All the physical processes can be construed as a transition from one form of energy to another. In fact, all living beings are operated by means of energy, which is derived from the environment. Man is only a part of the energy flow in nature.

Broadly, energy is used for the following purposes:

- Cooking, heating, lighting and other such facilities;
- Transporting people and goods;
- Manufacturing consumer goods and capital equipment;
- Production and conversion of primary fuels into other forms of energy as desired by the consumers *(e.g.,* conversion of chemical to electrical energy by dry cell battery); and many more.

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 as the major sectors of the economy depend upon the availability of energy resources.

In India, energy is consumed in a variety of forms. Fuelwood, animal waste and agricultural residues are the traditional sources of energy that continue to meet the bulk of the energy requirements in rural India. These non-commercial fuels are gradually getting replaced by commercial fuels, such as, coal, lignite, petroleum products, natural gas and electricity. Commercial fuels account for 60% of the total primary energy supply in India; while 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

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sources like solar, wind, ocean, biomass, etc. Petroleum and its products are the other large sources of energy.

The installed power generating capacity in the country has increased from a meagre 1,400 MW in 1947 to 92,864 MW at the end of 1998-99 ; comprising 22,438.48 MW hydro, 67,617.46 MW thermal (including diesel and gas), 1,840 MW nuclear and 968.12 MW wind. In a developing country like India—greater the availability of energy, the more is its shortage. It is obvious from the fact that inspite of this phenomenal increase in power generating capacity, presently, the peak shortage is approximately at 30% level with a deficit of about 2,000 million units.

The Govt. of India has formulated 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 utilising energy resources in an unjudicial manner. The main features of this policy are:

(i) accelerated exploitation of domestic conventional energy resources, viz., oil, coal, hydro and nuclear power;

(ii) intensification of exploration to achieve indigenous production of oil and gas;

(iii) management of demand of oil and other forms-of energy ;

(iv) energy conservation and management;

(v) optimisation of utilisation of existing capacity in the country

(vi) development and exploitation of renewable sources of energy to meet energy requirements of rural communities;

(vii) intensification of resources and developmental activities in new and renewable energy resources; and

(viii) organisation of training for personnel engaged-at various levels in the energy sector.

In the short term, the energy policy concentrates on development of domestic conventional energy resources along with demand management without adversly affecting economic growth. In the medium term, energy conservation and improved energy efficiency will improve the position. And in the long term, development of technologies to exploit resources of thorium as well as new and renewable ones on a large scale will be undertaken.

Energy Resources

The energy resources can be classified in many ways:

(A) **Commercial fuels.** These include coal, lignite, petroleum products, natural gas and electricity.

Non-commercial fuels. These include fuelwood, cow-dung, agricultural wastes, etc.

(B) **Primary energy resources.** Primary energy resources are those which are

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mined or otherwise obtained from the environment. These include fossil fuels (coal, lignite, crude oil and natural gas), nuclear fuels, water (hydro energy), solar, wind, ocean and geothermal energy.

Secondary energy resources. Secondary energy resources are those which do not occur in nature ; instead, they are derived from primary energy resources. These include petrol, diesel, electrical energy (from coal, diesel and gas), etc.

(C) **Conventional energy resources.** Convention energy mainly comes from fossil fuels such as oil, natural gases and coal. They occur naturally under the earth's surface in the form of crude oil, which is extracted, purified and distilled to separate it into various petroleum products.

These include fossil fuels (coal, petroleum and. natural gas), water (hydel power) and nuclear energy.

Non-conventional energy resources. Non-conventional or renewable sources of energy are the types of energy that are derived from sources that continually replenish themselves through natural processes. Such energy sources convert the energy found in things like sunlight, biomass, falling water and the wind into usable forms of power like heat and electricity.

These include solar, wind, geothermal, ocean (thermal, tidal and wave), biomass and hydrogen energy.

(D) **Non-renewable energy resources.** Non-renewable energy' sources are those natural resources which are exhaustible and cannot be replaced once they are used; These are available in limited amount and develop over a long period. These include fossil fuels (such as coal, oil and natural gas) and nuclear power.

Renewable energy resources. Renewable energy resources are those natural resources which are inexhaustible *(i.e.,* which can be replaced as we use them) and can be used to produce energy' again and again. These are available in unlimited amount in nature and develop in a relatively short period of time. These include solar, wind, water, geothermal, ocean, and biomass energy. Nuclear energy, however, can also be considered as inexhaustible source of energy-if atomic minerals are used in fast breeder reactor technology.

1.17 RENEWABLE ENERGY RESOURCES

While fossil fuels and hydro-electricity will continue to play a dominant role in the energy scenario in our country in the next few decades, conventional energy resources such as coal, oil, and natural gas are limited and non-renewable. Also, fossil fuels need to be used prudently on account of being environmentally harmful. On the other hand, renewable energy resources are indigenous, non-polluting and virtually inexhaustible. India, being a tropical country, enjoys abundant sunshine. The country's topography also provides opportunities for using solar, wind and small hydro resources; and its vast land resources can sustain production of significant quantities of biomass, yet another form of renewable energy. Renewable have enormous potential to meet the growing energy requirements of the increasing population of the developing world, while offering sustainable solutions to the global threats of

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climate change.

Renewable energy sources are indigenous and can contribute towards reduction in dependency on fossil fuels. Renewable energy sources assume special significance in India when viewed in the context of the geographic diversity and size of the country, not to mention the size of its rural economy. Since renewable energy resources are diffused and decentralised, they are more appropriate as local energy systems to meet the ever expanding and diversified energy needs. In this perspective, they offer numerous possibilities for meeting the basic energy needs of the rural poor. This apart, renewable energy offers significant possibilities for job creation. Such jobs would also help arrest rural to urban migration.

Renewable energy also provides national energy security at a time when decreasing global reserves of fossil fuels threatens the long-term sustainability of the Indian economy. The energy security is an issue not only at the national level but also at the local level. This means that a remote hamlet or village will not need to depend on mostly erratic energy supply from far flung areas but will be in a position to meet its own demands through indigenous energy resources. The use of such technologies, which on the one hand enable users to use traditional fuel more efficiently and on the other hand utilize locally appropriate renewable energy resources provides a certain level of energy security to these users.

SOLAR ENERGY

Solar energy is derived by using the sun's energy to produce electricity, heat and cooling for homes and industries. Solar collectors or solar thermal devices are used to convert solar energy into thermal energy. Examples of the applications of solar energy are solar water heaters, solar cookers and solar photovoltaic (PV).

The sun is a source of enormous energy. It is a fusion reactor at a distance of about $150 \times 10_6$ km from the earth. The energy from the sun in the form of radiations is called solar energy. Solar energy technology comprises of two distinct categories, viz., thermal conversion and photo conversion. Thermal conversion takes place through direct heating, ocean waves and currents, and wind. Photoconversion includes photosynthesis, photochemistry, photoelectro-chemistry, photogalvanism and photovoltaics. Solar radiation is collected and converted by natural collectors such as the atmosphere, the ocean and plant life, as well as by man-made collectors of many kinds (Fig. 2.4). There are a number of solar technologies by which it can be harnessed (Fig. 2.5).

Perhaps, the earliest use of direct solar energy by mankind was—drying the body or warming it in the sun during winters. Indeed, drying of clothes, fodder, timber, agricultural and animal products, salt water (to get salt), and passive space heating—remained the most extensive form of use of direct solar energy in the history of mankind. Now we have several techniques for harnessing solar energy. Some important solar harvesting devices are :

1. Solar Water Heater:

Solar water heaters—also called solar domestic hot water systems—can be a cost-

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effective way to generate hot water for your home. They can be used in any climate, and the fuel they use—sunshine—is free.

Solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't.

Most solar water heaters require a well-insulated storage tank. Solar storage tanks have an additional outlet and inlet connected to and from the collector. In two-tank systems, the solar water heater preheats water before it enters the conventional water heater. In one-tank systems, the back-up heater is combined with the solar storage in one tank.

This system of water heating is commonly used in hostels, hospitals, hotels, guesthouses, etc. as well as domestic and industrial units.

2. Solar Space Heating of Buildings

Solar space heating can be provided passively through the architectural design of the premises. At its simplest, this involves only the orientation of the building and providing large south-facing windows. More radical possibilities include the provision of an entire wall of double-glazed windows or a heavy dark-colored south-facing wall behind a layer of glass, with *room air* circulating by convection between the wall and the glass, or a flat roof covered by a pond of water over which insulating screen can be drawn at night (this also provides summer cooling).

Alternatively, an active technology of solar space heating where water is the medium is essentially an extension of the technology employed in solar water heating except that energy has to be recovered from the tank through a heat exchange surface. In systems employing air as the heat-transfer medium, there is no need of an additional heat exchanger as was the case with water. However, water systems are more common than air system they offer better heat-exchanger performance. Though, they do have the disadvantages of leakage and susceptibility to freezing.

For inclement days, an auxiliary heating system using electricity (or any other system) is required as a back-up.

3. Solar Air-Conditioning

Solar air conditioning refers to any air conditioning (cooling) system that uses power. This can be done through passive solar thermal energy conversion and photovoltaic conversion (sunlight to electricity).

Solar air-conditioning includes solar-powered refrigeration systems of Rankine cycle systems, absorption refrigerator systems and solar-regenerate desiccant cooling systems. Out of these, open-cycle absorption desiccant cooling systems seemed to offer the best prospects. In a typical desiccant cooling cycle, ambient air is adiabatically cooled, dehumidified, cooled both sensibly and evaporatively, and then dueled to the living area. In the regenerative stage, air is evaporatively cooled, heated as it cools the supply air stream, heated again by solar collectors, and

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ed. Simulation and analysis of desiccant cooling systems suggest that solar-ed systems can be cost-competitive with conventional vapor-compression tion systems. Desiccant cooling seems best suited for regions with about ting and cooling loads and high humidity.

Refrigeration

igeration is closely related to air-conditioning. It is generally required for ervation or for storage of medical and biological materials. A lot of experi-ve been carried out in several countries including USA, former USSR, id Sri Lanka on solar-operated coolers using absorption cooling cycles. t of these are aimed at household-scale for food refrigerators or small-manufacturing units. Although, most of the units/machines fabricated are design; but are generally too complicated to operate and therefore are not the people.

Drying

ing of agricultural and animal products is the most ancient, traditional and ad method of utilizing direct solar energy.

mary technique involves the spreading of the material (to be dried) in a on the ground to expose it to sun and wind. Agricultural products including ain, hay, fruits and vegetables are still dried in this manner all over the cluding the industrialized countries. In recent years, innovation has been particularly for fruit drying. Agricultural products are dried in a simple ryer which consists of a box insulated at the base, painted black on the and covered with a glass. To facilitate the flow of air over the drying ventilation holes are provided at the base and top of the sides. The drying s placed on carefully designed perforated trays/racks inside the cabinet. tion of improved process control has resulted in product quality.

arge portion of the world's supply of dried fruits and vegetables continues pared by sun drying. No doubt, it is the cheapest and simplest way to dry egions having abundant sunshine, where the post-harvest season is char-by low relative humidity and little or no rainfall. Spray drying pfmilk and g are examples of solar dried animal products.

Cooker:

oker, or solar oven, is a device which uses the energy of sunlight to heat ink to cook it or sterilize it.

solar cooker is a well-insulated shallow rectangular/square metal box blackened from the inner side and fitted with a flat glass cover. When sunlight, the solar radiation penetrates the glass cover (or covers, in glass covers are provided for minimizing the heat loss) and are absorbed ckened surface; thereby, resulting in an increase in temperature inside the cing pots blackened from outside are placed in the solar-box (or solar-

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cooker). The food gets cooked with the heat energy produced due to temperature inside the solar-cooker. The collector area of such a solar c be increased by providing a plane reflector mirror of size equal to the s box and is hinged on one side of the glass frame. The reflector mi provision for adjustment of reflector at different angles with the solar co the help of reflector mirror, a temperature rise of 15 to 20°C can be achie the solar- cooker.

7. Solar Greenhouses

A greenhouse is a closed structure covered with transparent material plastic) which acts as a solar collector and utilizes solar radiant ener growth of plants.

The incoming' short-wave solar radiations can pass through the green hou but the long-wave thermal radiations emitted by the objects within the g cannot escape through tbe glazed surface. As a result, the radiations g within the greenhouse and result in an increase in temperature. Further, the the greenhouse gets enriched with carbon dioxide (as there is no mix greenhouse air with ambient air) and the moisture loss is reduced due to transpiration. All these factors help the plant growth to sustain during colder months.

8. Solar Furnaces

Solar furnaces provide a. means of generating extremely high temperatu around 3,500°C) under very clean conditions, and cant be used to melt materials. In a solar furnace, high temperature is obtained by concentratin radiations on to a specimen using a number of heliostats (turnable mirrors on a sloping surface. The manufacture of fused aluminium crucibles and st properties of ceramics at extremely high temperatures are examples of th tion of such a furnace. The biggest advantage of a solar furnace is that h be accomplished without any contamination and temperature can be e trolled by changing the position of the material in focus. However, th furnace is likely to remain a specialist device, with no significant impact market as a whole. It is anticipated that in future, solar furnaces can be theiproduct on of nitric acid and fertilisers from air.

9. Solar Desalination

The use of solar energy for desalting sea-water and brackish well wate demonstrated in several moderate-sized pilot plants all over the world USA, USSR, Greece, Australia and several other countries. The centur cess of solar distillation, the basin-type still, has been modified and modern materials. In this method, solar radiation is admitted through a t air tight cover of sloping

The per litre distilled water cost obtained by this process is cheaper tha water obtained by other electrical energy-based processes

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ar Furnaces

rnaces provide a. means of generating extremely high temperatures (up to 3,500°C) under very clean conditions, and can be used to melt refractory s. In a solar furnace, high temperature is obtained by concentrating the solar is on to a specimen using a number of heliostats (turn able mirrors) arranged ping surface.

:r Electricity—Thermal

ergy may be used to heat a fluid, which then generates electricity through itional heat engine. To obtain an adequate working temperature, some form entration of solar energy is required, so that for most designs there is little tion from diffuse sunlight. Broadly, the systems fall into two categories:

(i) systems in which individual mirrors track the sun continuously; and

(ii) systems in which the mirrors are fixed (or can be adjusted from day to do not track continuously).

ius tracking systems use a large number of plane or curved mirrors (heliostats), ered to reflect sunlight onto a single tower mounted boiler. This gives a high ure and high efficiency, but requires complex, rugged and accurate mecha- the heliostats.

r Electricity-Photovoltaic

ltaics or solar cells are devices which directly convert incident solar radia- lectrical current. Invented in 1955, their use was initially focussed on pro- lectrical power to space crafts.

photovoltaic systems (SPV), electricity is generated directly from solar t works on the principle of photoelectric effect—when light falls on certain ike silicon, the electrons get excited and escape from the metal, whicb are ected by another metal and passed through wires in a steady stream; the flow thus set up constitutes the electric current.

r Pond

id is one of the most promising technologies in solar energy utilization for irposes. It is a large scale solar energy collector with integral heat energy or supplying thermal energy. This thermal energy can be used in various ch as, process heating, water desalination, refrigeration, drying and thermal / generation.

iow that fluids, such as water and air, become lighter and rise when heated. ; when water is heated by the sun's rays, hot water from the bottom of the s, reaches the surface and loses whatever heat it has gained to the atmo-

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sphere. The result is that the pond water remains at nearly atmospheric ten
This heat loss by convection can be prevented if dissolved salts are pres
bottom layer of the pond. Thus, the solar energy remains entrapped in t
This is the principle on which solar ponds work.

Solar ponds are large-area brine ponds about 1 0 m deep in which vertical
of salt concentrations are maintained so that the most concentrated and m
solutions are at the bottom of the pond.

Advantages of Solar Energy

1 It is a source of free energy, needs no fuel and produces no
pollution.

2 In sunny countries of India, solar power can be used and is a boon
regions where electricity supply shill not exists.

3 Solar energy is handy for low –power uses such as solar powere
lights and battery chargers, or reduces energy bills.

Disadvantages of Solar Energy

1 It doesn't work in night and during cloudy weather.

2 Solar power stations are very expensive to build. Solar cell cost a
compared to the amount of electricity they will produce in their l

3 Solar devices are bulky and not easy to handle.

HYDRO ENERGY

Surface water because of its potential energy in certain areas, provides t
est, neat and clean resource of energy. As a source of power, it has bee
human civilizations since its earlier days in the form of water- wheels.
electric power plant harnesses power from water flowing under pressure (
falling from a height). Electric generators driven by water turbines repres
of water energy as electricity.

Hydro or hydel power is one of the most important sources of energy, ne
thermal power. This can be assessed by the fact that nearly 30% of the te
of the world is met by hydro-electric power. The total hydro potential of
is about 5,000 GW. There are countries-in the world where almost ent
generation is hydro based. In Norway, the hydro power forms 99% o
installed capacity

The Indian Scenario

At present about 24% of the country's electricity is being generated th
hydro power plants. Out of the total installed power generating capacity
MW (at the end of 1998-99) in the country, 22,438.48 *MW* is from hy
As per the estimates of central electricity authority, the annual hydro
potential of our country at 60% load factor is 89,830 MW: yet hardly
has been harnessed so far.

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icks:

or hurdle in harnessing hydro power, probably is:

's the initial investment and

Comparatively much more gestation period of hydro projects.

Another major drawback of hydro projects is displacement of population

Damage to environment and fertile lands.

ems to be no escape from long gestation periods. But for the displacement ation and damage to environment and fertile lands, the focus is now shifting nstructing a few big dams to the construction of many small-scale hydroelec- ities. To be fair, a blend of both types of hydro projects is recommended.

ENERGY

ergy is a renewable source of non-polluting energy and is emerging as one ost potential sources of alternate energy which will be helpful to a great bridging the gap between the energy demand and supply. The wind re- s more intermittent and is strongly influenced by terrain or geography fac-

h speed winds have a lot of energy in them as kinetic energy due to their The driving force of the winds is the sun. The wind energy is harnessed by use of wind mills. At any given time, the amount of energy contained in the proportional to the wind speed at that instant in the context of wind-based roduction systems. This energy can be utilized for performing mechanical trical works. Wind turbines can be used to generate electricity, for lifting om wells, for direct water pumping and many more.

rbine, basically, consists of a few vanes or blades radiating from a central the wind blows against the vanes/blades, they rotate about the axis. This al motion is then utilized to perform some useful work—mechanical and/or l.

number of wind mills are installed in clusters called wind farms, which feed the utility grid and produce a large amount of electricity. These farms are located in coastal region s, open grasslands or hilly regions, particularly n passes and ridges where the winds are strong and steady. The wind speed l for satisfactory working of a wind generator is **15km/hr.**

lian Scenario

rated high in the world for wind resource availability. The total wind energy l in India is estimated at 25,000 MW. A total capacity of 732 MW has been installed by 1995-96.

rst wind farm project is at Mandvi in Kutch district of Gujarat; while a wind ster of 150 MW at Muppandal in Tamil Nadu is Asia's largest wind farm

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cluster.

Wind energy generation has been given a strong thrust by Ministry of non-(tional Energy Sources, Govt. of India. Research in the exploitation of wind is being carried out at the following institutes:

(i) National Aeronautical Laboratory (NAL), Bangalore.

(ii) Marine Chemicals Research Institute (MCRI), Bhavnagar.

(iii) Central Arid Zone Research Institute (CAZRI), Jodhpur.

Merits of Wind Energy

(1) It is a non-polluting and environment friendly source of energy.

(2) It is an important renewable and sustainable source of energy, availa of cost.

(3) The scope of wind resource, globally, is enormous and is less depen latitude than other solar based renewable energy technologies.

(4) The generation period is low and power generation starts from comn ing.

(5) Power generation is cheaper as there is no shortage of input c recurring expenses are almost nil.

(6) It can be made available easily in many off-shore, on-shore and areas; thus, helpful in supplying electric power to remote and rura

(7) In addition to the large-scale (MW sized) production of electrical wind power systems can be applied to smaller sized applications in oping countries as well as for energy supply in remote or specialize cations such as water pumping, battery charging, operating simple n ery, and heating end uses as well as hybrid energy (wind/diesel, wi systems.

(8) Wind power is particularly relevant to developing countries where ele supply may be absent or of limited capacity.

(9) Development of wind energy is recommended to broaden the natic ergy options for new energy sources.

Limitations of Wind Energy

(1) It has low energy density.

(2) It is generally favorable in geographic locations which are away fron

(3) If is variable, unsteady, irregular, intermittent, erratic and dangerous

(4) Wind turbine design, manufacture and installation have proved to b plex due to widely varying atmospheric conditions in which they l operate.

(5) Wind farms can be located only in vast open areas in location of fa

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ind. Generally, such locations are away from load centers.

he location of wind farms should not be on migratory routes. Otherwise, could play havoc with the birds and might lead to a disaster for some vian populations.

he appearance of windmills on the landscape and their continual whirling nd whistling can be irritating.

he use of wind power for electricity generation on a small scale is already conomical in remote locations. But, at present, it does not appear to be conomic for large scale generation.

eing fluctuating in nature, it requires energy storage batteries (which indi-ctly and substantially contribute to environmental pollution) or alternate ource of energy to fall back on, in case of non-availability of winds.

NERGY

y is renewable energy made available from materials derived from biologi-es. Biomass is any organic material which has stored sunlight in the form al energy.

defined as living matter or its residues, is a renewable source of energy. iass includes all the new plant growth, residues and wastes, algae, agricul-forest residues (like bagasse, corn cobs, bark, saw dust, wood shavings, mal droppings, etc.), wastes (like sewage, garbage, night soil, etc.), bio-le organic effluents from industries like sugar, slaughter house, meat pack-, breweries distilleries, etc. The main sources of biomass can be classified n two groups :

material including those derived from agriculture, forestry, municipal and wastes;

ing energy crops involving short rotation forestry plantations.

nts considered for energy production include sugarcane, sugarbeet, sor-m, wheat, grass, eucalyptus, sun flowers, short rotation hardwoods and These plants vary in their total biomass yield, their ability to grow on poor areas of poor climate, and the suitability of the end product for different

Conversion Processes

cked in biomass can be converted into useful energy by following methods:

ncineration or direct combustion: To allow them to dry out in the sun ot required for wood) and burn them or burn them at high temperature in ncinerator to produce heat, steam and electricity.

hermo chemical conversion: The organic matter is decomposed through ermo chemical processes having different temperature and pressure com-ination

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- Pyrolysis at high temperature (500-900°C) in the absence of oxy be used, particularly for wood, yielding methanol and hydrocarbor other products. Methanol may be used as a gasoline additive, or i chemically to provide a direct substitute for gasoline.
- Gasification of biomass i.e., by heating it with limited air or heatin temperature and pressure in the presence of steam and oxygen.
- **Biochemical conversion:** It may involve
- Anaerobic digestion to yield 'biogas', which is also a suitable treat animal manure. This approach is particularly applicable lo water-bas and farm-wastes, avoiding any requirement for drying, and the resi be used as a fertilizer.

- Fermentation of biomass using microbes to yield alchohol (biofuel)

BIOGAS

Biogas typically refers to a gas produced by the biological breakdown o matter in the absence of oxygen. Organic waste such as dead plant an material, animal dung, and kitchen waste can be converted into a gaseous fi biogas.

Biogas is produced by the anaerobic digestion or fermentation of biode materials such as biomass, manure, sewage, municipal waste, green wa material, and crops. Biogas comprises primarily methane (CH_4) -60% an dioxide (CO_2) -40% and may have small amounts of hydrogen sulphic moisture and nitrogen.

It has a calorific value of more than 5,000 kcal/m^3 depending on its carbo content. The calorific value of biogas can be improved further by reducing i dioxide content by passing the biogas through a lime solution. It boils at a ture less than 157°C and liquefies at a pressure of about 350 kg/cm^2.

Biogas is a sustainable source of energy by virtue of its production fro available natural organic wastes, simplicity of construction, operation an nance of the production units and multiple benefits.

Biogas production is carried out in an enclosed water-tight biogas plant (or made of bricks or steel. A slurry of waste organic matter is fed into the dige an inlet, and gas formed is trapped by an inverted drum which covers th of the liquid. As gas is produced, the drum rises—acting as a gas-storage From this chamber, the gas may be drawn-off as per requirement. The digestion takes place between a pH of.7.0 to 7.4 and at a temperature of

Biogas is a clean, cheap and convenient cooking fuel. It is a storage ener that can also be used for lighting purposes and running small motors for li providing power for cottage industries. There are several other advantages families if they adopt biogas technology. The rural women and childre spared from the ordeal of daily collection and loading on their heads heav

NOTES

wood. There will be an end to the fumes (that are part of the traditional
s) that are smarting to the eyes and create lung diseases, a lot of time is also
in cooking and cleaning of the utensils and vessels; indiscriminate felling of
or fuel is also reduced; and, if latrines are attached to these plants, it helps
: sanitation too. What makes the unit financially viable is the cash inflow in
of saving on firewood, and production and use of enriched manure.

ists have also developed biogas plant .that can operate on a variety of feed
als such as night soil, water hyacinth, agricultural wastes, deoiled castor cakes,
/ dust and food waste.

ıdian Scenario

is a worldwide interest in biogas production. In countries like India (and
), biogas production has become very common, particularly in rural areas
e of various advantages offered by the village and community scale produc-
f biogas as discussed earlier. In India, a large scale programme for the
tion of biogas has been taken up as the National Project for Biogas Devel-
ıt (NPBD) in the year 1981-82 as a centrally sponsored scheme. It was
ged to install 10 lakh number of biogas plants during the Eighth Plan period
inst 7.5 lakh numbers envisaged earlier.

ing energy from biomass conversion, the following steps have been taken in

A 10 MW rice straw based thermal plant (the first of its kind) has been commissioned by BHEL at Jhalkhari in Punjab.

A pilot plant to generate electricity from garbage and municipal wastes has been installed at Timarpur, Delhi.

The first large scale plant to produce fuel pellets from municipal garbage has begun trial runs at Mumbai.

A 100 kW gasifier system has been established at Port Blair; and a 15 kW sugarcane-water based system is under field evaluation.

biomass research centers, under different agro-climatic conditions of the
y, have been set up to provide R & D back up.

'UEL

l can be obtained by fermenting biomass that produces alcohols like ethanol
:thanol which can be used as fuels.

Ethanol- It can be produced from carbohydrate rich substances like sugarcane, corn and sorghum (Jowar). It burns clean and is non polluting. However, as compared to petrol its caloric value is less and therefore, produces much less heat than petrol. It is also considered to be an excellent substitute for kerosene and its combustion is as clean as LPG.Ethanol can be obtained from grain based or sugar- containing plants.

Check Your Progress:

5. what are renewable energy sources ?
6. What do you understand by solar refrigeration?

NOTES

2 **Gasohol-**It is a common fuel used in Brazil and Zimbabwe for runni and buses. In India too gasohol is planned to be used on trail basis i parts of the country, to start with Kanpur. It is a mixture of etha gasoline.

3 **Methanol-**It is useful since it burns at a lower temperature than gas diesel. Thus the bulky radiator may be substituted by sleek design cars. Methanol too is a clean, non-polluting fuel. Methanol can b obtained from woody plants.

Merits of Bio-energy

The bio-energy produced by plants has more advantages as compared t sources of energy, because:

(i) Plants ensure a continuous supply of energy due to their continuous

(ii) The cost of obtaining bio-energy through energy-plantations is less t cost of obtaining energy from fossil fuels.

(iii) The production of biogas (particularly from human or animal wast additional value in intensive agricultural systems as a method of a pollution.

(iv) Growth of biomass consumes more carbon dioxide than is released combustion of biomass besides producing the atmosphere-purifying as a by-product of the photosynthetic process.

(v) Within the energy supply system as a whole, biomass sources ha advantage over many other renewable sources that they provide a form of energy; and in many cases in a form suitable for vehicle prop Thus their function is complementary to that of the renewable sourc for electricity generation; and as pressure on oil supplies grows, bi energy sources will compete with synthetic liquid or gaseous fuels ma tured from coal.

(vi) Bio-energy has a tremendous potential, especially for rural areas.

Limitations of Bio-energy

Except biogas production, the other biomass energy sources have yet to es a significant economic role.

- Biomass produces greenhouse emissions.
- It takes considerable energy to produce biofuels from certain feedst resulting in less than desirable energy returns on energy invested (EROEI).
- Biomass collection is difficult.
- Biomass crops not available all year.
- Still an expensive source, both in terms of producing the biomass a

converting it to alcohols.

On a small scale there is most likely a net loss of energy—energy must be put in to grow the plant mass.

THERMAL ENERGY

NOTES

rmal energy is the type of energy that is produced by harnessing some of the ide the earth. A well may be drilled into a geothermal reservoir to produce / supply of hot water to heat buildings, heat water for fish farms, provide greenhouses, or for industrial applications. Geothermal plants produce power e hot water indirectly by converting the steam and heat from hydrothermal to electricity.

t (thermal energy) from the molten core of the earth offers an inexhaustible of energy. Though the total quantity of heat stored in the earth is vast, mal energy can only be exploited in particular areas (called 'hot spots'), eological formations lead to high temperature gradients. We can find evi- f such hot-spots in volcanic eruptions, geysers and bubbling mud holes. mal energy taken from natural steam, hot water or dry rocks may be used ric power generation, space heating, ground-water heat pumps, recreational h spas, agricultural growth enhancement, agricultural drying and industrial

lian Scenario

s vast potential for geothermal energy with more than 340 hot water springs erage temperatures of 80-100°C at their places of occurrence. Work is on al parts of India to survey and assess geothermal potential and utilization of mal energy for direct beat and power generation. A 5 kW geothermal pilot lant has been commissioned at Manikaran in Himachal Pradesh. A potential fW geothermal power has been estimated in the Puga Valley of Ladakh in and Kasbmir. But' larger scale geothermal power plants have not been ed till date. But it is hoped that with economic liberalization private compa- y come forward.

nstrate the feasibility of using geothermal energy, the Tapovan (nearJoshimath wal region) project was conceived. The project envisages application of nal energy for greenhouse heating, space heating, biogas production, fish on, poultry production, spa (place where there is a spring of mineral water nedicinal properties), etc.

of Geothermal Energy

Geothermal energy is the most versatile and least polluting renewable energy resource.

Geothermal energy is relatively inexpensive.

It is not subject to the same safety, political, price and operating cost uncertainties as imported oil, natural gas or nuclear fuel use.

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(4) Geothermal power plants could be brought on line more quickly tl other energy sources in case of an extended national emergency

(5) Hydrothermal power plants with modern emission controls have sh they have relatively benign environmental impacts.

(6) Within the electric supply system, geothermal sources could provic base load power with very low variable costs.

(7) The power generation level is higher for geothermal than for solar a

(8) Geothermal energy can be used effectively and efficiently for dir such as space and district heating, geothermal heat pumps (GHP), h bath resorts, aquaculture, greenhouses, industrial processes and e: oil recovery.

OCEAN ENERGY OR MARINE ENERGY

Marine energy or marine power (also sometimes referred to as ocean energy power) refers to the energy carried by ocean waves, tides, salinity, and oce perature differences. The movement of water in the world's oceans creat store of kinetic energy, or energy in motion. This energy can be harnessed to electricity to power homes, transport and industries.

The term marine energy encompasses both wave powers — power from waves, and tidal power — obtained from the kinetic energy of large b moving water. Offshore wind power is not a form of marine energy, as win is derived from the wind, even if the wind turbines are placed over water.

The oceans have a tremendous amount of energy and are close to many if concentrated populations. Ocean energy has the potential of providing a sul amount of new renewable energy around the world.

Oceans are large water bodies covering 70.8% of the Earth's total surface hold about 1,445 million cubic km of saline water. Energy from ocean or be obtained in many ways. These include:

1. Ocean Thermal Energy Conversion (OTEC)

The sun warms the oceans at the surface and wave motion mixes the warm downward to depths of about 100m. This mixed layer is separated from t cold water, formed at high latitudes, by a thermodine. This boundary is sor marked by an abrupt change in temperature, but more often the change is The resulting vertical temperature distribution, therefore, consists of two laye rated by an interface with temperature differences between them ranging fi to 30°C, with the higher values found in the equatorial waters. This simple tion implies that there are two enormous reservoirs, in some oceanic regio viding the heat source and heat sink required to operate a heat engine. The using this energy is referred to as OTEC. The OTEC makes use of the dif in temperature between the two layers of the sea to extract energy. This e used to drive turbines for generating electricity.

The Indian Scenario

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s having a large potential of OTEC, which could be of the order of about) MW which is about 150% of the present total installed power generating ty of the country. Some of the best sites in the world for. OTEC are situated Indian-mainland and near the Islands of Lakshadweep, Andaman and Nicobar. ean energy cell has been set up at IIT, Chennai to keep pace with the tional developments in this field. A US company, M/s Sea Solar Power Inc., noting the use of OTEC and the world's first plant is proposed off the coast ıil Nadu with a capacity of 100 MW.

s of OTEC

Power from OTEC is continuous, renewable and pollution free.

OTEC offers one of the most benign power production technologies, since the handling of hazardous substances is limited to the working fluid *(e.g.,* ammonia) and no noxious by-products are generated.

Unlike other sources of solar electricity, the output of an OTEC system would show very little daily or seasonal variation, and would be very easy to integrate into a wider electricity supply system.

Electric power generated by OTEC could be used to produce hydrogen.

Tropical and sub-tropical island sites could be made independent of conventional fuels for the production of electricity and fresh water by using plants of appropriate size.

al Energy

flowing waters carry with them kinetic energy. When such a flowing water ıters a turbine, a part of the momentum of the flowing water is transferred on urbine, and thus causing it to rotate. The rotation of the turbine can then be) generate electricity. Whether the water is in the open ocean, in an estuary river, its motion can thus be utilized in the generation of energy. The tides ing in the oceans are one such source of energy.

ıdian Scenario

lal power potential in India is estimated to be about 15,000 MW. The al sites identified are Gulf of Cambay (7,000 MW), Gulf of Kutch (1,000 ınd Sunderbans (100 MW) Other suitable sites are near Lakshadweep ;, Andaman and Nicobar islands and coasts of Orissa, Kerala, Tamil Nadu, aka and Maharashtra. Asia's first tidal power plant of 800-1000 MW ca- is proposed to be set up at Kandia in Gulf of Kutch.

ı of Tidal Energy

It is an inexhaustible and renewable source of energy.

Besides being inexhaustible, it is completely independent of the uncertainty of precipitation (rainfall, etc.). Even if there is a continuous dry spell for

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many years, there will be no effect whatsoever on tidal power ge

(iii) It is pollution-free source of energy, as it does not use any fuel does not produce any unhealthy waste.

(iv) Tidal power plants do not require large areas of valuable land as on the' bays or estuaries.

(v) Peak power demand can be effectively satisfied, when it works i nation with conventional power plants.

Limitations of Tidal Energy

(i) Variability in output caused by the variations in the tidal range.

(ii) Generation is intermittent. Although. this intermittent pattern coul proved to certain extent by using two (or more) basins and a doul system.

(iii) Tidal power schemes require low-head turbines, which are larger a expensive than high-head turbines of similar power.

(iv) Since the tidal ranges are highly variable, the turbines have to w wide range of head variation. This affects the efficiency of the tid

(v) Because tidal power schemes are feasible only at sites of unusually l range, their maximum possible contribution to energy needs, thoug is fairly small.

(vi) The most onerous problems in the use of tidal power are those of construction (particularly closure) in areas of high tidal flow; and c of the barrage, sluiceways and turbines by salt water.

(vii) Tidal power plants hamper the other natural uses of estuaries such as migration of marine organisms or navigation.

(viii) A tidal electric station would alter the current velocities and wav with consequential effects on the pattern of shoreline erosion and s regime.

3. Wave Energy

Wave power is the transport of energy by ocean surface waves, and the ca that energy to do useful work — for example, electricity generation. water d tion, or the pumping of water (into reservoirs). Machinery able to explc power is generally known as a wave energy converter (WEC).

Ocean waves are a derived form of solar energy, with wind being the ag transfers the sun's energy to the sea surface. Simply stated, the unequ heating of the earth generates wind, and wind blowing over water generates A unique property of ocean waves is their ability to travel vast oceanic d with negligible loss of energy. Even the longest waves do not begin to ' bottom' until they enter water depths of 300 m or less. Consequently, wave generated anywhere within an ocean basin ultimately arrives at some is continental margin of that basin, virtually undiminished.

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ndian Scenario

vave energy potential of the 6,000 km long Indian coast is estimated to be 40,000 MW. Trade wind belts in Arabian sea and Bay of Bengal are the ideal s for trapping wave energy. India's first wave energy power plant of 150 kW ity based on Oscillating Water Column (OWC) has been commissioned at aJam, near Thiruavanthpuram, by I.I.T. Chennai under the sponsorship from dian Government. It was commissioned in 1991. The Department of Ocean lopment has declared the~plant at Vizhinjam as a national facility for wave y and wave application studies. A Swediai Organisation, Sea Power AB, has oped technology for harnessing wave energy under Floating Wave Power ept (FWPC). Harnessing of wave energy on this principle is being explored ia and a 1 MW wave energy plant is being set Up in Andaman and Nicobar s.

ts of Wave Energy

It is a free, renewable and pollution-free energy resource.

Unlike tidal energy (which is very site-specific), some potential for the extraction of wave energy exists on almost any coastline.

) Energy has been naturally concentrated in waves. Therefore, the energy density of ocean waves is greater than that of wind as well as solar (the natural processes that generate them).

) Wave power devices do not require large land masses like solar or wind power devices.

Wave power devices are relatively pollution free. After removing energy from the waves, the water is left in a relatively calm state.

ations of Wave Energy

The variable nature of the output would limit the usefulness as the source of firm power. However, consideration could be given to combining wave power system with tidal barrage schemes to increase their firm power value.

Wave energy extraction equipments must be capable of Operating in a marine environment and withstanding very severe peak stresses in storms.

) A variety of working fluids and prime movers are required to convert the slow-acting, reversing wave forces into high-speed, unidirectional rotation of a generator shaft. That is, the wave energy conversion devices are relatively complicated.

With present state of technologies, wave power is expensive.

Relative scarcity of accessible sites of large wave activity.

rent Energy

etically, the moving ocean current can be used to generate energy by allowing ıter to pass through a series of turbines installed under water. But the energy

density that can be harnessed is low. Further, maintaining the turbines in pc even a bigger problem.

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HYDROGEN AS AN ALTERNATIVE FUTURE SOI OF ENERGY

Hydrogen burns in air in the presence of oxygen to form water and large of energy (150 kilojoules per gram). Due to highest calorific value, hydro serve as an excellent fuel.

1 It is highly combustible gas .

2 Hydrogen is a colorless and odorless gas.

3 The normal state of pure hydrogen is the hydrogen molecule (H_2) \ the lightest of all gases.

4 It is present in earth's atmosphere at very low levels (0.1 ppm).

5 Though it is very stable under normal conditions, but it undergoes reactions at elevated temperatures. It forms compounds with almo other element .

6 Moreover, it is an efficient, renewable, and clean or non –pollutin

7 It can be easily produced.

Production of hydrogen is possible in the following ways:

a) By thermal dissociation of water (at 3000^{0}K or above) hydrogen duced.

b) Thermo chemically, hydrogen is produced by chemical reaction o with some other chemicals in 2-3 cycles so that we do not nee temperatures as in direct thermal method and ultimately H_2 is prod

c) Electrolytic method dissociates water into hydrogen and oxygen by a current flow through it.

d) Photolysis of water involves breakdown of water in the presence of s to release hydrogen. Green plants and micro-algae also have photo water during photosynthesis. Efforts are underway to trap hydroge ecule which is produced during photosynthesis.

Advantages of Hydrogen Energy:

The hydrogen energy has following advantages as compared to other sou energy:

1. Hydrogen is colorless, odorless and entirely non- polluting, yieldir water vapour (with minimal NO) as exhaust when combusted in a eliminates the direct production of exhaust gases that lead to smc carbon dioxide emissions that enhances the effect of global warmin

2. Hydrogen is the lightest chemical element and has the best energy- to

ratio of any fuel (not counting tank mass).

3. Hydrogen can be produced anywhere; it can be produced domestically from the decomposition of water. Hydrogen can be produced from domestic sources and the price can be established within the country.

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NON RENEWABLE ENERGY SOURCES

These are the fossil fuels like coal, petroleum, natural gas and nuclear energy. The fuels are very precious because they have taken such a long time to be formed and if we exhaust their reserve at a fast rate as we have been doing, ever since we have discovered them, then very soon we will lose these resources forever.

FOSSIL FUELS :

Fossil fuels are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms. The age of the organisms and their resulting fossil fuels is typically millions of years, and sometimes exceeds 650 million years. The fossil fuels, which contain high percentages of carbon, include coal, petroleum, and natural gas. Fossil fuels range from volatile materials with low carbon. hydrogen ratios like methane, to liquid petroleum to nonvolatile materials composed of almost pure carbon, like anthracite coal. Methane can be found in hydrocarbon fields, alone, associated with oil, or in the form of methane clathrates. It is generally accepted that they formed from the fossilized remains of dead plants by exposure to heat and pressure in the Earth's crust over millions of years.

Fossil fuels are non-renewable resources because they take millions of years to form, and reserves are being depleted much faster than new ones are being made.

When coal, natural gas or oil are burned, they release gases into the atmosphere:

1 Carbon dioxide (CO_2) is a "greenhouse gas," trapping heat in the lowest part of the earth's atmosphere. This contributes to "global warming" - the average temperature of the earth slowly increases, affecting ecosystems across the globe.

2 Sulfur dioxide (SO_2) is a key contributor to acid rain, primarily in the northeast U.S.

3 Nitrogen oxide (NOx) contributes to acid rain and smog, as well as health issues such as lung inflammation, immune system changes and eye irritation.

There are three main types of fossil fuels:

1 Coal

2 Petroleum

3 Natural gas

COAL : Coal is the most abundant fossil resource in the world that consists mostly of carbon. Energy content (Btu/pound) ranges from 5,000 to 15,000 depending on the type of coal. Coal reserves are located all over the world. Coal was formed

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255-350 millions years ago in the hot, damp regions of the earth during the carboniferous age. The ancient plants along the rivers and swamps were buried after death into the soil and due to the heat and pressure gradually got converted into peat and coal over millions of years.

At present rate of usage, the coal reserves are likely to last for about 200 years and if its use increases by 2% per year, then it will last for another 65 years.India has about 5% of world's coal . Major coal fields in India are Raniganj, Jharia, Bokaro, Singrauli and Godavri Valley.

Coal is a burnable carbonaceous rock that contains large amounts of carbon. Coal can be burned to release energy. Coal contains elements such as hydrogen, oxygen, and nitrogen; has various amounts of minerals; and is itself considered to be a mineral of organic origin. Coal contain impurities like sulphur and as it burns , it produces the smoke which contains toxic gases like oxides of sulphur and nitrogen.

The Three Major Categories of Coal

Coal is classified into three categories, or ranks, based on how it responded to increasing heat and pressure over long periods of time and how much carbon it contains:

- **Lignite- (soft coal) -**This type of coal contains a lot of moisture and breaks apart easily .It has 70% carbon and low calorific value. It is also called as brown coal and is mainly used at electricity generating plants.
- **Bituminous-(medium hard coal) -** This coal has very little moisture .It has 80% carbon content and high heat value.
- **Anthracite-(hard coal)** It has lowest moisture content and 90% carbon .It makes good heating fuel for homes.

CRUDE OIL (PETROLEUM):

Crude oil is a naturally-occurring substance found trapped in certain rocks below the earth's crust. It is a dark, sticky liquid which, scientifically speaking, is classed as a hydrocarbon. This means, it is a compound containing only hydrogen and carbon. It is a mixture of alkane hydrocarbons. Hence, it has to be purified and refined by the process of fractional distillation, during which process different constituents separate out at different temperatures. We get large variety of products which are as follows ::

- Liquified Petroleum Gas (LPG)
- Kerosene
- Petrol
- Diesel
- Fuel oil
- Compressed Natural Gax (CNG)

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- Lubricating oil
- Paraffin wax
- Asphalt etc

It was also formed more than 300 million years ago. Some scientists say that tiny diatoms are the source of oil. Diatoms are sea creatures the size of a pin head. They do one thing just like plants; they can convert sunlight directly into stored energy.

Crude oil is highly flammable and can be burned to create energy.

It is the lifeline of global economy. There are 13 countries in the world having 67% of the petroleum reserves which together form the OPEC (Organization Of Petroleum Exporting Countries). About 1/4th of the oil reserves are in Saudi Arabia.

At the present rate of usage, the world's crude oil reserves are estimated to get exhausted in this century. Petroleum is considered to be a cleaner fuel as compared to coal as it burns completely and leaves no residue. It is also easier to transport and use .

NATURAL GAS:

Natural gas is the gas component of coal and oil formation. It is used in industrial and commercial heating and cooking and increasingly, to fuel electricity generation. In a compressed form, natural gas can also be used as a transportation fuel. Natural gas is either found mixed in oil or is released from coal.

It is mainly composed of methane (95%) with small amount of propane and ethane. It is the cleanest fossil fuel. It has a high caloric value of about 50Kj/g and burns without any smoke.

Natural gas is used as a domestic and industrial fuel. It is used as a fuel in thermal power plants for generating electricity. It is used as a source of hydrogen gas in fertilizer industry and as a source of carbon in tyre industry.

Compressed Natural Gas (CNG): Compressed natural gas is a fossil fuel substitute for gasoline (petrol), diesel, or propane/LPG. Although its combustion does produce greenhouse gases, it is a more environmentally clean alternative to those fuels, and it is much safer than other fuels in the event of a spill (natural gas is lighter than air, and disperses quickly when released). CNG may also be mixed with biogas, produced from landfills or wastewater, which doesn't increase the concentration of carbon in the atmosphere.

CNG is made by compressing natural gas (which is mainly composed of methane [CH_4]), to less than 1% of the volume it occupies at standard atmospheric pressure. It is stored and distributed in hard containers at a pressure of 200–248 bar (2900–3600 psi), usually in cylindrical or spherical shapes.

CNG is used in traditional gasoline internal combustion engine cars that have been converted into bi-fuel vehicles (gasoline/CNG). Natural gas vehicles are increasingly used in the Asia-Pacific region, Latin America, Europe, and America due to rising

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gasoline prices. In response to high fuel prices and environmental concerns, CNG is starting to be used also in tuk-tuks and pickup trucks, transit and school buses, and trains. Delhi has totally switched over to CNG.

Synthetic Natural Gas (SNG): It is a mixture of carbon monoxide and hydrogen. It is a connecting link between a fossil fuel and substituted natural gas. Low grade coal is initially transformed into synthetic gas by gasification followed by catalytic conversion to methane.

NUCLEAR ENERGY

Nucleus energy is energy in the nucleus of an atom. Atoms are tiny particles that make up every object in the universe. Nuclear energy is known for its high destructive power as evidenced from nuclear weapons. Nuclear Power in India is still not very well developed. There are four nuclear power stations with an installed capacity of 2005MW.

These are located at Tarapur (Maharasbtra) , Rana Pratap Sagar near Kota (Rajasthan) ,Kalpakkam (Tamil Nadu) and Narora (U.P.)The nuclear energy can also be harnessed for providing commercial energy. Nuclear energy can be generated by two types of reactions:

1. **Nuclear fission:**

It is the nuclear change in which nucleus of certain isotopes with large mass numbers are split into lighter nuclei on bombardment by neutrons and a large amount of energy is released through a

chain reaction .

$$_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{36}K^{92} + {}_{56}Ba^{141} + 3\ {}_{0}n^{1} + \text{Energy}$$

The fuel most widely used in nuclear fission is Uranium -235. Uranium is non renewable, though it is a common metal found in rocks all over the world. Nuclear Reactors make use of nuclear chain reaction. In order to control the rate of fission, only 1 neutron released is allowed to strike for splitting another nucleus.

2. Nuclear fusion:

It is a nuclear change in which two isotopes of light element are forced together at extremely high temperatures (1 billion ^{0} C) until they fuse to form a heavier nucleus releasing enormous energy in the process. It is difficult to initiate the process but it releases more energy than nuclear fission. Nuclear fusion power reactions are based on deuteriurn- deuterium reactions and deuterium-tritium reactions.

$$_{II}H^{2} + {}_{1}H^{2}?_{3}\ H\ e^{2} + {}_{0}n^{1} + {}_{0}n^{1} + \text{energy}$$

The deuterium –deuterium reactions promise an unlimited source of energy. However harnessing of fusion energy will take several more years due to the technical problems involved.

Two hydrogen-2 (Deuterium) atoms may fuse to form the nucleus of Helium at 1 billion C and release a huge amount of energy. Nuclear fusion reaction can also take

place between one Hydrogen-2 (Deuterium) and one Hydrogen-3 (Tritium) nucleus at 100 million 0 C forming Helium-4 nucleus, one neutron and a huge amount of energy.

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Advantages of Nuclear Energy:

1 As compared to electricity generated by burning fossil fuels, nuclear energy is clean. Nuclear power plants produce no air pollution or carbon dioxide.

2 Nuclear energy has tremendous potential and efficient to operate.

Disadvantages of Nuclear energy:

1 Any leakage from the reactor may cause devastating nuclear pollution.

2 Disposal of nuclear waste is a big problem.

3 Nuclear power plants have some major environmental risks. Nuclear power plants produce radioactive gases. These gases are to be contained in the operation of the plant. If these gases are released into the air, major health risks can occur.

4 Nuclear plants use uranium as a fuel to produce power. The mining and handling of uranium is very risky and radiation leaks can occur.

1.18 LAND RESOURCES

Land is a finite and valuable resource. It is a major constituent of the lithosphere and is one of the main components of natural environment besides air, water and plants. It forms about one-fifth of the earth's surface, covering about 13,393 million hectares, and is the source of many materials essential to man and other organisms. Most human or natural activities need space for their location and development, which is provided by land. The various purposes, for which land can be used, include agriculture and horticulture for food production, energy production, human dwellings and industrial/commercial purposes, waste disposal, forests, etc. Though the pattern of land use varies from country to country; broadly, the pattern of land use on earth is:

• Agricultural (arable) land	11%
• Pastures and meadows	22%
• Forest land	30%
• Urban and non-agricultural land (i.e. land area occupied by human dwellings and factories, roads and railways, deserts, glaciers, polar ice, marshes, rocks and mountains).	37%

In India, more than two-fifth land is agricultural land. The pattern of land distribution in India is as under :

• Agricultural land	43:6%
• Permanent pastures and meadows	14.6%
• Culturable wastelands	12.2%

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- Forests 10.7%
- Barren and inculturable land 8.4%
- Urban land 5.3%
- Nd information available 5.2%

Land as a Natural Resource

The surface layer of the land is called 'soil'. About four-fifth of the land area is covered by soil. The word 'soil' has been derived from the Latin word 'Solum'—meaning upper crust of the earth. Soil is generally defined as upper layer of the earth differentiated into various horizons and capable of supporting plant life. It is a collection of natural' bodies on the earth's surface containing living as well as non-living matter, and supporting or capable of supporting plants. Its upper limit is air or water and its lateral margins grade to deep water or barren areas of rock or ice. Its lowest limit is most difficult to define but is normally thought of as the lower limit of the common rooting depth of the native perennial plants, a boundary that is shallow in deserts and tundra and deep in humid tropics.

Soil is a dynamic layer of earth's crust which is constantly changing and developing. Soil formation takes place with the decomposition of rocks and minerals. Soil properties like soil texture, structure, permeability, soil water porosity, soil pH, organic and inorganic (nutrients) content, cation exchange capacity, microbial properties, etc. play an important role to determine its productivity. The topography, climate and biotic factors control the conditions of the soil.

Soil is a renewable natural resource. About 200-1000 years are needed for the formation of one inch or 2.5 cm soil, depending upon the climate and soil type. But, when rate of erosion is faster than rate of renewal, then the soil becomes a non renewable resource.

It plays a very vital role in the determination of the quality and composition of the biosphere. In fact, the biosphere develops over the soil. It is not only a home for microbes, but .also gives nutrition for plants. Some of the important functions of soil areas under:

(i) It provides mechanical support to the flora.

(ii) Due to its porosity and water-holding capacity, the soil serves as a reservoir of water and-supplies water to the plants (even when the land surface is dry).

(iii) The ion-exchange capacity of soil ensures the availability and supply of micro- and macro-nutrients for the growth of plants, microbes and animals.

(iv) Soil also helps in preventing excessive leaching of nutrient ions, while maintaining proper pH.

(v) Soil contains a wide variety of bacteria (like nitrifying, nitrogen-fixing, organotrophic, etc.), fungi, protozoans, and many other organisms which help in the decomposition and mineralization of organic matter and regeneration of nutrients.

Land Degradation and its Causes

Land degradation refers to deterioration or loss of fertility or productive capacity of the soil. All modern and growth oriented activities are having their direct or indirect impact on land. Land degradation is a real cause of alarm because soil formation is an extremely slow process and the the average annual erosion rate is 20-100 times more than the renewal rate. Though land resources are very much related to natural disasters like volcanic eruptions, earthquakes, etc., but it is due to human activities that soil gets polluted. The factors which are mainly responsible for land degradation are:

1. Soil Erosion:

Soil erosion refers to the loss or removal of the superficial layer of the soil by tbe action of wind, water or human actions. Soil erosion results in the loss of fertility because it is the top soil layer which is fertile. The factors that influence the extent to which soil erosion will occur include:

(a) *Distribution, intensity and amount of Rainfall.* The soil fails to absorb heavy rainfall restricted to a few months of the year resulting in plenty of run-off water which removes soil layers as it moves along, thus causing soil erosion.

(b) *Slope of the ground.* If the ground/landscape has steep slopes then infiltration of rain water decreases and the run-off is much faster, thus causing more soil erosion.

(c) Soil *type.* Light and open soils lose more silt than heavier loams (which merely swell up by wetting).

(d) *Vegetation covers.* Rain falling on bare land causes soil erosion because the top soil is loose and is easily carried away by the run-off. On the otber hand, vegetation holds the soil in place by forming a network of roots of the plants. Further, rain falling on thick vegetation cover gets partly absorbed by the vegetation, partly evaporates and partly soaked into the ground (by the humus formed by the decay of fallen leaves and twigs), resulting in less surface run-off and hence less soil erosion.

(e) *Soil mismanagement.* Uncontrolled grazing by cattle, faulty methods of surface drainage, wrong cultivation practices (like cutting fields along the direction of hill slopes), removal of forest litter, etc. are common practices that aggravate soil erosion.

2. Salination:

Salination refers to increase in the concentration of soluble salts in the soil. Poor drainage of irrigation and flood waters results in accumulation of dissolved salts on the soil surface. In arid and semi-arid areas with poor drainage and high temperatures, water evaporates quickly leaving behind a white crust of salts on the soil surface. The high concentration of salts in soil severely affects the water absorption process of the plants, resulting into poor productivity.

Salinity, however, can be checked by improving the drainage, and the salinated

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lands can be reclaimed by 'leaching' with plenty of water (i.e. heavy irrigation).

3. Water-logging:

In order to provide congenial moisture to the growing crops, farmers usually apply heavy irrigation to their farmland. Also, in order to leach down the salts deeper into the soil, the farmers provide more irrigation water. However, due to inadequate drainage and poor quality irrigation water there is accumulation of water underground and gradually it forms a continuous column with the water table. The productivity of water-logged soil is severely reduced due to lesser availability of oxygen for the respiration of plants.

4. Desertification:

Desertification is a slow process of land degradation that leads to desert formation. It is like a 'skin disease' over the planet wherein patches of degraded land, erupting separately, gradually join together. For example, the Thar Desert (India) was formed by the degradation of thousands of hectares of productive land. It may result either due to a natural phenomenon linked to climatic change or due to abusive use of land. In fact even for climatic change, it is the abusive land use that is largely responsible. Increasing human population has put a great pressure on the land. Vast areas of land have been cleared for agricultural, industrial, and other purposes Over- cultivation, overgrazing, deforestation, poor irrigation practices, all contribute towards desertification. These activities bring about changes in rainfall, temperature, wind velocity, etc. and lead to soil erosion. Such changes then lead to desertification of the productive lands. The topsoil, which takes centuries to build up, can be lost in just a few years through such practices. Land that recovered quickly in the past after long droughts and dry periods now tends to lose its biological and economic productivity if not sustainably managed.

India figures prominently in the United Nations Environment Programme, UNEP's *World Atlas of Desertification*, which shows the largest degraded area of agricultural land in the world, 1475 million ha to be in Asia. The annual loss of productivity due to soil erosion in the South Asia region is estimated at about US $ 5.4 billion. The re-classification of some towns in India as being not drought-prone but desert-prone is also significant in this regard.

5. Shifting cultivation:

Shifting (Jhum) cultivation, a very peculiar practice of slash and burn agriculture, prevalent among many tribal communities inhabiting the tropical and sub-tropical regions of Africa, Asia and Islands of Pacific ocean has also laid large forest tracts bare. This practice has led to complete destruction of forests in many hilly areas of India, especially the North-East and Orissa, and caused soil erosion and other associated problems of land degradation.

6. Urbanization:

Human activities are responsible for the land-degradation of forests, croplands and grasslands. The productive areas are fast reducing because of urbanization *i.e.* the developmental activities Such as human settlements and industries.

7. Landslides:

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Human activities such as construction of road and railway, canal, dams and reservoir and mining in hilly areas have affected the stability of hill slopes and damaged the protective vegetation cover both above and below roads and other such developmental works. This has upset the balance of nature, making such areas vulnerable to landslides.

8. Soil Pollution:

Soil pollutants (such as pesticides, chemicals, radioactive and industrial wastes, plastics, bottles and tin-cans, clothes, carcasses, etc.have an adverse effect on the physical, chemical and biological properties of soil and hence reduce its productivity.

1.19 ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATU-RAL RESOURCES

Nature is the vast store house of materials which are of immense use to man .Any such material which can be used directly or after transformation to sustain life is called a resource .Natural resources play very important role in the development of a nation. Resources like forest, water, soil, food, mineral and energy improve the economy of human society. However , continued use of any material will lead to its end. As such ,it is very important to use a resource in such a manner that it can be saved for future use ,i.e. it has to be conserved .If we want mankind to flourish ,there is a strong need to conserve these natural resources and use it in a sustainable way.

Efforts to conserve natural resources at national and international level are underway, but the individual efforts for conservation of natural resources can go a long way. Environment belongs to all of us and all of us have responsibility to contribute towards its conservation and protection .With our small efforts we can together help in conserving our natural resources to a large extent in the following ways :

1. CONSERVE WATER

1 Don't keep water taps running while brushing ,shaving, washing or bathing.

2 Install water saving toilets that use not more than 6 litres per flush.

3 While washing cloths with washing machine fill it only to the level required.

4 Reuse the soapy water of washings from cloths for washing off the courtyards , driveways etc.

5 Check and repair the water leaks in pipes and toilets .

6 Water the plants in your kitchen–garden and lawns in the evening when evaporation losses are minimum. Never water the plants in mid- day.

7 Use drip irrigation and sprinkling irrigation to improve irrigation efficiency .

8 Build rain water harvesting system in your house.

2. CONSERVE ENERGY

1 Turn off the lights , fan and other appliances when not in use .

2 Replace old light bulbs with energy saving fluorescent bulbs. They may cost more, but will save you much more in the long run.

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3 Turn off all electronic devices that are not in use. Not only turn them off but try to remember to unplug them. You will be surprised how much you will save with this simple step!

- Air dry your dishes. When washing in a dish washer, the heat generated during the wash cycle is more than enough to dry your dishes.
- Close vents and doors in unused rooms. No need to cool or warm areas that people are not in.
- Wash clothes in cold water. Believe it or not cold water does clean, and many laundry soap manufacturers now offer soaps specifically made for washing clothes in cold water
- Wash clothes in the morning or evening when its cooler. Sounds silly but the heat generated by the dryer will warm the house and in the summer months your air conditioner will use more energy to cool your home.

1 Plant shade trees and paint your house a light color if you live in a warm climate or a dark color if you live in a cold climate. Reductions in energy use resulting from shade trees and appropriate painting can save up to 2.4 tons of CO_2 emissions per year. (Each tree also directly absorbs CO2 from the air annually.)

2 Select the most energy-efficient models when you replace your old appliances. Look for the Energy Star Label - your assurance that the product saves energy and prevents pollution.

3. PROTECT THE SOIL

1 Grow plants that are indigenous to your area. Another thing to do is to plant trees and shrubs. These can provide shelter for your soil, while the roots will help to prevent excess water from washing it away.

2 Keep your soil moist, but do not drown it. This can be especially difficult during dry months. But over-watering can not only wash away soil, but cause it to degrade.

3 Keep enough vegetation strong, healthy and growing will bind the soil together and protect its surface.

4 Find a suitable tillage (ploughing) method for your location, amount of rainfall and variety of plant life. Tillage will optimize the biological and physical condition of soil. Make sure that you use a method that does not make the soil overly fine.

5 Built wind barriers at the boundaries of a farm, this will help stop the wind from blowing soil away.

6 Plant patches of high grass.

4. Promote Sustainable Agriculture:

1 Do not waste food; Take as much as you can eat.

2 Reduce the use of pesticides and use biological pesticides.

3 Fertilize your crop with organic fertilizers such as menure, bioferhlizer etc.

4 Use drip irrigation.

5 Eat local and seasonal vegetables.

6 Control pests.

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EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFE STYLE

There is a big divide in the world viz. North and South, more developed countries (MDCs) and Less Developed countries (LDCs), haves and have-nots. But this is observed that MDCs have only 22% of world's population but they use88% of natural resources, 73% of energy and command 85% of income, in turn they contribute very big proportion to its pollution.

On the other hand LDCs have very low or moderate industrial growth and have 78% of world's population. They use only 12% of natural resources, 27% of energy and have only 15% of global income. The rich have gone richer and the poor have stead even poorer. There is a huge gap between those two worlds. This is not sustainable growth. The solution to this problem is to have more equitable distribution of resources and wealth. A global consensus has to be reached for balanced distribution.

There are two major causes of unsustainability.

1. Over population in poor countries

2. Over consumption of resources by rich countries.

The rich countries will have to lower down their consumption levels and bare minimum needs of the poor must be satisfied by providing them resources. Need of the hour is fairer sharing of resources between rich and poor which will bring about sustainable development for all.

SUMMARY

Eco-education/environmental education is not a new concept. It has been in existence since the origin of humankind, as all human knowledge is derived out of interaction with nature and learning from nature.

Environmental science in its broadest sense is the science of complex interactions that occurs among the terrestrial, atmospheric, living and anthropological environments. It includes all the disciplines, such as chemistry, biology, sociology and government that affect or describe these interactions. In broadest sense, environmental science may be defined as the study of the earth, air, water and living environments and the effects of technology thereon.

The environment studies enlighten us, about the importance of protection and conservation of our indiscriminate release of pollution into the environment.

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.

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Human population is growing day-by-day. Continuous increase in population caused an increasing demand for natural resources. Due to urban expansion, electricity need and industrialization, man started utilizing natural resources at a much larger scale. Non-renewable resources are limited.

Water is, literally, the source of life on earth. It is the major constituent of. the hydrosphere that consists of the oceans, seas, rivers, streams, glaciers, lakes, reservoirs, polar ice caps and the shallow ground- water bodies that interflow with the surface water. Approximately 70.8% of the earth's surface is covered with water mainly in the form of oceans.

ANSWER TO CHECK YOUR PROGRESS

1. The total forest area of the world in 1990 was estimated to be 7000 million hectares which was reduced to 2890 million hectares in 1975 and fell down to just 2300 million hectares by 2000. Deforestation rate is relatively less intemperate countries, but it is very alarming in tropical countries where it is as high as 40-50 percent and at the present rate is it estimated that in the next 60years we would lose more than 90 percent of our tropical forests.

   The forested area in India seems to bave stabilized since 1982 with about 0.04%decline annually between 1982-90. FAO (1983) estimated that about 1.44 m hectares of land were brought under afforestation during this period leading to stabilization. As per FAO estimates, the deforestation rate per unit population in India is the lowest among the major tropical countries, despite the fact that we have a huge population size and very low per capita forest area (0.075 ha per capita). However, we are still far behind the target of achieving 33% forest areas, as per our National Forest Policy, as we are still having only 19.27% of our land area (63.38m ha) covered by forests based on satellite data (MoFF, 1998).

   Deforestation is defined as the reckless felling of trees by human beings for their use. Forests are burned or cut down for various reasons, like clearing of land for agriculture, harvesting of timber, expansion of cities, and many more; but the aim behind all these reasons is 'economic gains'. But we forget,that these economic gains are short- lived, while the long-term damaging effects of deforestation are disastrous and irreversible. At present we are losing forests at the rate of l.7crores hectares annually worldwide.

2. Water is, literally, the source of life on earth. It is the major constituent of. the hydrosphere that consists of the oceans, seas, rivers, streams, glaciers, lakes, reservoirs, polar ice caps and the shallow ground- water bodies that interflow with the surface water. Approximately 70.8% of the earth's surface is covered with water mainly in the form of oceans. It is estimated that the hydrosphere contains about 1,360 million cubic km of water. Of this about 97% is in the oceans and inland seas, where the high salt content does not permit its use for human consumption. About 2% of the water resource is locked in the glaciers and ice caps; while the rest (less than 1%) is available as fresh water, for human consumption and other uses, in surface water sources (such as rivers, streams, lakes and reservoirs) and ground water

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The total stock of ocean water and fresh water has been fairly constant throughout geological history. But the ratio between ocean water and fresh water has always changed according to climatic conditions. When the climate is very cold, much of the sea water is absorbed by glaciers and ice caps and fresh water increases at the expense of the sea water. When the climate is hot, glaciers and ice caps melt and sea water gains at the cost of fresh water. Sea level observations during the last ten decades or so indicate that the sea level is rising slowly. Which means, the global climate is getting warmer and warmer?

3. **Based on their properties, minerals are of two types:**

   (i) Metallic minerals-e.g.bauxite, laterite, haematite etc.

   (ii) Non metallic minerals-e.g. graphite, diamond, quartz, feldspar.

4. How can we avoid malnutrition and the ill effects of affluence such as obesity and cardiovascular diseases . Generally, it is as easy as consuming a balanced and varied diet with plenty of whole grains, fruits and vegetables. Cereals, like rice or wheat which form the staple food of mankind, supply us only with a fraction of our nutritional requirements. We have to supplement cereals with other food that provide plenty of fats and proteins and minor quantities of a number of vitamins and minerals. This means that the larger our diet sheet, the better our health will be.

   In order to obtain adequate amounts of each of the different nutrients, the daily diet should include appropriate quantities of a variety of different foodstuff. A diet in which various foodstuffs are mixed-in suitable proportions to carry out adequately

5. While fossil fuels and hydro-electricity will continue to play a dominant role in the energy scenario in our country in the next few decades, conventional energy resources such as coal, oil, and natural gas are limited and non-renewable. Renewable energy sources are indigenous and can contribute towards reduction in dependency on fossil fuels. Renewable energy sources assume special significance in India when viewed in the context of the geographic diversity and size of the country, not to mention the size of its rural economy. Since renewable energy resources are diffused and decentralised, they are more appropriate as local energy systems to meet the ever expanding and diversified energy needs. In this perspective, they offer numerous possibilities for meeting the basic energy needs of the rural poor. This apart, renewable energy offers significant possibilities for job creation. Such jobs would also help arrest rural to urban migration.

6. Solar refrigeration is closely related to air-conditioning. It is generally required for food preservation or for storage of medical and biological materials. A lot of experiments have been carried out in several countries including USA, former USSR, France and Sri Lanka on solar-operated coolers using absorption cooling cycles. And most of these are aimed at

household-scale for food refrigerators or small-scale ice manufacturing units. Although, most of the units/machines fabricated are simple in design; but are generally too complicated to operate and therefore are not usable by the people.

NOTES

TEST YOURSELF

1. What are renewable and non-renewable resources? Give examples.
2. Discuss the major use of forests. How would you justify that ecological uses of forests surpass commercial uses?
3. What are the major causes and consequences of deforestation?
4. Discuss with the help of live example around you, how big dams have affected forests and the tribals.
5. What are the environmental impacts of ground water usage?
6. Briefly discuss droughts and floods with respect to their occurrence and impacts.
7. What are major causes for conflicts over water? Discuss one international and one interstate water conflict.
8. Should we build big dams? Give arguments in favour of your answer.
9. What are the uses of various types of minerals?
10. What are the major environmental impacts of mineral extraction?
11. What is overgrazing? How does it contribute to environmental degradation?
12. Give brief account of non-renewable energy resources.
13. Discuss the merits and demerits of wind energy?
14. What is soil erosion? How can it be checked?
15. How can you as an individual conserve different natural resources?

1.20 REFERENCES AND FURTHER READING

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UNIT

2 ECOSYSTEMS

NOTES

The Chapter Covers :

Learning Objectives :

After going through this unit, You would be able to -

- Concept of ecosystem
- Functions of ecosystem
- Food chains, Food web
- Ecological pyramid

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2.1 INTRODUCTION

It is essential to first grasp the fundamentals of ecology in order to understand the environment. The word ecology comes from Greek word Oikos, meaning house or place to live. Taken literally, ecology refers to the study of organisms in their natural habitat. Ecology is concerned with the study of organisms in various habitats viz. land, oceans, fresh water, and air. Ecology can also be defined as the study of the structure and function of nature. Ecologists try to predict what will happen to organisms, populations, or communities under a particular set of habitat.

For practical purposes, we can consider ecology as the study of organisms and their environment. In other words, it is study of the interrelations between living organisms and their environment. Ecology proceeds at three levels:

1) The individual organism

2) The population (consisting of individuals of the same species)

3) The community (consisting of number of populations).

At the level of the organism, ecology deals with how individuals are affected by and how they affect their environment. For example, the greenhouse effect is areal danger, and what are the implications for human life as the earth heats up further.

At the level of population, ecology deals with the presence or absence of particular species and with trends and fluctuations in their numbers. To understand population fluctuations, the changes happening to individuals making up the population are analyzed.

Community ecology deals with the composition or structure of communities, and with the natural resources affected by them. Communities are not constant but are continually changing because of interactions among the populations and because of disturbances caused by climatic and geological events as well as human activities.

There are certain important concepts of ecology;

Living organism:

An organism is any form of life. A wide range and variety of organisms is present on the earth from the single celled amoeba to huge sharks, from microscopic blue-green algae to massive banyan tree. It includes all plants and animals.

Species:

Group of organisms that resemble one another in appearance, behaviour, chemistry and genetic structure form a species. Organisms of the same species can breed with one another and produce fertile offspring under natural conditions. For instance, all human beings (*Homo sapiens*) resemble one another in their body structure, body systems and they all have similar genetic structure. They are thus grouped together under the species sapiens.

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Population:

A population is a group of individuals of the same species occupying a given area at a given time. For example, the Asiatic lions in the Gir National Park, Gujarat, make a population. Group of individual organisms of the same species living within an area is called population.

Communities:

Communities of various species occupying a particular area and interacting with each other make up a community. For instance, when we say 'the community of the Gir National Park', we refer to the lion population, the deer population, the cattle population, the grass population and populations of all kinds of life forms present there. Thus community comprises several species interacting with each other. Any assemblage of populations living in a prescribed area or physical habitat that has characteristics in addition to its individual and population components can be called as community.

Cycles:

The circulation of the chemical elements in its biosphere from the environment to organisms and back to the environment is called cycle.

Food chain:

The transfer of food energy from its source in plants through a series of organisms where eating and being eaten is repeated a number of times are called food chain.

Carrying capacity:

Maximum population of a particular species that a given habitat can support in terms of resources over a given period of time.

2.2 CONCEPT OF ECOSYSTEM

An ecosystem is a community of organisms involved in a dynamic network of biological, chemical and physical interactions between themselves and with then on-living components. .Such interactions sustain the system and allow it to respond to changing conditions. Thus, an ecosystem includes the community, the non-living components and their interactions. The Gir ecosystem will thus include the various life forms found in the park (the community) and also the non-living components of the park, like the soil, rocks, water etc. and even the solar energy that is captured by the plants.

The sum total of all the ecosystems on planet Earth is called the biosphere, which includes all the earth's living organisms interacting with the physical environment as a whole to maintain a steady-state ecosystem.

The community of organisms and populations that are interacting with one another and with the chemical and physical components of their environment is called 'eco-system'.

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The term ecosystem was first proposed by A.G Tansley (1935) who defined ecosystem as follows: "Ecosystem is defined as a self-sustained community of plants and animals existing in its own environment."

Odum (1971) defined ecosystem as any unit that includes all the organisms in given area interacting with the physical environment, so that a flow of energy give rise to a clearly defined tropic structure, biotic diversity and material cycles within the system"

Michael Allaby (1983) defined ecosystem as a community of interdependent organisms together with the environment.

The term ecosystem is made up of two words: eco and system. Eco means ecological sphere or region of space where living things can exist while system mean interacting organisms living in a particular habitat (living space). Thus the system resulting frorn the integration of all the living and non-living factors is called ecosystem.

An ecosystem may be defined as a dynamic entity composed of a biological community and its associated abiotic environment. Often the dynamic interactions that occur within an ecosystem are numerous and complex. Ecosystems are also always undergoing alterations to their biotic and abiotic components. Some of these alterations begin first with a change in the state of one component of the ecosystem, which then cascades and sometimes amplifies into other components because of relationships.

An ecosystem is an integrated unit consisting of interacting plants, animals and microorganisms whose survival depends upon the maintenance and regulation of their biotic and abiotic structures and functions. The ecosystem is thus, a unit or % system which is composed of a number of sub-units that are all directly or indirectly linked with each other. They may be

- freely exchanging energy and matter from outside—**an open ecosystem**
- may be isolated from outside—**a closed ecosystem.**

2.3 ECOSYSTEM CHARACTERISTICS

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

STRUCTURAL FEATURES

Composition and organization of biological communities and abiotic components constitute the structure of an ecosystem.

I. Biotic Structure

The plants, animals and microorganisms present in an ecosystem form the biotic component. These organisms have different nutritional behavior and status in the

ecosystems and are accordingly known as *Producers* or *Consumers*, based on how they get their food.

(a) Producer- The organisms which can manufacture their own food are called Producers.They may be :

- **Photo autotroph** - They are mainly the green plants, which can synthesize their food themselves by making use of carbon dioxide present in the air and water in the presence of sunlight by involving chlorophyll, the green pigment present in the leaves, through the process of **photosynthesis.** They are also known as **photo autotrophs** (auto=self; troph=food, photo=light).
- **Chemo-autotrophs-** There are some microorganisms also which can produce organic matter to some extent through oxidation of certain chemicals in the absence of sunlight. They are known as **chemosynthetic** organisms or **chemo-autotrophs.** For instance in the ocean depths, where there is no sunlight, chemoautotrophic sulphur bacteria make use of the heat generated by the decay of radioactive elements present in the earth's core and released in ocean's depths. They use this heat to convert dissolved hydrogen sulphide (H_2S) and carbon dioxide (CO_2) into organic compounds.

(b) Consumers: All organisms which get their organic food by feeding upon other organisms are called consumers, which are of the following types:

- **Herbivores** (plant eaters): They feed directly on producers and hence also known *as primary consumers,* e.g. rabbit, insect, man.
- **Carnivores** *(meat* eaters): They feed on other consumers. If they feed on herbivores they are called *secondary consumers* (e.g. frog) and if they feed on other carnivores (snake, big fish etc.) they are known as *tertiary carnivores/consumers.*
- **Omnivores:** They feed on both plants and animals, e.g. humans, rat, monkeys, fox, many birds species.
- **Detritivores (*Detritus feeders or Saprotrophs):*** They feed on the parts of dead organisms, wastes of living organisms, their cast-offs and partially decomposed matter e.g. beetles, termites, ants, crabs, earthworms etc.

(C) Decomposers: They derive their nutrition by breaking down the complex organic molecules to simpler organic compounds and ultimately into inorganic nutrients. Various species of bacteria and fungi are decomposers.

In all the ecosystems, this biotic structure prevails. However, in some, it is the primary producers which predominate (e.g. in forests, agroecosystems) while in others the decomposers predominate (e.g. deep ocean).

II. Abiotic Structure

The physical and chemical components of an ecosystem constitute its abiotic structure. It includes climatic factors, edaphic (soil) factors, geographical factors, energy,

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nutrients and toxic substances.

(a) Physical Factors: The Sunlight and shade, intensity of solar flux, duration of sun hours, average temperature, maximum-minimum temperature, annual rainfall, wind, latitude and altitude, soil type, water availability, water currents etc. are some of the important physical features which have a strong influence on the ecosystem.

We can clearly see the striking differences in solar flux, temperature and precipitation (rainfall, snow etc.) pattern in a desert ecosystem, in a tropical rainforest and in tundra ecosystem.

(b) Chemical Factors: Availability of major essential nutrients like carbon, nitrogen, phosphorus, potassium, hydrogen, oxygen and sulphur, level of toxic substances, salts causing salinity and various organic substances present in the soil or water largely influence the functioning of the ecosystem.

All the biotic components of an ecosystem are influenced by the abiotic components and vice versa, and they are linked together through energy flow and matter cycling as shown diagrammatically in Fig.

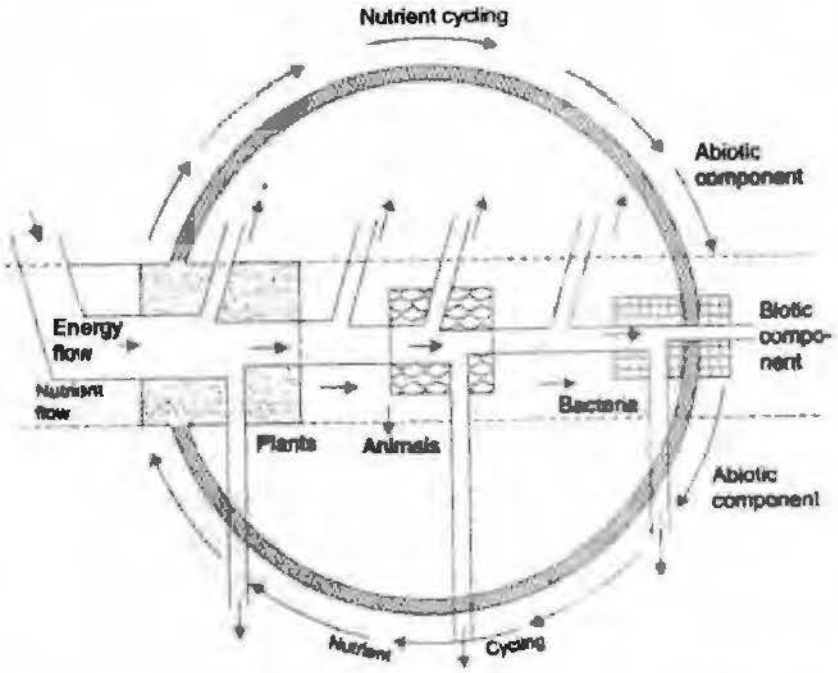

Fig.-1 : Nutrient cycling and energy flow mediated through food- chain. The flow of energy is unidirectional while the nutrients move in a cyclic manner from the abiotic to biotic (food chain) to Abiotic and so on.

1.4 FUNCTIONS

Every ecosystem performs under natural conditions in a systematic way. It receives energy from the sun and passes it on through various biotic components and in fact, all life depends upon this flow of energy. Besides energy, various nutrients and water are also required for life processes which are exchanged by the biotic components

within themselves and with their abiotic components within or outside the ecosystem. The biotic components also regulate themselves in a very systematic manner and show mechanisms to encounter some degree of environmental stress. The major functional attributes of an ecosystems are as follows:

(i) Food chain, food webs and trophic structure

(ii) Energy flow

(iii) Cycling of nutrients (Biogeochemical cycles)

(iv) Primary and Secondary production

(v) Ecosystem development and regulation

2.5 TROPHIC STRUCTURE

The structure and functions of ecosystems are very closely related and influence each other so intimately that they need to be studied together. The flow of energy is mediated through a series of feeding relation-ships in a definite sequence or pattern which is known as **food chain.** Nutrients too move along the food chain. The producers and consum-ers are arranged in the ecosystem in a definite manner and their inter- action along with population size are expressed together as **trophic structure.** Each food level is known as **trophic level** and the amount of living matter at each trophic level at a given time is known as **standing crop** or **standing biomass.**

Before we study about energy flow or nutrient cycling, we must learn about the food-chains, that provide the path through which the flow of energy *aoSJaatter* take place in ecosystem.

2.6 FOOD CHAINS

The sequence of eating and being eaten in an ecosystem is known as food chain. All organisms, living or dead, are potential food for some other organism and thus, there is essentially no waste in the functioning of a natural ecosystem. A caterpillar eats a plant leaf, a sparrow eats the caterpillar, a cat or a hawk eats the sparrow and when they all die, they are all consumed by microorganisms like bacteria or fungi (decomposers) which break down the organic matter and convert it into simple inorganic substances that can again be used by the plants—the primary producers. Some common examples of simple food chains are:

• Grass —> grasshopper —> Frog —> Snake —> Hawk (Grassland ecosystem)

• Phytoplanktons —> water fleas —> small fish ? Tuna (Pond ecosystem)

• Lichens —> reindeer —> Man (Arctic tundra)

Each organism in the ecosystem is assigned a feeding level or trophic level depending on its nutritional status. Thus, in the grassland food chain, grasshopper

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occupies the 1st trophic level, frog the Und and snake and hawk occupy the nird and the IVth trophic levels, re-spectively. The decomposers consume the dead matter of all these trophic levels. In nature, we come across two major types of food chains:

I. Grazing food chain: It starts with green plants (primary pro-ducers) and culminates in carnivores. All the examples cited above show this type of food chain. Another example could be

Grass —> Rabbit —> Fox

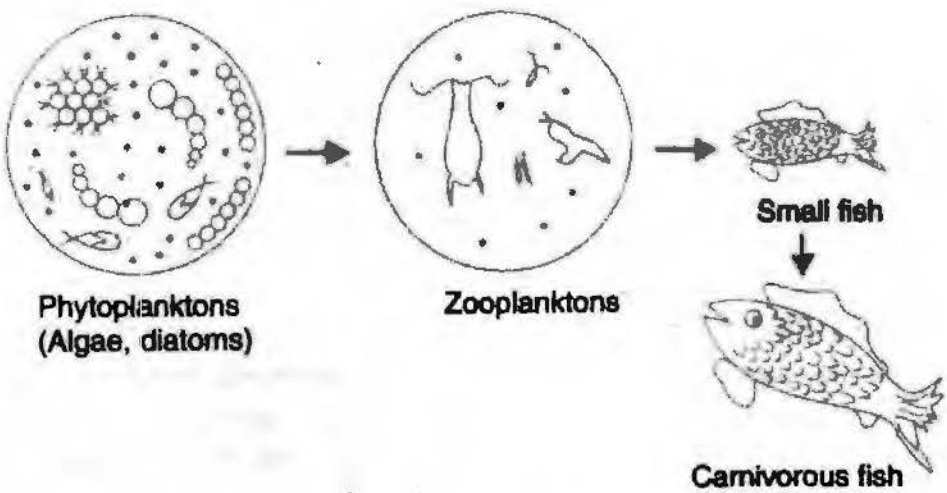

Fig.-2 : A grazing food chain in a pond ecosystem.

II. Detritus food chain: It starts with dead organic matter which the detritivores and decomposers consume. Partially decomposed dead organic matter and even the decomposers are consumed by detritivores and their predators. An example of the detritus food chain is seen in a Mangrove (estuary).

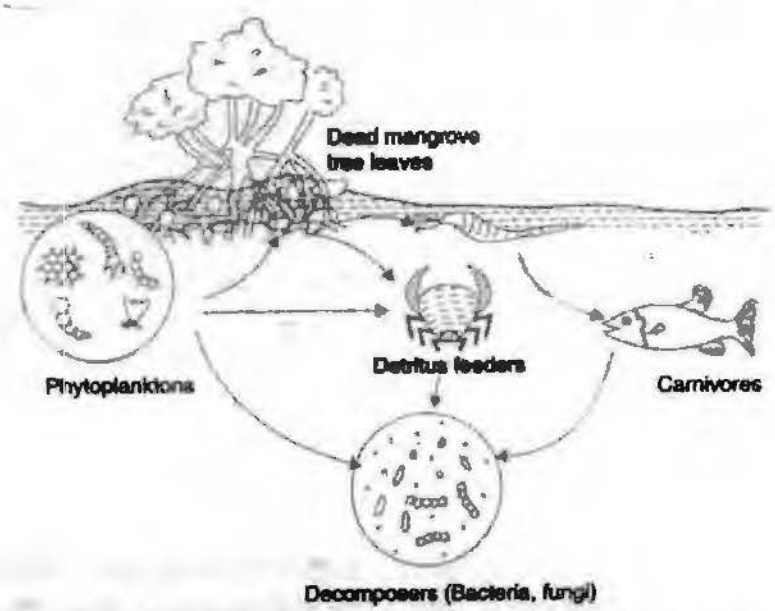

Fig.-3 : A detritus food chain in an estuary based on dead leaves of mangrove trees.

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Here, a large quantity of leaf material falls in the form of litter into the water. The leaf fragments are eaten by **saprotrophs.** (Saprotrophs are those organisms which feed on dead organic matter). These fallen leaves are colonized by small algae, which are also consumed by the saprotrophs or detritivores consisting of crabs, mollusks, shrimps, insect larvae, nematodes and fishes. The detritivores are eaten by small carnivorous fishes, which in turn are eaten by large carnivorous fishes.

Leaf litter -> algae -» crabs -> small carnivorous fish -> large carnivorous fish (Mangrove ecosystem)

Dead organic matter —> fungi —> bacteria (Forest ecosystem)

Thus the grazing food chain derives its energy basically from plant energy while in the detritus food chain it is obtained primarily from plant biomass, secondarily from microbial biomass and tertiarily from carnivores. Both the food chains occur together in naturalec but grazing food chain usually predominates.

2.7 FOOD WEB

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

Fig. illustrates an example of a food-web in the unique Antarctic Ecosystem. This is representing the total ecosystem including the Antarctic sea and the continental land. The land does not show any higher life forms of plants. The only species are that of some algae, lichens and mosses. The animals include penguins and snow petrel which depend upon the aquatic chain for their food energy.

In a tropical region, on the other hand, the ecosystems are much more complex. They have a rich species diversity and therefore, the food webs are much more complex.

Why nature has evolved food webs in ecosystems instead of simple linear food chains? This is because food webs give greater stability to the ecosystem. In a linear food chain, if one species becomes extinct or one species suffers then the species in the subsequent trophic levels are also affected. In a food web, on the other hand, there are a number of options available at each trophic level. So if one species is affected, it does not affect other trophic levels so seriously.

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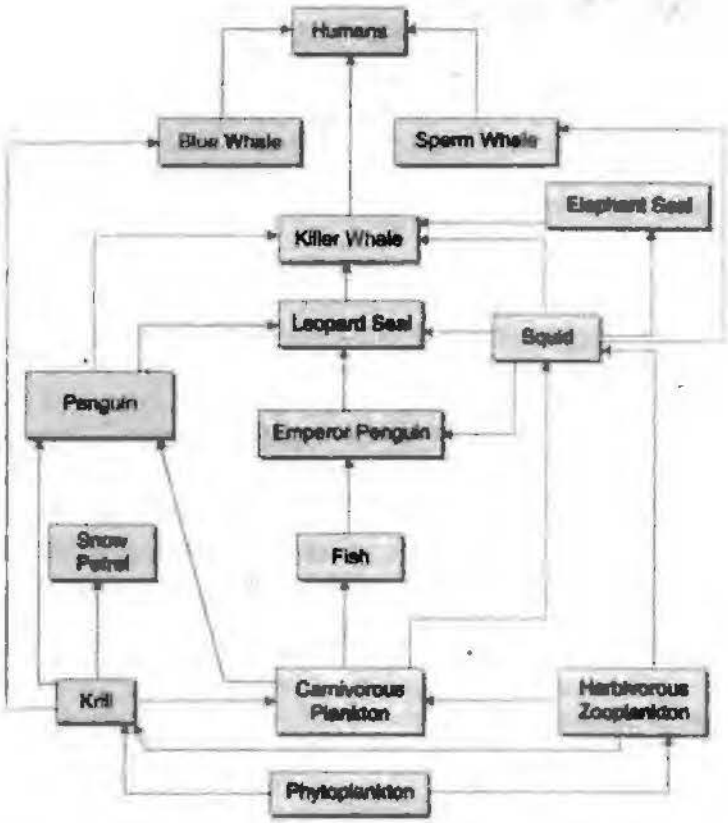

Fig.-4 : A simplified food web in Antarctic ecosystem.

Just consider the simple food chains of Arctic Tundra ecosystem:

Cladonia → Reindeer → Man

Grass → Caribou → Wolf

If due to some stress, the population of reindeer or Caribou falls, it will leave little option for man or wolf to eat from the ecosystem. Had there been more biodiversity, it would have led to complex food web giving the ecosystem more stability.

Significance of food chains and food webs

• Food chains and food webs play a very significant role in the ecosystem because the two most important functions of ***energy flow and nutrient cycling take place through them.***

• The food chains also help in maintaining and regulating the population size of different animals and thus, help maintain the ***ecological balance.***

• Food chains show a unique property of **biological magnification** of some chemicals. There are several pesticides, heavy metals and other chemicals which are non-biodegradable in nature. Such chemicals are not decomposed by microorganisms and they keep on passing from one trophic level to another. And, at each successive trophic level, they keep on increasing in concentration. This phenomenon is known as biomagnification or biological magnification.

2.8 ECOLOGICAL PYRAMID

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The ecological pyramid is defined as a graphic presentation of the ecological functions like the number of individuals in the various trophic levels. The producers form the base and the carnivore occurs at the top of food chain. These were developed by the Charles Elton. It was formed in the year 1927. They are also known as the Eltonian pyramids. The different organisms in the pyramid are present in the sequence wise and include the producers at the base which are followed by the herbivore. These are followed by the primary carnivore with the lion at the top.

There are different ecological pyramids which are known. They can be upright which means that the base is larger in size and it decreases as we move upwards. They can be inverted also which means that the base is smaller in size and it increases as we move upwards. It can be spindle shape which means that the base is thin along with the top but the middle part is broad. The pyramids deals with the number of individuals, amount of biomass and energy.

1.Pyramid of Biomass

Biomass is renewable organic (living) material. A pyramid of biomass is a representation of the amount of energy contained in biomass, at different trophic levels for a particular time. It is measured in grams per meter^2, or calories per meter^2. This demonstrates the amount of matter lost between trophic levels. Each level is dependent on its lower level for energy, hence the lower level determines how much energy will be available to the upper level. Also, energy is lost in transfer so the amount of energy is less higher up the pyramid.

There are two types of biomass pyramids: upright and inverted. An upright pyramid is one where the combined weight of producers is larger than the combined weight of consumers. An example is a forest ecosystem. An inverted pyramid is one where the combined weight of producers is smaller than the combined weight of consumers. An example is an aquatic ecosystem.

PYRAMID OF BIOMASS

2. Pyramid of Numbers

The pyramid of numbers represents the number of organisms in each trophic level. This pyramid consists of a plot of relationships between the number herbivores

Check Your Progress:

1. What are the functions of eco system?
2. What do you understand by pyramid of biomass?

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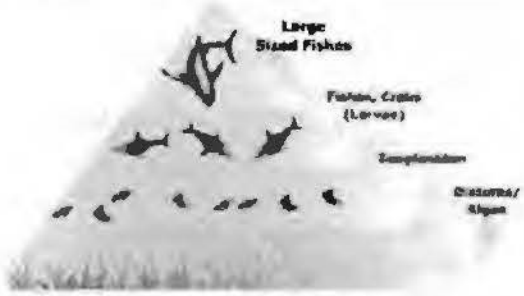
(primary consumers), first level carnivore (secondary consumers), second level carnivore (tertiary consumers) and so forth. This shape varies from ecosystem to ecosystem because the number of organisms at each level is variable

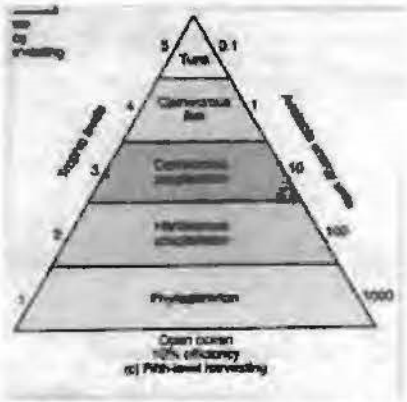
Upright, partly upright and inverted are the three types of pyramids of numbers. An aquatic ecosystem is an example of upright pyramid where the number of organisms becomes fewer and fewer higher up in the pyramid. A forest ecosystem is an example of a partially upright pyramid, as fewer producers support more primary consumers, but there are less secondary and tertiary consumers. An inverted pyramid of numbers is one where the number of organisms depending on the lower levels grows closer toward the apex. A parasitic food chain is an example.



PYRAMID OF NUMBER

3. Pyramid of Energy

The pyramid of energy represents the total amount of energy consumed by each trophic level. An energy pyramid is always upright as the total amount of energy available for utilization in the layers above is less than the energy available in the lower levels. This happens because during energy transfer from lower to higher levels, some energy is always lost.



PYRAMID OF ENERGY

2.9 MAJOR ECOSYSTEM INCLUDE

The kind of organisms which can five in a particular ecosystem depends upon their physical and metabolic adoptions to the environment of that place/ecosystem and on certain aspects of the history of our planet, which has determined what organisms have been able to travel where. On earth, there are sets of ecosystems within a geographical region which are exposed to same climatic conditions and having

dominant species with a similar life cycle, climatic adoptions and physical structure. This set of ecosystems is called a Biome. In the biosphere, there are—natural and artificial biomes (ecosystems).

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(1) Natural Ecosystems (Biomes)

Natural ecosystems operate by themselves under natural conditions without any interference by man. Natural ecosystems cany out many public service functions for us. Wastewater from houses and industries is often converted to drinkable water by filteration through natural ecosystems, such as soils. Air pollutants from industries and automobiles are often trapped on ieaves or converted to harmless compounds by forests. On the basis of particular type of habitat, they are further sub-divided as:

(a) Terrestrial Biomes (Ecosystems): They are often defined by the vegetation types that dominate the community. The types of vegetation affect the climate and soil structure and thus characterize the particular biome. Terrestrial vegetation has a rapid exchange of oxygen, water and carbon dioxide. The carbon dioxide concentration is affected by terrestrial vegetation seasonally and annually. Terrestrial biomes include :

-Forest ecosystem- include tropical rain forests, tropical deciduous forests, tropical scrub forests, temperate rain forests, temperate deciduous forests, evergreen coniferous forests,

-Grassland ecosystems- include tropical grasslands, temperate grasslands, polar grasslands.

-Desert Ecosystems- include tropical deserts, temperate deserts, cold deserts etc.

(b) Aquatic Biomes (Ecosystems)

An aquatic ecosystem is an ecosystem located in a body of water. It comprises aquatic fauna, flora and the properties of water too. There are two types of aquatic ecosystems, Marine and freshwater.

The Marine Ecosystem

Marine ecosystems are the largest ecosystems with coverage of nearly 71% of the Earth's surface and containing 97% of the planet's water. The water in Marine ecosystems has salts and minerals dissolved in them in high amounts. Different divisions of marine ecosystems are:

- Oceanic: The relatively shallow part of the ocean that lies over the continental shelf.
- Profundal: Bottom or deep water.
- Benthic Bottom substrates.
- Inter-tidal: The area between high and low tides.
- Estuaries
- Salt marshes
- Coral reefs

- Hydrothermal vents-where chemosynthetic bacteria form the food base.

Many types of organisms are found in marine ecosystems including brown algae, dinoflagellates, corals, cephalopods, echinoderms, and sharks.

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The Freshwater Ecosystem

In contrast to the Marine ecosystem, freshwater ecosystems only cover 0.8% of the Earth's surface and contain 0.009% of its total water. There are three basic types of freshwater ecosystems:

- **Lentic:** Still or slow-moving water like pools, ponds, and lakes.
- **Lotic:** Fast-moving water like streams and rivers.
- **Wetlands:** Places where the soil is saturated or inundated for a longer time.

These ecosystems are home to amphibians, reptiles and almost 41% of world's fish species. Faster moving turbulent water typically contains greater concentrations of dissolved oxygen, which supports greater biodiversity than the slow moving water of pools.

(2) Artificial Ecosystems (Biomes)

- The artificial ecosystem is also known as man-made or man-engineered ecosystems. All types of artificial ecosystems are introduce and managed by man.
- Gardens are also artificial ecosystem that are made and maintained by human. We can add any type of plant according to our likeness in the garden.
- Agriculture field is also an Artificial Ecosystem.
- Similarly villages, cities, towns and aquarium are also made by human.

Let us consider types, characteristic features, structure and functions of some major ecosystems.

TERRESTRIAL ECOSYSTEMS

FOREST ECOSYSTEM

These are the ecosystems having a predominance of trees that are interspersed with a large number of species of herbs, shrubs, climbers, lichens, algae and a wide variety of wild animals and birds. Forests are found in undisturbed areas receiving moderate to high rainfall and usually occur as stable climax communities. Depending upon the prevailing climatic conditions forests can be of various types:

- **Tropical rain forests:** They are evergreen broadleaf forests found near the equator. They are characterized by high temperature, high humidity and high rainfall, all of which favor the growth of trees. All through the year the climate remains more or less uniform. They are the richest in biodiversity. Different forms of life occupy specialized areas (niches) within different layers and spaces of the ecosystem depending upon their needs for food, sunlight, water, nutrient etc.

The Silent Valley in Kerala is the only tropical rain forest lying in India which is the natural habitat for a wide variety of species.

- **Tropical deciduous forests:** They are found a little away from the equator and are characterized by a warm climate the year round. Rain occurs only during monsoon. A large part of the year remains dry and therefore different types of deciduous trees are found here, which lose their leaves during dry season.
- **Tropical scrub forests:** They are found in areas where the dry season is even longer. Here there are small deciduous trees and shrubs.
- **Temperate rain forests:** They are found in temperate areas with adequate rainfall. These are dominated by coniferous trees like pines, firs, redwoods etc. They also consist of some evergreen broad-leaf trees.
- **Temperate deciduous forests:** They are found in areas with moderate temperatures. There is a marked seasonality with long summers, cold but not too severe winter and abundant rainfall throughout the year. The major trees include broad leaf deciduous trees like oak, hickory, poplar etc.
- **Evergreen coniferous forests (Boreal Forests):** They are found just south of arctic tundra. The winters are long, cold and dry. Sunlight is available for a few hours only. In summer the temperature is mild, sun-shines for long hours but the season is quite short. The major trees include pines, spruce, fir, cedar etc. which have tiny, needle-shaped leaves having a waxy coating so that they can withstand severe cold and drought. The soil is found to get frozen during winter and few species can survive. The leaves, also known as needles, fall on the forest floor and cover the nutrient poor soil. These soils are acidic and prevent other plants from growing. Species diversity is rather low in these forests.

GRASSLAND ECOSYSTEMS

Grasslands are dominated by grass species but sometimes also allow the growth of a few trees and shrubs. Rainfall is average but erratic. Limited grazing helps to improve the net primary production of the Grasslands but overgrazing leads to degradation of these grasslands resulting in desertification. Three types of grasslands are found to occur different climatic regions:

- **Tropical grasslands:** They occur near the borders of tropical rain forests in regions of high average temperature and low to moderate rainfall-In Africa, these are typically known as Savannas, which have all grasses with scattered shrubs and stunted trees. The Savannas have a wide diversity of animals including zebras, giraffes, gazelle, antelopes etc. During dry season, fires are

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quite common. Termite mounds are very common here. The termites gather the detritus (dead organic matter) containing a lot of cellulose and build up a mound. On the top of the mound fungi are found to grow which feed upon this dead matter including cellulose and in turn release methane, a greenhouse gas.

- **Temperate grasslands:** They are usually found on flat, gentle sloped hills, winters are very cold but summers are hot and dry Intense grazing and summer fires do not allow shrubs or trees to grow.

  - In United States and Canada these grasslands are known as **Prairies,**

  -in South America as **Pampas,**

  - in Africa as **Velds** and

  - in central Europe and Asia they are known as **Steppes.**

- **Polar grasslands (Arctic Tundra):** They are found in Arctic polar region where severe cold and strong, frigid winds along with ice and snow create too harsh a climate for trees to grow. In summers the sunshine's almost round the clock and hence several small annual plants grow in the summer. The animals include arctic wolf, weasel, arctic fox, reindeer etc. A thick layer of ice remains frozen under the soil surface throughout the year and is known as **permafrost.** In summer, the Tundra shows the appearance of shallow lakes, bogs etc. where mosquitoes, different type of insects and migratory birds appear.

DESERT ECOSYSTEMS

These ecosystems occur in regions where evaporation exceeds precipitation (rainfall, snow etc.). The precipitation is less than 25 mm per year. About l/3rd of our world's land area is covered by desert. Deserts have little species diversity and consist of drought resistant. The atmosphere is very dry and hence it is poor insulator. That is why in deserts the soil gets cooled up quickly making the nights cool. Deserts are of three major types, based on climatic conditions:

- **Tropical deserts** like Sahara and Namibia in Africa and Thar desert, Rajasthan, India are the driest of all with only a few species Windblown sand dunes are very common.
- **Temperate** deserts like Mojave in Southern California where day time temperatures are very hot in summer but cool in winters.
- **Cold deserts** like the Gobi desert in China have cold winters and warm summers.

Desert plants and animals are having most typical adaptations for conservation of water. Many desert plants are found to have reduced, scaly leaves so as to cut down loss of water due to transpiration or have succulent leaves to store water. Many a times their stems get flattened and develop chlorophyll so that they can take up the function of photosynthesis. Some plants show very deep roots to tap the groundwater. Many plants such as xerophytes have a waxy, thick cuticle

over the leaf to reduce loss of water through transpiration. Desert animals like insects and reptiles have thick outer coverings to minimize loss of water. They usually live inside burrows where humidity is better and heat is less. Desert soil is rich in nutrients but deficient in water.

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AQUATIC ECOSYSTEMS

POND ECOSYSTEM:

It is a small freshwater aquatic ecosystem where water is stagnant. Ponds may be seasonal in nature i.e. receiving enough water during rainy season. Ponds are usually shallow water bodies which play a very important role in the villages where most of the activities center around ponds. They contain several types of algae, aquatic plants, insects, fishes and birds. The ponds are, however, very often exposed to tremendous anthropogenic (human-generated) pressures. They are used for washing clothes, bathing, swimming, cattle bathing and drinking etc. and therefore get polluted.

LAKE ECOSYSTEM:

Lakes are usually big freshwater bodies with standing water. They have a shallow water zone called Littoral zone, an open-water zone where effective penetration of solar light takes place, called **Limnetic zone** and a deep bottom area where light penetration is negligible, known as **profundal zone** (Fig)

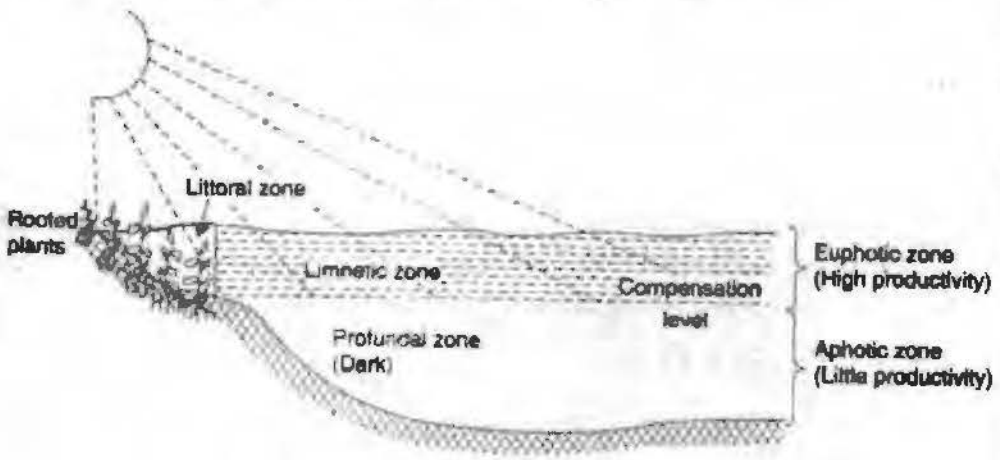

Fig.-5 : Zonation in a lake ecosystem.

The Dal Lake in Srinagar (J & K), Naini Lake in Nainital (Uttarakhand) and Loktak lake in Manipur are some of the famous lakes of our country.

Organisms : The lakes have several types of organisms:

-**Planktons** that float on the surface of waters e.g. *phytoplanktons* like algae and *zooplanktons* like rotifers.

-**Nektons** that swim e.g. fishes.

-**Neustons** that rest or swim on the surface.

-**Benthos** that is attached to bottom sediments e.g. snails.

-Periphytons that are attached or clinging to other plants or any other surface e.g. crustaceans.

STREAM ECOSYSTEM

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These are freshwater aquatic ecosystems where water current is a major controlling factor, oxygen and nutrient in the water is more uniform and land-water exchange is more extensive. Although stream organisms have to face more extremes of temperature and action of currents as compared to pond or lake organisms, but they do not have to face oxygen deficiency under natural conditions. This is because the streams are shallow, have a large surface exposed to air and constant motion which churns the water and provides abundant oxygen. Their dissolved oxygen level is higher than that of ponds even though the green plants are much less in number. The stream animals usually have a narrow range of tolerance to oxygen. That is the reason why they are very susceptible to any organic pollution which depletes dissolved oxygen in the water. Thus, streams are the worst victims of industrial development.

RIVER ECOSYSTEM:

Rivers are large streams that flow downward from mountain highlands and flowing through the plains fall into the sea. So the river ecosystems show a series of different conditions.

-The mountain highland part has cold, clear waters rushing down as water falls with large amounts of dissolved oxygen. The plants are attached to rocks (periphytons) and fishes are cold-water, high oxygen requiring fish like trouts.

-In the second phase on the gentle slopes, the waters are warmer and support a luxuriant growth of plants and less oxygen requiring fishes.

-In the third phase, the river waters are very rich in biotic diversity. Moving down the hills, rivers shape the land. They bring with them lots of silt rich in nutrients which is deposited in the plains and in the delta before reaching the ocean.

OCEAN ECOSYSTEM

These are gigantic reservoirs of water covering more than 70% of our earth's surface and play a key role in the survival of about 2,50,000 marine species, serving as food for humans and other organisms, give a huge variety of sea-products and drugs. Oceans provide us iron, phosphorus, magnesium, oil, natural gas, sand and gravel.

Oceans are the major sinks of carbon dioxide and play an important role in regulating many biogeochemical cycles and hydrological cycle, thereby regulating the earth's climate. The oceans have two major life zones: (Fig. 3.17)

Coastal zone: It is relatively warm, nutrient rich shallow water. Due to high nutrients and ample sunlight this is the zone of high primary productivity.

Open sea: It is the deeper part of the ocean, away from the continental shelf (The submerged part of the continent). It is vertically divided into three regions:

-Euphoric zone which receives abundant light and shows high photosynthetic activity.

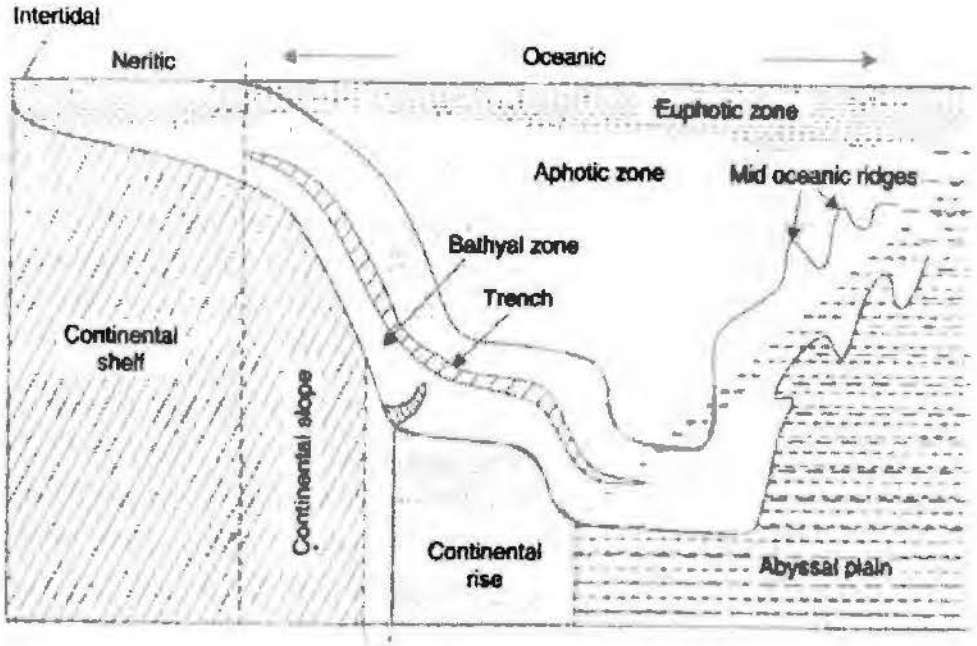

Fig.-6 : Vertical and horizontal zonation of a marine ecosystem.

-Bathyal zone receives dim light and is usually geologically active.

-Abyssal zone is the dark zone, 2000 to 5000 meters deep. The abyssal zone has no primary source of energy i.e. solar energy. It is the world's largest ecological unit but it is an incomplete ecosystem.

ESTUARY ECOSYSTEM

An estuary is a partially enclosed coastal area at the mouth of a river where fresh water and salty seawater meet. These are the transition zones which are strongly affected by tidal action. Constant mixing of water stirs up the silt which makes the nutrients available for the primary producers. There are wide variations in the stream flow and tidal currents at any given location dually, monthly and seasonally. Therefore, the organisms present in estuaries show a wide range of tolerance to temperature and salinity. Such organisms are known as **eurythermal** and **euryhaline.** Coastal bays and tidal marshes are examples of estuaries.

Estuaries are considered to be rich biodiversity and many of the species are endemic. There are many migratory species of fishes like eels and salmons in which half of the life is spent in fresh water and half in salty water. For them estuaries are ideal places for resting during migration, where they also get abundant food. Estuaries are highly productive ecosystems. The river flow and tidal action provide energy subsidies for the estuary thereby enhancing its productivity. Estuaries are of much use to human beings due to their high food potential. However, these ecosystems need to be managed judiciously and protected from pollution.

Types of Ecosystems based on Energy Resource

Ecosystems rely on two major sources of energy, the sun and chemical or nuclear fuels. So, on the basis of major input, ecosystem can be solar-powered and fuel-

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Check Your Progress:

3. What do you understand by artificial ecosystem?
4. what do you understand by stream ecosystem?

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powered ecosystems. On the basis of energy resources, the ecosystems are classified as:

(i) **Unsubsidized Natural Solar-powered Ecosystems:** In these types of ecosystems, the only source of power/energy is solar energy. These are unsubsidized in the sense that there is no auxiliary source of energy available to supplement solar, radiation/energy. These types of ecosystems have a low productivity or capacity to do work as they are subjected to shortage of nutrients or water. But from human point of view, these ecosystems are of utmost importance—it is here that large volumes of air are purified, water is recycled and climates are controlled. The energy input in these types of ecosystems ranges from 1,000 to 10,000 kCal./m^2/year and the average being 2,000 kcal./m^2/year. For example, ocean, upland forests, grasslands, etc.

(ii) **Naturally Subsidized Solar-powered Ecosystems:** In these types of ecosystems, the main source of energy is sun, which is augmented by natural non-solar energy. As a result of which extra amount of energy is available to the system that can be used for the production of more organic matter that may be exported to other systems or stored in themselves. The other auxiliary natural sources of energy may be tides, waves and currents, wind, torrential rains, etc. The energy input in these types of ecosystems ranges from 10,000 to 40,000 kcal/m^2/year, and the average being 20,000 kcal/m^2/year. The examples of these types of ecosystems are a coastal estuary, tropical rain forest, etc. A coastal estuary is subsidized by energy of tides, waves and currents. The back and forth flow of water does a part of necessary work of recycling mineral nutrients and transporting food "and wastes. As a result of which, organisms, in an estuary, can concentrate on conversion of sun energy into organic matter. That is why estuaries are more fertile than adjoining land or pond, receiving same solar input. In the same way tropical rain forests are subsidized by energy of wind and rain.

(iii) **Man Subsidized Solar-powered Ecosystems:** In these types of ecosystems, auxiliary fuel or other energy, like man and machine labour, is supplied by man. Here again, the main source of energy is sun. The power/energy input by man may be in the form of fertilizers, animal, power, machine power, sprays, etc. These systems are very advantageous for man as they produce food as well as fibre. The energy input varies from 10,000 to 40,000 kcal/m^2/year and the average being 20,000 kcal/m^2/year. Examples of these types of ecosystems are agriculture and aquaculture.

(iv) **Fuel-powered Ecosystems (or Urban-industrial Ecosystems):** In these ecosystems, the sun energy is replaced by highly concentrated potential energy of fuel, chemical or nuclear fuel. Examples of these systems are cities, suburbs, industrial parks, etc. These systems are man's wealth generating and also pollution generating systems. In these systems there is no limit of energy input. The energy input varies from 1,00,000 to 30,00,000 kcal/m^2/year and the average being 20 lacs kcal/m^2/year. These systems are parasitic in nature, because they depend on other ecosystems, as here consumption is large and production is bootless. For example, Mughal Gardens, Apughar, etc.

SUMMARY

For practical purposes, we can consider ecology as the study of organisms and their environment. In other words, it is study of the interrelations between living organisms and their environment. Ecology proceeds at three levels:

1) The individual organism

2) The population (consisting of individuals of the same species)

3) The community (consisting of number of populations).

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

The kind of organisms which can five in a particular ecosystem depends upon their physical and metabolic adoptions to the environment of that place/ecosystem and on certain aspects of the history of our planet, which has determined what organisms have been able to travel where. On earth, there are sets of ecosystems within a geographical region which are exposed to same climatic conditions and having dominant species with a similar life cycle, climatic adoptions and physical structure. This set of ecosystems is called a Biome. In the biosphere, there are—natural and artificial biomes (ecosystems).

ANSWER TO CHECK YOUR PROGRESS

1. Every ecosystem performs under natural conditions in a systematic way. It receives energy from the sun and passes it on through various biotic components and in fact, all life depends upon this flow of energy. Besides energy, various nutrients and water are also required for life processes which are exchanged by the biotic components within themselves and with their abiotic components within or outside the ecosystem. The biotic components also regulate themselves in a very systematic manner and show mechanisms to encounter some degree of environmental stress. The major functional attributes of an ecosystems are as follows:

   (i) Food chain, food webs and trophic structure

   (ii) Energy flow

   (iii) Cycling of nutrients (Biogeochemical cycles)

   (iv) Primary and Secondary production

   (v) Ecosystem development and regulation

2. **Pyramid of Biomass :**

   Biomass is renewable organic (living) material. A pyramid of biomass is a representation of the amount of energy contained in biomass, at different trophic levels for a particular time. It is measured in grams per meter^2, or calories per meter^2. This demonstrates the amount of matter lost between trophic levels. Each level is dependent on its lower level for energy, hence the lower level determines how much energy will be available to the upper level. Also, energy is lost in transfer so the amount of energy is less higher up the pyramid.

   There are two types of biomass pyramids: upright and inverted. An upright pyramid is one where the combined weight of producers is larger than the combined weight of consumers. An example is a forest ecosystem. An in-

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verted pyramid is one where the combined weight of producers is smaller than the combined weight of consumers. An example is an aquatic ecosystem.

3. • The artificial ecosystem is also known as man-made or man-engineered ecosystems. All types of artificial ecosystems are introduce and managed by man.
   • Gardens are also artificial ecosystem that are made and maintained by human. We can add any type of plant according to our likeness in the garden.
   • Similarly villages, cities, towns and aquarium are also made by human.

   Let us consider types, characteristic features, structure and functions of some major ecosystems.

4. These are freshwater aquatic ecosystems where water current is a major controlling factor, oxygen and nutrient in the water is more uniform and land-water exchange is more extensive. Although stream organisms have to face more extremes of temperature and action of currents as compared to pond or lake organisms, but they do not have to face oxygen deficiency under natural conditions. This is because the streams are shallow, have a large surface exposed to air and constant motion which churns the water and provides abundant oxygen. Their dissolved oxygen level is higher than that of ponds even though the green plants are much less in number. The stream animals usually have a narrow range of tolerance to oxygen. That is the reason why they are very susceptible to any organic pollution which depletes dissolved oxygen in the water. Thus, streams are the worst victims of industrial development.

TEST YOURSELF

1. What are the characteristics of ecosystem ?
2. What do you understand by food chaining ?
3. What is food web ?
4. What do you understand by ecological pyramid ?
5. What do you understand by grassland ecosystem ?
6. What do you understand by ocean ecosystem ?

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UNIT
3

BIODIVERSITY

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The Chapter Covers :

Learning Objectives :

After going through this unit, You would be able to -

- Biogeoporahical classification of india
- Value of biodiversity, Global biodiversity
- Hot spots of biodiversity:
- Threats to biodiversity:
- Conservation of biodiversity:

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3.1 INTRODUCTION

It is really amazing if we divide the whole mother earth into 10 billion parts, it is only one part where life exists and the surprising variety of living organisms which could be about 50 million species are all restricted to just about a kilometer-thick layer of soil, water and air. It is indeed wonderful to see that so much diversity has been created by nature on this earth from so little physical matter. Biodiversity refers to the variety and variability among all groups of living organisms and the ecosystem complexes in which they occur.

In the Conservation of Biological diversity (1992) biodiversity has been defined as the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. Biodiversity means the variety and variability of all living organisms. Biodiversity constitutes the biological wealth.

Biodiversity is at three levels:

- Genetic Diversity

- Species Diversity

- Ecosystem Diversity.

Genetic Biodiversity:

It is basic source of biodiversity. The genes found in organisms can form enormous number of combinations each of which gives rise to some variability. Genes are the basic units of hereditary information transmitted from one generation to other. When the genes within the same species show different versions due to new combinations, it is called genetic variability. For example, all rice varieties belong to the species Oryza sativa, but there are thousands of wild and cultivated varieties of rice which show variations at the genetic level and differ in their colour, size, shape, aroma and nutrient content of the grain. This is genetic diversity of rice.

Genetic biodiversity means the variation of genes within a species. A species have varieties and each variety has its own genes or genetic makeup. Diversity of genes within a species increases its ability to adapt to disease, pollution and other changes in environment. When a variety of a species is destroyed, genetic diversity gets diminished.

Species Biodiversity:

This is the variability found within the population of a species or between different species of a community. It represents broadly the species richness and their abundance in a community.

Till now only about 1 5 million living and 300000 fossil species have been actually described and given scientific names. It is quite likely that a large fraction of these

species may become extinct even before they are discovered and enlisted. Species biodiversity means variety of species within a region. Such diversity can be measured on the basis of species in a region. More species biodiversity means more biological wealth.

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Ecosystem Biodiversity:

This is the diversity of ecological complexity showing variations in ecological niches, tropic structure, food-webs, nutrient cycling etc. The ecosystems also show variations with respect to physical parameters like moisture, temperature, altitude precipitation etc. Thus there occurs tremendous diversity within the ecosystems, along these gradients.

We mainly consider diversity in forest ecosystem, which is supposed to have mainly a dominance of trees. But, while considering a tropical rainforest, a tropical deciduous forest, a temperate deciduous forest and a boreal forest, the variations observed are just too many and they are mainly due to variations in the above mentioned physical factors.

The ecosystem diversity is of great value that must be kept intact. This diversity has developed over millions of years of evolution. If we destroy this diversity, it would disrupt the ecological balance. We cannot replace the diversity of one ecosystem with that of another. Coniferous trees of boreal forests cannot take up the function of the trees of tropical deciduous forest lands and vice versa, because ecosystem diversity has evolved with respect to the prevailing environmental conditions with well regulated ecological balance.

Ecosystem biodiversity refers to variety of ecosystem in a particular region or zone as for example various ecosystems include forests, wetlands, arid zones, deserts etc. All these have their own fauna and flora (biodiversity).

3.2 BIOGEOPORAHICAL CLASSIFICATION OF INDIA

India has different types of climate and topography in different parts of the country and these variations have induced enormous variability in flora and fauna. India has a rich heritage of biological diversity and occupies the tenth position among the plant rich nations of the world.

It very important to study the distribution, evolution, dispersal and environmental relationship of plants and animals in time and space.

There are ten different bio-geographic habitats in India.

1. Trans-Himalayan – Upper regions

2. Himalayan – North-West Himalayas, West, Central and East Himalayas

3. Desert – Kutch, Thar and Ladakh

4. Semi-Arid – Central India, Gujarat-Rajwara

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5. Western Ghats – Malabar Coast, Western Ghat Mountains

6. Deccan Peninsula – Deccan Plateau South, Central, Eastern, Chhota Nagpur

7. Gangetic Plain – Upper Gangetic Plain, Lower Gangetic Plain

8. North-East India – Brahmaputra Valley, North Eastern Hills

9. Islands – Andaman Islands, Nicobar Islands, Laskhadweep etc.

10. Coasts- West Coast and East Coast

3.3 VALUE OF BIODIVERSITY

Biodiversity in terms of its commercial utility, ecological service, social and aesthetic value has enormous importance. We are benefited by other organisms in innumerable ways. Sometimes, we come to know and do appreciate the value of organism only after it is lost from this earth. Very small, insignificant, useless looking organism may play crucial role in the ecological balance of the ecosystem or may be a potential source of estimate for aesthetic value of biodiversity. Ecotourism is roughly estimated to generate about 12 billion dollars of revenue annually that roughly gives the aesthetic value of biodiversity.

1.Consumptive use value:

These include direct use values where the biodiversity product can be harvested and consumed directly e.g. fuel, food, drugs, fiber etc.

Food:

A large number of wild plants and shrubs are consumed by human beings as food. Aproximately 80000 edible plants species have been reported from wild. About90% of present day food crops have been domesticated from wild tropical plants. Even now our agricultural scientists make us of the existing wild species of plants that are closely related to our crop plants for developing new hardy strains. Wild relatives usually possess better tolerance and hardiness. A large number of wild animals are also our sources of food.

Drugs and medicines:

About 75% of the world's population depends upon plants or plant extracts for medicines. The wonder drug Penicillin used as an antibiotic is derived from a fungus called *Penicillium*. Likewise, we get Tetracycline from a bacterium. Quinine, the cure for malaria is obtained from the bark of Cinchona tree, while Digitalin is obtained from foxglove (Digitalis) which is an effective cure for heart ailments. Recently vinblastin and vincristine, two anticancer drugs, have been obtained from Periwinkle (*Catharanthus*) plant, which possesses anticancer alkaloids. A large number of marine animals are supposed to possess anti-cancer properties which are yet to be explored systematically.

Our forests have been used since ages for fuel wood. The fossil fuels coal, petroleum and natural gas are also products of fossilized biodiversity. Firewood collected by individuals are not normally marketed, but are directly consumed by tribals and local villagers, hence falls under constructive value.

2. Productive use values:

These are the commercially usable values where the product is marketed and sold. It may include lumber or wild gene resources that can be traded for use by scientists for introducing desirable traits in the crops and domesticated animals. These may include the animal products like tusks of elephants, musk from musk deer, silk from silk-worm, wool from sheep, fir of many animals, lac from lac insects etc, all of which are traded in the market. Many industries are dependent upon productive use values of biodiversity e.g. paper and pulp industry, plywood industry, Railway sleeper industry, Silk industry, textile industry, ivory-works, leather industry, pearl industry etc.

Despite international ban on trade in products from endangered species, smuggling of fur, hide, horns, tusks, live specimen etc. worth millions of dollars are being sold every year. Developing countries in Asia, Africa and Latin America are the richest biodiversity centers and wild life products are smuggled and marketed in large quantities to some rich western countries and also to China and Hong Kong where export of at skins and snake skins fetches a booming business.

3. Social value:

These are the values associated with the social life, customs, religion and psycho-spiritual aspects of the people. Many of the plants are considered holy and sacred in our country like Tulsi (occimum species) (Holy basil), Peepal, Mango (mangnijera Indica), Lotus, Bael etc. The leaves, fruits or flowers of these plants are used in workship or the plant itself is worshipped. The tribal people are very closely linked with the wild life in the forests. Their social life, songs, dances and customs are closely woven around the wildlife. Many animals like Cow, Snake, Bull, Peacock, Owl etc. also have significant place in our psycho-spiritual arena and thus hold special social importance. Thus biodiversity has distinct social value, attached with different societies.

4. Ethical value:

It is also sometimes known as existence value. It involves ethical issues like "all life must be preserved". It is based on the concept of "Live and Let Live". If we want our human race to survive, then we must protect all biodiversity, because biodiversity is valuable. The ethical value means that we may or may not use a species, but knowing the very fact that this species exists in nature gives us pleasure. We all feel sorry when we learn that "passenger pigeon", "dodo" are no more on this earth. We

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are not deriving anything direct from Kangaroo, Zebra or Giraffe, but we all strongly feel that these species should exist in nature as they are part of food chain. This means, there is an ethical value or existence value attached to each species.

5. Aesthetic value:

Great aesthetic value is attached to biodiversity. No one of us would like to visit vast stretches of barren lands with no signs of visible life. People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is now known as eco-tourism. The "willingness to pay" concept on such eco-tourism gives us even a monetary that may one day prove to be an effective option for something important in the future.

6. Option value:

These values include the potential of biodiversity that are presently unknown and need to be explored. There is a possibility that we may have some potential cure for AIDS or cancer existing within the depths of a marine ecosystem, or a tropical rainforest. Thus option value is the knowing that there are biological resources existing on this biosphere that may on day prove to be an effective option for something important in the future. Thus, the option value of biodiversity suggests that any species may prove to be a miracle species someday. The biodiversity is like precious gifts of nature presented to us. We should not commit the folly of losing these gifts even before unwrapping them. The option value also includes the values, in terms of the option to visit areas where a variety of flora and fauna, or specifically some endemic, rare or endangered species exist.

7. Ecosystem service value:

Recently, a non-consumptive use value related to self maintenance of the ecosystem and various important ecosystem services has been recognized. It refers to the services provided by ecosystems like prevention of soil erosion, prevention of floods maintenance of soil fertility, cycling of nutrients, fixation of nitrogen, cycling of water, their role as carbon sinks, pollutant absorption and reduction of the threat of global warming etc.

Different categories of biodiversity value clearly indicate that ecosystem, species and genetic diversity all have enormous potential and a decline in biodiversity will lead to huge economic, ecological and socio-cultural losses.

3.4 GLOBAL BIODIVERSITY

All the three levels are linked and constitute a gene pool. The 1992, United Nations Conference on Environment and Development at Rio put biological diversity on the international agenda by signing the Convention on Biological Diversity (CBD). This convention addresses many issues ranging from forests, agriculture to Intellectual Property Rights (IPRs).

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India is a signatory to CBD and ratified it in 1993. The Government of India has finalized the National Policy and Action Strategy for Biodiversity. Legislation was finalized and Indian Parliament passed Biodiversity Bill in 2002.The objective of the convention was "the conservation of biological diversity, the sustainable use of its components and equitable sharing of benefits arising out of the utilization of genetic resources." It also covered the ecological, economic and social aspects of biodiversity. The success of convention can be evaluated in two main ways:

a) By analyzing the changes in biodiversity components (i.e. species and ecosystems)

b) By measuring the effectiveness of measures taken to implement the convention.

According to the Worldwide Fund for Nature, scientists have identified about 1.4million having species. Of these around 1.03 million are animals and 248000 are higher plants. But human knowledge of the world's biodiversity is still not complete. Higher plants have also been fairly well studied but it is possible that15 percent more may still be discovered. Numerous insects, invertebrates, lower plants and microorganisms exist but have yet to be identified and described. One recent estimate put this figure as high as 30 million.

3.5 BIOLOGICAL DIVERSITY AT NATIONAL LEVEL (Indian Biodiversity):

Every country is characterized by its own biodiversity depending mainly on its climate. India has a rich biological diversity of flora and fauna. Overall six percent of the global species are found in India. It is estimated that India ranks 10th among the plant rich countries of the world, 11th in terms of number of endemic species of higher vertebrates and 6th among the centers of diversity and origin of agricultural crops. Total number of living species identified in our country is 150000. Out of a total 25 biodiversity hot-spots in the world, India possesses two, one in the north-east region and one in the Western Ghats. Indian is also one of the 12 mega-biodiversity countries in the world.

3.6 INDIA AS A MEGA-DIVERSITY NATION:

India is one of the 12 mega-diversity countries in the world. The Ministry of Environment and Forests, Govt. of India (2000) records 47000 species of plants and 81000 species of animals which is about 7% and 6.5% respectively of global flora and fauna. Those major groups of species include Endemism, Center of origin, Marine diversity etc. A large proportion of the Indian Biodiversity is still unexpected. There are about93 major wet lands, coral reefs and mangroves which need to be studied in detail. Indian forests cover 64.01 million hectares having rich biodiversity of plants in the Trans-Himalayan, north-west, west, central and eastern Himalayan forests, western ghats, coasts, deserts, Gangetic plains, deccan plateau and the

Check Your Progress:

1. What are the main levels of biodiversity?
2. What do you understand by Indian national biodiversity?

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Andaman, Nicobar and Lakshadweep islands. Due to very diverse climatic conditions there is a complete rainbow spectrum of biodiversity in our country.

3.7 HOT SPOTS OF BIODIVERSITY:

Areas which exhibit high species richness as well as high species endemism are termed as hot spots of biodiversity. Species which are restricted only to particular areas are known as endemic. India shows a good number of endemic species. About 62% of amphibians and 50% of lizards are endemic to India. Western Ghats are the site of maximum endemism. The term "Hot spots" was introduced by Myers (1988). There are 35 such hot spots of biodiversity on a global level out of which two are present in India, namely the Eastern Himalayas and Western Ghats.

These hotspots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity. According to Myers an area is designated as a hotspot when it contains at least 0.5% of the plant species as endemics.

a) Eastern Himalayas:

They display an ultra-varies topography that fosters species diversity and endemism. Recent studies have shown that Northeast India along with its contiguous regions of Burma and Chinese provinces of Yunnan and Schezwan is an active center of organic evolution and is considered to be the cradle of flowering plants. Out of the world's recorded flora 30% are endemic to India of which 35000 are in the Himalayas.

b) Western Ghats:

It extends along a 17000 km^2 strip of forests in Maharashtra, Karnataka, Tamilnadu and Kerala and has 40% of the total endemic plant species. The major centers of diversity are Agastyamalai Hills and Silent valley- the new Amambalam Reserve Basin. It is reported that only 6.8% of the original forests are existing today while the rest has been deforested or degraded, which raises a serious cause of alarm, because it means we have already lost a huge proportion of the biodiversity.

3.8 THREATS TO BIODIVERSITY:

Extinction or elimination of a species is a natural process of evolution. In the geologic period the earth has experienced mass extinctions. During evolution, species have died out and have been replaced by others. However, the rate of loss of species in geologic past has been a slow process, keeping in view the vast span of time going back to 444 million years. The process of extinction has become particularly fast in the recent years of civilization.

In the century the human impact has been so severe that thousands of species and varieties are becoming extinct annually. One of the estimates by the noted ecologist puts figure of extinction at 10000 species per year or 27 per day.

These amazing figures raise an alarm regarding the serious threat to biodiversity.

Over the last150 years the rate of extinction has escalated more dramatically. If the present trend continues we would lose 1/3rd to 2/3rd of our current biodiversity by the middle of twenty first century. Following are the major causes and issues related to threats to biodiversity:

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1. Loss of habitat:

Destruction and loss of natural habitat is the single largest cause of biodiversity loss. Billions of hectares of forests and grasslands have been cleared over the past 10000 years for conservation into agriculture lands, pastures, settlement areas or development projects. These natural forests and grasslands were the natural homes of thousands of species which perished due to loss of their natural habitat. Severe damage has been caused to wetlands thinking them to be useless ecosystems.

The unique rich biodiversity of the wetlands, estuaries and mangroves are under the most serious threat today. The wetlands are destroyed due to draining, filling and pollution thereby causing huge biodiversity loss. Sometimes the loss of habitat is in installments so that the habitat is divided into small and scattered patches, a phenomenon known as habitat fragmentation.

There are many wild life species such as bears and large cats that require large territories so subsist. They get badly threatened as they breed only in the interiors of the forests.

Due to habitat fragmentation many song birds are vanishing. There has been a rapid disappearance of tropical forests in our country also, at a rate of about 0.6% per year. With the current rate of loss of forest habitat, it is estimated that 20-25% of the global flora would be lost within few years. Marine diversity is also under serious threat due to large scale destruction of the fragile breeding and feeding grounds of our oceanic fish and other species, as a result of human intervention.

2. Poaching:

Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars per year continues, the developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth of wildlife. The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hong Kong are the major importers of the wildlife products or wildlife itself. The trading of such wild life products is highly profit making for the poachers who just hunt these prohibited wild lives and smuggle it to other countries mediated through mafia. The worst part is that for every live animal that actually gets into the market about 50 additional animals are caught and killed.

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3.9 MAN- WILDLIFE CONFLICTS

We have discussed about the need to preserve and protect wildlife. However, sometimes we come across conflicting situations when wildlife starts causing immense damage and danger to man and under such conditions it becomes very difficult for the forest department to pacify the affected villages and gain local support for wildlife conservation. Instances of man animal conflicts keep on coming to lime light from several states in our country. In Sambalpur, Orissa 195 humans were killed in the last 5years by elephants. In retaliation the villagers killed many elephants in the border region of Kote-Chamarajanagar belt in Mysore have been reported recently. The man-elephant conflict in this region has arisen because of massive damage done by the elephants to the farmer's cotton and sugarcane crops. The agonized villagers electrocute the elephants and sometimes hide explosives in the sugarcane fields, which explode as the elephants intrude into their fields. In fact, more killings are done by locals than by poachers.

In early 2004, a man-eating tiger reported to kill 16 Nepalese people and one 4 year old child inside the Royal Chitwan National Part, 240 Km South-west of Kathmandu. The park renowned for its wildlife conservation effort has become a zone of terror for the locals.

Similar incidents were reported near Sanjay Gandhi National Park, Borivali, Mumbai where similar incidents of human killings especially small children was reported. At times, such conflicting situations have been reported from the border regions of Corbett, Dudhwa, Palamau and Ranthambore National Parks in our country as well. In June, 2004 two men were killed by leopards in Powai, Mumbai. A total of 14 persons were killed during 19 attacks since January by the leopards from the Sanjay Gandhi National Park, Mumbai which has triggered a panic among the local residents.

Causes of Man-animal conflicts:

1. Dwindling habitats of tigers, elephants, rhinos and bears due to shrinking forests cover are compelled to move outside the forests and attack the field or sometimes even humans. Human encroachment into the forest areas has rendered all forest living animals to trespass the borders of human civilizations. This is because the conflicts between man and the wildlife have increased since it is an issue of survival of both.

2. usually the ill, weak and injured animals have a tendency to attack man. Also, the female tigress attacks the human if she feels that her newborn cubs are in danger. But the biggest problem is that if human-flesh istasted tested once then the tiger does not eat any other animal. At the same time, it is very difficult to trace and cull the man-eating tiger.

3. Earlier, forest department used to cultivate paddy, sugarcane etc. within the sanctuaries when the favorites staple food of elephants i.e. bamboo leaves

were not available. Now due to lack of such practices the animals move out of the forest in search of food. It may be noted that, one adult elephant needs 2 quintals of green fodder and 150 kg of clean water daily and if it is not available, the animal strays out.

4. Very often the villagers put electric wiring around their ripe crop fields. The elephants get injured, suffer in pain and turn violent.

5. Earlier there used to be wild-life corridors through which the wild animals used to migrate seasonally in groups to other areas. Due to development of human settlements in these corridors, the path of wildlife has been disrupted and the animals attack the settlements.

6. The cash compensation paid by the government in lieu of the damage caused to the farmers crop is not enough. In Mysore, a farmer gets compensation of Rs.400/- per quintal of expected yield while the market price is Rs.2400/- per quintal. The agonized farmer therefore gets revengeful and kills the wild animals.

Remedial Measures to Curb the Conflict:

1. Tiger Conservation Project (TCP) has made provisions for making available vehicles, tranquillizer guns, binoculars and radio sets etc. to tactfully deal with any imminent danger.

2. Adequate crop compensation and cattle compensation scheme must be started, along with substantial cash compensation for loss of human life.

3. Solar powered fencing should be provided along with electric current proof trenches to prevent the animals from straying into fields.

4. Cropping pattern should be changed near the forest borders and adequate fodder, fruit and water should be made available for the elephants within forest zones.

5. Wild life corridors should be provided for mass migration of big animals during unfavorable periods. About 300 km^2 area is required for elephant corridors for their seasonal migration.

6. In Similipal Sanctuary, Orissa there is a ritual of wild animal hunting during the month of April-May for which forest is burnt to flush out the animals. Due to massive hunting by people, there is a decline in prey of tigers and they start coming out of the forest in search of prey. Now there is WWF-TCP initiative to curb this ritual of "Akhand Shikar" in Orissa.

3.10 ENDANGERED SPECIES OF INDIA:

Endangered species in India comprise large varieties of rare species of wild animals, aquatic animals and insects. Indian wildlife consists of numerous species of birds,

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Check Your Progress:

3. What are the types of endangered species in India?
4. What do you understand by poaching?

mammals, reptiles etc, and is well known for comprising one of the richest varieties in the world. The Indian wildlife also contains several endangered species that are living critically on the verge of extinction.

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An endangered species is defined as a population of a living being that is at the danger of becoming extinct because of several reasons. Either they are few in number or are threatened by the varying environmental or predation parameters. The endangered species in India have been identified by different national and international organizations like the World Wildlife Fund (WWF), International Union for Conservation of Nature and Natural Resources (IUCN) and the Wildlife Institute of India (WII).

Statistics of Endangered Species in India

As per the official records, in India, there are over 130000 endangered animal species, although some experts believe that the number may be even more than the projected figures. However, some claim that the number is actually much more. The number of endangered species in India accounts for around 8.86 % of the world's mammals. The mammals are extended over 186 genera, 45 families and 13 orders out of which around 89 species are listed as threatened in the IUCN Red List of Threatened Animals (IUCN 2006).

Types of Endangered Species in India

The endangered species in India have been divided into 4 main categories-

* Critically Endangered (CR),

* Endangered (EN),

* Vulnerable (VU) and

* Threatened.

This classification was done by the International Union for Conservation of Nature and Natural Resources (IUCN) and Wildlife Institute of India (WII), in the year 2004. The population of the endangered species has been decreasing every passing minute.

Critically Endangered and Endangered Species in India

Among the endangered species in India, one of the most critically endangered one is the Siberian Tiger. This is a rare subspecies of tiger and they are an endangered species in India. The Asian Elephants found in India have also become the victims to the ever famous ivory poaching. However, the main cause behind their demur is considered to be the loss of habitat. Another endangered species in India is one of the big cats, the Golden Leopard with black marks. The number of this species has been reduced to as low as 14,000, in India. The main reasons behind the decline of Leopard population in India have been the loss of habitat and also human

population pressure on wildlife reserves in India. These reasons are also a matter of great concern for the other endangered species in India.

The major reason behind the habitat loss is the spread of agriculture. The Royal Bengal Tigers were also extensively being captured for pet trade, zoos and research, as well as for use in Oriental medicine, still in china.

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Further, the Critically Endangered species in India, as identified by the IUCN and WII include the Jenkins Shrew, Malabar Large-spotted Civet, Namdapha Flying Squirrel, Pygmy Hog, Salim Ali's Fruit Bats, Snow Leopard, Sumatran Rhinoceros, and the Wroughton's Free-tailed Bat. The list of Endangered species in India include the Asiatic Lion, Asiatic Black Bear, Desert Cat, Great Indian Rhinoceros, Hispid Hare, Hoolock Gibbon, Kashmir Stag, Lion-Tailed Macaque, Markhor, Nayan Ovis, Nilgiri Leaf Monkey, Pygmy Hog, Andaman Shrew, Andaman Spiny Shrew, Indian Elephant or Asian Elephant, Banteng, Blue Whale, Capped Leaf Monkey, Chiru, Fin Whale, Ganges River Dolphin, Golden Leaf Monkey, Asian arowana, Loggerhead Sea Turtle, Hoolock Gibbon, Indus River Dolphin, Kondana Soft-furred Rat, Lion-Tailed Macaque, Marsh Mongoose, Nicobar Tree Shrew, Nilgiri Tahr, Parti-coloured Flying Squirrel, Peter's Tube-nosed Bat, Red Panda, Sei Whale, Servant Mouse, Tiger, Wild Water Buffalo, and the Woolly Flying Squirrel.

Vulnerable and Threatened Species in India

Apart from the Critically Endangered and the endangered species in India, the International Union for Conservation of Nature and Natural Resources and Wildlife Institute of India also identified several species as vulnerable in India. These species include the Asiatic Wild Dog, Banteng Bos javanicus, Brow-antlered Deer, Brown Bear, Brown Palm Civet, Clouded Leopard, Common Otter, Ganges River Dolphin, Gaur, Goral, Grey Indian Wolf, Himalayan W-toothed Shrew, Himalayan Musk Deer, Himalayan Shrew, Jackal Canis Aureus, Andaman Horseshoe Bat, Andaman Rat, Argali, Asiatic Golden Cat, Asiatic Wild Ass, Macaque Monkey, Back-striped Weasel, Barasingha, Bare-bellied Hedgehog, Blackbuck, Brown fish owl, Central Kashmir Vole, Dhole, Dugong, Eld's Deer, Elvira Rat, Eurasian Otter, Fishing Cat, Four-horned Antelope, Gaur.

The other Vulnerable species are Himalayan Tahr, Humpback Whale, Indian Giant Squirrel, Irrawaddy Squirrel, Jerdon's Palm Civet, Kashmir Cave Bat, Kerala Rat, Khajuria's Leaf-nosed Bat, Kolar Leaf-nosed Bat, Lesser Horseshoe Bat, Mainland Serow, Malayan Porcupine, Mandelli's Mouse-eared Bat, Marbled Cat, Mouflon, Nicobar Flying Fox, Nilgiri Leaf Monkey, Nilgiri Marten, Nonsense Rat, Pale Grey Shrew, Palm Rat, Red Goral, Royal Bengal Tiger, Rock Eagle-owl, Rusty-spotted Cat, Sikkim Rat, Sloth Bear, Slow Loris, Smooth-coated Otter, Sperm Whale, Sri Lankan Giant Squirrel, Sri Lankan Highland Shrew, Stump tail Macaque, Takin, Wild Goat, Wild Yak and the Lesser Panda.

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The species like the Indian Wild Ass, the Leopard and the Red Fox have been identified as the threatened species in India.

In the current scenario, a number of organizations and eminent individuals are coming forward and providing adequate support to improve conservation of wildlife in India. The Government of India is also taking adequate measures to curb poaching. But the most important step that needs to taken is to spread awareness and educate the general public about conservation and preservation of wildlife and their habitat.

3.11 ENDEMIC SPECIES OF INDIA

India has many endemic plant and vertebrate species. Among plants, species endemism is estimated at 33% with c. 140 endemic genera but no endemic families. Areas rich in endemism are north-east India, the Western Ghats and the north-western and eastern Himalayas. A small pocket of local endemism also occurs in the Eastern Ghats .The Gangetic plains are generally poor in endemics, while the Andaman and Nicobar Islands contribute at least 220 species to the endemic flora of India.

WCMC's Threatened Plants Unit (TPU) is in the preliminary stages of cataloguing the world's centres of plant diversity; approximately 150 botanical sites worldwide are so far recognised as important for conservation action, but others are constantly being identified (IUCN, 1987). Five locations have so far been issued for India: the Agastyamalai Hills, Silent Valley and New Amarambalam Reserve and Periyar National Park (all in the Western Ghats), and the Eastern and Western Himalaya.

Endemism among mammals and birds is relatively low. Only 44 species of Indian mammal have a range that is confined entirely to within Indian territorial limits. Four endemic species of conservation significance occur in the Western Ghats. They are the Lion-tailed macaque *Macaca silenus*, Nilgiri leaf monkey *Trachypithecus johni* (locally better known as Nilgiri langur *Presbytis johnii*), Brown palm civet *Paradoxurus jerdoni* and Nilgiri tahr *Hemitragus hylocrius*.

Only 55 bird species are endemic to India, with distributions concentrated in areas of high rainfall. They are located mainly in eastern India along the mountain chains where the monsoon shadow occurs, south-west India (the Western Ghats), and the Nicobar and Andaman Islands .

In contrast, endemism in the Indian reptilian and amphibian fauna is high. There are around 187 endemic reptiles, and 110 endemic amphibian species. Eight amphibian genera are not found outside India.

They include, among the caecilians, *Indotyphlus*, *Gegeneophis* and *Uraeotyphlus*; and among the anurans, the toad *Bufoides*, the microhylid *Melanobatrachus*, and the frogs *Ranixalus*, *Nannobatrachus* and *Nyctibatrachus*.

Perhaps most notable among the endemic amphibian genera is the monotypic *Melanobatrachus* which has a single species known only from a few specimens

collected in the Anaimalai Hills in the 1870s .It is possibly most closely related to two relict genera found in the mountains of eastern Tanzania.

3.12 CONSERVATION OF BIODIVERSITY:

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The enormous value of biodiversity due to their genetic, commercial, medical, aesthetic, ecological and optional importance emphasizes the need to conserve biodiversity. Gradually we are realizing that wildlife is not just 'a game to be hunted', rather it is a gift of nature to be nurtured and enjoyed.

There are two approaches to biodiversity conservation:

a) ***In situ* conservation (within habitat) :**

This is achieved by protection of wild flora and fauna in nature itself e.g. Biosphere Reserves, National Parks, Sanctuaries, Reserve Forests etc

b) ***Ex situ* conservation (outside habitats):**

This is done by establishment of gene banks, seed banks, zoos, botanical gardens, culture collection tissue banks, zoological ganders, sperm banks etc.

SUMMARY

It is basic source of biodiversity. The genes found in organisms can form enormous number of combinations each of whicb gives rise to some variability. Genes are the basic units of hereditary information transmitted from one generation to other. When the genes within the same species show different versions due to new combinations, it is called genetic variability.

For example, all rice varieties belong to the species Oryza sativa, but there are thousands of wild and cultivated varieties of rice which show variations at the genetic level and differ in their colour, size, shape, aroma and nutrient content of the grain. This is genetic diversity of rice.

It is basic source of biodiversity. The genes found in organisms can form enormous number of combinations each of which gives rise to some variability.

This is the diversity of ecological complexity showing variations in ecological niches, tropic structure, food-webs, nutrient cycling etc. The ecosystems also show variations with respect to physical parameters like moisture, temperature, altitude precipitation etc. Thus there occurs tremendous diversity within the ecosystems, along these gradients.

This is the variability found within the population of a species or between different species of a community. It represents broadly the species richness and their abundance in a community.

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Ex situ conservation (outside habitats): This is done by establishment of gene banks, seed banks, zoos, botanical gardens, culture collection etc.

We have discussed about the need to preserve and protect wildlife. However, sometimes we come across conflicting situations when wildlife starts causing immense damage and danger to man and under such conditions it becomes very difficult for the forest department to pacify the affected villages and gain local support for wildlife conservation.

Instances of man animal conflicts keep on coming to lime light from several states in our country. In Sambalpur, Orissa 195 humans were killed in the last 5years by elephants. In retaliation the villagers killed 95 elephants in the border region of Kote-Chamarajanagar belt in Mysore have been reported recently. The man-elephant conflict in this region has arisen because of massive damage done by the elephants to the farmer's cotton and sugarcane crops.

The agonized villagers electrocute the elephants and sometimes hide explosives in the sugarcane fields, which explode as the elephants intrude into their fields. In fact, more killings are done by locals than by poachers.

ANSWER TO CHECK YOUR PROGRESS

1. **Biodiversity is at three levels:**

   - Genetic Diversity

   - Species Diversity

   - Ecosystem Diversity.

2. **BIOLOGICAL DIVERSITY AT NATIONAL LEVEL (Indian Biodiversity):** Every country is characterized by its own biodiversity depending mainly on its climate. India has a rich biological diversity of flora and fauna. Overall six percent of the global species are found in India. It is estimated that India ranks 10th among the plant rich countries of the world, 11th in terms of number of endemic species of higher vertebrates and 6th among the centers of diversity and origin of agricultural crops. Total number of living species identified in our country is 150000. Out of a total 25 biodiversity hot-spots in the world, India possesses two, one in the north-east region and one in the Western Ghats. Indian is also one of the 12 mega-biodiversity countries in the world.

3. **Types of Endangered Species in India :** The endangered species in India have been divided into 4 main categories-

* Critically Endangered (CR),

* Endangered (EN),

* Vulnerable (VU) and

* Threatened.

4. Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars per year continues, the developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth of wildlife. The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hong Kong are the major importers of the wildlife products or wildlife itself. The trading of such wild life products is highly profit making for the poachers who just hunt these prohibited wild lives and smuggle it to other countries mediated through mafia. The worst part is that for every live animal that actually gets into the market about 50 additional animals are caught and killed.

NOTES

TEST YOURSELF

1. Define biodiversity. Explain genetic, species and ecosystem diversities.
2. What do you mean by consumptive use value, productive use value, social value, ethical value and option value of biodiversity?
3. What are the major threats to biodiversity?
4. What are the main causes of man-wildlife conflicts? Discuss the remedial steps that can curb the conflict.
5. What are hotspots of biodiversity? Which are the hotspots found in India? Discuss salient features.
6. What is meant by in situ and ex situ conservation of biodiversity?

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UNIT 4 ENVIRONMENTAL POLLUTION

The Chapter Covers :

Learning Objectives :

After going through this unit, You would be able to -

- Air pollution, Water pollution, Soil pollution
- Marine pollution, Noise pollution
- Thermal pollution, Nuclear pollution
- Solid waste management
- Role of an individual in prevention of pollution

NOTES

4.1 INTRODUCTION

Environmental pollution had been a fact of life for many centuries and is a issue of serious international concern but it became a real problem since the start of the industrial revolution. Environmental pollution had been a fact of life for many centuries but it became a real problem since the start of the industrial revolution.

Pollution can be defined as any undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil), which can cause harmful effects on various forms of life or property.

Pollution may be:

- Local,
- Regional,
- Transboundary or global

The effects may be direct, indirect or cumulative, felt intermittently or constantly, immediate or after a delay; affecting the atmosphere, water bodies, oceans, ground water, and soil of be restricted to certain organisms, produce localities. The effects of pollution may be short term or longer term; pose a hazard or a nuisance; be toxic or non-toxic; take the form of a chemical, biological, radiation, heat, light, noise, dust, or odor problem.

Environmental pollution could be of various types:

- Air pollution
- Water pollution
- Soil pollution,
- Marine pollution,
- Noise pollution,
- Thermal pollution,
- Nuclear (radioactive) pollution

4.2 AIR POLLUTION

Going hand-in-hand with the increase in development and population is the increase in air pollution. Air pollution is basically the presence of foreign substances in air in excessive concentration which adversely affects the well being of the individual or causes damage to property. Wherever we live, the air is contaminated to some degree. The earliest pollutants noted in the atmosphere were of natural origin; like smoke, fumes, ash and gases from volcanoes and forest fires, or sand and dust from windstorms, or any other natural sources. But the real problems of air pollution came on the scene when human induced or anthropogenic sources started emitting pollutants. Considering all these, specific definitions of air pollution are given or adopted by different organizations and countries.

According to World Health Organization, air pollution is defined *as,* "substances put into air by the activity of mankind into concentration sufficient to cause harmful effect to his health, vegetables, property or to interfere with the enjoyment of his property."

Indian Standards Institute define air pollution as, "Air pollution is the presence in ambient atmosphere of substances, generally resulting from the activity of man, in sufficient concentration, present for a sufficient time and under circumstances which interfere significantly with the comfort, health or welfare of persons or with the full use or enjoyment of property."

Sources of Air Pollutants:

Sources of air pollution refer to the various locations, activities or factors which are responsible for the releasing of pollutants into the atmosphere. These sources can be classified into two major categories which are:

Anthropogenic sources (human activity) :-

- "Stationary Sources" include smoke stacks of power plants, manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices
- "Mobile Sources" include motor vehicles, marine vessels, aircraft and the effect of sound etc.
- Chemicals, dust and controlled burn practices in agriculture and forestry management. Controlled or prescribed burning is a technique sometimes used in forest management, farming, prairie restoration or greenhouse gas abatement. Fire is a natural part of both forest and grassland ecology and controlled fire can be a tool for foresters. Controlled burning stimulates the germination of some desirable forest trees, thus renewing the forest.
- Fumes from paint, hair spray, varnish, aerosol sprays and other solvents
- Waste deposition in landfills, which generate methane. Methane is not toxic; however, it is highly flammable and may form explosive mixtures with air. Methane is also an asphyxiate and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5% by displacement
- Military, such as nuclear weapons, toxic gases, germ warfare and rocketry

Natural sources

- Dust from natural sources, usually large areas of land with little or no vegetation
- Methane, emitted by the digestion of food by animals, for example cattle
- Radon gas from radioactive decay within the Earth's crust. Radon is a colorless, odorless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard. Radon gas from natural

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

- Smoke and carbon monoxide from wildfires
- Vegetation, in some regions, emits environmentally significant amounts of VOCs (Volatile Organic Carbon) on warmer days. These VOCs react with primary anthropogenic pollutants—specifically, NO_x, SO_2, and anthropogenic organic carbon compounds—to produce a seasonal haze of secondary pollutants.[6]
- Volcanic activity, which produce sulfur, chlorine, and ash particulates

Classification of Air Pollutants

Air pollutants are the substances which can cause undesirable changes in air .These substances may include gases, particulate matter, radioactive substances etc. Air pollutants may be classified according to origin, chemical composition and state of matter.

1. According to Origin

On the basis of origin, air pollutants can be divided into two categories—primary and secondary air pollutants.

- **Primary air pollutants** are those which are emitted directly to the atmosphere from the point source and found there in the form in which they are emitted. For example, particulates, carbon monoxide (CO), oxides of sulphur (SO_x), oxides of nitrogen ($N0_x$), hydrocarbons (HCs), radioactive compounds, particles of metal, pollen, bacteria, etc. The five main primary air pollutants (viz. particulates, CO, SO_x, NO_x and HCs) contribute more than 90% of global air pollution.
- **Secondary air pollutants** are those which are produced in the air by the interaction among two or more primary air pollutants, or by reaction with normal atmospheric constituents, with or without photo activation. For example, ozone, peroxyacetyl nitrate (PAN), formaldehyde, formation of acid mists, *smog* (coal induced and photochemical smog), etc.

2. According to Chemical Composition

On the basis of chemical composition, air pollutants can be divided as-organic and inorganic air pollutants.

- **Organic compounds** contain carbon, hydrogen and many also contain certain elements such as oxygen, nitrogen, sulphur and phosphorus. Examples of *organic air pollutants are* hydrocarbons, aldehydes, ketones, carboxylic acids, organic sulphur compounds, etc.

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- **Inorganic air pollutants** include compounds, such as CO, CO_2, SO_x, NOx, O_3, etc.

3. According to State of Matter

On this basis, air pollutants' are classified as—particulate and gaseous air pollutants.

- **Particulate air pollutants** include finely divided solids and liquids dispersed in gaseous media. Dust, smoke, fly ash, flumes, etc. are examples of solid particulates; while mist, spray, fog, etc., are liquid particulate air pollutants.
- **Gaseous air pollutants** are organic gases like benzene, methane, butane, aldehydes, ketones, etc., as well as, inorganic gases like CO, CO_2, SO_x, NOx, O3, etc.

Effects of Air Pollution on Human Health

The air we breathe has not only life sustaining properties, but also life damaging properties. An average man breathes 22,000 times a day and taken in 16 kg of air each day. The impurities in the inhaled air can affect human health in a number of ways, depending upon:

- The nature and concentration of the pollutants,
- Duration of exposure, and
- Age group of the receptor.

Depending upon the chemical nature of the pollutants, some pollutants may be harmful when present in small concentrations and others only if they are present in high concentrations. The duration of exposure to polluted air is also an important factor. The infants, elders and those with chronic diseases of the lungs or heart are more susceptible to the effects of air pollution. It has also been observed that the effect of air pollution on human health is worst or maximum during winter season, when pollution levels reach a climax. The various health effects are as under.

(i) Eye irritation-can be caused by many air pollutants such as NO_x, O_3, PAN, smog, particulates, etc.

(ii) Nose and throat irritation- can be caused by SO_2, NOx insecticides, pesticides, etc.

(iii) Gaseous pollutants like H_2S, SO_2, NO_2 and hydrocarbons can cause odour nuisance even at low concentrations.

(iv) Irritation of the respiratory tract can be caused by SO_x, NO_x, O_3, CO,etc.

(v) Increase in mortality and morbidity rate.

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(vi) A variety of particulates, particularly pollens, can initiate asthmatic attacks.

(vii) High concentrations of SO2, NO2, SPM (suspended particulate, matter) and photochemical smog can aggravate chronic pulmonary diseases like bronchitis and asthma.

(viii) Carbon monoxide, which is two hundred times more reactive than oxygen, combines and react with haemoglobin to form carboxyhaemoglobin. This reduces the oxygen carrying capacity of the blood and causes suffocation. Long exposure to CO may cause dizziness, unconsciousness and even death.

(ix) Nitric oxide (NO) can irritate the lungs and cause conditions like chronic bronchitis and emphysema .

(x) Hydrogen fluoride can cause fluorosis and mottling of teeth.

(xi) *Air* pollutants such as polycyclic organic compounds, aliphatic,hydrocarbons, etc. can cause cancer.

(xii) Dust particles can cause dust specific respiratory diseases such as, *silicosis* (associated with silica dust), *asbestosis* (associated with asbestos dust), etc.

(xiii) Heavy metals, like lead (emitted from vehicles), may enter the body through the lungs and can cause poisoning. Its high concentration can damage liver and kidney, it is also reported to cause abnormality in fertility and pregnancy, and mental development of children gets affected.

Effects of Air Pollution on Plants

Air pollution effects are not limited to the short term to the plant damaged or killed. Rather, air pollution can have long term effects that affect not only plants, but the animals that depend upon them.

Air pollutants affect plants by entering through stomata, destroy chlorophyll and affect photosynthesis. The primary factor that governs the gas absorption by the plant leaves is the degree of opening of the *stomata*. The stomata are the openings in the leaf, generally in the bottom of the leaf, through which CO_2, enters to play its role in photosynthesis. When the stomata are wide open (day time), the absorption is maximum and vice-versa. As a result, the same conditions that enhance the absorption of CO_2 also expose the plant to injury by absorbing a pollutant gas. Most of the plants close their stomata during night and are, therefore, much more resistant at night. The air pollutants that affect plants include SO_2, fluorides, NOx ,PAN, ethylene, NH_4 ,mercury, smog, herbicides, etc.

- Particulates deposited on leaves can form encrustations and plug the stomata and also reduce the availability of sunlight. The damage can result in death of the plants.
- SO_2 causes bleaching of leaves, chlorosis (loss or reduction of chlorophyll causing yellowing of leaf),injury and necrosis(dead areas of leaves) of leaf.

- NO_2 results in increased abscission(dropping of leaves) and suppressed growth.
- O_3 causes flecks on leaf surface, premature aging, necrosis and bleaching.
- PAN causes silvering of lower surface of leaves, damage to young and more sensitive leaves and suppressed growth.
- Flourides cause necrosis of leaf tip .
- Ethylene results in epinasty, leaf abscission and dropping of flowers.
- Pollutants erode waxy coating of the leaves called cuticle. Cuticle prevents excessive water loss and damage from diseases, pests, drought and frost.

Effects of Air Pollution on aquatic life

Air pollutants like Sox and NOx mix with rain water and form acid rain , which can cause high acidity in fresh water lakes. This affects aquatic life especially fish. Some of the fresh water lakes have experienced total fish death.

Effects of Air Pollution on Animals

The process by which the animals get poisoned is entirely different from that by which human beings exposed to air pollutants are poisoned. In case of animals, it is a two-step process :

(i) Accumulation of air pollutants in the vegetation and forage; and

(ii)Subsequent poisoning of the animals,, when they eat the contaminated vegetation/forage.

The pollutants mainly responsible for most livestock damage are:

Fluorine :

Of all the farm animals, cattle and sheep are the most susceptible to fluorine toxicity. Horses are quite resistant, while poultry are probably the most resistant to fluorine of all the farm animals. Fluorine is a cumulative poison under conditions of continuous exposure to sub acute doses. It's effects are lack of appetite, rapid loss of weight, lameness, periodic diarrhea, muscular weakness, wearing of teeth, and death.

Lead :

Chronic lead poisoning has been observed frequently in animals that have been grazing near smelters and lead mines. It causes paralysis and difficulty in breathing. In case of acute lead poisoning, the onset is sudden and the course is relatively short. There is complete loss of appetite, paralysis, and diarrhea.

Arsenic ;

In acute cases, it can cause severe salivation, thirst, vomiting, irregular pulse and respiration, abnormal body temperature, and death in few hours. Chronic arsenic poisoning causes cough, diarrhea, anemia, abortion, paralysis, and death.

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Economic Effects of Air Pollution:

Air pollution damage to **property/material** is a very important economic aspect of pollution, and it covers a wide range:

(i) Corrosion: Air pollution damages materials chiefly by corrosion of metals. The prime air pollutant responsible for Metallic corrosion is SO_2. In the presence of oxygen and moisture it is converted to sulphuric acid. Deposition of this acid on metal parts of building roofs, railway tracks, overhead wires, metal on bridges, and other structures cause enormous loss due to corrosion.

(ii) Damage to building materials: The acid deposition reacts' with lime stone, marble, and other building materials to cause deterioration and disfigured the building materials.

(iii) Damage to paints and protective covering: Pollutants like SO_2, O_3, H_2S, and aerosols damage protective coating and paints of the surface.

(iv) Damage of textile dyes and textile fibers: The fading of textile dyes and deterioration of natural and synthetic textile fibers is caused by SOx , NOx and O_3.

(v) Rubber Cracking: Rubber cracking of tyres and various forms of electrical insulation is caused by ozone and PAN.

(vi) Deterioration of leather and paper: Sulphur dioxide causes leather to lose much of its strength and ultimately disintegrate; with has posed a serious problem of storage of leather bound book in libraries. The impurities in paper absorb SO_2 and convert it in to H_2SO_4, in the presence of moisture, which makes' the paper extremely brittle and decreases its folding resistance.

(vii) Effect on glasses and ceramics: Although glasses and ceramics are especially resistant to the chemical action of air pollutants, but long exposure for years showed a change in their surface appearance.

(viii) Damage to objects of art and architecture: *Acid rains* cause intangible loss to objects of art and architecture throughout the world. For example, effects on the Taj Mahal,Belur Temple, Cleopatra's needle (a stone structure in London), Statue of Liberty, and many more monuments, paintings (such as Ajanta frescos), antique costumes and other art objects.

(ix) Increased transportation costs in period of smog.

Control of Air Pollution

Air pollution can be minimized by the following methods:

- Setting of industries after proper Environmental Impact Assessment studies.

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- Minimize activities which cause pollution like transportation and energy production.
- Modification of process and /or equipments
- Use of appropriate material
- Using low sulphur coal in industries
- Removing sulphur from coal (by washing or with the help of bacteria)
- Removing NOx during the combustion process and controlling the flow of air and fuel in industrial boilers.
- Vehicular pollution can be checked by regular tune up of engines; replacement of more polluting old vehicles; installing catalytic converters; by engine modification to have fuel efficient mixtures to reduce CO and hydrocarbon emissions.
- Using mass transport system, bicycles etc.
- Shifting to less polluting (clean) fuel (hydrogen gas)
- Using non conventional sources of energy.
- Using biological filters and bio- scrubbers.
- Planting more trees.
- Reduction of pollution at source.

Approaches to Air Pollution Control:

Basically, there are four approaches available for the control of emissions discharged into the atmosphere. They are:

(i) **Dispersion of source locations**. Air pollution can be controlled/checked by dispersion of the sources of air pollutants, through allocation of land, *i.e.,* by proper planning and zoning of industrial areas.

(ii) **Dilution**. By using tall stacks for industries or thermal plants, the emissions or pollutants can be discharged at a sufficient height from the ground, where the air movement, both horizontal and vertical, is more and chances of downward movement of air (i.e., inversion conditions) are less. This will help in dispersions of pollutants over a larger area in less time, and hence dilute the concentrations of pollutants near the source.

(iii) **Reduction at source by process changes.** This can be achieved by:

- substitution of raw materials; *e.g.,* the use of low-volatile coal in place of high-volatile coal, eliminates smoke and soot.
- substitution of fuel; *e.g.,* desulphurization and de-ashing reduce emissions of SO_2, SPM (suspended particulate matter) and ash.

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Similarly, natural gas can be used in place of coal, to minimize emissions.

- modification of the process; *e.g.*, in case of disposal of combustible refuse, sanitary landfill can be used instead of incinerators.
- *m*odification of the process equipment, or repair and maintenance of existing equipment helps in reducing atmospheric pollution.

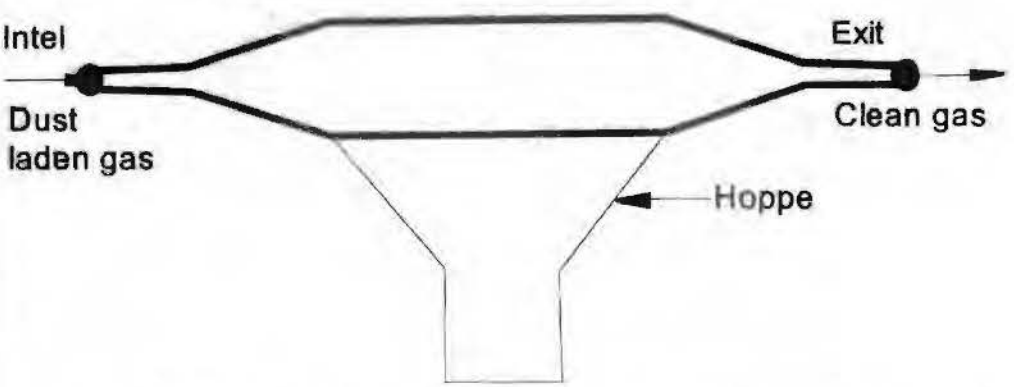
(iv) **Reduction at source by using control equipment**. This is the most effective method for reducing air pollution at source. Various control devices are used for controlling different types of pollutants emitted from different sources.

Since there are only a very few devices which are effective in the control of both particulate and gaseous contaminants, therefore, the control devices are normally designed to control either one or the other.

(A) CONTROL DEVICES FOR PARTICULATE CONTAMINANTS

The various types of control devices or equipments used for the removal of particulate matter from stationary sources are briefly discussed as under:

(1) Settling Chamber. It is the simplest type of equipment used for the collection of solid particles. The settling chamber consists of a chamber in which the carrier gas velocity is reduced, so as to allow the particulates to settle out of the moving stream under the action of gravity on the base of the chamber. The gas velocity in the chamber is kept sufficiently low, so that the settling time of a particle entering the chamber at the top is same or less than the time taken by the flue gas to pass through the chamber.



(2) Cyclone. It is a structure without moving parts, in which the velocity of an inlet dust laden gas stream is transformed into a combined vortex from which centrifugal forces tend to drive the suspended particles to the wall of the cyclone body. The cyclone is very efficient for larger particles. Cyclone efficiencies are greater than 90% for particles with dia. of the order of 10 um. For particles with dia. higher than 20 um, the efficiency is about 95%.

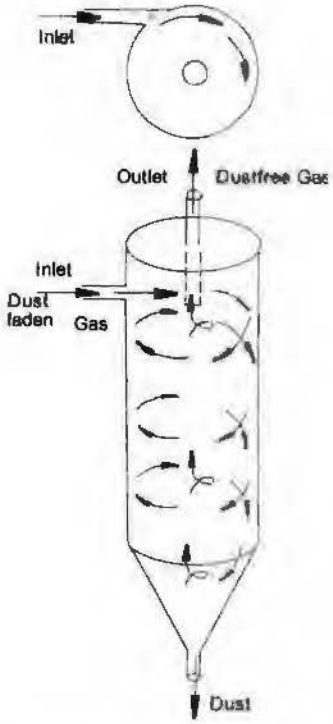


Fig.6 : Cyclone

(3) Filters. Particulate matter can be filtered, if the fumes containing them are forced to pass through a filtering device. The particles are held, while the gases pass through the media. Cloth fabric or fibrous medium, like mats of wool, cellulose, etc. may be used as a separator (or filter media). The most common type of fabric collector, used in industries, is 'Bag filter'.

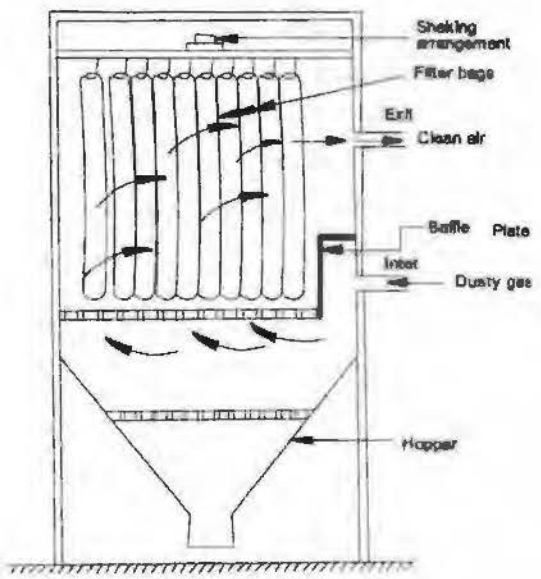


Fig.7 : Bag filter

(4) Electrostatic Precipitator. The Electrostatic Precipitator may be plate type or cylinder type. Vertical wires are placed between the

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parallel plates or wires is hung along the axis of the cylinder. High negative voltage is applied to the wire. Dust particles while passing from the lower end get negatively charged (ionized) and are collected on the positively charged surface (plates/cylindrical body) while the clean gas leaves from the top.

The deposited dust particles fall down in the dust collector or are removed by scrapping or by liquids. This device can remove submicroscopic particles.

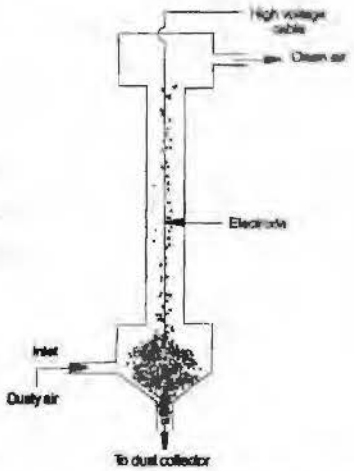

Fig.-8 : Electrostatic Precipitator

(5) Scrubbers or Wet Collectors. Factory fumes not only contain dust (particulate matter), but toxic gases also. So it is necessary that as far as possible all toxic/harmful substances (particulates and gases are removed before the emission of smoke. Scrubbers are devices which utilize water or any other specific liquid to assist in the removal particulates as well as gases by absorption and/or adsorption. The simplest type of gas scrubber is spray tower. The other types of scrubbers used are venturi-scrubbers, cyclone-scrubbers.

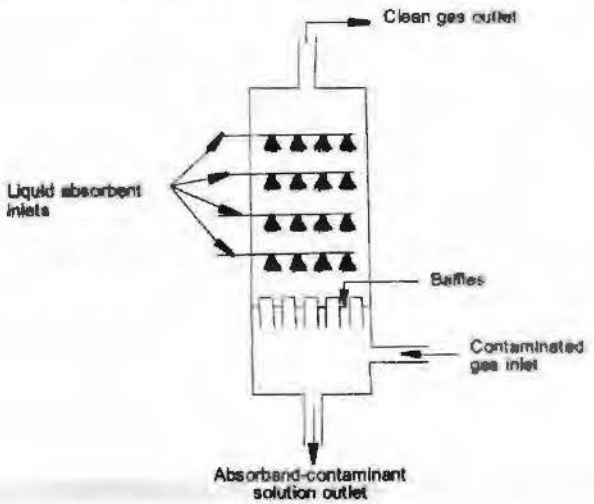

Fig.-9 : Spray tower

(B) CONTROL DEVICES FOR GASEOUS CONTAMINANTS

The principal gases of concern in air pollution control are SOx ,NOx, oxides of carbon (particularly CO), HCs, and organic and inorganic acid gases. The treatment processes for the control of these and other gaseous emissions include adsorption, absorption, condensation and combustion.

(1)Adsorption. Adsorption involves passing of a stream of effluent gas through a porous solid material (called the adsorbent) contained in an adsorption bed. The surface of the porous solid material attracts and hold the gas (the adsorbate) by either physical or chemical adsorption.

Some of the widely used adsorbent (materials possessing adsorptive properties) for the control of gaseous air pollutants are silica gel, alumina and bauxite have higher affinity for water (a polar vapour); while activated carbon has a bigher affinity for lower paraffin hydrocarbons (non-polar organic vapours)The devices or equipments that contain the adsorbent solid through which the effluent gas must pass are called *adsorbers eg*; Multiple Fixed bed adsorber.

Types of adsorber and uses:

S.No.	Adsorbent	Major use
1.	Activated carbon	For eliminating odours, purifying gas, and recovering solvents
2.	Activated alumina	For drying air, gases and liquids.
3.	Bauxite	For treating petroleum fractions, and drying gases and liquids.
4.	Bone char	For decolourzing sugar solutions.
5.	Fuller's earth	For refining vegetable oils, animal oils, fats and waxes.
6.	Molecular sieves (synthetic, silicate or zeolite molecular sieves)	For controlling and recovering Hg, S⊘ and NOx emissions.
7.	Silica gel	For drying and purifying gases.
8.	Strontium sulphate	For removing iron from caustic solutions.

(2) Absorption. The removal of one or more selected components from a gas mixture by absorption is probably the most important operation in the control of gaseous pollutant emissions. Absorption is a process in which a gaseous pollutant is dissolved in a liquid. Water is the most commonly used absorbent liquid. As the gas stream passes through the liquid, the liquid absorbs the gas, in much the same way that sugar is absorbed in a glass of water when stirred. Absorption is commonly

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used to recover products or to purify gas streams that have high concentrations of organic compounds. Absorption equipment is designed to get as much mixing between the gas and liquid as possible.

Absorbers are often referred to as scrubbers, and there are various types of absorption equipment. The principal types of gas absorption equipment include spray towers, packed columns, spray chambers, and venture scrubbers. The packed column is by far the most commonly used for the absorption of gaseous pollutants. One potential problem with absorption is the generation of waste-water, which converts an air pollution problem to a water pollution problem.

(3)Condensation

Condensation is the process of .converting a gas or vapor to liquid. Any gas can be reduced to a liquid by lowering its temperature and/or increasing its pressure. The most common approach is to reduce the temperature of the gas stream, since increasing the pressure of a gas can be expensive.

Condensers are widely used to recover valuable products in a waste stream. Condensers are simple, relatively inexpensive devices that normally use water or air to cool and condense a vapor stream. Condensers are typically used as pretreatment devices. They can be used ahead of adsorbers, absorbers, and incinerators to reduce the total gas volume to be treated by more expensive control equipment. Condensers used for pollution control are contact condensers and surface condensers. Removal efficiencies of condensers typically range from 50 percent to more than 95 percent, depending on design and applications. The widest application of condensers is in the field of HC's emission control

(4)Combustion:

Incineration, also known as combustion, is most used to control the emissions of organic compounds from process industries. This control technique refers to the rapid oxidation of a substance through the combination of oxygen with a combustible material in the presence of heat. When combustion is complete, the gaseous stream is converted to carbon dioxide and water vapor. Incomplete combustion will result in some pollutants being released into the atmosphere. Smoke is one indication of incomplete combustion. Equipment used to control waste gases by combustion can be divided in three categories: direct combustion or flaring, thermal incineration and catalytic incineration. Choosing the proper device depends on many factors, including type of hazardous contaminants in the waste stream, concentration of combustibles in the stream, process flow rate, control requirements, and an economic evaluation.

4.3 WATER POLLUTION

Water pollution is a state of deviation from the pure condition, whereby its normal properties and function are affected. To be more precise, water pollution can be defined as 'the presence of some foreign substances or impurities in water in such

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quantity so as to constitute a health hazard by lowering the water quality and making it unfit for use.

Some of the earliest noticeable signs of water pollution are offensive odours from rivers, streams, lakes and ocean beaches; oily and greasy material floating on surfaces of water bodies ; unchecked growth of aquatic weeds in water bodies; bad taste of drinking water; decrease of aquatic life (say fish) in fresh water bodies; and many more.

Classification of Water Pollutants

Water is used for various purposes including bathing, excretion, washing/food preparation, cleaning of floors and equipment, industrial operations, agricultural needs, and many more. After using, it is discharged as waste-water which is contaminated by various pollutants. The various types of water pollutants can be broadly classified into following categories:

(i) Organic pollutants;

(ii) Inorganic pollutants;

(iii) Radioactive pollutants; and

(iv) Suspended solids and sediments.

1. Organic Pollutants

Organic chemical compounds are of great importance to the human beings and other life forms on this planet. Most-of the substances of which living things are composed are organic compounds. In addition, the main foodstuffs (such as fats, proteins and carbohydrates), as well as a number of materials and substances necessary for modern living (such as cotton, petroleum, rubber, plastics, antibiotics, etc.), are all organic compounds. But their presence in water is not desirable as they not only impart taste, odour and colour to water, but some of the chemical compounds discharged by industries are toxic and carcinogenic too.

The organic pollutants may further be categorized as follows:

(a) Natural organic pollutants.

(b) Sewage and industrial effluents.

(c) Synthetic organic contaminants.

(d) Microbiological pollutants.

(e) Oil.

(a) **Natural Organic Pollutants.** Natural organic contaminants in water come from the breakdown of naturally occurring organic materials, such as, decay of leaves, plants, dead animals, etc. Micro-organisms are another source of organic compounds in water. In addition to cellular matter, many plants and micro-organisms release organic matter into a water body through their metabolic processes. Various types of algae and vegetation flourishing in a

Check Your Progress:

1. What do you understand by scrubbers or wet collectors?
2. What do understand by organic pollutants?
3. What do you understand by radioactive pollutants?

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lake or reservoir can also be source of objectionable organic compounds in water, for example, if there is a sudden die-off of the vegetation, water quality can become extremely bad.

(b) **Sewage and Industrial Effluents.** Organic pollutants are also discharged as municipal sewage and industrial effluents (such as food-processing units, paper mills, tanneries, slaughter houses, etc.).

(c) **Synthetic Organic Contaminants.** These are the man-made (anthropogenic) materials which may enter the water bodies along with sewage and other wastes. Synthetic organic contaminants include both volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). The most common organic pollutants in VOCs category are industrial solvents, such as—carbon tetrachloride (used as fire extinguisher and cleaning agent) and tetrachloroethylene (used as solvent and raw material). In SOCs category, the most common organic pollutants are pesticides and herbicides, and many other chemicals used in industrial processes (such as ethylbenzene, toluene and styrene). Most of these chemicals are potentially toxic to plants, animals and human beings.

Presently, the most controversial organic pollutants are poly-chlorinated biphenyls (PCBs) and dioxin, which are very toxic and known to cause cancer even at low concentrations.

(d) **Microbiological Pollutants.** Many micro-organisms (such as fungi, bacteria, viruses, protozoa, algae and helminthes) are found in polluted/untreated water. Most of these do not pose a health hazard to humans but some are known for its hazards. The organisms that can cause sickness in humans are called pathogenic organisms (or pathogens). Even though modern water treatment removes or inactivates known disease causing organisms to safe levels, still it is best if the source water is as free of contamination as possible.

(e) **Oil.** Oil is a naturally occurring mixture of thousands of different hydrocarbon compounds; and is thought to originate from vast deposits of plant material, and to a lesser extent animal material, buried and compressed by miles-deep layers of sediments. In addition to carbon and hydrogen atoms, hydrocarbons may contain oxygen, sulphur, nitrogen, vanadium, nickel and a variety of other atoms and group of atoms. Some of the common types of compounds present in crude oil are paraffins, cycloparaffins, aromatics, neptheno-aromatics, etc.

Water pollution due to oil may be due to oil entrained in refinery waste. Spillage of oil during transportation, oil tanker accidents, intentional discharge of crude oil into seas/oceans, sewage containing oily contents, etc.

2. Inorganic Pollutants

All surface water and ground water sources contain a variety of inorganic chemicals. Geological formations, with which the water comes in contact, are major sources

of inorganic chemicals. Other sources include industrial discharges and agricultural run-off. Inorganic pollutants in water include inorganic salts, mineral acids, metals or metal compounds, trace elements, complexes of metals with organics in natural water, and organo metallic compounds. Some of these are highly toxic and some are mildly toxic. The list of inorganic contaminants includes:

Aluminium	Chromium	Nitrite
Ammonia	Copper	Selenium
Antimony	Cyanide	Sodium
Arsenic	Fluoride	Strontium
Asbestos	Lead	ulphate
Barium	Manganese	Thallium
Beryllium	Mercury	Vanadium
Boron	Nickel	Zinc
Cadmium	Nitrate	

In fact, the inorganic contaminants are mainly the metals found in water; but, there are some other compounds and materials that are also included. Nitrates, phosphates and sulphates are the inorganic plant nutrients. The presence of these pollutants causes excessive growth of algae and other aquatic plants. These then die and decay and become oxygen-demanding waste. The dissolved oxygen supply depletes and aquatic animals (fish) die. There are reports that drinking water with excessive nitrates reduce oxygen carrying capacity of blood and kill unborn children and infants especially less than three months of age.

3. Radioactive Pollutants

Radioactivity found in water is mainly due to natural sources; but there is also a threat of radionuclide contamination from various industrial and medical processes. The main human activities which are responsible for radioactive pollution are use of radioactive materials in power plants and nuclear weapons ; use of radioactive isotopes in medical, industrial and research applications ; and mining and processing of ores to produce usable radioactive substances. Though all of the radioactive contaminants are carcinogenic, the radionuclide that are found in water and are of concern are uranium, radium 226 and 228, radon and thorium 230 and 232. Out of these, radon is generally found in public water supplies.

4. Suspended Solids and Sediments

Soil, sand and other solids washed into water bodies due to soil erosion (by natural processes, mining, agricultural and constructional activities, etc.), and disposal of sewage and industrial effluents into water bodies result in contaminating the water with suspended solids as well as sediments. These solids are in the form of organic or inorganic particles or of immiscible liquids (oils and greases). The presence of these solids increases the turbidity in water; thereby, reducing the amount of sunlight available for photosynthesis of the aquatic plants. Other effects include suffocation of the aquatic habitats (fishes, etc.), silting of rivers and reservoirs, erosion of pumping equipments and power turbines, etc.

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5. Heat

Water is widely used for dissipation of waste heat in power plants and industries. This heated water is then discharged into water bodies, where it has harmful effects on the aquatic life. Increased temperature of water reduces the amount of dissolved oxygen and increases the biological activity. This may lead to anaerobic conditions. As a result of which, the water quality reduces. Further, the toxicity of chemical pollutant increases with increase in temperature.

Rise in the temperature of water (and air) to a harmful level due to heat from power plants and industries are called "Thermal Pollution'.

Sources of Water Pollution

The main sources of water pollution are natural, agricultural, mining, municipal, industrial and accidental:

(a) Natural pollution may be due to aerial contaminants entering the water body due to rainfall or melting of ice. Decaying of plants, animals and organic matter; leachates from animal excreta will introduce micro-organisms in water.

(b) Agricultural pollution of water will be due to soil and silt washings from land surfaces, fertilisers, insecticides, pesticides and weed killers.

(c) Mining pollution of water will be due to fines or tailings from ore washing, inert suspended solids, soluble toxic materials and acid drainage.

(d) Municipal pollution of water will be due to sewage obtained from domestic premises, institutions, commercial and industrial buildings.

(e) Industrial pollution of water will be due to the effluents coming from various industries such as food and drugs, chemical, materials and energy.

(f) Accidental spillage of chemicals during loading and transit; and accidental leakage from industrial storage tanks, oil refineries etc.

The sources of water pollution can be divided into two categories, namely point sources and diffused sources.

1. Point Sources

Those sources which can be readily identified and are at a specific location near water which directly discharge effluent into them are known as point sources. For instance—industries, municipal sewage, treatment plants, combined sewer overflow, raw sewage discharges, etc. This type of discharge can be controlled. And the water pollution caused by these sources can be minimized if the effluents from these sources are centrally collected, treated up to acceptable levels and reused.

2. Diffused Sources

Diffused sources or non-point sources are the sources of generalized discharge of waste water whose location cannot be easily identified. Here, the pollutants scattered on the ground ultimately reach the water sources and cause water pollution.

For instance—run-off from agriculture lands, forestry, mining, construction, etc. This type of discharge of waste- water cannot be easily controlled. However, water pollution caused by diffused sources like agriculture can be controlled by changing the crop patterns, tillage practices and advanced farm management practices.

Effects of Water Pollution

It is a well-known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has been observed that millions of people worldwide are deprived of this.

Freshwater resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation. The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluent, and run-off from agricultural fields. Industrial growth, urbanization and the increasing use of synthetic organic substances have serious and adverse impacts on fresbwater bodies. It is a generally accepted fact that the developed countries suffer from problems of chemical discharge into the water sources mainly groundwater, while developing countries face problems of agricultural run-off in water sources. Polluted water like chemicals in drinking water causes problem to health and leads to water-borne diseases which can be prevented by taking measures can be taken even at the household level.

As we know, water is a vital resource essential for sustaining life; therefore, its contamination has immediate as well as far reaching effects on the health and environment of living beings. The adverse effects of water pollution can be studied under the following heads:

(i) Physical effects.

(ii) Oxidation effects.

(iii) Toxic chemical effects.

(iv) Chemical nutrient effects.

(v) Micro-organism effects.

(vi) Radionuclide effects.

Physical Effects. These will be due to:

- **Suspended solids particles:** Solids may be inert material wastes or insoluble finely divided organic solids. Inert material in water may slowly accumulate on vegetation foliage, and produce a deposit on the river bed. These may also cause reduction in solar energy absorption thereby decreasing rate of photosynthesis causing low oxygen conditions on the river bed. Suspended materials may also cause turbidity which reduces light penetration, reduces plant synthesis and restricts plant growth. Finely divided organic solids will be biodegraded and will cause reduction of the dissolved

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oxygen in water. All these physical effects will cause a disturbance of the balanced ecosystem.

- **Cooling water from power stations:** Cooling water from power stations can cause a rise in water temperature and bring about thermal pollution. Increased temperature will cause decrease in fresh water fauna population and increase in flora population. At higher temperatures blue green algae and sewage fungus will grow more which will result in plant death. The oxygen saturation percentage will be reduced and biodegradation will be increased. Both these factors will cause oxygen deficiency in water.
- **Oily surface of films:** Waste oil, fats and grease can enter water from several sources. These will form a thin film on the water surface which prevents the exchange of oxygen with the atmosphere causing reduction of water oxygen saturation. Spillage from oil tankers in sea will cause marine pollution and shore contamination. Oil slicks are responsible for the death of many birds.

Oxidation Effects by (Oxygen demanding waste): Organic and inorganic wastes which reaches water bodies decreases the dissolved Oxygen (DO) content of water.. (DO is the amount of oxygen dissolved in a given quantity of water at a particular temperature and pressure.). There are two types of oxidation reaction in which DO is used.

- **Oxidation of organic pollutants by the action of bacteria:** Organic matter which reaches water bodies is decomposed by microorganisms present in water. For this they need oxygen dissolved in water and it will cause increase in Biological Oxygen Demand (BOD) resulting in deficiency of oxygen in water. Low DO may be harmful to animals especially fishes. Oxygen depletion helps in release of phosphates from bottom sediments and causes eutrophication.
- **Chemical oxidation of other pollutants:** Oxidation of various toxic pollutants also result in decrease in the level of DO content of water.In chemical oxidation ferrous salts are converted into ferric salts which are deposited as rusty red gelatinous masses associated with filamentous bacteria which are toxic to biological life.

Toxic Chemical Effects: Chemicals in water can be both naturally occurring and introduced by human interference and can have serious health effects. Heavy metals. come from mining waste and tailings, landfills, or hazardous waste dumps.

- **Fluoride.** Fluoride in the water is essential for protection against dental caries and weakening of the bones, but higher levels can have an adverse effect on health. It can cause defects in teeth and bones, a disease called flourosis. In India, high fluoride content is found naturally in the waters in Rajasthan.

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- **Nitrates:** Nitrate present in water are harmful to human health. From nitrogen fertilizers, nitrate ions seep into water bodies from where these may bioaccumulate in the bodies of consumers. In the stomach nitrate is reduced to nitrite and is responsible for blue baby syndrome and stomach cancer.
- **Lead.** Pipes, fittings, solder, and the service connections of some household plumbing systems contain lead that contaminates the drinking water source. Lead poisoning affects kidneys , reproductive system, liver, brain and central nervous system. It also causes anemia and mental retardation in children.
- **Mercury:** Mercury dumped into water is transformed into water soluble methyl mercury by bacterial action, which is consumed by fish is the cause of minamata disease .
- **Cadmium:** Pollution by cadmium causes itai-itai disease which is caused by contaminated rice. In this disease bones, liver, kidney, lungs, pancreas and thyroid are affected.
- **Chlorinated solvents:** Metal and plastic effluents, fabric cleaning, electronic and aircraft manufacturing are often discharged and contaminate groundwater.
- **Pesticides:** Pesticides pollution is due to leachates from agricultural and horticultural land and from food processing plants. Pesticides through drinking water reach humans and are known to cause various health problems. They affects central nervous system, stimulate liver enzymes which results in rapid metabolism of drugs in the person who is on medication. The effectiveness of medicines will be reduced.DDT, one of the so many pesticides, produces harmful effect over the body
- **Acids and alkalis** may change the pH value of water from its neutral value of pH 7. Most animals and plants can grow between a pH value of 5 and 9. Changes in pH value may affect physiological processes and actions of toxins
- **Polychlorinated biphenyls (PCB)** are by-products of the plastic, lubricant, rubber and paper producing industries. They are stable, insoluble in water, and soluble in oils. These substances are harmful to fishes, predatory birds, marine and shore birds.
- **Cyanides** are very toxic to all biological life, and probably prevent enzyme action and immobilize the nervous system in animals and

Chemical Nutrient Effects: Domestic waste water, agricultural run-off, and industrial effluents contain phosphorus and nitrogen, fertilizer run-off, manure from livestock operations, which increase the level of nutrients in water bodies and can cause **eutrophication** in the lakes and rivers and continue on to the coastal areas. The nitrates come mainly from the fertilizer that is added to the fields .Chemical nutrients are required by -plants and animals for maintaining their growth and metabolism.

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Nitrates and phosphates occur in water in small quantities. These are sufficient to maintain balanced biological growth. The nutrient levels slowly rise as a result of the bio-degradation of dead organic material. This rise in nutrients is called ageing or eutrophication .

Micro-organism Effects: Wastes that are discharged into water contain pathogenic organisms that are capable of transmitting human diseases. Bacteria are responsible for cholera, typhoid fever, bacillary dysentery, gastroenteritis. Virus may cause poliomyelitis, infective hepatitis. Round worm, beef and pork, tape worms may also cause diseases.

Radio-Nuclide Effects: The increasing development of nuclear energy is producing more radioactive wastes to be disposed of into the environment, and it contains various radionuclides with long half lives. The nuclear waste into the atmosphere may enter water by a settling process by rains. Solid waste (nuclear) filled in containers is dumped into sea bed. The corrosive action of sea water may cause leakage of radioactive waste in water and it may pose health hazards. Radionuclides can enter the human body through dusts and aerosols and can also be absorbed by plants and animals.

In brief, water pollution can lead to spread of epidemics like cholera, jaundice, dysentery, typhoid, etc.; can cause nervous disorder due to the presence of metals like mercury, lead, copper etc. discharged from industrial effluents ; can affect biological processes of humans and animals if they consume water contaminated by the release of dyes, etc; and, last but not the least, increased water treatment costs.

Remedial measures for the control of water pollution are suggested:

(i) No intermixing of solid waste or effluent in water source should be done

(ii) Domestic and industrial waste waters should be disposed of (in water bodies or on land) after treatment to the required level/degree.

(iii) Treatment plant for domestic sewage should be designed in such a manner that efficient to be discharged in river may be utilized for irrigation purposes.

(iv) Extensive afforestation can help in minimizing non-point sources of pollution.

(v) Sources of water, for example, ponds, rivers, lakes etc. should be protected by providing enclosures or other suitable methods for the prevention of waste entry.

(vi) Bathing, washing, etc. should be prohibited in the vicinity of sources. Pollution caused by animals should also be prevented.

(vii) Treated effluents from industries should be discharged into water sources. It will be better to treat the effluent from each component of an industry separately.

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(viii) Excess use of fertilizers, pesticides, insecticides should be discouraged.

(ix) Ponds, lakes etc. should be regularly cleaned of aquatic weeds and plants.

(x) Special type of fish breeding which live on mosquito eggs, bacteria, aquatic weeds should be encouraged.

(xi) Public awareness regarding water pollution should be created.

(xii) Legislative controls should be more punitive.

4.4 SOIL POLLUTION

The area of earth which is capable of supporting life is represented by a thin mantle and there is a very complex relationship between this land and the other components of the environment. Man and other animals exhaust the resources of a given area and so natural forces cannot maintain the balance between the material consumed and returned to the soil.

Soil pollution was originally defined as the "contamination of the soil system by considerable quantities of chemical or other substances, resulting in the reduction of its fertility (or productivity) with respect to the qualitative and quantitative yield of the crops". However, if some of the contaminants are such that if they are taken up by the plants (with or without any detrimental effects on the plants), and enter into the food chain and impart detrimental/toxic effect on the consumers *(i.e.* animals and human beings), then that should also be treated as soil pollution.

Soil Pollutants

Natural and synthetic materials that can adversely affect the physical, chemical and biological properties of soil and seriously affect its productivity are called soil pollutants and this phenomenon is called soil pollution. The problem of soil pollution differs from air and water pollution in the respect that the pollutants remain in direct contact with the soil for relatively longer periods. The widespread industrialization and increasing consumption have changed the very complexion of soil. Thus the soil is getting heavily polluted day by day by toxic material and dangerous micro organisms which enter the air, water and food chain. For all this, man is the original and basic pollutant responsible for pollution hazards and toxic effects .

The soil gets polluted by the following ways:

1. By Agricultural Practices. Agro chemicals are common pollutants of soil as well as water pollution. Agro-chemicals such as fertilizers, pesticides, insecticides and weedicides cause soil pollution. DDT, BHC, etc. and chemicals like lead, mercury, arsenic, etc. accumulate in the soil permanently.

   Soil pollution resulting from excessive use of insecticides, herbicides and fertilizers adversely affect the physical, chemical and biological properties of soil.

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2. By Radioactive Materials. Radioactive substances resulting from explosion of nuclear devices also penetrate the soil and enter into food chain. The presence of radioactive substances causes many harmful effects in body tissues. Radioactive radiations also bring about changes through mutation and can cause death of organisms. Hiroshima and Nagasaki, which were bombarded in 2nd World War, are good examples of radioactive soil pollution.

3. By Biological Agents. Other important pollutants are the biological agents including various biological organisms from human and animal excreta. In addition to excreta, faulty sanitation, waste water disposed etc. includes land as well as soil pollution. These also spread various diseases.

Household refuse. Industrial water. Agricultural wastes are tipped on land. By these many chemicals undecided substances enter into surface and get mixed with ground water. These chemicals are harmful for living beings and affect plant and animals' growth.

Sources of Soil Pollution

Soil pollution mainly results from the following sources:

1. Industrial wastes
2. Urban wastes
3. Radioactive pollutants
4. Agricultural practices
5. Chemical and metallic pollutants
6. Biological agents.

1. By Industrial wastes.

Disposal of industrial waste is the major reason for soil pollution. These industrial pollutants are mainly discharged from pulp and paper mills, chemical industries, oil refineries, sugar factories, tanneries, textiles, steel industries, distilleries, coal and mineral mining industries, drugs, glass, cement, petroleum industries etc. Thermal, atomic and electric power plants are also the villain to add pollutants to the soil.

Fly ash, many industrial effluents are either discharged into streams or dumped into the surrounding land. Industrial wastes mainly consist of organic compounds along with inorganic complexes and non- biodegradable materials. The pollutants affect and alter the chemical and biological properties of soil.

2. By urban wastes.

Urban wastes comprise both commercial and domestic wastes consisting of dried sludge of sewage. All the urban solid wastes are commonly referred to as refuse.

Solid wastes and refuse contribute to soil pollution. This refuse contains garbage and rubbish materials like plastics, glasses, metallic cans, fibers, paper, rubbles, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products.

Pollution concentration in urban areas and unplanned industrial progress has to a greater extent contributed to soil pollution problems.

3. Radioactive pollutants.

Radioactive substances resulting from explosions of nuclear devices, atmospheric fall out from nuclear dust and radioactive wastes penetrate the soil and accumulate there creating soil pollution. Radioactive substances Radium, Thorium, Uranium, Carbon (C-14) are very common in soil, rock, water and air.

The product of nuclear fission, rain water (Sr-90, Cs-137) .to be deposited on the soil emit gamma radiation. Recently it has been indicated that some pknts such as lichen and mushroom can accumulate Cs-137 and other radic nuclides which concentrate in grazing animals.

4. Agricultural Practices.

Agricultural practices pollute the soil to a large extent. Advanced Agro-technology, huge quantities of fertilizers, pesticides, herbicides, weedicides and soil conditioning agents are employed to increase the crop yield. Many agricultural lands have now excessive amounts of plants and animals wastes which are posing soil pollution problems. Farm wastes, manure slurry, debris, soil erosion containing mostly inorganic chemicals are responsible for soil pollution. Some of the agents responsible *tor* this pollution are as follows :

- **Fertilizers.** Fertilizers are the chemical compounds that contain one or more of the plant nutrients *i.e.,* nitrogen, phosphorous and potassiurn. Excessive use of fertilizers makes soil pollutate. Fertilizers are retained by the soil and crop efficiently but there are some possibilities for the nitrates to be washed out due to negligence and appliances ir. applying fertilizers to arable lands. These nitrates cause several undesirable effects on the water quality of low land lakes or rivers creating numerous health hazards.
- **Pesticides.** By growing population density it is necessary to increase food production. Due to this it led to manipulation of land resources. Different kinds of pesticides used to control pests are causing a stress in the natural environment. With the increasing use of pesticide; it is observed that pesticide residues coexist within biological system with other forms of life.
- **Soil conditioners and other chemical agents.** In addition to the fertilizers, pesticides and biocides, soil conditioners and fumigants are also employed to the land system to increase and protect the

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soil fertility, to kill the hazardous insects. These chemical agents are reported to cause alterations in both agricultural and horticultural soil areas. They contain several toxic metals such as Pb, As, Cd, Hg, Co etc. which when applied to a land will accumulate on the soil permanently thereby introducing these chemical components into growing crops.

5. Chemical and metallic pollutants.

A number of industries including textiles, dyes, soap and synthetic detergents, drugs, cement, rubber, paper and pulp etc. and metal industries pour their hazardous effluents in soil and water creating disastrous effects on living organisms. Synthetic chemicals and fertilizers are a source of trace metals which are added to the soil either deliberately or as an impurity. In many soils 50 to 100% of soil carbon is found complexed with clay containg organic and inorganic components which affect the soil texture, its fertility and stabilization of soil organic matter.

6. Biological Agents.

Soil gets large quantities of human, animals and birds excreta which constitute the major source of land pollution by biological agents. Digested sewage sludge as well as heavy application of manures to soil without periodic leaching could cause chronic salt hazard to plants within a few years. Sludges to have faults as they contain enough live viruses and viable intestinal worms. The pathogenic organisms that pollute the soil may be classified into three major categories:

- **Pathogenic organisms occurring naturally in contaminated soil.** Bacteria algae, protozons nematodes etc. These organisms are important agents in increasing or decreasing the soil fertility, in altering the physical texture of the soil and in attacking roots of plants.
- **Pathogenic Organisms Excreted by Man.** Human excreta includes pathogens such as enteric bacteria and parasitic worm such as *Tenia* solium. These organisms are transmitted to the man by the consumption of vegetables or fruits.
- **Pathogenic Organisms Excreted by Animals.** This category includes pathogenic bacteria and worms excreted by animals like earth-worms, millipedes, dipterous larvae, snails including higher animals carry fungal and bacteria spores. The disease producing organisms are transmitted from animals to soil and then from soil to man.

To control soil pollution from these sources, municipal and industrial waste waters have to be properly collected, treated and posed-of scientifically in water bodies or on lands. Proper care must be taken in treating heavy metal and other toxic waste materials.

Effects of Soil Pollution

The environment has deteriorated owing to industrial stress, urbanization, population density and numerous other villains which make the earth as a paradise for infectious agents. Such chronically accumulated environment contaminates our air, water, foodand soil etc. thereby severely affecting the health. Nearly 80% of the diseases particularly in developing world can be linked with soil and water. About 90% of the pollution load in river system is due to faecal matter. The soil is highly polluted by several pathogenic organisms and hazardous industrial effluents. Soil pollution is the result of urban-technological revolution and speedy exploitation of every bit of natural resources.

(i) Industrial Wastes consist of a variety of chemicals which are extremely toxic to living being. Different industries release different harmful toxins. These toxins enter in the food chain causing a number of undesirable effects.

(ii) Industrial effluents when discharged through sewage system will poison the biological purification mechanism of sewage treatment causing several soil and water-borne diseases.

(iii) Metallic contaminants (Hg, Zn, Cd, etc.) destroy bacteria and beneficial micro organisms in the soil.

(iv) The wastes including building materials, sludge, dead animal skeletons, and thrown away garbage pile up at public places and cause obstruction in daily life.

(v) Sewage is the good medium for the growth of pathogenic bacteria, viruses etc. Vibrio cholera found in sewage causes cholera.

(vi) Solid wastes result in offensive odour and cause clogging of ground water filters. Suspended matter in sewage can blanket : the soil, thereby interfering with fhe soil moisture.

(vii) Radioactive pollutants can produce great human misery when food containing radionuclides is taken by man, some of them concentrate in specific body organs and cause undesirable diseases.

(viii) Radiation actually affects the soil and soil fertility. These radiations kill plant species.

(ix) A recent report indicates that a large number of induced radio nuclides as carbon-14, Fe-55, Mn-54, Co-57 etc. get concentrated in biological systems.

(x) Potassium fertilizers in soil are reported to decrease the valuable nutrient ascorbic acid (vitamin C) and carotene in vegetables and fruits.

(xi) Excessive use of nitrogenous fertilizers in land leads to accumulation of nitrate in the soil. This excess accumulation can cause diarrhea and cyanosis in children.

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(xii) Phosphate fertilizer is considered detrimental to crop production.

(xiii) Cereal crops like jawar, maize etc. grown on alkaline soil absorb higher amounts of fluorides and are responsible for the spread of fluorosis.

(xiv) Pesticides retained in soil concentrates in crop, vegetables etc. which taint them to such an extent that they are not usable.

(xv) Pesticides like DDT, Andrin etc. are known to percolate gradually through soil into ground water and contaminate drinking water supplies.

A Methods to Minimize Soil Pollution

The problem of soil pollution can be minimized to some extent by adopting the following techniques :

(i) Separate garbage bins can be used to collect different varieties of wastes for recycling purposes.

(ii) Paper should not be mixed with glass or plastic which are difficult to recycle.

(iii) Encouraging the people by ways of subsiding the waste.

(iv) Tax-exemptions are also beneficial to enhance recycling of wastes.

(v) Making use of recycled paper instead of fresh ones. For example, local administrative offices in Japan use recycled paper to initiate reuse of waste.

(vi) By reducing the creation of waste recovering, recycling and reusing potential wastes, the amounts of waste can be reduced effectively.

4.5 MARINE POLLUTION

Marine pollution has been going on unnoticed for a long time by discharge of domestic sewage, agricultural wastes and industrial effluents into the rivers which end up in the seas. Besides these, washing of cargo tanks in the open sea, discharge of oils and petroleum products, waste disposal and dumping of radionuclides waste into sea also cause marine pollution. However, in marine water the most serious pollutant is oil.

Causes

- Accidental and deliberate discharge of crude oil into the ocean by cargo ships is regarded as one of the prime causes of pollution of the water body.
- Dumping of industrial wastes into ocean is another reason for marine pollution. The wastes often contain toxic materials such as mercury, dioxin, PCBs, PAHs and radioactive materials, which contaminate the water of ocean.
- Deposition of sediments from mining leads to ocean pollution.

- Trash washed into the ocean after heavy rain or floods gives rise to marine debris, which pollutes the water body.
- Dumping of human wastes, plastic and disposal of untreated or partially treated sewage water into the ocean is called 'garbage dumping'. This is one of the leading causes of marine pollution.
- Carbon dioxide, emitted by automobiles, due to the burning of fossil fuels, leads to air pollution. The contaminated air containing carbon dioxide reaches the ocean in the form of acid rain, thereby polluting the water.

Effects

- Oil spilling is hazardous for the marine life. It seriously affects the life cycle of coral reefs thriving in the ocean. The oil spilled in the ocean could clog up the gills of fishes, thereby preventing respiration. It affects the process of photosynthesis of marine plants, since it blocks the sunlight.
- Toxic wastes have direct effect on marine life and affect the human beings indirectly. When the harmful toxic wastes are dumped into the ocean, the fishes could consume the poisonous chemicals. When the fish is eaten by humans, this could lead to food poisoning.
- Dumping of garbage into ocean can deplete the oxygen dissolved in water. As a result, the health of marine life is affected seriously. Due to lack of oxygen, the sea animals including whales, seals, herrings, dolphins, penguins and sharks could perish.
- Carbon dioxide is hazardous for marine life including coral reefs and free-swimming algae.
- Plastics dumped into ocean can affect the marine life seriously. Plastic items such as bottles and bags could choke and suffocate the sea animals, as they eat them thinking that they are food. Plastics are known to be a major cause for the death of turtles, as they swallow the floating bags, mistaking them for jelly fish.

4.6 NOISE POLLUTION

It is excessive, displeasing human, animal or machine-created environmental noise that disrupts the activity or balance of human or animal life. The word noise comes from the Latin word nauseas, meaning seasickness. It has been defined as unwanted sound, a potential hazard to health and communication dumped into the environment with regard to the adverse effect it may have on unwilling ears. Noise is defined as unwanted sound. Sound, which pleases the listeners, is music and that which causes pain and annoyance is noise. At times, what is music for some can be noise for others.

In simple terms, noise is unwanted sound. Sound is a form of energy which is emitted by a vibrating body and on reaching the ear causes the sensation of hearing

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through nerves. Sounds produced by all vibrating bodies are not audible. The frequency limits of audibility are from 20 HZ to 20,000 HZ.

Sound is produced by the vibrations of an object or mechanism and transmitted in the form of waves—alternating increase and decrease in pressures. It radiates outward through a material medium of molecules, more or less like the ripples spreading out on water surface when some heavy object (say stone) has been thrown into it. The speed of sound varies according to the nature of the carrier media. When we speak of speed of sound, we ordinarily mean the speed at which sound travels in air at sea level. This is around 331 m/s. In water, sound travels about 5 times faster than in air. In iron and steel it is even faster, about 3 times faster than the speed in water.

Unlike all other pollution causing components of environment (such as waste water, contaminated air, and solid waste), sound/noise is not an element, compound or substance which can accumulate and harm future generations. It is a special kind of wave-action usually transmitted by air, in the form of pressure waves and received by the hearing apparatus (ear) in the body of human beings and animals.

Unit of Measurement

A decibel is the standard for the measurement of noise. The zero on a decibel scale is at the threshold of hearing, the lowest sound pressure that can be heard, on the scale acc. To smith, 20 db is whisper, 40 db the noise in a quiet office 60 db is normal conversation, 80 db is the level at which sound becomes physically painful.

The Noise quantum of some of the cities in our country indicate their pitch in decibel in the nosiest areas of corresponding cities, e.g. Delhi- 80 db, Kolkata - 87,Bombay-85, Chennai-89 db etc.

Two properties of sound are important, namely the pitch or frequency, and intensity or pressure or energy. The pitch or frequency refers to the rate of vibration of the sound, and is measured in Hertz (Hz) units. The frequency of sound is determined by the number of times the vibrating waves undulate per second. The slower the cycle, the lower the pitch or frequency. The pitch becomes higher as the cycles increase in number.

Decibel (dB) is used in environmental noise pollution as a measure of sound power level, sound intensity level, and sound pressure level. It should be noted that, in each case the term 'level' is synonymous with the decibel. A decibel (one-tenth of a bel) is a physical unit based on the weakest sound that can be detected by the human ear. It is named after Alexander Graham Bell, the inventor of the telephone.

Measurement of Noise

Noise is measured by means of a sound level meter.. The sound level meter is positioned in a desired location, with no obstruction from the sound source, and then reading is' taken. Whenever possible, the sound level meter should be mounted on a tripod and the operator should be at least 0.5 m away from the nearest edge of the level meter. The outdoor measurements are made 1.2 to 1.5 m above the

ground and at least 3.5 m away from the reflecting surfaces such as buildings. Indoor sound measurements should be made at least 1.2 to 1.5 m above the floor, at least 1.0 m from walls and 1.5 in from windows. Indoor measurements are normally made with windows closed. Measurements that deviate from these recommended distances should be specified accordingly.

Effects of Noise

Noise has always been with the human civilization but it was never so obvious, so intense, so varied & so pervasive as it is seen in the last of this century. Noise pollution makes men more irritable. The effect of noise pollution is multifaceted & inter related. The effects of Noise Pollution on Human Being, Animal and property are as follows:

- **It decreases the efficiency of a man**:-

  Regarding the impact of noise on human efficiency there are number of experiments which print out the fact that human efficiency increases with noise reduction.

- **Lack of concentration**:-

  For better quality of work there should be concentration , Noise causes lack of concentration. In big cities , mostly all the offices are on main road. The noise of traffic or the loud speakers of different types of horns divert the attention of the people working in offices.

- **Fatigue:-**

  Because of Noise Pollution, people cannot concentrate on their work. Thus they have to give their more time for completing the work and they feel tiring

- **Abortion is caused**: -

  There should be cool and calm atmosphere during the pregnancy. Unpleasant sounds make a lady of irriative nature. Sudden Noise causes abortion in females.

- **It causes Blood Pressure**: -

  Noise Pollution causes certain diseases in human. It attacks on the person's peace of mind. The noises are recognized as major contributing factors in accelerating the already existing tensions of modern living. These tensions result in certain disease like blood pressure or mental illness etc.

- **Temporary or permanent Deafness**:-

  The effect of nose on audition is well recognized. Mechanics , locomotive drivers, telephone operators etc. All have their hearing impairment as a result of noise at the place of work. Physicist, physicians & psychologists are of the view that continued exposure to noise level above. 80 to 100 db is unsafe, loud noise causes temporary or permanent deafness.

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- **Effect on vegetation:-**

  Now is well known to all that plants are similar to human being. They are also as sensitive as man. There should be cool & peaceful environment for their better growth. Noise pollution causes poor quality of crops in a pleasant atmosphere.

- **Effect on animal:-**

  Noise pollution damage the nervous system of animal. Animal looses the control of its mind. They become dangerous.

- **Effect on property:-**

  Loud noise is very dangerous to buildings, bridges and monuments. It creates waves which struck the walls and put the building in danger condition. It weakens the edifice of buildings.

Table: Degree of hearing loss and its effect

S. No	Average hearing loss, in dB	Effect
1.	0	Threshold of hearing
2.	< 25	No real difficulty in hearing
3.	25 to 40	Difficulty in hearing soft speech
4.	40 to 50	Difficulty in hearing normal speech
5.	> 50	Hearing aid is required
6.	50 to 70	Difficulty in hearing loud speech
7.	70 to 90	Only shouted speech is understood
8.	> 90	Unable to hear even amplified speech

Sources/Causes of Noise

The sources of noise are more in urban and industrial areas, than in rural areas. The sources, in general, may be

- **Stationary sources** include industries; use of loudspeakers on various occasions like festivals, elections, worships in temples, mosques, etc., and during advertisements; mining operations; use of bulldozers, drillers and dynamites to break rocks; household gadgets like vacuum cleaner, TV, radio, stereo, grinder, mixer, etc.; common vegetable and fish markets; etc.
- **Mobile sources** include road traffic, railway traffic, air traffic, navigation, etc.

For a better understanding of the subject, the sources of noise can be classified in following categories:

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1. Transportation/Traffic Noise

This can be further sub-divided into three categories, viz. Road traffic noise. Aircraft noise and Rail traffic noise.

(a) Road Traffic or Highway Noise.

The noise generated from highway traffic is one of the major sources of noise pollution. Highway noises are of two types, viz., noises generated by individual vehicles, and noises generated by a continuous flow of vehicles of all types. The noises from individual vehicles include noise from engine and transmission, exhaust noise, noise due to slamming of car doors, and use of horn. Traffic speed is, however, one of the major causes of noise.

(b) Aircraft Noise.

This source of noise pollution has been increasing steadily during recent years, especially close to international airports, and has now become a very serious problem. Aircraft noise differs from road traffic noise in the sense that it is not continuous but intermittent. Noise made by jet planes is intrinsically more disturbing than that of propeller-driven aircraft because it is of far higher pitch. Noise is at a maximum during take-off and landing. Aircraft fly close to the ground for quite some distance during the landing, and this noise often constitutes a more sustained environmental nuisance than the intense noise of shorter duration produced during take-off. Major cities around the world have banned or reduced flights at night; and also prescribed noise limits. Noise limits prescribed by London Heathrow Airport for take-offs are 110 PN dB during day and 102 PN dB during night [PN dB stands for 'Perceived Noise Level', 1 PN dB = dB (A) scale +13].

(c) Rail Traffic Noise.

Noise from rail traffic is not a serious nuisance as compared to the road traffic and airport noise. The noise produced is, generally of lower frequency than that of road vehicles; and further, most railway tracks run through rural areas. The impact of noise pollution by trains is felt maximum in buildings located beside railway tracks. The introduction of electric locomotives has helped greatly in the reduction of rail traffic noise.

2. Industrial Noise

In industries, noise is the byproduct of energy conversion. The major sources of noise in an industrial plant may include electromechanical machines (like motors, generators, etc.), impact machines (like punching, stamping, hammers, etc.), combustion processes (furnaces), fluid motion (compressors, fans, etc.), and unbalanced or improperly fitted mechanical parts (like shafts, gears, etc.). For most of the industrial plants, the noise problem is limited to indoors. Textile mills, foundries, machine tool and automobile industries, fertilizer plants and many other industries where heavy machines are working at high speed have very high noise pollution, which requires urgent attention as millions of industrial workers are victims of industrial noise.

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3. Noise from Construction Works

Noise from construction sites is generally far worse than the noise originating from factories. There are two reasons for this—one is that construction (of roads, bridges, buildings, dams, etc.) may become necessary anywhere, and the other reason is that construction equipments are inherently noisy (see Table).

S. No.	Construction equipment	Typical sound level [dB (A) at 15 m]
1.	Pile driver	101
2.	Rock drill	98
3.	Paver	89
4.	Scrapper	88
5.	Jack hammer	88
6.	Dump truck	88
7.	Dozer	87
8.	Concrete mixer	85
9.	Pneumatic tools	85
10.	Backhoe	85
11.	Concrete breaker	85
12.	Hand held free saw	82
13.	Air compressor	81
14.	Generator	76
15.	Pump	76

Table. Typical sound levels of major construction equipment

4. Other sources of Noise

It includes a variety of noise sources which disturb and annoy general public. The most prominent are:

- **Celebrations:** The indiscriminate use of loudspeakers in public functions, entertainments, festivals, elections, etc.
- **Home appliances:** These sources include vacuum cleaners, TV, and radio sets, washing machines, etc.
- **Crackers:** Burning of crackers during Diwali or marriages also cause noise pollution. During Diwali the fire crackers are allowed between 6.00 p.m and 10.00 p. m. No firework between 10.00 p. m and 6.00 p. m.

The techniques employed for noise control can be broadly classified as

- Control at source
- Control in the transmission path
- Using protective equipment.

Noise Control at Source: The noise pollution can be controlled at the source of generation itself by employing techniques like-

- Reducing the noise levels from domestic sectors: The domestic noise coming from radio, tape recorders, television sets, mixers, washing machines, cooking operations can be minimised by their selective and judicious operation. By

usage of carpets or any absorbing material, the noise generated from felling of items in house can be minimised.

- Maintenance of automobiles: Regular servicing and tuning of vehicles will reduce the noise levels. Fixing of silencers to automobiles, two wheelers etc., will reduce the noise levels.
- Control over vibrations: The vibrations of materials may be controlled using proper foundations, rubber padding etc. to reduce the noise levels caused by vibrations.
- Low voice speaking: Speaking at low voices enough for communication reduces the excess noise levels.
- Prohibition on usage of loud speakers: By not permitting the usage of loudspeakers in the habitant zones except for important meetings / functions. Now-a-days, the urban Administration of the metro cities in India, is becoming stringent on usage of loudspeakers.
- Selection of machinery: Optimum selection of machinery tools or equipment reduces excess noise levels. For example selection of chairs, or selection of certain machinery/equipment which generate less noise (Sound) due to its superior technology etc. is also an important factor in noise minimisation strategy.
- Maintenance of machines: Proper lubrication and maintenance of machines, vehicles etc. will reduce noise levels. For example, it is a common experience that, many parts of a vehicle will become loose while on a rugged path of journey. If these loose parts are not properly fitted, they will generate noise and cause annoyance to the driver/passenger. Similarly is the case of machines. Proper handling and regular maintenance is essential not only for noise control but also to improve the life of machine

Control in the transmission path

The change in the transmission path will increase the length of travel for the wave and get absorbed/refracted/radiated in the surrounding environment. The available techniques are briefly discussed below.

- **Installation of barriers:** Installation of barriers between noise source and receiver can attenuate the noise levels. For a barrier to be effective, its lateral width should extend beyond the line-of-sight at least as much as the height.
- **Design of building:** The design of the building incorporating the use of suitable noise absorbing material for wall/door/window/ceiling will reduce the noise levels.
- **Green belt development:** Green belt development can attenuate the sound levels. The degree of attenuation varies with species of greenbelt.

Using protection equipment

Protective equipment usage is the ultimate step in noise control technology, i.e. after noise reduction at source and/or after the diversion or engineered control

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of transmission path of noise. The usage of protective equipment and the worker's exposure to the high noise levels can be minimized by -

- **Job rotation:** By rotating the job between the workers working at a particular noise source or isolating a person, the adverse impacts can be reduced.
- **Exposure reduction:** Regulations prescribe that, noise level of 90 dB (A) for more than 8 hr continuous exposure is prohibited. Persons who are working under such conditions will be exposed to occupational health hazards. The schedule of the workers should be planned in such a way that, they should not be over exposed to the high noise levels.
- **Hearing protection:** Equipment like earmuffs, ear plugs etc. are the commonly used devices for hearing protection. Attenuation provided by earmuffs vary widely in respect to their size, shape, seal material etc. Literature survey shows that, an average noise attenuation up to 32 dB can be achieved using earmuffs

Ambient Air Quality Standards in Respect of Noise

The ambient air quality standards in respect of noise are given in Table

Table. Ambient Air Quality Standards of Noise

Area code	Category of area	Limits in dB (A) Leq.	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

Note:

(1) Day time is reckoned between 6 A.M. and 9 P.M.

(2) Night time is reckoned between 9 P.M. and 6 A.M.

(3) Silence zone is defined as areas upto 100 m around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.

(4) Mixed categories of areas should be declared as one of the four above-mentioned categories by the competent authority, and the corresponding standards shall apply.

4.7 THERMAL POLLUTION

Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence. A common cause of thermal pollution is the use of water

as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment at a higher temperature the change in temperature impacts organisms by (a) decreasing oxygen supply, and (b) affecting ecosystem composition. Urban runoff—storm water discharged to surface waters from roads and parking lots—can also be a source of elevated water temperatures.

Thermal pollution is also commonly known as heat pollution and occurs when heat released into water or air produces undesirable effects. Thermal pollution can be a sudden, acute event or a long-term, chronic process. Sudden heat releases usually occur due to natural events, *i.e.,* forest fires and volcanoes, or due to human-induced events, *i.e.,* fire storms.

Causes or Sources of Thermal Pollution

The various causes for thermal pollution are as follows:

(1) **Nuclear Power Plants** : Nuclear power plants including drainage from hospitals, research institutes, nuclear experiments and explosions, emit a large amount of unutilized heat and traces of toxic radionuclear into nearby water streams. Emissions from nuclear reactors and processing installations are also responsible for increasing temperature of water bodies.

(2) **Coal-fired Power Plants**: Some thermal power plants use coal as fuel. Coal-fired power plants constitute the major source of the thermal pollution.

(3) **Industrial Effluents**: Industries generating electricity, like coal powered and nuclear powered plants, require large amount of cooling water for heat removal. Other industries like textile, paper, pulp and sugar industry also release heat in water, but to a lesser extent.

(4) **Domestic Sewage** ; Domestic sewage is casually 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 DO content decreases and the demand of oxygen increases. And, hence the anerobic conditions will set up resulting in the release of foul and offensive gases in water.

(5) **Hydro-Electnc Power** : Generation of hydro-electric power also, sometimes results in negative thermal loading of water systems. Industries other than electric power industries, with cooling requirements, also contribute to the thermal pollution.

Effects of Thermal Pollution

Every species has an optimal temperature and a range of temperature within which it can survive. For some species this range is very small and slightest change in water temperature can be a problem for them. When the water temperature rises more than 1.5°C above the normal, the lake fish move away; while river fish can withstand a rise in temperature up to 3°C.

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The release of large amounts of heated water into the river or pond or lake changes the average water temperature. The change in temperature impacts organisms by :

(a) Decreasing oxygen supply,

(b) Affecting ecosystem composition

(c) Fish spawning cycles may be disturbed;

(d) The fish may be highly susceptible to the diseases. If warmer water causes physical stress in fish, they may be easier for the predators to catch, and, also can change the type and availability of food for fish at various times of the year.

Management of Thermal Pollution

The control of thermal pollution is necessary, as its detrimental effects on aquatic ecosystem may be *worse*, in future. There are several solutions to thronic thermal discharge into water bodies. Some of the viable solutions are as follows :

(1) **Cooling Towers.**

The use of water from water source for cooling purpose, with subsequent return to the water body after passing through the condenser is termed as cooling process. To make the cooling process more effective, cooling towers are designed to control the temperature of Witter. Cooling towers, in fact, are used to dissipate the recovered waste tieat so as to eliminate the problems of thermal pollution.

(2) **Cooling Ponds.**

Cooling ponds/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. It is the simplest and cheapest method which cools the water to a considerable low temperature. But the technique alone is less desirable and inefficient in termsof air-water contact.

(3) **Artificial Lake.**

Artificial lakes are man-made bodies of water which offer possible alternative to once-through cooling. The heating effluents can be discharged into the lake at one end and the water for cooling purpose may be withdrawn from the other end. The heat is eventually dissipated through evaporation. So 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 maximizing the benefits. Some of the potential physical application's of power plant rejected heat are—industrial and space heating; and biological applications such as soil warming, fish culture, livestock shelters, and heating greenhouses. But most of these potential physical applications are for colder regions/locations.

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4.8 NUCLEAR POLLUTION

One of the most important and dangerous type of pollution is nuclear pollution. Nuclear pollution is produced by nuclear explosion which are carried out for performing nuclear tests and which is used for making nuclear weapons. Due to this explosion about 15 to 20% of the radioactive particles enter into the stratosphere. Once they entered into the air they continue to fall on the earth after about every 6 month up to several years. Almost 5% of the radioactive material entered into the troposphere, which is the lowermost layer of the atmosphere.

Radioactive (nuclear) pollution is a special form of physical pollution related to all major life-supporting systems—air, water and soil. It is always convenient to discuss radioactive pollution separately because its nature of contamination is different from other types of pollution. Its effects are also of special kinds. Radioactivity is the phenomenon of emission of energy from radioactive isotopes *(i.e.* unstable isotopes), such as Carbon-14, Uranium-235, Uranium-238, Uranium-239, Radium-226, etc. The emission of energy from radioactive substances in the environment is often called as 'Radioactive Pollution'.

Sources

The sources of radioactivity are both natural and man-made. The natural sources include:

- Cosmic rays from outer space. The quantity depends on altitude and latitude, it is more at higher latitudes and high altitudes.
- Emissions from radioactive materials from the Earth's crust. People have been exposed to low levels of radiation from these natural sources for several millennia. But it is the man-made sources which are posing a threat to mankind. The man-made sources of radioactivity are nuclear wastes *(i.e.* waste material that contains radioactive nuclei) produced during the:
- Mining and processing of radioactive ores;
- Use of radioactive material in nuclear power plants;
- Use *of* radioactive isotopes in medical, industrial and research applications ; and
- use of radioactive materials in nuclear weapons.

The greatest exposure to human beings comes from the diagnostic use of X-rays, radioactive isotopes used as tracers and treatment of cancer and other ailments.

Effects

(i) Radiations may break chemical bonds, such as DNA in cells. This affects the genetic make-up and control mechanisms. The effects can be instantaneous, prolonged or delayed types. Even it could be carried to future generations.

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(ii) Exposure at low doses of radiations (100-250 rads), men do not die but begin to suffer from fatigue, nausea, vomiting and loss of hair. But recovery is possible.

(iii) Exposure at higher doses (400-500 rads), the bone marrow is affected, blood cells are reduced, natural resistance and fighting capacity against germs is reduced, blood fails to clot, and the irradiated person soon dies of infection and bleeding.

(iv) Higher irradiation doses (10,000 rads) kill the organisms by damaging the tissues of heart, brain etc.

(v) Workers handling radioactive wastes get slow but continuous irradiation and in course of time develop cancer of different types.

(vi) Through food chain also, radioactivity effects are experienced by man. But the most significant effect of radioactivity is that it causes long range effects, affecting the future of man and hence the future of our civilization.

Control

On one hand, the peaceful uses of radioactive materials are so wide and effective that modern civilization cannot go without them; on the other hand, there is no cure for radiation damage. Thus the only option against nuclear hazards is to check and prevent radioactive pollution. For this:

- leakages from nuclear reactors, careless handling, transport and use of radioactive fuels, fission products and radioactive isotopes have to be totally stopped.
- safety measures should be enforced strictly.
- waste disposal must be careful, efficient and effective.
- there should be regular monitoring and quantitative analysis through frequent sampling in the risk areas.
- preventive measures should be followed so that background radiation levels do not exceed the permissible limits.
- appropriate steps should be taken against occupational exposure.
- safety measures should be strengthened against nuclear accidents.

Precautions after the Disposal of Nuclear Waste

The careful, efficient and effective treatment/disposal of radioactive waste, just do not complete the task. A regular supervision of the disposal sites is must. The essential precautions, at the disposal sites, that have to be taken include:

(i) Monitoring radioactivity around the disposal sites.

(ii) Prevention of erosion of radioactive waste disposal sites.

(iii) Prevention of any drilling activity in and around the waste disposal site.

(iv) Periodic and long term monitoring of such disposal sites and areas of naturally occurring uranium rich rocks.

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4.9 SOLID WASTE MANAGEMENT

Higher standard of living of ever increasing population has resulted in an increase in the quantity and variety of waste generated. It is now realized that if waste generation continues indiscriminately then very soon it would be beyond rectification. Management of solid waste has therefore become very important in order to minimize the adverse effects of solid wastes.

Solid waste (waste other than liquid or gaseous) can be classified as

- Municipal,
- Industrial,
- Agricultural,
- Medical,
- Mining waste
- Sewage sludge.

Sources of Urban and Industrial wastes:

These wastes consists of medical waste from hospitals, municipal solid waste from homes, offices, markets (commercial waste) small cottage units, and horticulture waste from parks, gardens and orchards etc.The urban solid waste materials that can be degraded by microorganisms are called biodegradable wastes. For example these types of waste are vegetable wastes, stale food, tea leaves, egg shells, peanut shells, dry leaves etc.

Wastes that cannot be degraded by microorganisms are called non-biodegradable waste e.g. polyethylene bags, scrap metal, glass bottles etc.Recently Government of Maharshtra is the process of passing legislation on usage of polyethylene bags. Government had put a ban on use of these bags. Industrial waste consists of large number of materials including factory rubbish, packaging material, organic waste, acids etc. There are large quantities of hazardous and toxic materials are also produced during industrial processing.

Effects of solid wastes:

Municipal solid waste heap up on the roads due to improper disposal system. People clean their own houses and litter their immediate surroundings which affect the community including themselves. This type of dumping allows biodegradable materials to decompose under uncontrolled and unhygienic conditions. This produces foul smell and breeds various types of insects and infectious organisms besides spoiling the aesthetics of the site. Industrial solid wastes are sources of toxic

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metals and hazardous wastes, which may spread on land and can cause changes in physicochemical and biological characteristics thereby affecting productivity of soils. Toxic substances may leach or percolate to contaminate the ground water.

Management of solid waste:

For waste management we must focus on three 'Rs'- Reduce, Reuse and Recycle before destruction and safe storage of wastes.

1. Reduction in use of raw materials
2. Reuse of waste materials
3. Recycling of materials

For discarding wastes the following methods could be used:

1. Sanitary landfill
2. Composting
3. Incineration

4.10 ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

The role of every individual in preventing pollution is of paramount importance because if every individual contributes substantially the effect will be visible not only at the community, city, state or national level but also at the global level as environment has no boundaries. It is the responsibility of the human race which has occupied the commanding positions on this earth to protect the earth and provide conducive environment for itself an innumerable other species which evolved oh this earth. A small effort made by each individual at his own place will have pronounced effect at the global level. It is appropriately said "Think globally act locally."Each individual should change his or her lifestyle in such a way as to reduce environmental pollution.

The role of an individual in maintaining a pollution free, pure and congenial environment and in preserving its resources is actually the need of the hour. Individuals can, however, play an important role in abatement of air, water, soil or noise pollution in the following simple manners:

1. Help more in pollution prevention than pollution control
2. Use eco-friendly products
3. Cut down the use of CFCs (Chloroflaro Carbons) as they destroy the ozone layer. Do not use polystyrene cups that have CFC molecules in them which destroy ozone layer-Hon'ble Mr.Lalu prasad Yadav- Railway Minister has initiated use of earthen pots for tea serving in Railway which is a commendable decision in this regard.
4. Use the chemicals derived from peaches and plums to clean computer chips and circuit boards instead of CFCs.

5. Use CFC free Refrigerators.

The manufacture and operation of such devices should be encouraged that don't pollute. If they cost more than their higher prices may be offset by including environmental and the social costs of pollution in the price of such products which pollute environment. Air pollution can be prevented by using really clean fuel i.e. hydrogen fuel. Hydrogen for that matter should not be produced by passing current in water as for generation of this current; again the environment will be polluted. So solar hydrogen fuel is the need of the hour.

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Following are the practical hints for an individual to prevent pollution:

- Reduce your dependency on fossil fuel especially coal or oil.
- Save electricity by not washing it when not required because electricity saved electricity generated without polluting the environment.
- Adopt and popularize renewable energy sources.
- Improve energy efficiency. This will reduce the amount of waste energy.
- promote reuse and recycling whatever possible and reduce the production of wastes.
- use mass transport system. For short visits use bicycle or go on foot.
- Decrease the use of automobiles.
- Use pesticides only when absolutely necessary that too in right amounts.
- Use rechargeable batteries, it will reduce metal pollution.
- Use less hazardous chemicals wherever possible.
- The solid waste generated during one manufacturing process can be used as a raw material for some other processes.
- Do not put pesticides, paints, solvents, oils or other harmful chemicals into the drain or ground water.
- Use only the minimum and required quantity of water for various activities.
- When building a home save (don't cut) trees.
- Plant more trees as trees can absorb many toxic gases and can purify the air.
- Check population growth so that demand of materials is under controls.

4.11 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. Human societies have witnessed a large number of such natural hazards in different parts of the world and have tried to learn to control these processes to some extent.

Check Your Progress:

4. What are the sources of soil pollution?
5. what are main sources of noise pollution?
6. What are the types of solid waste?

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Major such disasters include a devastating earthquake which hit Bhuj Town in Gujarat caused massive damage, Earth-quake generated water waves called Tsunamis caused tremendous damage in Tamil nadu and Kerala.

'Disaster management can be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.

Types of disasters

There is no country that is immune from disaster, though vulnerability to disaster varies. There are four main types of disaster.

- **Natural disasters :** These disasters include floods, hurricanes, earthquakes and volcano eruptions that can have immediate impacts on human health, as well as secondary impacts causing further death and suffering from floods causing landslides, earthquakes resulting in fires, tsunamis causing widespread flooding and typhoons sinking ferries
- **Environmental emergencies :** These emergencies include technological or industrial accidents, usually involving hazardous material, and occur where these materials are produced, used or transported. Large forest fires are generally included in this definition because they tend to be caused by humans.
- **Complex emergencies :** These emergencies involve a break-down of authority, looting and attacks on strategic installations. Complex emergencies include conflict situations and war.
- **Pandemic emergencies :** These emergencies involve a sudden onset of a contagious disease that affects health but also disrupts services and businesses, bringing economic and social costs.

Any disaster can interrupt essential services, such as the provision of health care, electricity, water, sewage/garbage removal, transportation and communications. The interruption can seriously affect the health, social and economic networks of local communities and countries. Disasters have a major and long-lasting impact on people long after the immediate effect has been mitigated. Poorly planned relief activities can have a significant negative impact not only on the disaster victims but also on donors and relief agencies. So it is important that physical therapists join established programmes rather than attempting individual efforts.

There are several causes for such disasters which include:

1. Anthropogenic activities such as Impoundment of huge quantities of water in the lake behind a big dam e.g. Koyna Dam in Maharashtra have created few incidence of minor and major earthquakes., underground nuclear testing e.g.Pokharan II testing at desert of Rajasthan, Deep well disposal of liquid waste.

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2. Due to heavy rainfalls or sudden snow melt can swell the rivers disproportionately- causes a great economic loss and health related problems.

3. Landslides occur when coherent rock of soil masses move down slope due to gravitational pull. Water and vegetation influence landslides. Chemical action of water gradually causes chemical weathering of rocks making them prone to landslides.

SUMMARY

According to World Health Organization, air pollution is defined as, "substances put into air by the activity of mankind into concentration sufficient to cause harmful effect to his health, vegetables, property or to interfere with the enjoyment of his property."

Air pollutants are the substances which can cause undesirable changes in air .These substances may include gases, particulate matter, radioactive substances etc. Air pollutants may be classified according to origin, chemical composition and state of matter.

Primary air pollutants are those which are emitted directly to the atmosphere from the point source and found there in the form in which they are emitted. For example, particulates, carbon monoxide (CO), oxides of sulphur (SOx), oxides of nitrogen (N0x), hydrocarbons (HCs), radioactive compounds, particles of metal, pollen, bacteria, etc. The five main primary air pollutants (viz. particulates, CO, SOx, NOX and HCs) contribute more than 90% of global air pollution.

Secondary air pollutants are those which are produced in the air by the interaction among two or more primary air pollutants, or by reaction with normal atmospheric constituents, with or without photo activation. For example, ozone, peroxyacetyl nitrate (PAN), formaldehyde, formation of acid mists, smog (coal induced and photochemical smog), etc.

Particulate air pollutants include finely divided solids and liquids dispersed in gaseous media. Dust, smoke, fly ash, flumes, etc. are examples of solid particulates; while mist, spray, fog, etc., are liquid particulate air pollutants.

Gaseous air pollutants are organic gases like benzene, methane, butane, aldehydes, ketones, etc., as well as, inorganic gases like CO, CO2, SOx, NOx, O3, etc.

Air pollutants like Sox and NOx mix with rain water and form acid rain , which can cause high acidity in fresh water lakes. This affects aquatic life especially fish. Some of the fresh water lakes have experienced total fish death.

ANSWER TO CHECK YOUR PROGRESS

1. **Scrubbers or Wet Collectors.** Factory fumes not only contain dust (particulate matter), but toxic gases also. So it is necessary that as far as possible all toxic/harmful substances (particulates and gases are removed before the emission of smoke. Scrubbers are devices which utilize water or any other specific liquid to assist in the removal particulates as well as gases by absorption and/or adsorption. The simplest type of gas scrubber is spray

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tower. The other types of scrubbers used are venturi-scrubbers, cyclone-scrubbers.

2. **Organic Pollutants :** Organic chemical compounds are of great importance to the human beings and other life forms on this planet. Most-of the substances of which living things are composed are organic compounds. In addition, the main foodstuffs (such as fats, proteins and carbohydrates), as well as a number of materials and substances necessary for modern living (such as cotton, petroleum, rubber, plastics, antibiotics, etc.), are all organic compounds. But their presence in water is not desirable as they not only impart taste, odour and colour to water, but some of the chemical compounds discharged by industries are toxic and carcinogenic too.

3. **Radioactive Pollutants :** Radioactivity found in water is mainly due to natural sources; but there is also a threat of radionuclide contamination from various industrial and medical processes. The main human activities which are responsible for radioactive pollution are use of radioactive materials in power plants and nuclear weapons ; use of radioactive isotopes in medical, industrial and research applications ; and mining and processing of ores to produce usable radioactive substances. Though all of the radioactive contaminants are carcinogenic, the radionuclide that are found in water and are of concern are uranium, radium 226 and 228, radon and thorium 230 and 232. Out of these, radon is generally found in public water supplies.

4. Soil pollution mainly results from the following sources:

   1. Industrial wastes
   2. Urban wastes
   3. Radioactive pollutants
   4. Agricultural practices
   5. Chemical and metallic pollutant
   6. Biological agent.

5. **Sources/Causes of Noise :** The sources of noise are more in urban and industrial areas, than in rural areas. The sources, in general, may be

   - **Stationary sources** include industries; use of loudspeakers on various occasions like festivals, elections, worships in temples, mosques, etc., and during advertisements; mining operations; use of bulldozers, drillers and dynamites to break rocks; household gadgets like vacuum cleaner, TV, radio, stereo, grinder, mixer, etc.; common vegetable and fish markets; etc.
   - **Mobile sources** include road traffic, railway traffic, air traffic, navigation, etc.

For a better understanding of the subject, the sources of noise can be classified in following categories:

6. Solid waste (waste other than liquid or gaseous) can be classified as
   - Municipal,
   - Industrial,
   - Agricultural,
   - Medical,
   - Mining waste
   - Sewage sludge.

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TEST YOURSELF

1. Define pollution. Name various atmospheric pollutants.
2. Write note on Air Pollution. How can we control it?
3. Differentiate between sound and noise.
4. Briefly describe the sources, effects and control of noise pollution.
5. Write a short note on Water Pollution.
6. What are the adverse effects and measures to control water pollution?
7. What are the sources of soil pollution? How does soil pollution affect soil productivity? What are the remedies for the same?
8. Classify solid waste. What are the sources of urban and industrial solid waste?
9. How can you as an individual prevent environmental pollution? Why such effort is necessary?
10. What are various types of disasters? How could they be controlled? What are the steps to be borne in mind in Disaster Management?

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UNIT

5 SOCIAL ISSUES AND THE ENVIRONMENT

The Chapter Covers :

Learning Objectives :

After going through this unit, You would be able to -

- Water conservation
- Global warming
- Ozone layer depletion
- Environmental legislations
- Enforcement of environmental legislation: major issues

5.1 INTRODUCTION

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Sustainable Development is such a concept that signifies that rate of consumption or use of natural resources should be approximate the rate at which these resources can be substituted or replaced.

It also requires that a nation or society should be able to satisfy its requirements-social, economic and others- without undermining the interest of future generations. Countries of North (Developed) use too many natural resources and such practice cannot continue long. Mother Nature has been making available its resources and services as well it is also serving as receptacle for absorbing wastes for too long a time. We have to realize now that Nature today is very fragile.

Nature is finite. And experts have warned that it has reached to a critical threshold beyond which it would lead to Ecological Decline that would further lead to nothing but

"DISASTER". These experts are strong advocates of "limits to growth"philosophy.This concept of sustainable development can be further extended with the principle of justice and equity (equal distribution) between the peoples of North and South. Therefore, the national as well as international leaders and institutions respectively have major responsibility for sound developmental, economic and environmental issues. They should keep in view the principle of equity and those principles that determine the intergenerational inequities.

Another aspect of sustainable development is related to System Analysis, that is to say, how economic, social and environmental systems interact at various scales of operation to lead sustainable development that will strike optimal balance among the three subsystems. It must ultimately lead to reducing poverty of people in developing countries by minimizing resources depletion, environmental damage and social instability.

To summarize, Sustainable Development (Following aspects are to be highlighted)

*Protecting environment

*Avoiding depletion of non-renewable resources

*Seek reliance on alternative sources

*Equal access to resources

*Principle of Intergenerational distribution of resources-Important

*Systems thinking

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- **Population and its implication:**

There are two aspects that affect environment:
a) Population growth and

b)economic development.

- **Limits to Growth:**

We will need to change attitudes, consumption patterns, manufacturing and marketing practices and get into technological world that it is less intensive in its use of materials and energy to be able to manage the environmental crisis. Just improvement of efficiency alone is not going to be enough.

Growth has been treated as an infinite variable. This is not a correct assumption. The "earth's carrying capacity" is not seriously thought about. And such world has to desperately try to keep pace with the environmental problems because of such incorrect assumptions. For example, climate change (global warming), can be combated only if the world transits to a non-carbon energy economy, only after that the limitations of environments concerns posed by a carbon energy economy would get lessened.

The world needs an international mechanism that not only provides incentives to all nations to live within their entitled norms (amounts) but also help to promote a rapid transition to a non-carbon energy economy. There is considerable scope for dematerialization and de-energisation without a decrease in living standards This will be possible only if it is promoted through changes in the fiscal system which supports appropriate technological improvements. This can only happen if principle of sufficiency is ignored. We will need to set a level of sufficiency i.e. this much and not beyond it. There is a difference between ecology of means and ecology of ends.

- **Economy:**

Rate of Gross National Product (GNP) is important indicators of economic performance of any nation Increase GNP indicates economic health of the country. Such increase however is based on high rate of consumption of natural resources of which depletion of environmental resources is significant. Economic growth comes in conflict with issues of environmental concerns.

Ever since India had adopted the Economic Reforms Models via liberalization globalization. However, there are significant advantages from the above transition; ecological disadvantages are required to be taken into account. Long term ecological costs are to be taken into account. In our effort to increase the GNP, we may not like to liquidate ecological assets. High economic growth results into high rate of extraction, transformation and utilization of non-renewable resources. It is important to also achieve good rate of regeneration of natural resources. Economic growth cannot take place without sustaining ecological costs.

Economic growth has to be environmentally sustainable Developing countries have

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yet to undertake more developmental programs and yet to attain reasonable standards of living. Therefore, GNP must increase in these countries. Elements of resource generation and positive approach to environment have to be incorporated in developmental programs.

- **Poverty:**

In order to properly manage environment and resources, due consideration should be given to the fact that poor people directly depend upon natural resources for their livelihood. Sustainable development must address the issue of eradication of poverty which is linked with employment both of women and youth and other income generation programs.

- **Human Settlement Issues:**

The environmental implications of urban development and other human (slums) must be recognized. It will be necessary to give priority to the needs of urban as well as rural poor. The human settlement program should concentrate on following aspects:

1. Providing shelter to all

2. Investment in infrastructure- water, sewage and solid waste

3. Promotion of sustainable energy and transport system

4. Promotion of sustainable land use management

- **Land Resources:**

Land not only includes a physical entity in terms of topography but it also includes natural resources, soil, minerals and biota. These components provide varieties of services are essential for life support system. Land is infinite resource. Integrated approach is necessary for management of land.

- **Forests:**

There should be a rational approach adopted for management of forests and forests lands. Sustainable forest development, production of forest products and forest services requires institutional approach at government level.

5.2 URBAN PROBLEMS RELATED TO ENERGY

Cities are the main centers of economic growth, trade, education, innovations and employment. Until recently a big majority of human population lived in rural areas and their economic activities centered on agriculture, cattle, rearing, fishing, hunting or some cottage industry. It was some two hundred years ago with the dawn of industrial era the cities showed rapid development.

Now about50% of the world population lives in urban areas and there is increasing movement of rural folk to cities in search of employment. The urban growth is so fast that it is becoming difficult to accommodate all the industrial, commercial and residential facilities within a limited municipal boundary. As a result there is spreading

of the cities into the sub-urban or rural areas too. A phenomenon known as urban sprawl. In developing countries too urban growth is very fast and in most of the cases it is uncontrollable and unplanned growth. In contrast to the rural set up, the urban set up is densely populated, consumes a lot of energy and materials and generates a lot of waste.

The energy requirement of urban population is much higher than that of rural ones. This is because urban people have a higher standard of life and their lifestyle demands more energy inputs in every sphere of life. The energy demanding activities include,

1. Residential and commercial lighting
2. Transportation means including automobiles and public transport for moving from residence to workplace
3. Modern life-style using a large number of electrical gadgets in everyday life.
4. Industrial plants using a big proportion of energy
5. A large amount of waste generation which has to be disposed off properly using energy based techniques,
6. Control and prevention of air and water pollution which need energy dependent technologies.

Due to high population density and high energy demanding activities, the urban problems related to energy are much more magnified as compared to rural population,

5.3 WATER CONSERVATION

Water being one of the most precious and indispensable resources needs to be conserved. The following strategies can be adopted for conservation of water.

1. **Decreasing run-off losses:** Huge water-loss occurs due to run-off on most of the soils, which can be reduced by allowing most of the water to infiltrate into the soil. This can be achieved by using contour cultivation, terrace framing, water spreading, chemical treatment or improved water-storage system.
    a) Contour cultivation: on small furrows and ridges across the slopes trap rainwater and allow more time for infiltration. Terracing constructed on deep soils have large water-storage capacity. On gentle slopes trapped run off is spread over a large area for better infiltration.
    b) Conservation-bench terracing: It involves construction of a series of benches for catching the runoff water.

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c) Water spreading is done by channeling or lagoon-leveling, In channeling, the water flow is controlled by a series of diversions with vertical intervals. In lagoon leveling, small depressions are dug in the area so that there is temporary storage water.

d) Chemical wetting agents (Surfactants): These seem to increase the water intake rates when added to normal irrigated soil.

e) Surface crop residues, tillage, mulch, animal residues etc. help in reducing run-off by allowing more time for water to penetrate into the land.

f) Chemical conditioners like gypsum (CaSO4.2H2O) when applied to sodic soils improve soil permeability and reduce run off. Another useful conditioner is HPAN (hydrolyzed poyacrylonitrile)

g) Water-storage structures like farm ponds, dug-outs etc. build by individual farmers can be useful measures for conserving water through reduction of runoff.

2. **Reducing evaporation losses:** This is more relevant in humid regions. Horizontal barriers of asphalt placed below the soil surface increase water availability and increase crop yield by 35-40%. This is more effective on sandy soil but less effective on loamy sand soils. A co-polymer of starch and acrylonitrile called 'super slumper' has been reported to absorb water up to 1400 times its weight. The chemical has been found to be useful for sandy soils.

3. **Storing water in soil:** Storage of water takes place in the soil root zone in humid regions when the soil is wetted to field capacity. By leaving the soil fallow for one season water can be made available for the crop grown in next season.

4. **Reducing irrigation losses:**

   a) use of lined or covered canals to reduce seepage

   b) Irrigation in early morning or late evening to reduce evaporation losses

   c) Sprinkling irrigation and drip irrigation to conserve water by 30-50%

   d) Growing hybrid crop varieties with less water requirements and tolerance to saline water help conserve water.

5. **Reuse of water:**

   a) treated wastewater can be used for ferti-irrigation

   b) using grey water from washings, bath-tubs etc. for watering gardens, washing cars or paths help in saving fresh water.

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6. **Preventing wastage of water:** This can be done in households, commercial buildings and public places.

   a) Closing taps when not in use

   b) Repairing any leakage from pipes

   c) Using small capacity flush in toilets.

7. **Increasing block pricing:** The consumer has to pay a proportionately higher bill with higher use of water. This helps in economic use of water by the consumers.

5.4 RAIN WATER HARVESTING:

Rainwater harvesting is a technique of increasing the recharge of groundwater by capturing and storing rainwater. This is done by constructing special water-harvesting structures like dug wells, percolation pits, lagoons, check dams etc.

Rainwater, wherever it falls, is captured and pollution of this water is prevented. Rainwater harvesting is not only proving useful for poor and scanty rainfall regions but also for the rich ones. The annual average rainfall in India is 1200 mm; however, in most places it is concentrated over the rainy season, from June to September. It is an astonishing fact that Cherapunji, the place receiving the second highest annual rainfall as11000 mm still suffers from water scarcity.

The water flows with runoff and there is little vegetation to check the run off and allow infiltration. Till now there is hardly any rain-water harvesting being done in this region, thereby losing all the water that comes through rainfall.

Rainwater harvesting has the following objectives:

1. To reduce runoff loss

2. To avoid flooding of roads

3. To meet the increasing demands of water

4. To raise the water table by recharging ground water

5. To reduce ground water contamination

6. To supplement ground water supplies during lean seasons

Rainwater can be mainly harvested by any one of the following methods:

1. By storing in tanks or reservoirs above or below ground

2. By constructing pits, dug wells, lagoons, trench or check dams on small rivulets

3. By recharging the ground water.

Before adopting a rainwater harvesting system, the soil characteristics, topography, rainfall pattern and climatic conditions should be understood.

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Traditional Rainwater Harvesting:

In India, it is an old practice in high rainfall areas to collect rainwater from roof tops into storage tanks. In foot-hills water flowing from springs are collected by embankment type water storage. In Himalayan foot-hills people use the hollow bamboos as pipelines to transport the water of natural springs. Rajasthan is known for its "Tankas" (underground tanks) and "Khadins" (Embankments) for harvesting rainwater.

In our ancient times, we had adequate Taalaabs, Baawaris,Johars, Hauz etc. in every cities, village and capital cities of our Kings and Lords which were used to collect rainwater and ensure adequate water supply in dryperiods.Modern Techniques of Rainwater Harvesting: In arid and semi-arid regions artificial ground water recharging is done by constructing shallow percolation tanks. Check-dams made of any suitable native material (brush, polls, rocks, plants, loose rocks, wire nets, stones, slabs, sacks etc.) are constructed for harvesting runoff from large catchment areas.

Rajendra Singh of Rajasthan popularly known as "Waterman" has been doing a commendable job for harvesting rainwater by building check-dams in Rajasthan and he was honored with the prestigious Magsaysay Award for his work .Ground water flow can be intercepted by building ground water dams or storing water underground. As compared to surface dams, ground water dams have several advantages like minimum evaporation loss, reduced chances of contamination etc. In roof top rainwater harvesting which is a low cost and effective technique for urban houses and buildings, the rainwater from the top of the roofs is diverted to some surface tank or pit through a delivery system which can be later used for several purposes. Also it can be used to recharge underground aquifers by diverting the stored water to some abandoned dug well or by using a hand pump. All the above techniques of rainwater harvesting are low cost methods with little maintenance expenses.

Rainwater harvesting helps in:

- Recharging the aquifers,
- Improves ground water quality by dilution,
- Improves soil moisture
- Reduces soil erosion by minimizing run-off water.

5.5 WATERSHED MANAGEMENT:

The land area drained by a river is known as the river basin. The watershed is defined as the land area from which water drains under gravity to a common drainage channel. Thus watershed is a delineated area with a well defined topographic boundary and one water outlet. The watershed can range from a few square kilometers to few thousand square kilometers in size.

In the watershed the hydrological conditions are such that water becomes concentrated within a particular location like a river or a reservoir, by which the watershed is drained. The watershed comprises complex interactions of soil, landform, vegetation, land use activities and water. People and animals are an integral part of a

watershed having mutual impacts on each other. We may live anywhere we would be living in some watershed.

A watershed affects as it is directly involved in sustained food production, water supply for irrigation, power generation, and transportation as well as for influencing sedimentation and erosion, vegetation growth, floods and droughts. Thus management of watersheds treating them as a basic functional unit is extremely important and the first such Integrated Watershed Management was adopted in 1949 by the Damodar Valley Corporation.

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Watershed degradation:

The watersheds are very often found to be degraded due to uncontrolled, unplanned and unscientific land use activities. Organizing, deforestation, mining, construction activities, industrialization, shifting cultivation, natural and artificial fires, soil erosion and ignorance of local people have been responsible for degradation of various watersheds.

Objectives of Watershed Management:

Rational utilization of land and water sources for optimum production causing minimum damage to the natural resources is known as watershed management. The objectives of watershed management are as follows:

1. To rehabilitate the watershed through proper land use adopting conservation strategies for minimizing soil erosion and moisture retention so as to ensure good productivity of the land for the farmers.
2. To manage the watershed for beneficial developmental activities like domestic water supply, irrigation, hydropower generation etc.
3. To minimize the risks of floods, droughts and land slides
4. To develop rural areas in the region with clear plans for improving the economy of the regions.

Watershed management practices:

In the fifth year plan, watershed management approach was included with a number of programs for it and a national policy was developed. In watershed management the aspects of development are considered with regard to availability of the resources.

The practices of conservation and development of land and water are taken up with respect to their suitability for people's benefit as well as sustainability.

Various measures taken up for management include the following:

1. **Water harvesting:**

   Proper storage of water is done with provision for use in dry seasons in low rainfall areas. It also helps in moderation of floods.

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2. **Afforestation and agro-forestry:**

In watershed development, afforestation and crop plantation play a very important role. They help to prevent soil erosion and retention of moisture. In high rainfall areas, woody trees are grown in between crops to substantially reduce the runoff and loss of fertile soil. In Dehradun trees like Eucalyptus, Leucaena and grasses like chrysopogon are grown along with maize or wheat to achieve the objectives. Woody trees grown successfully in such agro-forestry programs include Sheesham, Teak and Keekar which havebeen used in watershed areas of river Yamuna.

3. **Mechanical measures for reducing soil erosion and runoff losses:**

Several mechanical measures like terracing, bunding, bench terracing, no-till farming, contour cropping, strip cropping etc. are used to minimize runoff and soil erosion particularly on the slopes of watersheds. Bunding has proved to be a very useful method in reducing runoff, peak discharge and soil loss in Dehradun and Siwaliks

4. **Scientific mining and quarrying:**

Due to improper mining, the hills lose stability and get disturbed resulting in landslides, rapid erosion etc. Contour trenching at an interval of one meter on overburdened dump, planting some soil binding plants land draining of water courses in the mined area are recommended for minimizing the destructive effects of mining in watershed areas.

5. **Public participation:**

People's involvement including the farmers and tribals is the key to the success of any watershed management program, particularly the soil and water conservation. People's cooperation as well as participation has to be ensured for the same. The communities are to be motivated for protecting a freshly planted areas and maintaining a water harvesting structure implemented by the government or some external agency (NGO) independently or by involving the locale people.

5.6 RESETTLEMENT AND REHABILITATION ISSUES:

Problems and concerns:

Economic development raises the quality and standard of living of the people of a country. Developmental projects are planned to bring benefits to the society. However, in the process of development, very often there is over-exploitation of natural resources and degradation of the environment. Besides this, quite often, the native people of the project site are directly affected. These native people are generally the poorest of the poor, underprivileged tribal people.

Various types of projects result in the displacement of the native people who undergo tremendous economic and psychological distress, as the socioeconomic and ecological base of the local community is disturbed.

a) Displacement problems due to dams:

The big river valley projects have one of the most serious socio-economic impacts due to large scale displacement of local people from their ancestral home and loss of their traditional profession or occupation. India is one of the countries in the world leading in big dam construction and in the last 50 years more than 20 million people are estimated to have directly or indirectly affected by these dams e.g. Hirakum Dam, Bhakra Nangal Dam, Tehri Dam are the examples where many people and their villages in the vicinity got affected. It also resulted in movement lead by Sunderlal Bahuguna- movement called Chipko Movement- One more stir is currently on is Sardar Sarovar Project- three states people and many villages get affected.

b) Displacement due to mining:

Mining is another developmental activity, which causes displacement of the native people. Several thousands of hectares of land area is covered in mining operation and the native people are displaced. Sometimes displacement of local people is due to accidents occurring in mined areas like subsidence of land that often leads to shifting people e.g. various mines are predominant in Jharkhand, these mines had displaced many people.

c) Displacement due to creation of National park:

When some forests are covered under a National Park, it is a welcome step for conservation of the natural resources. However, it also has a social aspect associated with it which is often neglected. A major portion of the forest is declared as core-area, where the entry of local dwellers or tribals is prohibited. When these villagers are deprived of their ancestral right or access to forests, they usually retaliate by starting destructive activities. There is a need to look into their problems and provide them solution such as employment etc.

REHABILITATION ISSUES:

The United Nations Universal Declaration on Human Rights has declared that right to housing is a basic human right. In India, most of the displacements have resulted due to land acquisition by the government for various reasons. For this purpose, the government has the Land Acquisition Act, 1894 which empowers it to serve notice to the people to vacate their lands if there is a need as per government planning. Provision of cash compensation in lieu of the land vacated exists in the Act.

The major issues related to displacement and rehabilitation are as follows:

1.Tribes are usually the most affected amongst the displaced who are already poor. Displacement further increases their poverty due to loss of land, home, jobs, food insecurity, loss of access to common property assets, increased morbidity and mortality and social isolation.

b) Break up of families in an important social issue arising due to displacement in which the women are the worst affected and they are not even given cash/ land compensation.

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c) The tribals are not familiar with the market policies and trends. Even if they get cash compensation, they get alienated in the modern economic set up.

d) The land acquisition laws ignore the communal ownership of property, which is an inbuilt system amongst the tribals. Thus the tribals lose their communitarian basis of economic and cultural existence. They feel like fish out of water.

e) Kinship systems, marriages, social and cultural functions, their folk-songs, dances and activities vanish with their displacement, Even when they are resettled; it is individual-based resettlement, which totally ignores communal settlement.

f) Loss of identity and loss of the intimate link between the people and the environment is one of the biggest loss. The age-long indigenous knowledge, which has been inherited and experienced by them about the flora, fauna, their uses etc. gets lost.

REHABILITATION POLICY:

There is a need for a comprehensive National Rehabilitation Policy. Different states are following different practices in this regard.

There is a need to raise public awareness on these issues to bring the resettlement and rehabilitation plans on a humane footing and to honour the human rights of the oustees.

ENVIRONMENTAL ETHICS:

Environmental ethics refers to the issues, principles and guidelines relating to human interactions with their environment. It is rightly said, "The environmental crisis is an outward manifestation of the crisis of mind and spirit.' It all depends on how do we think and act. If we think "Man is all powerful and the supreme creature on this earth and man is the master of nature and can harness it at his will", it reflects our human-centric thinking. On the other hand, if we think "Nature has provided us with all the resources for leading a beautiful life and she nourishes us like a mother, we should respect her and nurture her", this is an earth-centric thinking.

The first view urges us to march ahead gloriously to conquer the nature and establish our supremacy over nature through technological innovations, economic growth and development without much botheration to care for the damage done to the planet earth.

The second view urges us to live on this earth as a part of it, like any other creation of Nature and live sustainably.

So, we can see that our acts will follow what we think. If we want to check the environmental crisis, we will have to transform our thinking and attitude. That in turn, would transform our deeds, leading to a better environment and better future. These two world-views are discussed in here in relation to environmental protection:

a) Anthropocentric Worldview:

This view is guiding most industrial societies. It puts human beings in the center giving them the highest status. Man is considered to be most capable for managing the planet earth.

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The guiding principles of this view are:

1. Man is the planet's most important species and is in the in-charge of the rest of the nature.
2. Earth has an unlimited supply of resources and it all belongs to us.
3. Economic growth is very good and more the growth, the better it is, because it raises our quality of life and the potential for economic growth is unlimited.
4. A healthy environment depends upon a healthy economy.
5. The success of mankind depends upon how good managers we are for deriving benefits for us from nature.

b) Eco-centric Worldview:

This is based on earth-wisdom. The basic beliefs are as follows:

1. Nature exists not for human beings alone, but for all the species.
2. The earth resources are limited and they do not belong only to human beings.
3. Economic growth is good till it encourages earth-sustaining development and discourages earth-degrading development.
4. A healthy economy depends upon a healthy environment.
5. The success of mankind depends upon how best we can cooperate with the rest of the nature while trying to use the resources of nature for our benefit.

Environmental ethics can provide us the guidelines for putting our beliefs into action and help us decide what to do when faced with crucial situations.

Some important ethical guidelines known as Earth ethics or Environmental Ethics are as follows:

- One should love and honour the earth since it has blessed you with life and governs your survival.
- One should keep each day sacred to earth and celebrate the turning of its seasons.
- One should not hold yourself above other living things and have no right to drive them to extinction.
- One should be grateful to the plants and animals which nourish you by giving you food.

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- One should limit your offsprings because too many people will overburden the earth.
- One should not waste your resources on destructive weapons.
- One should not run after gains at the cost of nature rather should strive to restore its damaged majesty.
- One should not conceal from others the effects you have caused by your actions on earth.
- One should not steal from future generations their right to live in a clean and safe planet by impoverishing or polluting it.

One should consume the material goods in moderate amounts so that all may share the earth's precious treasure of resources. If we critically go through the above Ten Commandments for earth ethics and reflect upon the same we will find that various religions teach us the same things in one form or the other.

Our Vedas also have glorified each every component of nature as gods or goddesses so that people have a feeling of reverence for them. Our religious and cultural rituals make us perform such actions that would help in the conservation of nature and natural resources.

Even the various festivals envisaged by Hinduism also prescribe the participation of humans in the celebrations through nature. (Nisarga Pooja is what we perform during celebrations of our festivals e.g. Satyanarayana Pooja, Vatapournitma, Baishakhi, Ganesh Festival, Dassaraetc.)The concept of Ahimsa in Buddhism and Jainism ensure the protection and conservation of all forms of life, thereby keeping the ecological balance of the earth intact. Our teachings on "having fewer wants" ensure to put "limits to growth" and thus guide us to have an eco-centric life style.

CLIMATE CHANGE:

Climate change is changing our economy, health and communities in diverse ways. Scientists warn that if we do not aggressively curb climate change now, the results will likely be disastrous.

Climate change is the single biggest environmental and humanitarian crisis of our time. The Earth's atmosphere is overloaded with heat-trapping carbon dioxide, which threatens large-scale disruptions in climate with disastrous consequences.

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in region Such conditions which average over a long period at least 30 years is called climate.

The Intergovernmental Panel On Climate Change (IPCC) in 1990 and 1992 published best available evidence about past climate change, the green house effect and recent changes in global temperature. It is observed that earth's temperature has changed considerably during the geological times. It has experienced several glacial

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and interglacial periods. However, during the past10000 years of the current interglacial period, the mean average temperature has fluctuated by 0.51° c over 100 to 200 year period.

We have relatively stable climate for thousands of years due to which we have practiced agriculture and increased population. Even small changes in climatic conditions may disturb agriculture that would lead to migration of animals including humans. Anthropogenic activities are upsetting the delicate balance that has been established between various components of the environment.

Green house gases are increasing in atmosphere resulting in increase in the average global temperature. This may upset the hydrological cycle; result in floods and droughts in different regions of the world, cause sea level rise, changes in agricultural productivity, famines and death of humans as well as livestock.

5.7 GLOBAL WARMING:

Global warming is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to the greenhouse gases released by people burning fossil fuels.

Troposphere, the lower most layer of the atmosphere traps heat by natural process due to the presence of certain gases. This effect is called Green House Effect as it is similar to the warming effect observed in the horticultural Greenhouse made of glass.

The amount of heat trapped in the atmosphere depends mostly upon the concentration of heat trapping or green house gases and length of time they stay in the atmosphere. The major green house gases are carbon dioxide, ozone, methane, nitrous oxide etc. and water vapours.The average global temperature is 15°c. In the absence of green house gases this temperature would have been 18° c. Therefore, greenhouse effect contributes a temperature rise to the tune of 33°c.

Heat trapped by green house gases in the atmosphere keeps the planet warm enough to allow us and other species to exist. The two predominant green house gases are water vapors which are controlled by hydrological cycle and carbon dioxide which is controlled mostly by the global carbon cycle. While the levels of water vapor in the troposphere have relatively remained constant the levels of carbon dioxide have increased.

Other gases whose levels have increased due to human activities are methane, nitrous oxide. Deforestation has further resulted in elevated levels of carbon dioxide due to non removal of carbon dioxide by plants through photosynthesis. Warming or cooling by more than 2° c over the past few decades may prove to be disastrous for various ecosystems on the earth including humans as it would alter the conditions faster than some species could adapt or migrate. Some areas will become inhabitable because of droughts or floods following rise in average sea level.

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5.8 GREEN HOUSE GASES:

The phenomenon that worries the environmental scientists is that due to anthropogenic activities there is an increase in the concentration of the greenhouse gases in the air that absorbs infra-red light containing heat and results in the re-radiation of even more of the outgoing thermal infra-red energy, thereby increasing the average surface temperature beyond 15° c. The phenomenon is referred to as the enhanced green house effect to distinguish its effect from the one that has been operating naturally for millennia.

The green house gases include Carbon dioxide, Chlorofluorocarbons, methane and nitrous oxide etc. These are the green house gases present in the troposphere and resulting in an increase in the temperature of air and the earth.

Impacts of enhanced green house effect:

The enhanced greenhouse effect will not only cause global warming but will also affect various other climatic and natural processes.

1. **Global temperature increase:**

   It is estimated that the earth's mean temperature will rise between 1.5 to 5.5 ° c by 2050 if input of greenhouse gases continues to rise at the present rate. Even at the lower value, earth would be warmer that it has been for 10000 years.

2. **Rise in Sea Level:**

   With the increase in global temperature sea water will expand. Heating will melt the polar ice sheets and glaciers resulting in further rise in sea level. Current models indicate that an increase in the average atmospheric temperature of 3° c would raise the average global sea level by 0.2-1.5 meters over the next 50-100 years. One meter rise in sea level will inundate low lying areas of cities like Shanghai,Cairo, Bangkok, Sydney, Hamburg and Venice as well as agricultural lowlands and deltas in Egypt, Bangladesh, India, China and will affect rice productivity. This will also disturb many commercially important spawning grounds, and would probably increase the frequency of storm damage to lagoons, estuaries and coral reefs. In India, the Lakshadweep Islands with a maximum height of 4 meters above the level may be vulnerable. Some of the most beautiful cities like Mumbai may be saved by heavy investment on embankment to prevent inundation. Life of millions of people will be affected, by the sea level rise that have build homes in the deltas of Ganges, the Nile, the Mekong, the Yangtze and the Mississippi rivers.

3. **Effects on human health:**

   The global warming will lead to changes in the rainfall pattern in many areas, thereby affecting the distribution of vector-borne diseases like malaria, filariasis, elephantiasis etc.

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Areas which are presently free from diseases like malaria may become the breeding grounds for the vectors of such diseases. The areas likely to be affected in this manner are Ethiopia, Kenya and Indonesia. Warmer temperature and more water stagnation would favour breeding of mosquitoes, snails and some insects, which are the vectors of such diseases. Higher temperature and humidity will increase/aggravate respiratory and skin diseases.

4. **Effects on Agriculture:**

There are different views regarding the effect of global warming on agriculture. It may show positive or negative effects on various types of crops in different regions of the world. Tropical and subtropical regions will be more affected since the average temperature in these regions is already on the higher side. Even a rise of 2° c may be quite harmful to crops.

Soil moisture will decrease and evapo-transpiration will increase, which may drastically affect wheat and maize production. Increase in temperature and humidity will increase pest growth like the growth of vectors for various diseases. Pests will adapt to such changes better than the crops. To cope up with the changing situation drought resistant, heat resistant and pest resistant varieties of crops have to be developed.

Measures to check global warming: To slow down enhanced global warming the following steps will be important:

1. Cut down the current rate of use of CFCs and fossil fuel.
2. Use energy more efficiently
3. Shift to renewable energy resources
4. Increase in nuclear power plants for electricity production
5. Shift from coal to natural gas
6. Trap and use methane as a fuel
7. Reduce beef production.
8. Adopt sustainable agriculture
9. Stabilize population growth
10. Efficiently remove carbon dioxide from smoke stacks
11. Plant more trees.
12. Remove atmospheric carbon dioxide by utilizing photosynthetic algae.

5.9 ACID RAIN

Oxides of sulfur and nitrogen originating from industrial operations and fossil fuel combustion are the major sources of acid forming gases. Acid forming gases are

Check Your Progress:

1. What is rain water harvesting?
2. What are the main objectives of watershed management?
3. What is global warming?

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oxidized over several days by which time they travel several thousand kilometers. In the atmosphere these gases are ultimately converted into sulfuric and nitric acids. Hydrogen chloride emission forms hydrochloric acid. These acids cause acidic rain. Acid rain is only one component of acidic deposition. Acidic decomposition is the total wet acidic deposition (acid rain) and dry deposition. Rain water is turned acidic when its pH falls below 5.6. In fact clean or natural rain water has a pH of 5.6 at 20° c because of formation of carbonic acid due to dissolution of CO2 in water. In absence of rain, dry deposition of acid may occur.

Acid forming gases like oxid s of sulphur and nitrogen and acid aerosols get deposited on the surface of water bodies, vegetation, soil and other materials. On moist surfaces or in liquids these acid forming gases can dissolve an form acids similar to that formed in acid rain.

Effects of acid rain:

Acid rain causes a number of harmful effects below pH 5.The effects are visible in the aquatic even at pH less than 5.5.

1. It causes deterioration of buildings especially made of marble e.g. monuments like Taj Mahal. Crystals of calcium and magnesium sulphate are formed as a result of corrosion caused by acid rain.
2. It damages stone statues. Priceless stone statues in Greece and Italy have been partially dissolved by acid rain.
3. It damages metals and car finishes.
4. Aquatic life especially fish are badly affected by lake acidification.
5. Aquatic animals suffer from toxicity of metals such as aluminum, mercury, manganese, zinc and lead which leak from the surrounding rocks due to acid rain.
6. It results in reproductive failure, and killing of fish.
7. Many lakes of Sweden, Norway, Canada have become fishless due to acid rain.
8. It damages foliage and weakens trees.
9. It makes trees more susceptible to stresses like cold temperature, drought, etc. Many insects and fungi are more tolerant to acidic conditions and hence they can attack the susceptible trees and cause diseases.

Control of Acid Rain:

1. Emission of SO_2 and NO_2 from industries and power plants should be reduced by using pollution control equipments.
2. Liming of lakes and soils should be done to correct the adverse effects of acid rain.

3. A coating of protective layer of inert polymer should be given in the interior of water pipes for drinking water.

5.10 OZONE LAYER DEPLETION

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The ozone layer is a layer in Earth's atmosphere containing relatively high concentrations of ozone (O_3). However, "relatively high," in the case of ozone, is still very small with regard to ordinary oxygen, and is less than 10 parts per million, with the average ozone concentration in Earth's atmosphere being only about 0.6 parts per million. The ozone layer is mainly located in the lower portion of the stratosphere from approximately 20 to 30 kilometres (12 to 19 mi) above Earth, though the thickness varies seasonally and geographically.

The ozone layer absorbs 97–99% of the Sun's medium-frequency ultraviolet light (from about 200 nm to 315 nm wavelength), which potentially damages exposed life forms on Earth.

Ozone in the Earth's stratosphere is created by ultraviolet light striking oxygen molecules containing two oxygen atoms (O_2), splitting them into individual oxygen atoms (atomic oxygen); the atomic oxygen then combines with unbroken O_2 to create ozone, O_3.

The ozone molecule is also unstable (although, in the stratosphere, long-lived) and when ultraviolet light hits ozone it splits into a molecule of O_2 and an atom of atomic oxygen, a continuing process called the ozone-oxygen cycle, thus creating an ozone layer in the stratosphere, the region from about 10 to 50 kilometres (33,000 to 160,000 ft) above Earth's surface. About 90% of the ozone in our atmosphere is contained in the stratosphere. Ozone concentrations are greatest between about 20 and 40 kilometres (12 and 25 mi), where they range from about 2 to 8 parts per million.

In recent years, the ozone layer has been the subject of much discussion. And rightly so, because the ozone layer protects both plant and animal life on the planet.

The fact that the ozone layer was being depleted was discovered in the mid-1980s.

The main causes of ozone layer depletion are:

- CFC's (Chlorofluorocarbons, Man),
- halons (Man),
- carbon tetrachloride and methyl chloroform (found so far in increasing amounts at lower altitudes, Nature and Man), and
- bromine oxide (volcanoes), and bromine from manmade sources.

Manmade chemicals like chlorofluorocarbons, bromofluorocarbons and water vapor the major depleters of the ozone layer. There is evidence that natural sources of bromides and chlorides from ocean spray and volcanos can contribute to the

depletion of the ozone as well as the Chloro- and Bromo- fluorocarbons. It is thought that these levels have been constant from the ocean and the "normal" ozone levels are in balance with this natural depletion.

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The simplified reactions are:

$CFCl_3 + hi \rightarrow CFCl_2 + Cl$

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + O_3 + hv(?) \rightarrow Cl + 2\ O_2$

In words:

Only ozone (not oxygen) in our current atmosphere can absorb UV-B radiation which is very harmful for all the living organisms when it is at elevated levels. Potential impacts are death to algae and phytoplankton... all surface life in eventually, diseases and cancer.

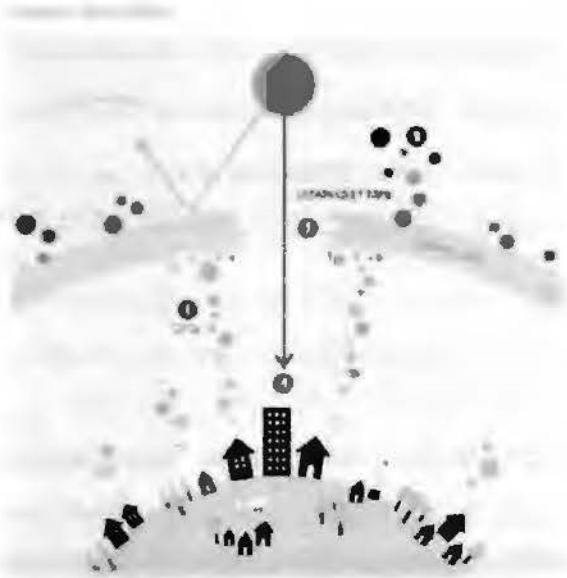
The fluorine in some of these compounds does not contribute to the destruction of ozone. Ozone cannot displace fluorine from whatever molecule it is joined to.

The largest player of both Man's and Nature's depletion of ozone is water vapor.

The largest player of solely Man's efforts to the depletion of ozone is the CFCs used late in the 20th century and still being made in the third world. These compounds are so stable, they are only removed from the air in the "ozone layer".

5.11 EFFECTS OF OZONE LAYER DEPLETION

Reductions in stratospheric ozone levels will lead to higher levels of UVB reaching the Earth's surface. The sun's output of UVB does not change; rather, less ozone means less protection, and hence more UVB reaches the Earth. Studies have shown that in the Antarctic, the amount of UVB measured at the surface can double during the annual ozone hole.



The effect of ozone depletion on the Earth's surface is the increased levels of ultraviolet-B radiation. This type of UV-B radiation is harmful to humans, animals

and plants. The increases in UV-B radiation have been observed not only under the ozone hole in Antarctica but in other places like the Alps (Europe) and Canada (North America).

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1. Effects on human health.

Skin cancer:

Today it is estimated that skin cancer rates increased due to stratospheric ozone depletion. The most common type of skin cancer, the so-called non-melanoma, is due to exposure to UV-B radiation for several years.

The Immune System:

A person's defense to fight infection depends on the strength of their immune system. It is known that exposure to ultraviolet light reduces the effectiveness of the immune system, not only related with skin infections but also with those observed in other parts of the body.

UNEP noted that the effects on the immune system contains one of the questions of concern and to suggest that exposure to UV-B radiation could negatively influence immunity against infectious diseases. For example, leishmaniasis and malaria, and fungal infections such as Candida.

Exposure to UV-B radiation may well make the immune system to tolerate the disease rather than fighting it. This could mean the usefulness of vaccination programs in both industrialized and developing countries.

2. Aquatic Ecosystems

The loss of phytoplankton, the base of the marine food chain, has been observed as a result of increased ultraviolet radiation. Under the ozone hole in Antarctic phytoplankton productivity decreased between 6 and 12 percent.

3. Terrestrial Ecosystems

Animals:

For some species, increased UV-B involves the formation of skin cancer. This has been studied in goats, cows, cats, dogs, sheep and laboratory animals and is probably saying that this is a feature common to several species. Infections in cattle may worsen with increased UV-B radiation.

Plants:

In many plants UV-B radiation can have the following effects: to alter their growth and damage plants, reducing the growth of trees flowering time changes, make plants more vulnerable to disease and produce toxic substances. There could even be loss of biodiversity and species. Among the crops in which negative effects were due to the impact of UV-B are the soybean and rice.

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4. Air Pollution

The loss of ozone in the atmosphere cause high UV-B increase the levels of ozone in the Earth's surface, especially in urban and suburban areas, reaching potentially harmful concentrations in the early hours of the day.

The low-level ozone can cause respiratory problems and exacerbate asthma, as well as damage to trees and some cereals. In addition, low ozone levels contribute to the increasing problems caused by acid rain.

5. Effects on Biogeochemical Cycles

Increases in solar UV radiation could affect terrestrial and aquatic biogeochemical cycles, thus altering both sources and sinks of greenhouse and chemically-important trace gases e.g., carbon dioxide (CO2), carbon monoxide (CO), carbonyl sulfide (COS) and possibly other gases, including ozone. These potential changes would contribute to biosphere-atmosphere feedbacks that attenuate or reinforce the atmospheric buildup of these gases.

6. Effects on Materials

Synthetic polymers, naturally occurring biopolymers, as well as some other materials of commercial interest are adversely affected by solar UV radiation. Today's materials are somewhat protected from UVB by special additives. Therefore, any increase in solar UVB levels will therefore accelerate their breakdown, limiting the length of time for which they are useful outdoors.

5.12 WASTELAND RECLAMATION

Economically unproductive lands suffering from environmental deterioration are known as wastelands. The wastelands include salt-affected lands, sandy areas, gullied areas, undulating uplands, barren hill-ridge etc. Snow covered areas, glacial areas and areas rendered barren after Jhum cultivation are also included in wastelands. More than half of our country's geographical area (about 175million ha) is estimated to be wasteland, thus indicating the seriousness of the problem for a country like ours which has to support 1/6th of the world's population .Maximum wasteland areas in our country lie Rajasthan (36 million ha) followed by M.P. and Andhra Pradesh. In Haryana the wastelands cover about 8.4% of the total land area and most of it comprises saline, sodic or sandy land areas. Wastelands are formed by natural processes, which include undulating uplands, snow-covered lands, coastal saline areas, sandy areas etc. or by anthropogenic (man-made) activities leading to eroded, saline or waterlogged lands.

Wasteland Reclamation Practices: Wasteland reclamation and development in our country falls under the purview of Wasteland Development Board, which works to fulfill following objectives:

1. To improve the physical structure and quality of marginal soils

2. To improve the availability of good quality water for irrigating these lands

3. To prevent soil erosion, flooding and landslides

4. To conserve the biological resources of land for sustainable use

5.13 ENVIRONMENTAL LEGISLATIONS

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India is the first country in the world to have made provisions for the protection and conservation of environment in its constitution. On 5th June, 1972, environment was first discussed as an item of international agenda in the U.N.Conference on Human Environment in Stockholm and thereafter 5th June is celebrated all over the world as World Environment Day. Soon after the conference our country took substantive legislative steps for environmental protection. The Wildlife (Protection) Act was passed in 1972, followed by the Water (Prevention and Control of Pollution) Act, 1974, the Forest (Conservation) Act, 1980, Air (Prevention and Control of Pollution) Act, 1981 and subsequently the Environment (Protection) Act, 1986.

Constitutional Provisions: The provisions for environmental protection in the constitution were made through the 42nd amendment as follows:

Article 48-A of the constitution provides: "The state shall endeavor to protect and improve the environment and to safeguard forests and wildlife of the country.

Article 51A (g) provides: "It shall be the duty of the every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.

Thus our constitution includes environmental protection and conservation as one of our fundamental duties.

Some of the important Acts passed by the Government of India are discussed as follows:

5.14 WILDLIFE (PROTECTION) ACT, 1972

Objectives of the Wildlife Protection Act- according to the section 1 of this Act, the objectives of this act are-

- To maintain essential ecological processes and life supporting systems.
- To preserve biodiversity
- To ensure a continuous use of species, ie., protection and conservation of wildlife.

Important terms defined in the Act-

(a) **Wildlife-**It includes any animal, bees, butterflies, crustaceans, fish,moth and aquatic and land vegetation which forms part of any habitat.

(b) **Habitat-**include 'land, water or vegetation or vegetation which is the natural home of any wild animal' .

(c) **Hunting-** according to the Act ,it means

- To capture, kill , poison, share and trap any wild animal or trying to do so.
- To injure, destroy or take away any part of body of such animal and damaging the eggs or nest of wild birds and reptiles.

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(d)Animal articles-any article made from any part of a captive or wild animal.

The major activities and provisions in the act can be summed up as follows:

1. It defines the wild-life related terminology.

2. It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.

3. Under the Act, comprehensive listing of endangered wild life species was done for the first time and prohibition of hunting of the endangered species was mentioned.

4. Protection to some endangered plants.

5. The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.

6. The Act provides for the constitution of Central Zoo Authority.

7. There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.

8. The act imposes a ban on the trade or commerce in scheduled animals.

9. It provides for legal powers to officers and punishment to offenders.

10. It provides for captive breeding programme for endangered species.

Several Conservation Projects for individual endangered species like Lion (1972), Tiger (1973), Crocodile (1974) and Brown antlered Deer (1981) were stated under this Act. The Act is adopted by all states in India except J & K,which has it own Act.

Some of the major drawbacks of the Act include

- mild penalty to offenders,
- illegal wild life trade in J & K,
- personal ownership certificate for animal articles like tiger and leopard skins,
- no coverage of foreign endangered wildlife,
- pitiable condition of wildlife in mobile zoos and little emphasis on protection of plant genetic resources.

5.15 FOREST (CONSERVATION) ACT, 1980

This act deals with the conservation of forests and related aspects. Except J & K, the act is adopted all over India. The Act covers under it all types of forests

including reserved forests, protected forests or any forested land irrespective of its ownership.

Objectives of the Act-

- Protection and conservation of forest .
- To ensure judicious use of forest products.

Important terms defined in the Act-

(a) Forest- means a biotic community composed predominantly of trees, shrubs and woody climbers.

(b) Forest produce- 'timber, wood, bark, charcoal, oil, resin, lac, seeds etc.,whether brought from or found in a forest or not'.'

The salient features of the Act are as follows:

1. The State Government has been empowered under this Act to use the forests only for forestry purposes. If at all it wants to use it in any other way, it has to take prior approval of Central Government, after which it can pass orders for declaring some part of reserve forest for non-forest purposes (e.g. mining) or for clearing some naturally growing trees and replacing them by economically important trees (reforestation).
2. It makes provision for conservation of all types of forests and for this purpose there is any Advisory committee which recommends funding for it to the Central Government.
3. Any illegal non-forest activity within a forest area can be immediately stopped under this Act. Non-forest activities include clearing of forest land for cultivation of any type of plants/crops or any other purpose (except re-afforestation). However, some construction work in the forest for wildlife or forest management is exempted from non-forest activity (e.g. fencing, making water-holes, trench, pipelines, check posts, wireless communication etc.)

1992 Amendment in the Forest Act

1. In 1992, some amendment was made in the Act which made provisions for allowing some non-forest activities in forests, without cutting trees or limited cutting with prior approval of Central Government, These activities are setting of transmission lines, seismic surveys, exploration, drilling and hydroelectric projects. The last activity involves large scale destruction of forest, for which prior approval of the Center is necessary.
2. Wildlife sanctuaries, National Parks etc. are totally prohibited for any exploration or survey under this Act without prior approval of Central Government even if no tree-felling is involved.
3. Cultivation of tea, coffee, spices, rubber and plants which are cash-crops, are included under non-forestry activity and not allowed in reserve forests.

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4. Even cultivation of fruit-bearing trees, oil-yielding plants or plants of medicinal value in forest area need to be first approved by the Central Government. This is because newly introduced species in the forest area may cause an imbalance in the ecology of the forest. If the species to be planted is a native species, then no prior clearance is required.

5. Tusser cultivation (a type of silk-yielding insect) in forest areas by tribals as a means of their livelihood is treated as a forestry activity as long as it does not involve some specific host tree like Asan or Arjun. This is done in order to discourage monoculture practices in the forests which are otherwise rich in biodiversity.

6. Plantation of mulberry for rearing silkworm is considered a non-forest activity. The reason is same as described above.

7. Mining is a non-forestry activity and prior approval of Central Government is mandatory. The Supreme Court in a case T.N.Godavarman Thirumulkpad Vs.Union of India (1997) directed all on-going mining activity to be ceased immediately in any forest area of India if it not got prior approval of Central Government.

8. Removal of stones, bajri, boulder etc. from river-beds located within the forest area fall under non-forest activity.

9. Any proposal sent to central government for non-forest activity must have a cost-benefit analysis and Environmental Impact statement (EIS) of the proposed activity with reference to its ecological and socio-economic impacts.

Thus, the Forests (Conservation) Act has made ample provisions for conservation and protection of forests and prevents deforestation.

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

Objectives of the Act-

- Maintaining or restoring the wholesomeness of water
- Prevention and control of water pollution.
- Establishment of Central and State Boards for pollution control.

Important term defined in the Act-

Pollution is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water or such discharge as is likely to cause a nuisance or render the water harm aquatic plants and other organisms or animal life. The definition of water pollution has thus encompassed the entire probable agents in water that may cause any harm or have a potential to harm any kind of in any way.

It provides for maintaining restoring the wholesomeness of water by preventing and controlling its pollution. Pollution is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water or such discharge as is likely to cause a nuisance or render the water harmful or injurious to public health and safety or harmful for any other use or to aquatic plants and other organisms or animal life. The definition of water pollution has thus encompassed the entire probable agents in water that may cause any harm or have a potential to harm any kind of in any way.

The salient features and provisions of the Act are summed up as follows:

1. It provides for maintenance and restoration of quality of all types of surface and ground water.
2. It provides for the establishment of Central and State Boards for pollution control.
3. It confers them with powers and functions to control pollution. The Central and State Pollution Control Boards are widely represented and are given comprehensive powers to advise, coordinate and provide technical assistance for prevention and control of pollution of water.
4. The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards.
5. The Act makes provisions for various penalties for the defaulters and procedure for the same. **The main regulatory bodies are the Pollution Control Boards, which have been, conferred the following duties and powers:**

Central Pollution Control Board (CPCB):

The board is supposed to:

1. Advise the central government in matters related to prevention and control of water pollution.
2. Coordinate the activities of State Pollution Control Boards and provides them technical assistance and guidance.
3. Organize training programs for prevention and control of pollution.
4. Organize comprehensive programs on pollution related issues through mass media.
5. Collect and compile and publish technical and statistical data related to pollution.
6. Prepare manuals for treatment and disposal of sewage and trade effluents.
7. Lay down standards for water quality parameters,

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8. Plan nation-wide programs for prevention, control or abatement of pollution.
9. Establish and recognize laboratories for analysis of water, sewage or trade effluent sample.

The State Pollution Control Boards also have similar functions to be executed at state level and are governed by the directions of CPCB.

1. The board advises the state government with respect to the location of any industry that might pollute a stream or well.
2. It lays down standards for effluents and is empowered to take samples from any stream, well or trade effluent or sewage passing through an industry.
3. The State Board is empowered to take legal samples of trade effluent in accordance with the procedure laid down in the Act, The sample taken in the presence of the occupier or his agent is divided into two parts, sealed, signed by both the parties and sent for analysis to some recognized lab. If the samples do not conform to the prescribed water quality standards (crossing maximum permissible limits), then 'consent' is refused to the unit.
4. Every industry has to obtain consent from the Board (granted for a fixed duration) by applying on a prescribed Proforma providing all technical details, along with a prescribed fee following which analysis of the effluent is carried out.
5. The Board suggests efficient methods of utilization, treatment and disposal of trade effluents. The Act has made detailed provisions regarding the power of the Boards to obtain information, take trade samples, restrict new outlets, restrict expansion, enter and inspect the units and sanction or refuse consent to the industry after effluent analysis. While development is necessary it is all the more important to prevent pollution which can jeopardize the lives of people. Installation and proper functioning of effluent treatment plants in all polluting industries is a must for checking pollution of water and land. Despite certain weaknesses in the Act, the Water Act has ample provisions for preventing and controlling water pollution through legal measures.

5.17 THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

Objectives of the Act-

- Prevention, control and abatement of air pollution.
- Maintaining the quality of air.
- Establishment of Boards for the prevention and control of air pollution.

Important terms defined in the Act

(a) **Air Pollution-** as the presence of any pollutant in the air.

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(b) **Air Pollutant**- any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.

(c) **Control equipment**- means any apparatus, device, equipment or system to control the quality and manner of emission of any air pollutant and include any device used for securing the efficient operation of any industrial plants.

Salient features of the act are as follows:

1. It provides for prevention control and abatement of air pollution.
2. Air pollution has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.
3. Noise pollution has been inserted as pollution in the Act in 1987.
4. Pollution control boards at the central or state level have the regulatory authority to implement the Air Act. Just parallel to the functions related to Water (Prevention and control of pollution) Act, the boards perform similar to functions related to improvement of air quality. The boards have to check whether or not the industry strictly follows the norms or standards laid down by the board under section 17 regarding the discharge of emission of any air pollutant. Based upon analysis report, consent is granted or refused to the industry.
5. Just like the Water Act, the Air Act has provisions for defining the constitution, power and function of Pollution Control Boards, funds, accounts, audit, penalties and procedures.
6. Section 20 of the Act has provision for insuring emission standards for automobiles. Based upon it the state government is empowered to issue instructions to the authorities in charge of registration of motor vehicles (under Motor Vehicle Act, 1939) that is bound to comply with such instructions.
7. As per section 19 in consultation with the state pollution control board the state government may declare an area within the state as "Air Pollution Control Area" and can prohibit the use of any fuel other than approved fuel in the area causing air pollution. No person shall without prior consent of State Board operate or establish any industrial unit in the "Air Pollution Control Area". The Water and Air Acts have also made special provisions for appeals. Under Section 28 of Water Act and Section 31 of Air Act, a provision for appeals has been made. An appellate authority consisting of a single person or three persons appointed by the head of the State, Governor is constituted to hear such appeals as filed by some aggrieved parties due to some order made by the State Board within 30 days of passing the

orders. The Appellate Authority after giving the appellant and the State Board, an opportunity of being heard, disposes off the appeal as expeditiously as possible.

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5.18 THE ENVIRONMENT (PROTECTION) ACT, 1986

The Act came into force on November 19, 1986, the birth anniversary of our late Prime Minister Indira Gandhi, who was a pioneer of environmental protection issues in our country. The Act extends to whole of India.

Objectives of the Act-

- Protection and improvement of the environment ;
- Prevention of hazards to all living creatures (plants, animals and humans) and property;
- Maintenance of harmonious relationship between humans and their environment.

Terms related to environment have been described as follows in the Act:

(a) **Environment** includes water, air and land and the interrelationship that exist among and between them and human beings, all other living organisms and property.

(b) **The environmental pollution** means the presence of any solid, liquid or gases substance present in such concentration as may be or tend to be injurious to environment.

(c) **Hazardous substance** means any substance or preparation which by its physico-chemical properties or handling is liable to cause harm to human beings, other living organisms, property or environment. The Act has given powers to the central government to take measures to protect and improve environment while the state government coordinate the actions.

Salient Features of the Act-

The Act has given powers to the Central Government to take measures to protect and improve environment while the state government coordinate the actions.

The most important function of central government under this act includes: Setting up of

a) The standards of quality of air, water or soil for various areas and purposes.

b) The maximum permissible limits of concentration of various environmental pollutants for different areas.

c) The procedures and safeguards for the handling of hazardous substances.

d) The prohibition and restrictions on the handling of hazardous substances indifferent areas.

e) The prohibition and restriction on the location of the industries and to carry on process and operations in different areas.

f) The procedures and safeguards for the prevention of accidents which may cause environmental pollution and providing for remedial measures for such accidents.

The power of entry and inspection, power to take sample etc. under this act lies with the Central Government or any officer empowered by it.

For the purpose of protecting and improving the quality of the environment and preventing and abating pollution, standards have been specified under Schedule-IV of Environment (Protection) Rules 1986 for emission of gaseous pollutants and discharge of effluents/waste water from industries.

These standard vary from industry to industry and also vary with the medium into which the effluent is discharged or the area of emission.

5.19 ENFORCEMENT OF ENVIRONMENTAL LEGISLATION: MAJOR ISSUES

We have seen that there are a number of important environmental laws in the form of Acts for safeguarding our environmental quality. But in spite of these acts we find that we are not able to achieve the target of bringing 33% of our land cover under forests. Still we are losing our Valuable Biological Diverty. The rivers have been turned into open sewers in many places and the air in our big cities is badly polluted. The status of environment shows that there are drawback in environmental legislations and problems in their effective implementation.

5.20 PUBLIC ENVIRONMENTAL AWARENESS:

Public awareness about environment is at a stage of infancy. Off late, some awareness has taken place related to environmental degradation, pollution etc.but incomplete knowledge information and ignorance about many aspects has often led to misconceptions. Development has paved the path for rise in the levels or standards of living but it has simultaneously led to serious environmental disasters. Issues related to environment have been often been branded as anti-development. The wisdom lies in maintaining a balance between our needs and supplies so that the delicate ecological balance is not disrupted. Some of the main reasons responsible for widespread environmental ignorance can be detailed below:

1. Our courses in Science, technology, economics etc. have so far failed to integrate the knowledge in environmental aspects as an essential component of the curriculum.
2. Our planners, decision-makers, politicians and administrators have not been trained so as to consider the environmental aspects associated with their plans.
3. In a zeal to go ahead with some ambitious development projects, quite often there is a purposeful concealment of information about environmental aspects.

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Check Your Progress:

4. What do you understand by acid rain?
5. What are the objectives of forest conservation act, 1980?
6. What are the objectives of forest conservation act, 1986?

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4. There is greater consideration of economic gains and issues related to eliminating poverty by providing employment that overshadows the basic environmental issues.

Methods to Propagate Environmental Awareness

There is immense need for Environmental awareness. It is to be created through formal and informal education to all sections of the society. Everyone needs to understand it because 'environment belongs to all' and 'every individual matters' when it comes to conservation and protection of environment. Various stages and methods that can be useful for raising environmental awareness in different sections of the society are given below:

1. Among students through education: Such education should be imparted to the students right from the childhood age. These studies are now being incorporated at all stages in schools, colleges as per the directives of the Supreme Court.
2. Among the masses through mass-media: Media can play an important role to educate the masses through articles, rallies, campaigns, street plays, TV serials etc. This will appeal all age groups at the same time.
3. Among the planners, decision makers and leaders: It is very important to give these classes of people necessary orientation and training through specially organized workshops and training programs

SUMMARY

We will need to change attitudes, consumption patterns, manufacturing and marketing practices and get into technological world that it is less intensive in its use of materials and energy to be able to manage the environmental crisis. Just improvement of efficiency alone is not going to be enough.

In order to properly manage environment and resources, due consideration should be given to the fact that poor people directly depend upon natural resources for their livelihood. Sustainable development must address the issue of eradication of poverty which is linked with employment both of women and youth and other income generation programs.

Huge water-loss occurs due to run-off on most of the soils, which can be reduced by allowing most of the water to infiltrate into the soil. This can be achieved by using contour cultivation, terrace framing, water spreading, chemical treatment or improved water-storage system.

The watersheds are very often found to be degraded due to uncontrolled, unplanned and unscientific land use activities. Organizing, deforestation, mining, construction activities, industrialization, shifting cultivation, natural and artificial fires, soil erosion and ignorance of local people have been responsible for degradation of various watersheds.

This view is guiding most industrial societies. It puts human beings in the center giving them the highest status. Man is considered to be most capable for managing the planet earth.

Climate change is changing our economy, health and communities in diverse ways. Scientists warn that if we do not aggressively curb climate change now, the results will likely be disastrous.

Global warming is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to the greenhouse gases released by people burning fossil fuels.

Pollution is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water or such discharge as is likely to cause a nuisance or render the water harm aquatic plants and other organisms or animal life. The definition of water pollution has thus encompassed the entire probable agents in water that may cause any harm or have a potential to harm any kind of in any way.

The effect of ozone depletion on the Earth's surface is the increased levels of ultraviolet-B radiation. This type of UV-B radiation is harmful to humans, animals and plants. The increases in UV-B radiation have been observed not only under the ozone hole in Antarctica but in other places like the Alps (Europe) and Canada (North America).

Economically unproductive lands suffering from environmental deterioration are known as wastelands. The wastelands include salt-affected lands, sandy areas, gullied areas, undulating uplands, barren hill-ridge etc. Snow covered areas, glacial areas and areas rendered barren after Jhum cultivation are also included in wastelands. More than half of our country's geographical area (about 175million ha) is estimated to be wasteland, thus indicating the seriousness of the problem for a country like ours which has to support 1/6th of the world's population .Maximum wasteland areas in our country lie Rajasthan (36 million ha) followed by M.P. and Andhra Pradesh. In Haryana the wastelands cover about 8.4% of the total land area and most of it comprises saline, sodic or sandy land areas. Wastelands are formed by natural processes, which include undulating uplands, snow-covered lands, coastal saline areas, sandy areas etc. or by anthropogenic (man-made) activities leading to eroded, saline or waterlogged lands.

The Act came into force on November 19, 1986, the birth anniversary of our late Prime Minister Indira Gandhi, who was a pioneer of environmental protection issues in our country. The Act extends to whole of India.

We have seen that there are a number of important environmental laws in the form of Acts for safeguarding our environmental quality. But in spite of these acts we find that we are not able to achieve the target of bringing 33% of our land cover under forests. Still we are losing our Wild Life. The rivers have been turned into open sewers in many places and the air in our big cities is badly polluted. The status of environment shows that there are drawback in environmental legislations and problems in their effective implementation.

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ANSWER TO CHECK YOUR PROGRESS

1. **RAIN WATER HARVESTING:** Rainwater harvesting is a technique of increasing the recharge of groundwater by capturing and storing rainwater. This is done by constructing special water-harvesting structures like dug wells, percolation pits, lagoons, check dams etc.

   Rainwater, wherever it falls, is captured and pollution of this water is prevented. Rainwater harvesting is not only proving useful for poor and scanty rainfall regions but also for the rich ones. The annual average rainfall in India is 1200 mm; however, in most places it is concentrated over the rainy season, from June to September. It is an astonishing fact that Cherapunji, the place receiving the second highest annual rainfall as11000 mm still suffers from water scarcity.

2. The objectives of watershed management are as follows:

   1. To rehabilitate the watershed through proper land use adopting conservation strategies for minimizing soil erosion and moisture retention so as to ensure good productivity of the land for the farmers.
   2. To manage the watershed for beneficial developmental activities like domestic water supply, irrigation, hydropower generation etc.
   3. To minimize the risks of floods, droughts and land slides
   4. To develop rural areas in the region with clear plans for improving the economy of the regions.

3. **GLOBAL WARMING :** Global warming is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to the greenhouse gases released by people burning fossil fuels.

   Troposphere, the lower most layer of the atmosphere traps heat by natural process due to the presence of certain gases. This effect is called Green House Effect as it is similar to the warming effect observed in the horticultural Greenhouse made of glass.

4. **ACID RAIN :** Oxides of sulfur and nitrogen originating from industrial operations and fossil fuel combustion are the major sources of acid forming gases. Acid forming gases are oxidized over several days by which time they travel several thousand kilometers. In the atmosphere these gases are ultimately converted into sulfuric and nitric acids. Hydrogen chloride emission forms hydrochloric acid. These acids cause acidic rain. Acid rain is only one component of acidic deposition. Acidic decomposition is the total wet acidic deposition (acid rain) and dry deposition. Rain water is turned acidic when its pH falls below 5.6. In fact clean or natural rain water has a pH of 5.6 at 20° c because of formation of carbonic acid due to dissolution of CO2 in water. In absence of rain, dry deposition of acid may occur.

5. **Objectives of the Act-**
   - Protection and conservation of forest .
   - To ensure judicious use of forest products.
6. **Objectives of the Act-**
   - Protection and improvement of the environment ;
   - Prevention of hazards to all living creatures (plants, animals and humans) and property;
   - Maintenance of harmonious relationship between humans and their environment.

TEST YOURSELF

1. What do you understand by sustainable development? What are the major measures to attain sustainability?
2. Why is urban requirement of energy more than rural requirement?
3. Discuss the measures to conserve water.
4. What is rainwater harvesting? What are the purposes served by it?
5. What is a watershed? Critically discuss the objectives and practices of watershed management.
6. What do we mean by "Environmental Refugees" or "outs tees"? What are the major causes for displacement of native tribal people? Discuss with examples.
7. What are the major issues and problems related to rehabilitation of the displaced tribal? Discuss with examples.
8. What are greenhouse gases and greenhouse effects? How do they contribute to the global warming?
9. Discuss the major implications of enhanced global warming.
10. Write an essay on Acid Rain.
11. Discuss various measures for Wasteland reclamation.
12. Discuss salient features of various environmental legislations.
13. Write notes on various authorities established by various laws for prevention and control of environmental pollution.

5.21 REFERENCES AND FURTHER READING

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UNIT 6

HUMAN POLLUTION AND THE ENVIRONMENT

NOTES

The Chapter Covers :

Learning Objectives :

After going through this unit, You would be able to -

- Population growth
- Family welfare programmes
- Human rights
- Value education
- Role of information technology in environment and human health

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6.1 INTRODUCTION

The population of the earth has always been a critical question unanswered for decades and hundreds of years. In 1800, the earth was home to about 1 billion people. The dramatic way in which global human population grew is really alarming. It is amazing to note that it took about 39000 years of human history to reach 1 billion and 130 years to reach the second billion and 45 years to reach 4billion. And it might take a span of few decades to double the same. We have already crossed 6 billion and may reach 11 billion by 2045 as per the World Bank estimates. This trend of human population growth has definite reasons.

6.2 POPULATION GROWTH:

In the beginning of human civilization, during the Stone Age, population was quite stable. Environmental conditions were hostile and humans had not yet developed adequate artificial means for adaptations to these stresses. Droughts and outbreak of diseases used to be quite common leading to mass deaths. The 14th Century A.D. experienced large scale mortality due to bubonic plague when about 50% of people in Asia and Europe died due to the disease.

With scientific and technological advancement, life expectancy of humans improved. People started living in definite settlements leading a more stable life with better sanitation, food and medical facilities. Victory over famine-related deaths and infant mortality became instrumental for a rapid increase in population size. In agriculture based societies children were considered as economic assets who would help the parents in the fields and that is why in the developing countries, population growth climbed to unthought-of heights, at the rate of 3-4% per year, accounting for about 90-95% of total population growth of the world in the last 50years.

6.3 POPULATION EXPLOSION

There has been a dramatic reduction in the doubling time of the global human population, as we have already discussed. In the 20th Century, human population has grown much faster than ever before. Between 1950-90, in just 40 years the population crossed 5 billion mark with current addition about 92 million every year, so to say adding a new Mexico every year.

In the year 2000, the world population was 6.3 billion and it is predicted to grow four times in next 100 years. This is unprecedented growth of human population at an alarming rate is referred to as population explosion.

The Indian scenario: India is the second most populous country of the world with1 billion people. If the current growth rates continue, it will have 1.63 billion people by 2050 and will become the most populous country surpassing China. So we are heading for very serious ramifications of the population explosion problem. Do we have the resources and provisions for feeding, housing, educating and employing all those people being added every year? If we look at the population statistics of our country we find that in just 35 years after independence we added

another India in terms of population. On 11th May 2000 we became 1 Billion and now we can say that every 6th person in this world is an Indian.

6.4 THE POPULATION CLOCK

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Every second, on average 4-5 children are born and 2people die, thus resulting in net gain of nearly 2.5 people every second. This means that every hour we are growing by about 9000 and everyday by about 214000. Population explosion is causing severe resource depletion and environmental degradation. Our resources like land, water, fossil fuels, minerals etc. are limited and due to over exploitation these resources are getting exhausted. Even many of the renewable resources like forests, grasslands etc. are under tremendous pressure.

Industrial and economic growth are raising our quality of life but adding toxic pollutants into the air, water and soil. As a result, the ecological life-support systems are getting jeopardized. There is a fierce debate on this issue as to whether we should immediately reduce fertility rates through worldwide birth control programs in order to stabilize or even shrink the population or whether human beings will devise new technologies for alternate resources, so that the problem of crossing the carrying capacity of the earth will never actually come. There are two important views on population growth which we need to understand:

1. **Malthusian Theory**:

   According to Malthus, human populations tend to grow at an exponential or compound rate whereas food production increases very slowly or remains stable. Therefore, starvation, poverty, disease, crime and misery are invariably associated with population explosion. He believes "positive checks" like famines, disease outbreak and violence as well as "preventive checks" like birth control need to stabilize population growth.

2. **Marxian Theory**:

   According to Karl Marx, population growth is a symptom rather the cause of poverty, resource depletion, pollution and other social ills. He believed that social exploitation and oppression of the less privileged people leads to poverty, overcrowding, unemployment, environmental degradation that in turn, causes over population. A compromise between the two views is required because all these factors seem to be interdependent and interrelated. Equity and social justice to all, allowing everyone to enjoy good standard of living is the need of the hour that can voluntarily help in achieving a stabilized global population.

6.5 FAMILY WELFARE PROGRAMMES

Population explosion is like a time bomb that must be diffused well in time. The population must be kept much below the carrying capacity and stabilized, so that the aftermath of explosion could be avoided. It is not precisely known as to how

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long we can continue our exponential growth in population and resource use without suffering overshoot or dieback. We are getting warning signals that if not controlled, the increasing population is going to deplete all the resources beyond their regeneration capacity. A catastrophic doomsday model warns us that the earth cannot sustain more than two more doublings i.e. 25 billion.

6.6 FAMILY PLANNING:

Family planning allows couples to decide their family size and also the time spacing of their offspring. Almost every culture in the past used to practice some traditional fertility control methods through some traditions, taboos and folk medicine.

Modern science has provided several birth control techniques including mechanical barriers, surgical methods, chemical pills and physical barriers to implantation. More than a hundred contraceptive methods are on trial.

The United Nations Family Planning Agency provides funds to 135 countries. Many of these countries include abortion as part of the population control programme which very often encourages female infanticide thereby disturbing the optimal male: female ratio in a society. The birth control programmes have often faced strong opposition from religious groups. Nonetheless, World Health Organization (WHO) estimates that today about 50 percent of the world's married couples adopt some family planning measures as compared to just 10% about 30 years back. Still some 300 million couples do not have access to family planning.

The Indian Context:

India started the family planning programme in 1952 while its population was nearly 400 million. In 1970's, forced family planning campaign by the Government resulted in a turmoil all over the country. In 1978, the government raised the legal minimum age of marriage from 18 to 21for men and 15 to 18 years for women. Even in 1981 census no drop in population growth was observed. Since then funding for family planning programmes has been increased further.

Unable to reach a consensus regarding population policy, the state governments in 2000 were allowed to adopt their own approach. In Kerala, the population has been stabilized with a focus on social justice as already discussed. It is now comparable to many industrialized nations including USA and it has proved that wealth is not a pre-requisite for zero population growth. Andhra Pradesh has also just achieved the target of ZPG in 2001, but it has been done with a different approach. The poor class was encouraged to be sterilized after two children by paying cash incentives, better land, housing, wells and subsidized loans. In contrast, Bihar and UP have shown increase in their growth rates (more than2.5%).

Successful family planning programs need significant societal changes including social, educational and economic status for women, social security, political stability, proper stability, proper awareness and confidence building along with accessibility and affectivity of the birth control measures.

6.7 ENVIRONMENT AND HUMAN HEALTH:

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Health is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."Health is influenced by many factors such as:

1. Nutritional factors

2. Biological factors

3. Chemical factors

4. Psychological factors

These factors may cause harmful changes in the body's conditions are called disease.The following aspects contribute to the disease and impact on human health:

- Infectious organism
- Chemicals
- Noise
- Radiations
- Diet
- Settlement

Let us explain the above aspects in details:

Infectious organisms

Disease causing organisms pose great environmental threats to health more severely in the developing countries especially the tropical ones. High temperature and moisture along with malnutrition help many diseases to spread in these countries.

Infectious organisms can also cause respiratory diseases. Such diseases include malaria, schistosomiasis, filariasis etc. Most of these infections take place when the environmental conditions are unclean and unhygienic.

Chemicals

A large number of chemicals are introduced in the environment by anthropogenic activities. Industrial effluents containing various chemicals are of major concern. These chemical could be divided into categories i.e. hazardous and toxic chemicals.

Some of the chemicals cause abnormality in growth and development while others also sometimes affect the nervous system and the reproductive system. Some chemicals/pesticides like DDT and other industrial pollutants may act as hormone analogs in humans and other species. These environmental hormones affect reproduction, development and cause various types of ailments including tumors.

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Noise:

Although human ear is capable of tolerating a range of sound levels, yet if sound levels beyond permissible level exist for certain duration, it becomes painful and sometimes irreparable damage occurs. Besides hearing damage various types of physiological and psychological changes are induced by noise pollution.

Radiations

Radiations are known to cause short-term and long term changes in various organs. Cosmic rays and ultra-violet rays cause harmful effects on human health which may include cancer.

Diet

Diet has a very important role in maintaining health. Malnutrition makes human prone to other diseases. There is strong correlation between cardiovascular diseases and the amount of salt and fat in one's diet. Food contamination can cause various ill effects. Various adulterated pulses, condiments, oils etc. sold in the market to earn profit affect human health.

Settlement

Proper environment, availability of basic necessities of lifelike water, sanitation etc. are essential for health living. Housing is very important from security point of view. Improper settlement and poor physical environment may cause various psychological problems which affect various vital physiological processes in the body.

6.8 HUMAN RIGHTS:

Human rights are the rights that a human being must enjoy on this earth since he or she is a human being. Although the foundation of human rights was laid in the13th Century when resistance to religious intolerance, socio-economic restraints and scientific dogmas resulted in some revolts mainly due to the liberal thoughts of some philosophers.

However, true hopes for all people for happy, dignified and secure living conditions were raised with the Universal Declaration of Human Rights (UNDHR) by the UNO on December 10, 1948.The World Health Organization estimates indicate that one out every five persons in this world is malnourished, lacks clean drinking water, lacks proper hygienic conditions and adequate health facilities, one out of three persons does not have enough fuel to cook or keep warm and one of five persons is desperately poor for whom life is nothing but struggle for survival. Every year 40 million people are dying due to consumption of contaminated drinking water.

It is quite painful to look at the environmental inequalities. The developed nations utilizing most of the natural resources and reaping the benefits of industrial develop-

ment are not bearing the burden of their hazardous wastes, as they export such wastes to many developing countries that have to face the toxic impacts of the hazardous wastes. The worker class and the poor are the main victims and sufferers of adverse effects of industrial toxins, foul smelling polluted air, unclean and unsafe drinking water, unhealthy working conditions, occupational health hazards etc. The indigenous people and tribal people are the worst victims of development who lose their homes and lands to dams and reservoirs and are deprived of their human rights to native homes. (e.g. Sardar Sarvor Narmada Nigam project-hampered tribal and many others- their rehabilitation is still a burning issue- activists such as Ms.Medha Patkar, Baba Amte are still fighting the unending battle with the respective governments- but very little yielded from the stir so far.)

6.9 FAMILY VALUES:

1) **Difference regarding function of family:** As a result of industrialization and restructure of pay packets, the function of family has changed considerably. Compared to today the family had much more function in the past. Now a number of functions, which used to be performed by families in the past, have been taken over by other institutions. Traditionally an Indian family used to be a center of birth, rearing and education of children. The children used to get training in the ancestral profession. The function of socialization of children, too, used to be performed by the family. But in the industrialized society of today family is not required to fulfill these roles. Today children are born in hospital. Even for the Protection, nurture and care of the children there are today a number of official and non-official institutions. In big towns we find today a number of Infant-Care centers, homes for orphaned and children homes. The education of children today is done in schools and not in homes. The professional training also is no longer the obligation of the family.

   What is even more serious and disgusting that even feeding is no longer the exclusive obligation of the family! Many people in metropolis eat out of homes. In almost all big cities people rarely take lunch at home except on Sunday and holidays. In many families both husband and wife go out for work. In these circumstances the function of a modern family are more formal than real.

2) **Breaking up of Joint Family:** Traditionally most of the Indian families were joint families. As result of industrialization, most of these joint families are breaking up and are being replaced by nuclear families. There are a number of reasons for this. Firstly, in industrial town there is acute shortage of residential accommodation. Most of the people have to content themselves with a single or two room accommodations. In these circumstances, it is physically exceedingly difficult if not impossible to retain the joint family system.

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Secondly, as a sequel to industrialization family trades and professions have been eliminated. The sense of the same parents differs widely in respect of economic and social levels. This has given rise to individualization. As a result of all these conditions joint family is all but finished in industrial towns.

3) **Small families:** As a result of industrialization, the cost of living has gone up. At the same time standard of living has also gone up considerably. Everybody wants good clothes, houses and other comforts of life. Obviously, it is not possible to maintain the standard within a big family. Therefore, people these days want to keep small families. The prevalence of contraceptives and abortion had made this goal easily attainable. Thus we find that there is a strong trend towards small families in industrialized towns.

4) **Change in the status of Women:** In past the status enjoyed by women in Indian society was rather low. Women were shut up in the four walls of the home. From economic and social points of view woman was subject to man. The women enjoyed no independence. Without husband the condition of a woman was miserable. As a result of industrialization there has been much improvement in the status of women. They are therefore becoming independent all walks of life. Their status and respect in society has therefore improved considerably. Now-a-days women consider themselves equal, even superior, to man. As a result of this feeling many women today do not like to marry. They wish to assert their independence by defying the laws of society.

5) **Disintegration of Family:** As a result of industrialization the outlook of intense individualism has grown. Everyone wants to have his own way; no one likes to be subject to anybody. Nobody these days appreciates the need for adjustment and give and take. Thus we find in modern society, families breaking up under last strain. There is continuous tension and conflict in the minds of family members. As a consequence of this situation it is small wonder that families are breaking up fast in urban society.

6) **Difference in family goals:** The goals and ideals, which nourished the traditional Indian family, were spiritual and religious. The housewives used to regard their husbands as a goal or divine beings. The willingly subjected themselves to each and every whim of their husbands. Even children used to give unqualified respect to their parents. The father was regarded to be head of the family and his command was rarely defied. In Indian homes Ram and Sita were ideals of paternal devotion and wife's dedication to husband respectively.

In modern industrial society there is no room for such ideals. For a modern wife, the husband can be at best a honorable colleague and under no circumstances, a God. The status of father in a family is being lowered as a result of industrialization. Compared to parents, children now have more say in the family affairs. In the past

the functions, which were, regarded sacred duty and ideals are now considered acceptable only from utilitarian point of view. The father no longer holds away over family members.

6.10 CONSUMERISM:

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Because of rapid industrialization, the comparative gap between rich and poor is widening. Those with jobs and those with-outs have been reality of the rat race of daily life. Those with money are willing to spend it for their comforts and those with-outs are resorting to unsocial elements resulting in increase in crimes especially financial crimes like dacoits, embezzlement, misappropriations etc. It's the impact of the continuous increase in salaries and wages every year, that the habits of spending have undergone change.

In such society those who have jobs and reasonable salary or wage are now not worrying about the money in their pockets. Such persons are willing to buy things, articles beyond their buying capacity. There are increasing tendencies of resorting to availing loans from financial institutions, banks. The tendencies of buying the articles, house, luxury items, car, and two-wheelers on installments have also been impact of changing pay structures.

The savings habits have been getting converted into spending habits.

6.11 SOCIETY:

The members of society have direct impact of such changes in pay structures. The society also becomes money minded. The ideals change and immoral things are pretended to be sound and worth following. The value system changes. The issues like consumerism, corruption and dreaming for unrealistic dreams brings about the change in every member of the society. The shopkeepers change their style of selling. Landlords change their rate of rents. Even the Grocer start selling items, which he would never, had, given his/her religion. Since the matters of religion is neglected while selling certain items. The whole society undergoes the change in approach to life. Such society is called industrial society.

Main features of such society are:

1. **Domination of machines:** In this society machine dominates man. Everything is done with the help of machines, so that the importance of man and manual work very much decreases.
2. **Mass production:** In industrialization there is always mass production. It is because unless society is in a position to feed the machines, there will be no industrialization. Goods are produced on large-scale basis.
3. **Exploitation of workers:** In this society, there is naked exploitation of workers. They are paid basis minimum wages so that they survive and work for industry. They are not given any share in profits. Even their wages

Check Your Progress:

1. What are factors which influence the human health?
2. What do you understand by consumerism?

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are increased after a lot of agitation.

4. **No identification with the work:** Another feature is that the worker is not identified with the work, which he is doing. The owner of the industry is interested only in getting his goods and making his brand popular in the market, rather than bring workers on the forefront.

5. **Poor working conditions:** The workers are not paid adequately with the result that they cannot afford to live in good houses. They live in slums in miserable conditions. Working conditions in which laborers are required to work too are not good. This is a continuing feature of the industry.

6. **Environmental Pollution:** Industry bring with it pollution in the environments. Smoke of chimney of factories, noise of the machines, chemical water flowing out of factories and residue of factory raw materials and dust all create problems of environment pollution and that is unavoidable in the factory situation.

7. **Trend towards urbanization:** Industries are set abound places where communication and other facilities are easily available. Once industries had been set up a town develops around that. There are always employment opportunities in the industries. The people therefore, start migrating from rural areas. In this way trend towards urbanization starts.

8. **Pressure on existing institutions:** Industrialization exerts heavy pressure on existing institutions like marriage, family rural life, and educational system and so on. With industrializanon the institutions of marriage has come under heavy strains. It is now considered a friendship and not religious institution. So is the case of religion. Many religious practices are now questioned. Single-family system is replacing old joint family system. Awakening has started coming in the rural areas where people are not prepared to accept everything blindly. In fact there is no existing social institution, which does not come under strain with industrialization.

9. **Scientific advancement:** In modern era, there is always keen desire of society to have new inventions. This can be possible only when more attention is paid to scientific advancement. Every effort is made to have scientific inventions so that new machines can do maximum work within minimum time.

10. **Material prosperity:** Industrialization has brought with it material prosperity. These nations, which are industrially advanced, are economically rich In fact outlook of these nations is purely materialistic and those weigh everything in terms of money.

11. **Colonialism:** Industrialization has brought with it colonialism and evils which this system brings with it. It is unavoidable because so many goods are produced with the help of machines that unless these are quickly marketed

these will create many problems. In this way, industrial societies have its own advantages and disadvantages but fact remains that today every nation is in a race to industrialize itself.

6.12 VALUE EDUCATION

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Education is one of the most important tools in bringing about socio-economic and cultural progress of a country. However, the objective of education should not merely be imparting coaching to the students that they get through examinations with good results and get some good job.

Education does not simply mean acquiring a lot of information but also its righteousness and use within the framework of a spectrum of ethical values. The rapid strides of scientific and technological advancement have no doubt, brought revolutionary changes in our everyday life and information technology has shrunk the whole world into a "global village", with access to very information sitting in one corner over the internet. But, in this frenzy for development and mad race for progress perhaps man has become too materialistic, self-centered and over-ambitious and the desired ideals of a real good life have been pushed to the background.

Value-based education thus has a very significant role:

- In providing proper direction to our youth,
- To inculcate a positive attitude in them and
- To teach them the distinction between right and wrong.
- It teaches them to be compassionate, helpful, peace loving, generous and tolerant so that they can move towards more harmonious, peaceful, enjoyable and sustainable future.

Value education helps in arriving at value-based judgment in life based on practical understanding of various natural principles rather than acquiring certain prejudices. Value education encompasses human values, social values, professional values, religious values, national values, aesthetic values and environmental values. Value education increases awareness about our national history, our cultural heritage, national pride, constitutional rights and duties, national integration, community development and environment.

Value education has different phases i.e. value awareness, value orientation, value appraisal, value selection, value commitment and value action. The basic aim is to create and develop awareness about the values, their significance and role. After knowing them the student's mindset would get oriented towards those values and he will try to critically analyze the same and then select the values which really appeal to him. This will be followed by commitment that needs to be re-affirmed over and over again so that every action is taken keeping those values in view.

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Value based Environmental Education:

Environmental education or environmental literacy is something that every person should be well versed with. The principles of ecology and fundamentals of environment can really help create sense of earth-citizenship and a sense of duty to care for the earth and its resources and to manage them in a sustainable way so that our children and grand children to inherit a safe and clean planet to live on.

Following is the various ways in which we can make environmental education value based:

1. Preparation of text books and resource materials about environmental education can play an important role in building positive attitudes about the environment. The basic human value 'man in nature' rather than 'nature for man' needs to be infused through the same.

2. Social values like love, compassion, tolerance and justice which are the basic teachings of most of our religions need to be woven into environmental education. These are the values to be matured so that the forms of life and the biodiversity on this earth are protected.

3. Cultural and religious values enshrined in Vedas like "Dehi me dadami te" i.e."you give me and I give you" (Yajurveda) emphasize that man should not exploit nature without nurturing her. Our cultural customs and rituals in many ways teach us to perform such functions as would protect and nurture nature and respect every aspect of nature, treating them as sacred, be it rivers, earth, mountains or forests.

4. Environmental education should encompass the ethical values of earth-centric rather than human-centric world-view. The educational system should promote the earth-citizenship thinking. Instead of considering human being as supreme we have to think of the welfare of the earth.

5. Global values stress upon the concept of the human civilization is a part of the planet as a whole and similarity nature and various natural phenomena over the earth are interconnected and inter-linked with special bonds of harmony. If we disturb this harmony anywhere there will be an ecological imbalance leading to catastrophic results.

6. Spiritual values highlight the principles of self-restraint, self-discipline, contentment, reduction of wants, freedom from greed and austerity.

All these values promote conservationism and transform our consumerist approach. The above mentioned human values, socio-cultural, ethical, spiritual and global values incorporated into environmental education can go a long way in attaining the goals of sustainable development and environmental conservation.

Value-based environmental education can bring in a total transformation of our mind-set, our attitudes and our life-styles.

"What is the use of building a beautiful house if you don't have a decent planet to place it on?" perhaps this single question can answer the main burning question-"What is real development and progress?"

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We certainly do not want development in exchange of environmental disasters, health hazards, loss of mental peace and merciless destruction of nature's beauty and natural resources. The value elements in environmental education alone can succeed in achieving the real goals of environmental literacy.

6.13 HIV/AIDS

AIDS, the Acquired Immuno Deficiency Syndrome is not a hereditary disease but is caused by HIV (Human Immunodeficiency Virus), HIV from an infected person can pass to a normal person through blood contact generally during unprotected sex with infected person and sharing needles or syringes contaminated with small quantities of blood from HIV positive person. HIV can also pass from infected mothers to their babies during pregnancy, delivery or breast feeding.HIV, however, doesn't spread through tears, sweat, urine, faeces or saliva during normal kissing. It also does not spread by sharing utensils, towels, clothing, toilet seats or insect bite like that of mosquito or bed bug.

According to a recent estimate about 40 million people are living with HIV/AIDS worldwide and 70% of them in Sub Saharan Africa. HIV/AIDS has been identified as the forth largest cause of mortality. About 3 million people died due to HIV/AIDS in 2003. AIDS is rapidly spreading in Eastern Europe and Asia. It is expected that in the coming decades there will be sharp increase in HIV/AIDS cases in Russia, China and India. AIDS was discovered in 1983. Although sufficient knowledge has been gained about the disease yet a definite source of this virus could not be identified.

Most evidences have suggested that AIDS has spread from Africa. It is believed that the virus has been transferred to humans from primates like African Monkey (White sooty mangabeys) or chimpanzees.

According to another theory HIV has spread through vaccine programmes in various parts of the world in the following manner:

1. HIV has spread in Africa through HIV contaminated polio vaccine prepared by using monkey's kidney.
2. It had spread through hepatitis B viral vaccine in New York, Los Angeles and San Francisco.
3. It has spread through small pox vaccine programme of Africa.

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It is also hypothesized that AIDS is a man made epidemic produced by genetically engineered laboratory produced virus. AIDS itself does not kill humans. The deaths occur due to attack by other diseases because of the weakening of immune system. There is decline in T-cells which are the key infection fighters in the immune system. HIV destroys or disables these cells as a result of which various types of infectious diseases due to microbial invasion occur. Even dreaded disease like cancer can easily develop in the HIV infected persons. Consumption of alcohol is understood to increase the susceptibility to infection and progression of AIDS.

Effects of HIV/AIDS on Environment:

When there is an AIDS epidemic large number of deaths occurs which adversely affect local environment and natural resources. Due to large number of deaths there is loss of labour and the level of production decreases. With fewer adults, young members with limited resources like land and lack of experience and knowledge find it difficult to look after the perennial crops and prefer crops requiring less labour and time. They devote less time for soil conservation, forestry conservation, especially if there are deaths of professional forest workers.

Demand of easily accessible fuel wood increases. More timber is required for making coffins or for pyre making.

More water is required for maintaining hygiene in AIDS affected locality. The HIV carriers are also not able to perform well due to lack of energy and frequent fever and sweating.

6.14 WOMEN AND CHILD WELFARE

Women and children are usually the soft targets, who suffer in a number of ways mainly because they are weaker, helpless and economically dependent.

Women Welfare

Women usually suffer gender discrimination and devaluation at home, at workplace, in matrimony, in inheritance, in public life and power, particularly in developing countries. The gender violence, victimization and harassment take many forms across culture, race or nation. The statistical data provided by the Ministry of Women and Child Development is an eye opener that deglorifies the celebrated culture of our country. The exceptionally high number of cases of abduction, dowry deaths, rape, domestic violence, criminal offences and mental torture to women is something that needs immediate attention and reforms in interest of the women. Women are often the worst victims of communal enmities. The human rights of women are violated too often in a male dominated patriarchal society. Thus, there is an urgent need for policy reforms and more stringent legislation as well as educational and legal awareness amongst women for checking the atrocities and injustice towards her. There are now many 'women groups' who actively take up women welfare issues and legally constituted 'women cells' that exist almost everywhere and fight for protection of women rights and dignity. There is full-fledged Ministry for Women and Child

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Development whose sole aim is to work for the welfare and upliftment of women encompassing family planning, health care, education and awareness. There is a need for complete transformation and reorientation of social ethos for restoring dignity, status, equality and respect for women. Women are also the victims of capitalism, development and environment. The exploitative nature of capitalist development not only affects the natural environment but the traditional, social, cultural and family life of women. After losing the forests and getting dehabitlitated from their native places, men folk usually migrate to towns in search of household with little resources.

Development projects like mining very often play havoc with the life of women. Men can still work in the mines or migrate to towns after getting compensation from the government. The National Network for Women and Mining (NNWM) with about 20 groups in different mining states of India is rightly fighting for a "gender audit" of India's mining companies. The displaced women are the worst affected as they do not get any compensation and are totally dependent upon the males for wages. The displaced women driven out from their land-based work are forced to take up marginalized work which is highly un-organized and often socially humiliating. Issues related to their dignity and honour have not received any attention. The NNWM is now working for rights of women over natural resources, resettlement and compensation issues.

Besides the government initiatives there are now a number of non-government(NGOs) mostly as "Mahila mandals" to create awareness amongst women of remote villages even to empower them, train them, educate them and help them to become economically self-dependent. On the international level, the United Nations Decade for Women (1975-85)witnessed inclusion of several women welfare related issues on international agenda. The CEDAW (International Convention on the Elimination of all forms of Discrimination Against Women, 1979) has been a landmark outcome of the decade to be accepted as an international standard for the protection of women's human rights and socio-economic upliftment.It is however, most important for all women, in the mainstream, tribal, refugees and the down-trodden to be educated about these issues.

Child Welfare:

Children are considered to be the assets of a society. But ironically, the statistical figures depict that about a million babies, out of 21 million born every year in India are abandoned soon after their birth due to different socio economic reasons.

Around 20 million children in our country are estimated to be working as child labours, some of them in various hazardous industries like the match industry, fire-work industries, brassware industry and pottery industry. Poverty is the main reason to drive these children into long hours of work in miserable, unhealthy conditions and yet they do not get the minimum nutritive food, what to talk of educational and recreational facilities, which are their childhood rights.

Check Your Progress:

3. What arethe effects of HIV/AIDS on environment?
4. What is the role of databases in the human health?

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The UN General Assembly in 1959 adopted the Declaration of the Rights of a child. After the UN convention on Rights of Child, it became International Law in the year 1990, consisting of 54 articles and a set of international standards and measures to promote and protect the well being of children in a society. The law defines right of the child to survival, protection, development and participation. The right of survival emphasizes on adequately good standards of living, good nutrition and health. The right of protection means freedom from exploitation, abuse, in human treatment and neglect. The right of development ensures access to education, early childhood care and support, social security and right to leisure and recreation. The right to participation means freedom of thought, conscience and religion and appropriate information to the child.

The World Summit on Children held on September 30, 1990 had a focus agenda for the wellbeing of the children targeted be achieved in the beginning of the new millennium. India is also a signatory to the World Declaration on Survival, Protection and Development of Children. A national plan for action for children has been formulated by the Ministry of Human Resource Development (MHRD), Government of India in which a strategic plan has been formulated for children welfare in the priority areas of health, education, nutrition, clean and safe drinking water, sanitation and environment.

Primary education must be free and easily available to one and every child in the country. Universalization of effective access to at least primary level schooling, special emphasis on girl child's education including health and nutrition, upgradation of home based skills, mid-day meals scheme, expansion of earlier childhood development activities including low cost family based involvements are some of the important actions envisaged. Children are also most affected due to environmental pollution. "They consume more water, food and air than adults. Hence more susceptible to any environmental contamination," says one of the scientific reports of Center for Science and Environment (CSE, New Delhi). Water diseases are the biggest threat to children, affecting around 6 million children in India.

Childhood cancer rates are also increasing by 6% every year. Even the growing foetus in the mother's womb is not safe and free from the adverse effects of environmental toxins. It is high time to work together for a secure and cleaner environment so as to give our children a cleaner and safer planet.

6.15 ROLE OF INFORMATION TECHNOLOGY IN ENVIRON- MENT AND HUMAN HEALTH:

Information technology has tremendous potential in the field of environmental education and health as in any other field like business, economics, politics or culture. Development of internet facilities, World Wide Web (WWW), geographical information system (GIS) and information through satellites has generated a wealth of up to date information on various aspects of environment and health.

A number of software have been developed for environment and health studies which are user friendly and can help an early learner in knowing and understanding the subject.

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Database

Database is collection of interrelated data on various subjects. It is usually in computerized form and can be retrieved whenever required. In the computer the information of the database is arranged in a systematic manner that is easily manageable and can be very quickly retrieved. The Ministry of Environment and Forests, Government of India has taken up the task of compiling a database on various biotic communities. The comprehensive database includes wild life database, conservation database, forest cover database etc.

Database is also available for diseases like HIV/AIDS, Malaria, Fluorosis etc. National Management Information System (NMIS) of the Department of Science and Technology has compiled a database on Research and Development Projects along with information about Research Scientists and Personnel involved.

Environmental Information System (ENVIS):

The Ministry of Environment and Forests, Government of India has created an Information System, called Environmental Information System (ENVIS). With its Head Quarters in Delhi it functions in 25 different centers all over the country. The ENVIS work for generating a network of database in areas like pollution control, Clean Technologies, Remote Sensing, Coastal Ecology, Biodiversity, Western Ghats and Eastern Ghats, Environmental Management, Media Related to Environment, Renewable Energy, Desertification, Mangroves, Wild life, Himalayan Ecology, Mining etc. The National Institute of Occupational Health provides computerized information on occupational health i.e. the health aspects of people working various hazardous and non-hazardous industries, safety measures etc.

6.16 REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (GIS)

The satellite imageries provide us actual information about various physical and biological resources and also to some extent about their state of degradation in a digital form through remote sensing.

We are able to gather digital information on environmental aspects like water logging, desertification, deforestation, urban sprawl, river and canal network, mineral and energy reserves and so on. Geographical Information System (GIS) has proved to be a very effective tool in environmental management. GIS is technique of superimposing various thematic maps using digital data on a large number of interrelated or interdependent aspects.

Several useful softwares have been developed for working in the field of GIS. Different thematic maps containing digital information on a number of aspects like

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water resources, industrial growth, human settlements, road network, soil type, forest land, crop land or grass land etc are superimposed in a layer form in computer using software. Such information is very useful for future land use planning.

Even interpretation of polluted zones, degraded lands or diseased cropland etc can be made based on GIS. Planning for locating suitable areas for industrial growth is now being done using GIS by preparing zoning Atlas. GIS serves to check unplanned growth and related environmental problems.

Our satellite data also helps in providing correct, reliable and verifiable information about forest cover, success of conservation efforts etc. They also provide information of atmospheric phenomenon like approach of monsoon, ozone layer depletion, inversion phenomenon, smog etc.We are able to discover many new reserves of oil, minerals etc with the help of information generated by remote sensing satellites. Thus Remote Sensing and GIS play a key role in resource mapping, environmental conservation, management, planning and environmental impact assessment.

It also helps in identifying several disease infected areas which are prone to some vector born diseases like malaria, schistosomiasis etc based upon mapping of such areas. There are several Distribution Information Centers (DICs) in our country they are linked with each other and with the central information network having access to international database.

World Wide Web:

A vast quantum of current data is available on World Wide Web. One of the most important online learning centers with power web is www.mhhe.com/environmentalscience and multimedia Digital Content Manager (DCM\) in the form CD-ROM provides most current and relevant information on principals of environmental science, various problems, queries, applications and solutions. The World Wide Web with resource material on every aspect, classroom activities, digital files or photos, power point lecture presentations, animations, web exercises and quiz has proved to be extremely useful both for the students and the teachers of environmental studies.

The role of online learning center website has the following distinguishing features:

1. **Student friendly features:**

   These include practice quiz, how to study tips, hyperlinks on every chapter's topic with detailed information, web exercises, case studies, environment maps, key terms, career information, current articles and interactive encyclopedia and how to contact your elected officials.

2: **Teacher friendly features:**

   These include in addition to above supplement resource charts, additional case studies, answer to web exercises, solution to critical thinking questions,

editing facilities to add or delete questions and create multiple versions same test etc. Information technology is expanding rapidly with increasing applications and new avenues are being opened with effective role in education, management and planning in the field of environment and health.

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SUMMARY

The Indian scenario: India is the second most populous country of the world with1 billion people. If the current growth rates continue, it will have 1.63 billion people by 2050 and will become the most populous country surpassing China. So we are heading for very serious ramifications of the population explosion problem. Do we have the resources and provisions for feeding, housing, educating and employing all those people being added every year? If we look at the population statistics of our country we find that in just 35 years after independence we added another India in terms of population. On 11th May 2000 we became 1 Billion and now we can say that every 6th person in this world is an Indian.

Human rights are the rights that a human being must enjoy on this earth since he or she is a human being. Although the foundation of human rights was laid in the13th Century when resistance to religious intolerance, socio-economic restraints and scientific dogmas resulted in some revolts mainly due to the liberal thoughts of some philosophers.

Women and children are usually the soft targets, who suffer in a number of ways mainly because they are weaker, helpless and economically dependent.

AIDS, the Acquired Immuno Deficiency Syndrome is not a hereditary disease but is caused by HIV (Human Immunodeficiency Virus). HIV from an infected person can pass to a normal person through blood contact generally during unprotected sex with infected person and sharing needles or syringes contaminated with small quantities of blood from HIV positive person.

Children are considered to be the assets of a society. But ironically, the statistical figures depict that about a million babies, out of 21 million born every year in India are abandoned soon after their birth due to different socio economic reasons.

The satellite imageries provide us actual information about various physical and biological resources and also to some extent about their state of degradation in a digital form through remote sensing.

ANSWER TO CHECK YOUR PROGRESS

1. Health is influenced by many factors such as:

    1. Nutritional factors
    2. Biological factors
    3. Chemical factors
    4. Psychological factors

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2. **CONSUMERISM:** Because of rapid industrialization, the comparative gap between rich and poor is widening. Those with jobs and those with-outs have been reality of the rat race of daily life Those with money are willing to spend it for their comforts and those with-outs are resorting to unsocial elements resulting in increase in crimes especially financial crimes like dacoits, embezzlement, misappropriations etc. It's the impact of the continuous increase in salaries and wages every year, that the habits of spending have undergone change.

3. **Effects of HIV/AIDS on Environment:** When there is an AIDS epidemic large number of deaths occurs which adversely affect local environment and natural resources. Due to large number of deaths there is loss of labour and the level of production decreases. With fewer adults, young members with limited resources like land and lack of experience and knowledge find it difficult to look after the perennial crops and prefer crops requiring less labour and time. They devote less time for soil conservation, forestry conservation, especially if there are deaths of professional forest workers.

4. **Database :** Database is collection of interrelated data on various subjects. It is usually in computerized form and can be retrieved whenever required. In the computer the information of the database is arranged in a systematic manner that is easily manageable and can be very quickly retrieved. The Ministry of Environment and Forests, Government of India has taken up the task of compiling a database on various biotic communities. The comprehensive database includes wild life database, conservation database, forest cover database etc.

   Database is also available for diseases like HIV/AIDS, Malaria, Fluorosis etc. National Management Information System (NMIS) of the Department of Science and Technology has compiled a database on Research and Development Projects along with information about Research Scientists and Personnel involved.

TEST YOURSELF

1. What do you mean by Population clock? How is it related to the concept of Zero population growth and Life expectancy?
2. How can you trace history of population growth? How can you predict the population growth trends of a nation? Explain with examples.
3. What is meant by "Population Explosion"? Discuss the Indian scenario.
4. What is meant by "population stabilization"? Discuss the family welfare and family planning programmes in Indian context.
5. Discuss the influence of environmental parameters and pollution on human health.
6. What is Universal Declaration of Human Rights? What is its importance in achieving the goals of equity, justice and sustainability?

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7. Discuss the salient features of Draft Declaration of Human Rights and Environment.
8. What are the objectives and elements of value education? How can the same be achieved?
9. Briefly discuss HIV/AIDS mode of its spread and its effect on environment.
10. Discuss various issues and measures for women and child welfare at international and national level.11. What is the role of NMIS, ENVIS and GIS in dissemination of environmental information and environmental management?

6.17 REFERENCES AND FURTHER READING

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