LOVELY PROFESSIONAL UNIVERSITY

ENVIRONMENTAL STUDIES

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Printed by
EXCEL BOOKS PRIVATE LIMITED
A-45, Naraina, Phase-I,
New Delhi-110028
for
Lovely Professional University
Phagwara

SYLLABUS

Environmental Studies

Objectives:

- To make the students familiar with the environment issues.
- To sensitize the students about the ecological concern and environmental pollution.

Sr. No.	Topics
1	Environmental Science: Meaning, Scope, Importance and need for public awareness
2	Natural resources and associated problems: Forest resources: deforestation and over exploitation.
3	Mineral resources: effects of extracting mineral resources on environment Food resources: world food problems, Effects of modern agriculture and problem of fertilizers & pesticides.
4	Energy resources: crisis of growing energy needs, Renewable and non-renewable resources of energy, Alternative energy resources. Land resource: Land as a resource, land degradation, soil erosion and desertification. Role of individual in conservation of natural resources and equitable use of resources for sustainable life.
5	Meaning, structure and functions of eco system, Energy flow on eco system, Food chain and food web, Ecological pyramid.
6	Environment pollution: meaning, causes effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution.
7	New sources of pollution: Thermal pollution, Nuclear pollution. Role of individual in prevention of pollution, Disaster management in case of floods, earthquake, cyclone and landslides.
8	Environment and social issues: From unsustainable to sustainable development, Energy related problems of urban people, rain water harvesting, Climate change and global warming, Acid rain and ozone layer depletion, Environment Protection Act.
9	Environment and human population: Population growth and population explosion, Family welfare programmes, Effects of environment on human life, Human rights Environment awareness and human welfare: HIV/AIDS, women and child welfare; Role of information technology in environmental awareness
10	Water resources: over utilisation of surface and underground water, floods, drought, Benefits and problems of dams.

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Unit 1: Environmental Science: An Overview

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Objectives

After studying this unit, you should be able to:

- Explain the concept of Environment
- Discuss the meaning of Environmental Science
- Get an overview of the Scope and Importance of Environmental studies
- Describe the various Types of Environment
- Explain the Need for Public Awareness

Introduction

The science of Environment studies is a multidisciplinary science because it comprises various branches of studies like chemistry, physics, medical science, life science, agriculture, public health, sanitary engineering etc. It is the science of physical phenomena in the environment. It studies of the sources, reactions, transport, effect and fate of physical a biological species in the air, water and soil and the effect of from human activity upon these. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the meaning, scope, importance and types of Environmental Science.

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1.1 Environment Explained

The word "Environment" is originated from French environ means 'around' or 'to surround' or 'to encompass'. This means that environment includes things or objects or events that surround us. But this definition is not enough. This needs to be enlarged to include that there is interaction between objects and surrounding. It is the interaction between living beings (plants and animals) and its environment that includes physical non-living components like oceans or land or mountains. It also includes interaction among living beings. It is thus a multidirectional system of interactions and this system is made up of living organisms and non-living physical components like air, water and land of our planet earth and its associated features like weather, waves and tides. When we consider environment, as a system concept, we must be clear that a system is made up of components which can be separately identified and studied. However, they are connected and these connections are repeated in time and space.

Notes Each component is a system by itself and can be referred to as ecosystem. Lakes, ponds, mountain ranges, forests and coastlines are some of the components of ecosystems.

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

1. ***What is Surrounded:*** The answer to this question is living objects in general and man in particular.
2. ***By what Surrounded:*** The physical attributes are the answer to this question, which become environment. In fact, the concern of all education is the environment of man. However, man cannot exist or be understood in isolation from the other forms of life and from plant life. Hence, environment refers to the sum total of condition, which surrounds point in space and time. The scope of the term Environment has been changing and widening by the passage of time.

   Did u know? In the primitive age, the environment consisted of only physical aspects of the planted earth land, air and water as biological communities. As the time passed on man extended his environment through his social, economic and political functions.

3. ***Where Surrounded:*** The answer to this question. It is in nature that physical component of the plant earth, viz. land, air, water, etc., support and affect life in the biosphere. According to a Goudie environment is the representative of physical components of the earth where in man is an important factor affecting the environment.

1.1.1 Definitions of Environment

Some important definitions of environment are as under:

'A person's environment consists of the sum total of the stimulation which he receives from his conception until his death.' It can be concluded from the above definition that Environment comprises various types of forces such as physical, intellectual, economic, political, cultural, social, moral and emotional. Environment is the sum total of all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms.

– Boring

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'The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturity of living organisms.'

– Douglas and Holland

1.1.2 Element of Environment

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

1. ***Physical elements:*** Physical elements are as space, landforms, water bodies, climate soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.
2. ***Biological elements:*** Biological elements such as plants, animals, micro-organisms and men constitute the biosphere.
3. ***Cultural elements:*** Cultural elements such as economic, social and political elements are essentially manmade features, which make cultural milieu.

Caselet

Environment Protection in China: The Burden is Heavy and the Road is Long

One-Fifth of the population of the world live in China. China is the biggest developing country in the world. China also has a higher biodiversity and is the most abundant World Natural and Cultural Heritage country, so Chinese environmental protection is very important to the globe. China is facing the crucial period of developing the economy and protecting the environment. At present in China, the top officials have understood the importance of protecting the environment for Chinese sustainable development in the new century and have attached great importance to environmental protection. This is a good opportunity to carry out the basic national policy and protecting the ecological environment. Nevertheless, there are more difficulties in doing this in China than in the U.S. These reasons are as follow:

First of all, the level of the Chinese economy and technology is not very high. Developing the economy is a task of primary importance to the local government. They can't put more money into environmental protection. In some regions, the common people have to harm the environment in order to live. For example in the southwest of China, the resources of plants and animals are quite abundant. The area of the northwest is about one half of China and it's the source of the main rivers, including the Yellow River, the Yangtze River, and the Lancang River. The government should pay much attention to both areas. Furthermore, the northwest of China is a very ecologically sensitive area. The key ecological issues are drought and the shortage of sufficient water, and the ecosystem is very fragile in that vast area. A developing economy needs not only money but also more resources and these bring pollution; so there are conflicts with the environment to some degree. However, the level of the economy and technology in this region is relatively low. The funds put into the environmental protection are so limited. The local government has a dilemma and has to make a choice between economic development and environmental

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protection. Especially currently, the national strategy of developing the western area challenges the ecological environment. If we lack scientific process in the decision-making policy and enough evaluation of the ecological environment, we will take great risks.

Secondly, the environmental consciousness of our common people is not very strong. Although the Chinese government has already done many educational programs on environmental protection, many persons are restricted by their level of scientific and cultural awareness, and are affected by the traditional concepts. For example, those who live on a mountain rely on the mountain; those living near the water rely on the water. People make use of local resources more and more, without taking steps to recover them and protect the environment promptly.

Third, the government should improve the laws for environmental protection. On the one hand, the government should perfect the current law. On the other hand, the government should reform the current systems in many aspects. That is to say, the government should govern the country according to the law and enforce the law strictly.

Source: http://www.mhhe.com/EnviroSci/CaseStudyLibrary/International/CaseStudy_Int_EnvironmentProtect.pdf

Self Assessment

State whether the following statements are true or false:

1. Lakes, ponds, mountain ranges, forests and coastlines are some of the components of ecosystems.
2. Biological elements are as space, landforms, water bodies, climate soils, rocks and minerals.
3. Cultural elements such as economic, social and political elements are essentially manmade features, which make cultural milieu.

1.2 What is Environmental Science?

Environmental science is the study of the interactions between the physical, chemical, and biological components of the natural world, including their effects on all types of organisms and how humans impact their surroundings.

Environment is everything that affects an organism during its lifetime. In turn, all organisms, including people, affect many components in their environment. From a human point of view, environmental issues involve concerns about science, nature, health, employment, profits, law, politics, ethics, fine arts, and economies. Therefore, environmental science is by its nature a multidisciplinary field. The word environmental is usually understood to mean the surrounding conditions that affect people and other organisms.

Some people consider themselves conservationists. A conservation ethic focuses on sustainable resource use, allocation, and protection. The primary focus is on maintaining the health of ecosystems and their biological diversity. Other people may be termed environmentalists. The environmental ethic is a diverse scientific, social, and political movement. An environmentalist is someone who actively works to preserve the environment from destruction or pollution. Environmental decision making often involves compromise. A decision that may be supportable from a scientific or economic point of view may not be supportable from a political point of view or vice versa. Generally, the parties involved debate and argue their viewpoints. Ultimately, when decisions are finally made, each party may have given grounds; but hopefully, all parties are willing to accept the compromises they have made.

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1.2.1 Review of Key Concepts of Environmental Science

Reviews of Key Concepts of Environmental Science are as follows:

1. ***Ecological Concepts*:** Environmental science was developed from the science of ecology. Ecology is the study of the way organisms interact with each other and with their nonliving surroundings. These interactions involve energy and matter. Living things require a constant flow of energy and matter to ensure their survival. If the flow of energy and matter ceases, the organism dies. Ecology deals with the ways in which organisms are shaped by their surroundings, how they use these surroundings, and how an area is altered by the presence and activities of organisms. Everything that affects an organism during its lifetime is in its environment.

Example: from its birth to its death, a caribou interacts with millions of other organisms (bacteria, food plants, parasites, mates, predators), drinks water, breathes, and responds to changes in temperature and weather conditions. This list only outlines some of the various components that make up a caribou's environment. Because of this complexity, it is useful to subdivide the concept of environment into abiotic (nonliving) and biotic (living) factors.

2. ***Food Chains:*** Autotrophs are the foundation of all food sources in the environment. Autotrophs are organisms that produce their own food. Green plants such as spruce trees and pitcher plants, lichens such as caribou moss, and algae such as seaweeds, are the best known and most obvious autotrophs in Newfoundland and Labrador. In the process called photosynthesis, water, carbon dioxide, and light energy are used by all autotrophs to produce sugar (chemical energy). Oxygen is released into the atmosphere as a result of this process. Autotrophs, in this case called producers, provide a source of energy in the form of food for consumers, such as herbivores, that are a source of energy for carnivores. Animals typically consume a varied diet and, in turn, serve as food for a variety of other creatures that prey on them. This vital and somewhat complex relationship between decomposers, producers, and consumers is known as a food chain. Most food chains are interconnected with other food chains. These interconnections create food webs.

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Food Web Summary

1. Autotrophs (for example: green plants, seaweeds, and lichens) are called producers because only they can use energy to manufacture food from inorganic raw materials.
2. This food feeds herbivores, called primary consumers.
3. Carnivores that feed on herbivores are called secondary consumers.
4. Carnivores that feed on other carnivores are tertiary (or higher) consumers.

Every organism on Earth plays a role in one or more food webs. When an organism is removed from the web or chain, other species are affected, sometimes in a minor way and sometimes dramatically.

Task Human beings are at the top of a great number of food chains. Based on your meals over a week, develop a series of food chains in which you are the final consumer and examine the results. Do you regularly eat from the lower levels of the food pyramid (salads and cereals), or from the upper levels (meat or fish)? What are the environmental implications of your food consumption patterns?

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Self Assessment

Fill in the blanks:

4. Environment is everything that affects an ..... during its lifetime.
5. A ..... focuses on sustainable resource use, allocation, and protection.
6. ..... is the study of the way organisms interact with each other and with their nonliving surroundings.

1.3 Scope and Importance of Environmental studies

All the environmental problems pose a great challenge to us over way of life irrespective whether we are living in developed countries or developing countries. We find today that our economic growth is proceeding at a faster rate. Standard of living are rising especially in the developed nations and among the middle and upper strata of society in the developing nations; international trade is rapidly growing, production of goods and food grains is increasing; life expectancy is going up and many diseases have been brought under control.

Caution Many more positive developments like those in communication and information system are indication of human capacity to make use of science and technology for making life more comfortable.

However, we must take care of the results arising out of such situations which show a rapid pace of growth and development. If this development is destroying our support system i.e., our natural resources, then we have to reconsider our concept of living standard and economic development. If by producing bumper crops and large quantities of food grain we deplete our ground water resource and erode our topsoil and lose soil fertility and we are damaging our life support system. Our livestock (sheep, goat and cow), which is the major source of animal proteins, lives on grazing land which is under great pressure. Overgrazing has led to increase in desertification and in turn, to dust storms. As mentioned earlier, our forests are under great stress. Trees are cut faster than they can be planted. Deforestation thus leads to floods, it also causes imbalance in ecosystem. The capacity of ecosystem to absorb excessive carbon dioxide produced as a result of burning of fossil fuels (coal, petrol) is reduced. The result is rise in the level of carbon dioxide leading to rise in the earth's temperature which further leads to melting of ice in the arctic causing havoc in the form of cyclones and floods. We are witnessing loss of biodiversity, which means we are losing biological wealth. Our plants and animals are being destroyed due to destruction of habitat, climate change and pollution. We must realize that each species of plants and animals not only has a role in ecosystem but many of them constitute a source of life saving drugs.

Example: In 1999, winter storm in France destroyed millions of trees and buildings. Such natural disasters due to hurricanes and cyclones are occurring often causing not only environmental damage but also huge economic losses.

There is another aspect of environmental studies, namely the economic growth, needs our attention. The economies of both the developed and developing world are growing. India and China constitute largest population of developing world; both are in the process of expanding their economies. Large number of people in both these countries is getting into middle class economically, and affluence and consumption, particularly in China, is as increasing as in Japan. Imagine what will happen if people of China and India come to have one car per family as in

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USA; it would mean consumption of as much fuel per day as is being daily produced. And where will be the place to park these vehicles. To do this, land will have to be made available which is now being used for agriculture. This would lead to decline in agriculture output.

Example: Take an example of paper consumption. If per capita consumption of paper in China or India rises to the same level as of USA, the forests would disappear gradually.

Many more examples of these kinds lead us to conclude that we need a different model of economic development, certainly not based on western fossil fuel or carbon but a new kind of economic model that would stop the decline of natural wealth in our ecosystem. A new economy is needed that would take into consideration the basic ecological concepts. The experts are of the opinion that carbon based economy should be replaced by hydrogen based economy where we would be using renewable source of energy. We cannot ignore the above consideration of economy and environmental relationship.

The scope and importance of environment are as follows:

1.3.1 Scope of Environment

The scope of environmental studies is very large. We have today, fairly good knowledge of this subject especially the environmental problems that concern us and our future on this planet. Some of the problems are global because they affect everyone in the world.

Example: Global Warming, Climate Change and Ozone Depletion.

The environment consists of four segments as under:

1. ***Atmosphere:*** The atmosphere implies the protective blanket of gases, surrounding the earth:
   - It sustains life on the earth.
   - It saves it from the hostile environment of outer space.
   - It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.
   - It transmits only here ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultraviolet waves below about 300 nm.

   Caution The atmosphere is composed of nitrogen and oxygen, besides, argon, carbon dioxide, and trace gases.

2. ***Hydrosphere:*** The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reservoir, polar icecaps, glaciers, and ground water.
   - Nature 97% of the earth's water supply is in the oceans,
   - About 2% of the water resources are locked in the polar icecaps and glaciers.
   - Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit to be used for human consumption and other uses.

3. ***Lithosphere:*** Lithosphere is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil e.g. minerals, organic matter, air and water.

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4. ***Biosphere:*** Biosphere indicates the realm of living organisms and their interactions with environment that is atmosphere, hydrosphere and lithosphere.

1.3.2 Importance of Environment

The environment studies enlighten us, about the importance of protection and conservation of our indiscriminate release of pollution into the environment. At present a great number of environment issues, have grown in size and complexity day by day, threatening the survival of mankind on earth. We study about these issues besides and effective suggestions in the Environment Studies. Environment studies have become significant for the following reasons:

1. ***Environment Issues Being of International Importance:*** It has been well recognised that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.

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

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

4. ***Need for an Alternative Solution:*** It is essential, especially for developing countries to find alternative paths to an alternative goal. We need a goal as under:

   - A goal, which ultimately is the true goal of development an environmentally sound and sustainable development.
   - A goal common to all citizens of our earth.
   - A goal distant from the developing world in the manner it is from the overconsuming wasteful societies of the "developed" world.

5. ***Need to Save Humanity from Extinction:*** It is incumbent upon us to save the humanity from extinction, consequent to our activities constricting the environment and depleting the biosphere, in the name of development.

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

7. ***Misra's Report:*** Misra (1991) recognized four basic principles of ecology, as under:

   - Holism
   - Ecosystem
   - Succession
   - Conversation

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Holism has been considered as the real base of ecology. In hierarchical levels at which interacting units of ecology are discussed, are as under:

Individual $\rightarrow$ Population $\rightarrow$ Community $\rightarrow$ Ecosystem $\rightarrow$ Biome $\rightarrow$ Biosphere

Misra (1991) has recognised four basic requirements of environmental management as under:

- Impact of human activities on the environment,
- Value system,
- Plan and design for sustainable development,
- Environment education

Keeping in view the of goal of planning for environmentally sustainable development India contributed to the United Nations Conference on Environment and Development (UNCED), also referred to as "Earth Summit".

Self Assessment

State whether the following statements are true or false:

7. The atmosphere is not composed of nitrogen and oxygen.
8. Biosphere is the outer mantle of the solid earth.
9. Holism has been considered as the real base of ecology.

1.4 Various Types of Environment

According to Kurt Lewin, environment is of three types which influence the personality of an individual as under:

1. Physical Environment,
2. Social and Cultural Environment, and
3. Psychological Environment.

These may be explained as under:

1. ***Physical Environment:*** Physical environment refers to geographical climate and weather or physical conditions wherein and individual lives. The human races are greatly influenced by the climate. Some examples are as under:
   (a) In the cold countries i.e. European countries the people are of white colour. Likewise, in Asian and African countries, that is, in hot countries people are of dark complexion.
   (b) The physique of an individual depends on climate conditions as the individual tries to adjust in his physical environment.
   (c) The human working efficiency also depends on the climatic conditions.
2. ***Social Environment:*** Social Environment includes an individual's social, economic and political condition wherein he lives. The moral, cultural and emotional forces influence the life and nature of individual behaviour. Society may be classified into two categories as under:
   (a) An open society is very conductive for the individual development.
   (b) A closed society is not very conductive for the development.

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3. ***Psychological Environment:*** Although physical and social environment are common to the individual in a specific situation, yet every individual has his own psychological environment, in which he lives. Kurt Lewin has used the term 'life space' for explaining psychological environment. The Psychological environment enables us to understand the personality of an individual. Both the person and his goal form psychological environment.

If a person is unable to overcome the barriers, he can either get frustrated or completed to change his goal for a new psychological environment. But adopting this mechanism, the individual is helped in his adjustment to the environment.

Self Assessment

Fill in the blanks:

10. ..... environment refers to geographical climate and weather or physical conditions wherein and individual lives.

11. ..... Environment includes an individual's social, economic and political condition wherein he lives.

12. If a person is unable to overcome the barriers, he can either get frustrated or completed to change his goal for a new ..... environment.

1.5 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.

Notes 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 varieties have caused soil salinity and damage to physical structure of soil.

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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 are an important challenge. It so finding our suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean which are difficult challenges is essential.

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

Did u know? 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 department 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 suffer 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, out of 226 mha, about 175 mha or 66 per cent is degraded to varying degrees. Water and wind erosion causes further degradation of almost 150 mha. This degradation is to be avoided.

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

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

9. ***Evil Consequences of Urbanisation:*** Nearly 27 per cent Indians live in urban areas. Urbanisation and industrialisation has given birth to a great number of environmental 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

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

Self Assessment

State whether the following statements are true or false:

13. A population of over thousands of millions is growing at 4.11 per cent every year.
14. High yielding varieties have caused soil salinity and damage to physical structure of soil.
15. Urbanisation and industrialisation has given birth to a great number of environmental problems.

Case Study

Biodiversity – Threat or Opportunity?

Shell has recently developed a biodiversity policy and action-plan, the first for an oil and gas company worldwide. The company sought the views of some of the world's leading conservation organizations, and in June 2000, a five-year partnership was established with the Smithsonian Institution (SI).

Shell and SI had worked together before on the Camisea project in the Amazonian jungle of Peru. The institution's Monitoring and Assessment of Biodiversity Programme (SI/MAB) took primary responsibility for organizing and carrying out scientific biodiversity studies. The team of national and international experts gathered baseline information to determine what types of changes the project would bring about in the area's natural systems, and then provided Shell staff with the information needed to support appropriate decisions concerning its operations—such as citing the gas processing plant, determining the proper depth to bury gas pipelines, use of native species in regenerating the pipeline corridor, and what impacts helicopters and roads might have on biodiversity.

The new partnership has taken Shell and SI/MAB to Gabon. Gabon is one of the last remaining countries with high potential for the conservation of biodiversity. This is in part due to the relatively low population density (estimated at 1.2 million in 1990), an estimated 50 percent of who are located in the three major cities of Libreville, Port-Gentil, and Franceville. In rural areas the density does not exceed 2 per km^2, with vast areas in the interior being uninhabited. Over 85 percent of the country remains forested, with the remainder being savanna. The forests are floristically diverse. Likewise, fauna is rich, with over 130 mammal species, at least 20 of which are monkeys, over 600 species of birds, more than 70 species of reptiles, and 100 species of amphibians.

The project aims to increase biodiversity knowledge of the tropical Gabonese forest by first collecting baseline data on what occurs and where. This is achieved through the use of biodiversity inventories— providing lists of species for a particular area—or by biodiversity assessments—quantitative species lists for particular areas. Once we know what occurs in an area, we can then study ecosystem function in order to understand how the different components interact. This provides us with solid scientific information that can be used for implementing management decisions that will help to conserve or reduce

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the risk to biodiversity. Monitoring programs can then be put into place that will evaluate how effectively management is achieving its desired goals. When the process becomes cyclical and the monitoring results are fed back into management decisions, we can say that we are conserving biodiversity through "adaptive management."

The project will also seek to build strong links with regional stakeholders (including local communities, national and international nongovernmental organizations, governments, Shell managers, operators, and contractors) to use the gathered biological information for conservation, to train local scientists in the use of established SI/MAB protocols for assessments and monitoring, to disseminate the scientific results to all stakeholders in appropriate formats, and to apply the framework developed to establish guidelines and other materials as appropriate for development projects around the world. Other partnership opportunities will be sought as the project develops and new areas are explored, such as environmental education or sustainable community programs designed around biodiversity issues—for example, eco-tourism. It is hoped that this project will be a catalyst for levering other sources of income and partnership interest in meeting the project's overall objectives.

Core to the project's success is the building of local capacity with regards to biodiversity. It is hoped that this project will help local decision makers and link to Gabon's national biodiversity strategy. Secondly, the knowledge gained may be used to influence and develop a more responsible corporate culture with regards to the country's rich biodiversity. The project will also benefit Shell by providing guidance on how to operate in future projects while minimizing operational footprints and using best technology to improve project designs. Only through our furthered understanding of the importance of biodiversity—where it exists, why it matters, and how it works—will we be able to make reasoned and informed judgments about how best to conserve it, where to prospect, and where to leave alone. However, in order to provide for a sustainable future, we must also provide sustained economic growth. In the near future, this will continue to be dependent on the exploration and extraction of natural resources for energy. It is our belief that the two can coexist.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.mhhe.com/EnviroSci/CaseStudyLibrary/International/CaseStudy_Int_BiodiversityThreat.pdf

1.6 Summary

- Environment means the surrounding external conditions influencing development or growth of people, animal or plants; living or working conditions etc.
- Environment is constituted by the interacting systems of physical, biological and cultural elements interrelated in various ways, individually as well as collectively.
- Environmental science is the study of the interactions between the physical, chemical, and biological components of the natural world, including their effects on all types of organisms and how humans impact their surroundings.
- Environmental science was developed from the science of ecology.

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- The scope of environmental studies is very large.
- Autotrophs are the foundation of all food sources in the environment.
- We have today, fairly good knowledge of this subject especially the environmental problems that concern us and our future on this planet.
- 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.
- Standard of living are rising especially in the developed nations and among the middle and upper strata of society in the developing nations; international trade is rapidly growing, production of goods and food grains is increasing; life expectancy is going up and many diseases have been brought under control.

1.7 Keywords

Atmosphere: The atmosphere is a layer of gases which surrounds the entire Earth.

Biosphere: Biosphere indicates the realm of living organisms and their interactions with environment that is atmosphere, hydrosphere and lithosphere.

Ecological: Ecology is the scientific study of interactions of organisms with one another and with the physical and chemical environment.

Ecosystem: A biological community of interacting organisms and their physical environment.

Environment: Environment means the surrounding external conditions influencing development or growth of people, animal or plants; living or working conditions etc.

Environmental Science: It is the study of the interactions between the physical, chemical, and biological components of the natural world, including their effects on all types of organisms and how humans impact their surroundings.

Holism: Holism is the concept or belief that all of the properties of a system cannot be explained by the component parts alone.

Hydrosphere: The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reservoir, polar icecaps, glaciers, and ground water.

Lithosphere: Lithosphere is the outer mantle of the solid earth.

Physical Environment: It refers to geographical climate and weather or physical conditions wherein and individual lives.

Pollution: The presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects.

Social Environment: It includes an individual's social, economic and political condition wherein he lives.

1.8 Review Questions

1. What are the three questions involve in environment?
2. Highlight the element of Environment.

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3. Define Environmental science.
4. Discuss the Key Concepts of Environmental Science.
5. Explain the scope of environmental studies.
6. Describe the importance of environmental studies.
7. Throw some light on the Misra's four basic principles of ecology.
8. Discuss the Various Types of Environment.
9. Is there any need for the public awareness of environmental studies? If yes, give reason.
10. "Environment is everything that affects an organism during its lifetime." Elucidate.

Answers: Self Assessment

1.	True	2.	False
3.	True	4.	Organism
5.	Conservation Ethic	6.	Ecology
7.	False	8.	False
9.	True	10.	Physical
11.	Social	12.	Psychological
13.	False	14.	True
15.	True		

1.9 Further Readings

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Unit 2: Natural Resources: An Introduction

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Objectives

After studying this unit, you should be able to:

- Explain the meaning of Natural Resources
- Discuss the Renewable and Non-renewable Resources
- Get an overview of different types of Natural Resources produced in India
- Describe the various types of Environment
- Explain the Natural Resources and Associated Problems

Introduction

In the previous unit, we dealt with the general concepts included in Environmental Science. Conservation of resources is an absolute necessity for economic growth, development and adequate living standards of growing populations. To understand these issues, it is essential to understand the functioning of the natural resources and the environment of which they are the parts. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the meaning, types and the problems associated with the Natural Resources.

2.1 Meaning of Natural Resources

Our environment provides us with a variety of goods and services necessary for our day to day lives. These natural resources include, air, water, soil, minerals, along with the climate and solar

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energy, which form the non-living or 'abiotic' part of nature. The 'biotic' or living parts of nature consist of plants and animals, including microbes. Plants and animals can only survive as communities of different organisms, all closely linked to each in their own habitat, and requiring specific abiotic conditions. Thus, forests, grasslands, deserts, mountains, rivers, lakes and the marine environment all form habitats for specialised communities of plants and animals to live in. Interactions between the abiotic aspects of nature and specific living organisms together form ecosystems of various types. Many of these living organisms are used as our food resources. Others are linked to our food less directly, such as pollinators and dispersers of plants, soil animals like worms, which recycle nutrients for plant growth, and fungi and termites that break up dead plant material so that microorganisms can act on the detritus to reform soil nutrients.

A natural resource may be defined as any material given to us by nature which can be transformed in a way that it becomes more valuable and useful. We use variety of materials derived from environment.

Example: We have materials like metals (steel, aluminium, copper, zinc, lead); we have non-metallic materials (sand, stones, clay, limestone); we have minerals (phosphates, potash, lime); then we have raw materials like wood, coal, petroleum.

We use variety of materials derived from environment. For example we have materials like metals (steel, aluminium, copper, zinc, lead); we have non-metallic materials (sand, stones, clay, limestone); we have minerals (phosphates, potash, lime); then we have raw materials like wood, coal, petroleum.

Natural resources are generally defined as all those things given by nature on, above and under the surface of the earth. In this broad sense natural resources include land, water, forests, fisheries and animals, mineral ores and sources of energy like coal, petroleum, gas and uranium, etc.

There is no direct link between the availability of natural resources and the level of economic development. There are many countries which are rich in natural resources but still they are underdeveloped.

In fact, for the economic development of a country, optimum exploitation of natural resources is more important than their availability. Nevertheless, importance of natural resources cannot be undermined. Natural resources of a country influence not only economic growth but also its economic structure.

2.1.1 Changes in Land and Resource Use

During the last 100 years, a better health care delivery system and an improved nutritional status has led to rapid population growth, especially in the developing countries. This phenomenal rise in human numbers has, in the recent past, placed great demands on the earth's natural resources. Large stretches of land such as forests, grasslands and wetlands have been converted into intensive agriculture. Land has been taken for industry and the urban sectors. These changes have brought about dramatic alterations in land-use patterns and rapid disappearance of valuable natural ecosystems. The need for more water, more food, more energy, more consumer goods, is not only the result of a greater population, but also the result of over-utilization of resources by people from the more affluent societies, and the affluent sections of our own.

Industrial development is aimed at meeting growing demands for all consumer items. However, these consumer goods also generate waste in ever larger quantities. The growth of industrial complexes has led to a shift of people from their traditional, sustainable, rural way of life to urban centres that developed around industry. During the last few decades, several small urban centres have become large cities; some have even become giant mega-cities. This has increased

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the disparity between what the surrounding land can produce and what the large number of increasingly consumer-oriented people in these areas of high population density consumes.

Caution Urban centres cannot exist without resources such as water from rivers and lakes, food from agricultural areas, domestic animals from pasture lands and timber, fuel wood, construction material and other resources from forests.

Rural agricultural systems are dependent on forests, wetlands, grasslands, rivers and lakes. The result is a movement of natural resources from the wilderness ecosystems and agricultural sector to the urban user. The magnitude of the shift of resources has been increasing in parallel with the growth of industry and urbanisation, and has changed natural landscapes all over the world. In many cases, this has led to the rapid development of the urban economy, but to a far slower economic development for rural people and serious impoverishment of the lives of wilderness dwellers. The result is a serious inequality in the distribution of resources among human beings, which is both unfair and unsustainable.

2.1.2 Earth's Resources and Man

The resources on which mankind is dependent are provided by various sources or 'spheres':

1. ***Atmosphere:*** The atmosphere forms a protective shell over the earth. The lowest layer, the troposphere, the only part warm enough for us to survive in, is only 12 kilometres thick. The stratosphere is 50 kilometres thick and contains a layer of sulphates which is important for the formation of rain. It also contains a layer of ozone, which absorbs ultraviolet light known to cause cancer and without which, no life could exist on earth. The atmosphere is not uniformly warmed by the sun. This leads to air flows and variations in climate, temperature and rainfall in different parts of the earth. It is a complex dynamic system. If its nature is disrupted it affects all mankind. Most air pollutants have both global and regional effects.
   - Oxygen for human respiration (metabolic requirements).
   - Oxygen for wild fauna in natural ecosystems and domestic animals used by man as food.
   - Oxygen as a part of carbon dioxide, used for the growth of plants (in turn are used by man).
2. ***Hydrosphere:*** The hydrosphere covers three quarters of the earth's surface. A major part of the hydrosphere is the marine ecosystem in the ocean, while only a small part occurs in fresh water. Fresh water in rivers, lakes and glaciers, is perpetually being renewed by a process of evaporation and rainfall. Some of this fresh water lies in underground aquifers. Human activities such as deforestation create serious changes in the hydrosphere. Once land is denuded of vegetation, the rain erodes the soil which is washed into the sea.

   Clean water for drinking (a metabolic requirement for living processes).
   - Water for washing and cooking.
   - Water used in agriculture and industry.
   - Food resources from the sea, including fish, crustacea, and sea weed, etc.
   - Food from fresh water sources, including fish, crustacea and aquatic plants.
   - Water flowing down from mountain ranges harnessed to generate electricity in hydroelectric projects.

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3. ***Lithosphere:*** The lithosphere began as a hot ball of matter which formed the earth about 4.6 billion years ago. About 3.2 billion years ago, the earth cooled down considerably and a very special event took place - life began on our planet.

Did u know? The crust of the earth is 6 or 7 kilometers thick and lies under the continents. Of the 92 elements in the lithosphere only eight are common constituents of crystal rocks. Of these constituents, 47% is oxygen, 28% is silicon, 8% is aluminium, 5% is iron, while sodium, magnesium, potassium and calcium constitute are 4% each. Together, these elements form about 200 common mineral compounds.

Rocks, when broken down, form soil on which man is dependent for his agriculture. Their minerals are also the raw material used in various industries.

- Soil, the basis for agriculture to provide us with food.
- Stone, sand and gravel, used for construction.
- Micronutrients in soil, essential for plant growth.
- Microscopic flora, small soil fauna and fungi in soil, important living organisms of the lithosphere, which break down plant litter as well as animal wastes to provide nutrients for plants.
- A large number of minerals on which our industries are based.
- Oil, coal and gas, extracted from underground sources. It provides power for vehicles, agricultural machinery, industry, and for our homes.

4. ***Biosphere:*** This is the relatively thin layer on the earth in which life can exist. Within it the air, water, rocks and soil and the living creatures, form structural and functional ecological units, which together can be considered as one giant global living system, that of our Earth itself. Within this framework, those characterised by broadly similar geography and climate, as well as communities of plant and animal life can be divided for convenience into different biogeographical realms. These occur on different continents. Within these, smaller biogeographical units can be identified on the basis of structural differences and functional aspects into distinctive recognizable ecosystems, which give a distinctive character to a landscape or waterscape. Their easily visible and identifiable characteristics can be described at different scales such as those of a country, a state, a district or even an individual valley, hill range, river or lake.

- Food, from crops and domestic animals, providing human metabolic requirements.
- Food, for all forms of life which live as interdependent species in a community and form food chains in nature on which man is dependent.
- Energy needs: Biomass fuel wood collected from forests and plantations, along with other forms of organic matter, used as a source of energy.
- Timber and other construction materials.

Task Take a simple object in daily use and track its components back to each of its spheres.

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Caselet

Depletion of Natural Resources at Goa, India

Goa, a world famous and popular tourist destination in India comprise of more than 100 km long coast where approximately 70 km comprise of sandy beaches. Present case study on innumerable iron and manganese ore mines in Goa; offer the opportunity to learn the effectiveness and implementation of Indian Environmental (Protection) Rules, 1986 and Environmental Impact Assessment Notification 2006 (procedures applicable to obtain Environmental Clearance for new projects and expansion of existing projects) and Costal regulation Zone (CRZ) legislation of India. Mine owners, generally operate legally after procuring Environmental Clearance from Ministry of Environment & Forest, India and the possibility exist that many mine owners or small scale ore producers, operate illegally i.e. without obtaining environmental clearances or even after expiry of environmental clearance time period. Goa, is identified by sandy stretches and complex network of water bodies across plain land, where, legal and illegal, unquantifiable excavation of iron and manganese ore and depletion of forest land may cause devastation due to inundation, underground water profile damage etc. Due to these large scale operations, 70 km long Goa sea coast may be completely destroyed or inundate, even before the envisaged rise of sea level due to climate change! Today, when climate change is taking place at faster rate than expected, this kind of operations should be monitored and stopped to the possible extent, so that natural resources depletion and land degradation will be restricted.

Source: http://iopscience.iop.org/1755-1315/6/35/352040/pdf/1755-1315_6_35_352040.pdf

Self Assessment

State whether the following statements are true or false:

1. There is a direct link between the availability of natural resources and the level of economic development.
2. Natural resources of a country influence only economic growth.
3. Industrial development is aimed at meeting growing demands for all consumer items.
4. The atmosphere forms a protective shell over the earth.

2.2 Renewable and Non-renewable Resources

On the basis of continuity, the resources are classified as under:

2.2.1 Renewable Resources

Resources, which can be renewed along with their exploitation, are always available for use. Hence they are called renewable resources.

Example: Forests are renewable. If trees are felled for wood, original forest covers may be maintained through planning new trees i.e. a forestation. Likewise, solar energy and wind energy are examples of renewable resources. Though water and biological living resources are considered renewable.

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They are in fact renewable only within certain limits. They are linked to natural cycles such as the water cycle.

- Fresh water (even after being used) is evaporated by the sun's energy, forms water vapour and is reformed in clouds and falls to earth as rain. However, water sources can be overused or wasted to such an extent that they locally run dry. Water sources can be so heavily polluted by sewage and toxic substances that it becomes impossible to use the water.
- Forests, once destroyed, take thousands of years to regrow into fully developed natural ecosystems with their full complement of species. Forests thus can be said to behave like non-renewable resources if overused.
- Fish are today being over-harvested until the catch has become a fraction of the original resource and the fish are incapable of breeding successfully to replenish the population.
- The output of agricultural land if mismanaged drops drastically.
- When the population of a species of plant or animal is reduced by human activities, until it cannot reproduce fast enough to maintain a viable number, the species becomes extinct.
- Many species are probably becoming extinct without us even knowing, and other linked species are affected by their loss.

2.2.2 Non-renewable Resources

The formation of some resources like iron ore, coal, mineral oil etc. has taken several thousand years. Once they are used in unlimited way, they cannot be easily replaced. Thus, their exploitation at large scale will result in their fast depletion. Some such resources are called non-renewable resources or exhaustible.

These are minerals that have been formed in the lithosphere over millions of years and constitute a closed system. These non-renewable resources, once used, remain on earth in a different form and, unless recycled, become waste material.

Non-renewable resources include fossil fuels such as oil and coal, which if extracted at the present rate, will soon be totally used up. The end products of fossil fuels are in the form of heat and mechanical energy and chemical compounds, which cannot be reconstituted as a resource.

Self Assessment

Fill in the blanks:

5. ....., which can be renewed along with their exploitation, are always available for use.
6. The output of ..... land if mismanaged drops drastically.
7. Many ..... are probably becoming extinct without us even knowing.
8. ..... resources include fossil fuels such as oil and coal, which if extracted at the present rate, will soon be totally used up.

2.3 Different Types of Natural Resources Produced in India

The type of resources available, their quantities, their distribution within the different regions of a country determine, to a considerable extent, the type and scale of industries that can be developed. In the Third World countries where level of development is still very low, natural resources are of considerable importance. Most of these countries lack capital, technical know-

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how and enterprise, and therefore only limited substitution of capital and labour for land and natural resources is possible, liven now, in most of these countries the economic life is largely determined by available resources. India is rich in natural resources. Some of its important resources are discussed below.

Land Resources

In terms of area India ranks seventh in the world with a total area of 32, 87.263 sq. km. (32.87 crore hectare). It accounts for 2.42% of total area of the world. In absolute terms India is really a big country. However, land man ratio is not favourable because of the huge population size.

Land utilisation figures are available for about 92.9% of total geographical area, that is, for 3,287.3 lakh hectare. Forest constitutes 21.02 per cent of the total geographical area of country. Out of a total land area of 304.2 million hectares about 170.0 million hectares is under cultivation. Food grains have preponderance in gross cropped areas as compared to non food grains.

Did u know? According to Agricultural Census, the area operated by large holdings (10 hectares and above) has declined and area operated under marginal holdings (less than one hectare) has increased. This indicates that land is being fragmented.

Forest Resources

India's forest cover in 2007 was 69.09 million hectare which is 21.02 per cent of the geographical area. Of this, 8.35 million hectare is very dense forest, 31.90 million hectare is moderately dense forest and the rest 28.84 million hectare is open forest.

The per capita forest in India (0.5 hectare) is much less than that in the world (1.9 hectares). According to the National Policy on Forests (1988), one-third (33%) of the country's area should be covered by forests in order to maintain ecological balance.

Mineral Resources

Iron Ore: India possesses high quality iron-ore in abundance. The total reserves of iron-ore in the country are about 14.630 million tonnes of haematite and 10,619 million tonnes of magnetite. Haematite iron is mainly found in Chhattisgarh, Jharkhand, Odisha, Goa and Karnataka.

The major deposit of magnetite iron is available at western coast of Karnataka. Some deposits of iron ore are also found in Kerala, Tamil Nadu and Andhra Pradesh. During 2007-08, its production touched the height of 2.06,939 thousand tonnes (estimated).

Coal and Lignite: Coal is the largest available mineral resource. India ranks third in the world after China and USA in the realm of coal production. The main centres of coal in India are the West Bengal Bihar region. Madhya Pradesh. Maharashtra, Odisha and Andhra Pradesh. Bulk of the coal production comes from Bengal-Jharkhand coalfields.

Notes They contribute 60 to 65% of the total production. The total known geological reserves of all types of coal stands estimated at 264.54 billion tonnes as of January I. 2008. During 2009-10 the import and export of coal was about 67.744 MT and 2.171 MT respectively.

Bauxite: Bauxite is a main source of metal like aluminium. The total resources of bauxite as per United Nations Framework Classification (UNFC) in the country were placed at 3,290 million

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tonnes as on April 1, 2005. The areas of bauxite deposits in India are: Andhra Pradesh, Jharkhand, Goa, Gujarat, Jammu & Kashmir, Karnataka, Kerala, Chhattisgarh, Maharashtra, Odisha, Rajasthan, Tamil Nadu and Uttar Pradesh. Major reserves are concentrated in the Fast Coast bauxite deposits of Odisha and Andhra Pradesh.

Mica: Mica is a heat resisting mineral which is also a bad conductor of electricity. It is used in electrical equipments as an insulator. India stands first in sheet mica production and contributes 60% of mica trade in the world. As per UNFC, the total resources of Mica in the country are estimated at 39,3855 tonnes. The important mica bearing pegmatite occurs in Andhra Pradesh, Jharkhand, Bihar and Rajasthan.

Crude Oil: Oil is being explored in India at many places of Assam and Gujarat. Digboi, Liadarpur, Naharkatia, Kasimpur, Palliaria, Rudrapur, Shivsagar, Mourn (all in Assam) and Hay of Khambhat, Ankaleshwar and Kalol (all in Gujarat) are the important places of oil exploration in India. The exploration of oil reserves is still on the way in other parts of the country.

Gold: India possesses only a limited gold reserve. There are only three main gold mine regions—Kolar Goldfield, Kolar district and Hutti Goldfield in Raichur district (both in Karnataka) and Ramgiri Goldfield in Anantpur district (Andhra Pradesh).

As per UNFC, total gold metal ore reserves (primary) as on April 1, 2009 were estimated at 390.29 million tonnes, with a metal content of 490.81 tonnes. Most of the gold (about 38.71 tonnes) is reserved in Kolar and Hutti mines. In 2003-04, 3,363 kg of gold was produced which increased to 3,400 kg (estimated) during 2007-08.

Diamond: As per UNEC the total reserves of diamond is estimated at around 4582 thousand carats which are mostly available in Panna (Madhya Pradesh), Rammallakota of Kurnur district of Andhra Pradesh and also in the Basin of Krishna River.

The new kimberlile fields have been discovered in Raipur and Pastar districts of Chhattisgarh, Nuapada and Bargarh districts of Odisha, Narayanpet – Maddur Krishna areas of Andhra Pradesh and Raichur-Gulbarga districts of Karnataka.

Limestone: Limestone is available almost in all the slates of the country and every state contributes in its production. Andhra Pradesh is the leading state followed by Rajasthan, Karnataka, Madhya Pradesh, Gujarat, Odisha, Chhattisgarh and Tamil Nadu. As per UNFC, the total reserves of limestone of all categories and grades were placed at 1, 75,345 million tonnes as of April 1, 2(X) 5.

Manganese: Manganese is used in the production of steel and other iron compounds. The total resources of manganese ore in the country are placed at 379 million tonnes. Its maximum deposit is found in Karnataka, besides, Odisha, Madhya Pradesh. Maharashtra and Goa also possess relatively larger deposits of manganese. Some deposits are also found in Andhra Pradesh, Jharkhand, Rajasthan, Gujarat and West Bengal.

Copper: As per United Nations Framework Classification (UNFC), the total resources of copper ore are placed at 1.39 billion tonnes with a metal content of 11,418 thousand tonnes. Important copper producing areas are Singhbum (Bihar); Balaghat (Madhya Pradesh); Jhunjhunu and Alwar (Rajasthan); Khammam (Andhra Pradesh); Chitradurga and Hasan districts of Karnataka and Sikkim.

Barytes: It is a colourless or white mineral which consists of barium sulphate. Barium metal is obtained from barytes. As per UNFC, India has got 74 million tonnes deposits of barytes as on April 1, 2005 which are mostly available in Mangampet of Cuddapah district of Andhra Pradesh.

Chromite: It is a mineral of brown black shade with which chromium and its other compounds are prepared. As per IJNFC, the total resources of chromite as on 1st April, 2005 were 213 million tonnes.

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Chromite deposits of economic significance occur in Andhra Pradesh. Bihar, Karnataka, Maharashtra, Manipur, Odisha and Tamil Nadu. The largest share (about 96%) of the total geographical resource is accounted by Cuttack district in Odisha.

Dolomite: It is mostly a colourless mineral (sometimes white or pink) which is the main source of calcium magnesium carbonate. Magnesium and its compounds are obtained from dolomite.

Did u know? As per UNFC, the reserves of all types of dolomite are estimated at 7.533 million tonnes which are mostly found in Odisha, Madhya Pradesh, Gujarat, Chhattisgarh, Andhra Pradesh and Maharashtra.

Fluorspar: It is a shining mineral which contains calcium fluoride. Fluorine and its compounds are obtained from fluorspar. This mineral is mainly available in Gujarat, Chhattisgarh, Maharashtra and Rajasthan. As per UNFC, the total resources of fluorite in the country as on April 1, 2005 were estimated at 20.16 million tonnes.

Gypsum: Gypsum is a colourless or white mineral which contains calcium sulphate. It is used in the production of cement and plaster of Paris. The total resources of gypsum in India as per UNFC as on April 1, 2005 were estimated at 1.237 million tonnes. Most of its deposits are found in Rajasthan, Tamil Nadu, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh and Gujarat.

Graphite: It is a crystalline form of carbon which is used in making pencils and electrodes. Graphite is also used as a lubricant and moderator in atomic reactors. As per UNFC, the total resources of graphite in India as on April 1, 2005 were estimated at about 168.77 million tonnes. It contains carbon between 10 to 40%. Odisha is the main graphite producing state.

Ilmenite: It is a black coloured mineral having some magnetic property. It contains iron titanium oxide with which titanium and titanium dioxide are obtained.

Nickel: Nickel is mostly available in Cuttack, Kyonjhar and Mayurbhanj districts of Odisha. Sukinda region of Cuttack district contains maximum deposits of nickel. As per UNFC, the total resources of nickel ore have been estimated at 189 million tonnes. About 92% resources are in Odisha and remaining 8% are distributed in Jharkhand, Nagaland and Karnataka.

Phosphate Minerals: Phosphate minerals are of different types—phosphorite deposits are available in Chhattarpur, Sagar and Jhabua districts of Madhya Pradesh, Udaipur, Jaisalmer and Banswada districts of Rajasthan, Dehradun and Tehri districts of Uttarakhand and Lalitpur district of Uttar Pradesh.

Notes Bihar, Andhra Pradesh, Rajasthan, West Bengal and Tamil Nadu possess ample reserves of apatite. As per UNFC as on April 1, 2005, the total resources of rock phosphate were placed at 305 million tonnes, and of apatite at 26.86 million tonnes.

Tungsten: As per UNFC, the total resources of tungsten ore in the country have been estimated at 87.39 million tonnes. The main deposits are at Degana. Rajasthan it is also found in Haryana, Maharashtra, West Bengal, Andhra Pradesh, Karnataka, Tamil Nadu and Uttarakhand.

Magnesite: India possesses abundant reserves of magnesite. Magnesite is an important refractory metal which is used in making fire bricks. It contains magnesium carbonate. Magnesium is also obtained from its processing. The total known deposits of magnesite in India as per UNEC as on April 1, 2005, were about 338 million tonnes.

Fireclay: It is used in making bricks. As per UNFC, as on April 1, 2000, the total reserves of fire clay in India were about 705 million tonnes. These reserves are mostly available in Gondawana

Notes

coal regions and basins. Jharkhand, Gujarat, Madhya Pradesh, Odisha, Tamil Nadu, West Bengal and Chhattisgarh are the states where fire clay is abundantly available.

Self Assessment

State whether the following statements are true or false:

9. Land utilisation figures are available for about 92.9% of total geographical area.
10. The major deposit of Bauxite is available at western coast of Karnataka.
11. India possesses only a limited gold reserve.
12. Manganese is used in the production of steel and other iron compounds.

2.4 Natural Resources and Associated Problems

The problems that are associated with the Natural Resources are as follows:

1. ***The Unequal Consumption of Natural Resources:*** A major part of natural resources are today consumed in the technologically advanced or 'developed' world, usually termed 'the North'. The 'developing nations' of 'the South', including India and China, also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases. Energy from fossil fuels is consumed in relatively much greater quantities in developed countries. Their per capita consumption of food too is much greater as well as their waste of enormous quantities of food and other products, such as packaging material, used in the food industry.

Example: The USA with just 4% of the world's population consumes about 25% of the world's resources. Producing animal food for human consumption requires more land than growing crops.

Thus countries that are highly dependent on non-vegetarian diets need much larger areas for pastureland than those where the people are mainly vegetarian.

2. ***Planning Land Use:*** Land itself is a major resource, needed for food production, animal husbandry, industry, and for our growing human settlements. These forms of intensive land use are frequently extended at the cost of 'wild lands', our remaining forests, grasslands, wetlands and deserts. Thus it is essential to evolve a rational land-use policy that examines how much land must be made available for different purposes and where it must be situated.

Example: There are usually alternate sites at which industrial complexes or dams can be built, but a natural wilderness cannot be recreated artificially. Scientists today believe that at least 10 percent of land and water bodies of each ecosystem must be kept as wilderness for the long-term needs of protecting nature and natural resources.

Land as a resource is now under serious pressure due to an increasing 'land hunger' - to produce sufficient quantities of food for an exploding human population. It is also affected by degradation due to misuse. Land and water resources are polluted by industrial waste and rural and urban sewage. They are increasingly being diverted for short-term economic gains to agriculture and industry. Natural wetlands of great value are being drained for agriculture and other purposes. Semi-arid land is being irrigated and overused.

Notes

Caution The most damaging change in land use is demonstrated by the rapidity with which forests have vanished during recent times, both in India and in the rest of the world.

Forests provide us with a variety of services. These include processes such as maintaining oxygen levels in the atmosphere, removal of carbon dioxide, control over water regimes, and slowing down erosion and also produce products such as food, fuel, timber, fodder, medicinal plants, etc. In the long term, the loss of these is far greater than the short-term gains produced by converting forested lands to other uses.

3. ***The Need for Sustainable Lifestyles:*** The quality of human life and the quality of ecosystems on earth are indicators of the sustainable use of resources. There are clear indicators of sustainable lifestyles in human life.

   - Increased longevity
   - An increase in knowledge
   - An enhancement of income

These three together are known as the 'Human development index'. The quality of the ecosystems has indicators that are more difficult to assess.

- A stabilized population.
- The long term conservation of biodiversity.
- The careful long-term use of natural resources.
- The prevention of degradation and pollution of the environment.

Task **Utilisation of Resources**

The use of a resource begins with its collection, its processing into a useable product, and transport through a delivery system, to the consumer who uses it. It also involves disposal of the waste products produced at each step. Each step in resource use can affect the environment for better or worse. The control of these steps is known as environmental management. Think of a resource you use and track it through these steps.

E.g. the cotton in the clothes you are wearing. At each step notes:

1. What other resources are needed at this step to move the resource you chose to the next?
2. What waste products are generated at that step?
3. How are they likely to be disposed off?
4. What pollutants are generated in the process?

Self Assessment

Fill in the blanks:

13. Advanced countries produce over .....% of global industrial waste and greenhouse gases.
14. ..... provide us with a variety of services.

Notes

15. The ..... of human life and the quality of ecosystems on earth are indicators of the sustainable use of resources.

16. The quality of the ..... has indicators that is more difficult to assess.

Case Study

Bangalore's Population and Natural Resources Dilemma

The boom in the IT sector, the ever increasing migratory population, and the added natural increase in the population has increased the pressure on the natural environment and infrastructure. Spurred by economic development and the space technologies revolution (transport, communication and information), rapid urban growth and restructuring are expected over the next 10 to 20 years. This will be characterized by urban redevelopment in the city centre, suburban expansion with new sub-centres, and leap-frog urban sprawl. Urban growth has two contradictory facets. On the one hand, mega-cities act as engines of economic and social growth; on the other, most of this is accompanied by both poverty and environmental degradation, e.g. encroachment on valuable agricultural land, increasing use of the private car and energy consumption, inner city decline, premature write-down and under-utilization of the existing built environment. Impacts of land use changes on environmental sustainability will become globally significant through their cumulative effects. This is considered to be one of the major global change issues.

Faced with severe negative impacts, urban planners need to rethink the most important development policies and manage urban sprawl and urban growth on a more sustainable basis. For instance, in the USA, urban sprawl has sparked off a national debate over land use policy that includes smart growth management and growth boundary measures. Growth brings prosperity to the citizens, and improves the standard of living. At the same time growth places greater strain on basic infrastructure and services, which have not been designed to cope with such rapid growth? In many instances, economic growth may also not be equitable, and may create islands of prosperity and poverty. If rapid urban growth is not sustainable, then what impacts are placed on the natural resources and the environment (water, air, biodiversity, land use change, loss of prime agricultural land, energy consumption, and solid waste disposal), to name a few? In developing countries such as India and China, patterns of urban growth (compact or sprawling) have been studied in the context of their special social and economic circumstances.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source:http://cgge.aag.org/PopulationandNaturalResources1e/CS_India_Aug12/CS_India_Aug12_print.html

2.5 Summary

- A natural resource may be defined as any material given to us by nature which can be transformed in a way that it becomes more valuable and useful. We use variety of materials derived from environment.

Notes

- Natural resources are generally defined as all those things given by nature on, above and under the surface of the earth.
- Industrial development is aimed at meeting growing demands for all consumer items.
- The atmosphere forms a protective shell over the earth.
- The lowest layer, the troposphere, the only part warm enough for us to survive in, is only 12 kilometres thick.
- The hydrosphere covers three quarters of the earth's surface.
- The lithosphere began as a hot ball of matter which formed the earth about 4.6 billion years ago.
- Biosphere is the relatively thin layer on the earth in which life can exist.
- Resources, which can be renewed along with their exploitation, are always available for use.
- Non-renewable resources include fossil fuels such as oil and coal, which if extracted at the present rate, will soon be totally used up.
- Land utilisation figures are available for about 92.9% of total geographical area, that is, for 3,287.3 lakh hectare.
- India's forest cover in 2007 was 69.09 million hectare which is 21.02 per cent of the geographical area.
- Land itself is a major resource, needed for food production, animal husbandry, industry, and for our growing human settlements.
- The quality of human life and the quality of ecosystems on earth are indicators of the sustainable use of resources.

2.6 Keywords

Atmosphere: Atmosphere is the huge blanket of gas that circles the entire Earth.

Biodiversity: Biodiversity is the variety of species, their genetic make-up, and the natural communities in which they occur.

Biosphere: The regions of the surface and atmosphere of the earth or other planet occupied by living organisms.

Ecosystems: An ecosystem is a complex set of relationships among the living resources, habitats, and residents of an area.

Fossil Fuels: A natural fuel such as coal or gas, formed in the geological past from the remains of living organisms.

Hydrosphere: The hydrosphere is the liquid water component of the Earth.

Industrial Development: Industrial development means developing industries i.e. improving there mechanism, introducing machines to increase there efficiency.

Land use: Land use is characterised by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it.

Lithosphere: The lithosphere is the solid, rocky layer covering the entire surface of the planet, composed of the crust and the hard uppermost mantle, and reacts to stresses as a brittle solid.

Notes

Natural Resources: Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain.

Non-renewable Resources: A non-renewable resource is a natural resource which cannot be reproduced, grown, generated, or used on a scale which can sustain its consumption rate; once depleted there will be no more available for future use.

Renewable Resources: A substance of economic value that can be replaced or replenished in the same amount or less time as it takes to draw the supply down.

Resources: An economic or productive factor required accomplishing an activity, or as means to undertake an enterprise and achieve desired outcome.

2.7 Review Questions

1. What do you understand by natural resource?
2. "Industrial development is aimed at meeting growing demands for all consumer items." Elucidate.
3. Write brief note on Lithosphere.
4. Highlight the importance of hydrosphere.
5. Write short note on Biosphere.
6. Distinguish between Renewable and Non-renewable Resources.
7. Throw some light on any five Mineral Resources.
8. Highlight the importance of Land Resources.
9. What are the problems that are associated with the Natural Resources?
10. "Our environment provides us with a variety of goods and services necessary for our day to day lives." Explain.

Answers: Self Assessment

1.	False	2.	False
3.	True	4.	True
5.	Resources	6.	Agricultural
7.	Species	8.	Non-renewable
9.	True	10.	False
11.	True	12.	True
13.	75	14.	Forests
15.	Quality	16.	Ecosystems

2.8 Further Readings

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Unit 3: Forest Resources

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Objectives

After studying this unit, you should be able to:

- Explain the meaning of Forest Resources
- Discuss the Importance of Forest Resources
- Describe the meaning of Deforestation
- Explain the Use and Overexploitation of Forest Resources

Introduction

In the previous unit, we dealt with the general concepts included in Natural Resources and its associated problems. Forests have a tremendous importance to the humans. They constitute important components of our environment. Forests are important renewable natural resource. Forest ecosystem is dominated by trees, the species varying in different parts of the world. Forests are intimately linked with our culture and civilization. They contribute significantly to the economic development of our country. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the meaning, importance and overexploitation of Forest Resources along with the meaning of Deforestation.

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3.1 Meaning of Forest Resources

A forest can be defined as a biotic community predominant of trees, shrubs or any other woody vegetation usually in a closed canopy. It is derived from Latin word 'foris' means 'outside'. The chief products which forests supply is wood which is used as fuel raw materials, new materials for various industries as pulp, paper, board, plywood, timber for furniture items. They also produce minor forest products like canes, gum, resins, dyes, tannins lac, fish, etc.

Forests shape natural environment by influencing factors such as temperature, humidity and precipitation. In addition forests also shape the soil environment by affecting its composition, structure, chemical properties water contents and play an important role in geochemical cycles of water, carbon, nitrogen, oxygen, phosphorus, sculpture and a number of other elements.

Forests influence flood conditions by intercepting surface run-off infiltration, evaporation, and most importantly provide suitable habitats for a number of important plant and animal species and this help in maintaining a broad genetic base from which future strains of species could be developed. Forests also have aesthetic and tourist values.

Forest resources play an important role in the development of regions, states and nations. These resources are subject to changes because of variations in their growth, harvest and land use conversions. Changing of forest resources can significantly influence the environment on which future performance of these resources depends. It is an established fact that forest resources are environment both are interrelated in such a way that they cannot be separated from each other.

Excessive harvesting of forest resources affects the environment of the forest, which leads to the changes in climate, or other elements of the environment. Rapid increase in the deforestation and fossil fuel combustion has been considered to affect largely the forest resources. The major issues of global warming, acid rains and other forms of atmospheric pollution have become the target problems of the global level for it mere survival of the living beings.

Did u know? India's Forest Cover is 676,000 sq.km (20.55% of geographic area). Scientists estimate that India should ideally have 33% of its land under forests. Today we only have about 12% thus we need not only to protect our existing forests but also to increase our forest cover.

3.1.1 Ecological Significance of Forests

The ecological significance of forests:

- Balances CO_2 and O_2 levels in atmosphere.
- Regulates earth temperature and hydrological cycle
- Encourage seepage and reduces runoff losses, prevents drought
- Reduces soil erosion (roots binding), prevents siltation and landslides thereby floods
- Litter helps in maintaining soil fertility
- Safe habitat for birds, wild animals and organisms against wind, solar radiation and rain

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Managing Forests Responsibly

It has been proven that responsible forest management involves harvesting that minimises the disturbance to the wider forest ecology. It is in the interest of the world's timber trade (not to mention the environment!) that forests are managed responsibly, and trade in forest products supports more responsible and sustainable forest management. Regulation of the trade in threatened species and forest certification are two ways to promote better forest management. Forest certification is a two-stage process. First, forests are independently certified to a recognised standard, such as the Forest Stewardship Council (FSC). Next is the certification of operations in the timber supply chain, referred to as the 'chain of custody' certification. Often, it is a simple equation. If the annual cut in a forest exceeds the annual growth, it spells trouble. However, good management policies and practices, tested against the best international standards, coupled with a chain of custody to the user, wise design and minimum waste can be combined to safeguard the resource for the future.

3.1.2 The Function of Trees

Forest products are used in our daily lives. All the activities listed above directly or indirectly involve forests. Some are easy to figure out - fruits, paper and wood from trees, and so on. Others are less obvious - by-products that go into the manufacture of other everyday items like medicines, cosmetics and detergents.

But looking at it beyond our narrow, human, not to mention urban, perspective, forests provide habitats to diverse animal species, and they also form the source of livelihood for many different human settlements as well as for governments.

They offer watershed protection, timber and non-timber products, and various recreational options. They prevent soil erosion, help in maintaining the water cycle, and check global warming by using carbon dioxide in photosynthesis.

Over the past 50 years, about half the world's original forest cover has been lost, the most significant cause for that being humans beings' unsystematic use of its resources.

When we take away the forest, it is not just the trees that go. The entire ecosystem begins to fall apart, with dire consequences for all of us.

Did u know?

1. 30% of the world's forests are primarily used for production of wood and non-wood products.
2. The total global trade in forest products was valued at around $379 billion in 2005.
3. The livelihoods of 1.6 billion people depend on forests.

3.1.3 Timber Extraction, Mining and Dams

Timber extraction, mining and dams are invariably parts of the needs of a developing country. If timber is overharvested the ecological functions of the forest are lost. Unfortunately forests are located in areas where there are rich mineral resources. Forests also cover the steep embankments of river valleys, which are ideally suited to develop hydel and irrigation projects.

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Thus there is a constant conflict of interests between the conservation interests of environmental scientists and the Mining and Irrigation Departments. What needs to be understood is that long-term ecological gains cannot be sacrificed for short-term economic gains that unfortunately lead to deforestation. These forests where development projects are planned can displace thousands of tribal people who lose their homes when these plans are executed. This leads to high levels of suffering for which there is rarely a satisfactory answer.

Caselet

Chipko Movement from Barucha

About 300 years ago, a ruler in Rajasthan decided to fell the 'khejri' trees in his state to create lime. Local women led by a Bishnoi woman, Amrita Devi, clung to the trees to prevent the felling of the trees that formed the basis of the scarce resources on which they were dependent. The women were ruthlessly massacred. It is said that the ruler later realised his mistake. The story, however, has been remembered and was revived in the 1970s when severe tree-felling for timber in the Himalayas prompted local women, supported by people such as Sunderlal Bahuguna and Chandi Prasad Bhat, led a people's movement to prevent deforestation by timber contractors. They called their movement the 'Chipko' movement in memory of the event during which women had clung to their trees and given up their lives. The movement followed the path the 300 Bishnoi women had taken three centuries ago in Rajasthan. Chipko is a movement primarily begun and supported by local women in the hills of Uttarakhand and Garhwal, where the women (the traditional fuel collectors) have had to bear the brunt of deforestation. They have not only realized that their fuelwood and fodder resources have receded away from their 'resource use areas' around their settlements due to commercial timber extraction, but that this has led to serious floods and the toss of precious soil. Chipko activists have made long padyatras across the Himalayas protesting against deforestation. The movement has been highly successful and has been primarily supported by empowering local women's groups, who are the most seriously affected segment. The movement has proved to the world that the forests of the hills are the life-support systems of local communities and of immense value in terms of local produce, and that the forest has less quantifiable but even more important ecological services such as soil conservation and the maintenance of the natural water regime of the whole region. The ability of local women to band together in the foothills of the Himalayas goes back to the pre-independence days when women such as Miraben, a disciple of Gandhiji, moved to this region and understood that it was the deforestation that led to floods and devastation of villages in the valleys and in the Gangetic plains below. They also appreciated that substitution of oak and other broad-Leaved forests of the Himalayas with the planting of fast-growing pine for timber and resin was an ecological and social disaster which reduced the forest resources used by traditional hill communities.

Source: http://www.angrau.ac.in/media/1653/BIRM301.pdf

Self Assessment

State whether the following statements are true or false:

1. The chief products which forests supply are wood.
2. Changing of forest resources can not influence the environment on which future performance of these resources depends.

Notes

3. Rapid decrease in the deforestation and fossil fuel combustion has been considered to affect largely the forest resources.
4. If timber is overharvested, the ecological functions of the forest are lost.

3.2 Importance of Forest Resources

The importance of forest resources can be explained as under:

1. ***Ecological Balance:*** Forests and wildlife are essential to maintain ecological balance of an area.
2. ***Renewable Natural Resources:*** Forests are important renewable natural resources.
3. ***Ecosystem:*** Trees dominate forest ecosystem; their species content varieties in different parts of the world.
4. ***Economic Development:*** Forest contributes to the economic development of the country because they provide goods and services to the people and industry.
5. ***Environment Quality:*** The forest enhances the quality of environment by influencing the life supporting system.
6. ***Safeguard against Pollution:*** Forest check air pollution and soil erosion. Thus, they exercise safety and against pollution.
7. ***Soil Conservation:*** Forest save the hill-slopes from landslides.
8. ***Wind Erosion:*** In deserts, trees reduce wind erosion by checking wind velocity.
9. ***Check the Extension Balance:*** The forest checks strong gales and keeps the soil intact beneath the roots of trees and thus checks extension of desert.
10. ***Maintains Ecological Balance:*** The forest check pollution of air through increasing oxygen content of the air.
11. ***Attract Rainfall:*** By causing condensation of water vapour in clouds, forests attract rains.
12. ***Control Floods:*** The floods are controlled because forests dry up rainwater like sponge.
13. ***Linked with Cultural and Civilization:*** Forests are linked with our cultural and civilization.
14. ***Supply of Raw Material:*** Forest supply wood, which is used as under:
    (i) Fuel,
    (ii) Raw material for various industries as pulp, paper, newsprint, board;
    (iii) Timber for furniture items;
    (iv) To be used in packing articles like fruits, tea etc.
    (v) For preparing matches, sport goods etc.
15. ***Minor forest products:*** Some examples of minor forest products, are canes, gums, resins, dyes, flocks, medicines, tannins, lac, fibres, katha, etc.

Example: For tribal people are provided with food like tuber, roots, leaves, fruits, meat from birds and other animals etc.

16. ***Employment opportunities:*** About eight crore people are employed in wood based industries like paper and match and small and cottage industries, besides, those who are employed in the forest department in various states.

Notes

17. ***Revenue Receipts:*** The forest provides ₹ 400 crores per year as revenue to the government.
18. ***Fodder for Cattle:*** Forest provides fodder to cattle.
19. ***Foreign Exchange Earners:*** Forest produces a great number of articles like essential oils, resins and dyes which find market in foreign countries. Nearly ₹ 50 crores is earned in foreign exchange through selling lac, terpentine oil and sandal wood oil to abroad.

Thus, the forests are nation's wealth. They are useful to us directly and indirectly.

Self Assessment

Fill in the blanks:

5. Forests and wildlife are essential to maintain ..... of an area.
6. Forest saves the ..... from landslides.
7. In deserts, trees ..... wind erosion by checking wind velocity.
8. Forest provides ..... to cattle.

3.3 Deforestation: Meaning and Results

Deforestation is the process of felling trees indiscriminately resulting in nude or seminude surface of the hill hitherto covered by thick forests. Deforestation refers to the loss of forest cover; land that is permanently converted from forest to agricultural land, golf courses, cattles, pastures, home, lakes or desert. The FAO (Food and Agriculture Organization of the UN) defines tropical deforestation as "change of forest with depletion of tree crown cover more than 90% " depletion of forest tree crown cover less than 90% is considered forest degradation.

Did u know? Where civilizations have looked after forests by using forest resources cautiously, they have prospered, where forests were destroyed, the people were gradually impoverished. Today logging and mining are serious causes of loss of forests in our country and all over the world. Dams built for hydroelectric power or irrigation have submerged forests and have displaced tribal people whose lives are closely knit to the forest. This has become a serious cause of concern in India.

The National Forest Policy of 1988 now gives an added importance to JFM. Another resolution in 1990 provided a formal structure for community participation though the formation of Village Forest Committees. Based on these experiences, new JFM guidelines were issued in 2000. This stipulates that at least 25 per cent of the income from the area must go to the community. From the initiation of the program, until 2002, there were 63,618 JFM Committees managing over 140,953 sq. km of forest under JFM in 27 States in India. The States have tried a variety of approaches to JFM. The share for village forest committees ranges from 25 per cent in Kerala to 100 percent in Andhra Pradesh, 50 percent in Gujarat, Maharashtra, Orissa and Tripura. In many States 25 per cent of the revenue is used for village development. In many States non-timber forest products (NTFPs) are available for people free of cost. Some States have stopped grazing completely; some have rotational grazing schemes which have helped in forest regeneration.

Caution One of India's serious environmental problems is forest degradation due to timber extraction and our dependence on fuelwood. A large number of poor rural people are still highly dependent on wood to cook their meals and heat their homes. We have not been able to plant enough trees to support the need for timber and fuelwood.

Notes

3.3.1 Causes for Deforestation

Main causes responsible for deforestation are as under:

(a) Felling of trees to meet the ever increasing demand of the cities.

(b) Grazing by the local cattle, goats, sheep etc. They not only destroy the vegetation but also pull out the roots of plants. After denudation of our Himalayas, the process of deforestation started in the Shivalik range. Shivalik sal forests were overexploited for industry use, i.e. railway sleepers etc. Consequently, the foothills of the Shivaliks are in semi desert conditions.

(c) Meeting out the growing hunger for land. It has hit the ecology of the country badly very soon India is likely to have more of wasteland than productive land. Large scale deforestation has badly affected the weather facing almost each year more of bleak than the normal weather.

(d) The increase in shifting (jhum) cultivation in North east and Orissa has also laid large in forest tracts bare. As the jhum cycle is shortened to six years only (in some districts, even 2-3 years only), too short period does not provide enough time for natural repair of damaged ecosystem.

(e) A major cause of deforestation has been the construction of hill roads. About a decade back, they were about 30,000 km long. Most of these roads are in state and most fragile belt of Himalayas. Road construction damaged the protective vegetation cover both above and below roads. It blocked natural and pollution streams.

3.3.2 Evil Consequences of Deforestation

With deforestation ecological balance maintain by nature breaks away. Floods or drought are the terrible consequences. The trees, increase rainfall of an area, as well as conserve the water which falls on the ground rain.

Caution Consequent to deforestation, the plant reduces evaporation allowing water to remain in solid for a long time.

In our country unabated deforestation over grazing and the growing hunger for land has hit the ecology of India badly. If it goes on, we may soon have more of wasteland than productive land. Large-scale deforestation has badly affected the weather. Evil consequences of deforestation can be summed up as under:

1. ***Adverse Effect on Productivity:*** It is noticed that the devastating effects of deforestation in India include soil, water and wind erosions, estimated to cost over 16,400 crores every year. Deforestation affects productivity of our croplands in two ways as under:

   - The deforestation increases the soil erosion increase manifold. The soil so washed leads to an accentuated cycle of floods and drought.
   - Deforestation creates to use cow dung and crop wastes as fuel mainly for cooking.

   As a result no part of the plant goes back to loss in soil fertility.

2. ***Land/Erosion and Landslides:*** Deforestation has been causing tremendous land erosion and landslides. Data reflect that about 6,000 million ton of topsoil is lost annually due to water erosion in the absence of trees. The loss worked out from the topsoil erosion in 1973

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was ₹ 700 crore. The figures for the years 1976, 1977 and 1978 are ₹ 889 crore, ₹ 1,200 crore and ₹ 1,091 crore respectively.

3. ***Low per Capita Forestland:*** As far as per capita forestland is concerned, India today is the poorest in the world. The per capita forestland in India is 0.10 hectare compared to the world average of 1 hectare.

Task Will the public have the opportunity to provide input into the management of forest resources? Give reasons which support your answer.

Self Assessment

State whether the following statements are true or false:

9. The National Forest Policy of 1978 now gives an added importance to JFM.
10. Felling of trees to meet the ever increasing demand of the cities.
11. A major cause of deforestation has not been the construction of hill roads.
12. With deforestation ecological balance maintain by nature breaks away.

3.4 Use and Overexploitation of Forest Resources

People who live in or near forests know the value of forest resources first hand because their lives and livelihoods depend directly on these resources. However, the rest of us also derive great benefits from the forests which we are rarely aware of. The water we use depends on the existence of forests on the watersheds around river valleys. Our homes, furniture and paper are made from wood from the forest. We use many medicines that are based on forest produce. And we depend on the oxygen that plants give out and the removal of carbon dioxide we breathe out from the air.

Forests once extended over large tracts of our country. People have used forests in our country for thousands of years. As agriculture spread the forests were left in patches which were controlled mostly by tribal people. They hunted animals and gathered plants and lived entirely on forest resources. Deforestation became a major concern in British times when a large amount of timber was extracted for building their ships. This led the British to develop scientific forestry in India. They however alienated local people by creating Reserved and Protected Forests which curtailed access to the resources. This led to a loss of stake in the conservation of the forests which led to a gradual degradation and fragmentation of forests across the length and breadth of the country.

Notes Scientists estimate that India should ideally have 33 percent of its land under forests. Today we have only about 12 percent. Thus we need not only to protect existing forests but also to increase our forest cover.

Another period of overutilisation and forest degradation occurred in the early period following independence as people felt that now that the British had gone they had a right to using our forests in any way we pleased. The following years saw India's residual forest wealth dwindle sharply. Timber extraction continued to remain the Forest Department's main concern up to the 1970s. The fact that forest degradation and deforestation was creating a serious loss of the important functions of the forest began to override its utilisation as a source of revenue from timber.

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3.4.1 Effects of Over-Exploitation of Forest Resources

It has been a global concern that the environmental degradation leads to danger situation on the ecosystem. The practice of over-exploitation of forest resources has been increasingly observed in the Indian contemporary social scenario. Resulting from this malpractice, the ecosystem or environment has been adversely effected. The main resources for survival of living-beings are soil, water and vegetation. The over-exploitation of any one of these resources may lead to maladjustment and environmental degradation as well. The environmental degradation resulting from over-exploitation of forest resources has been affecting the life of communities, both human and plants, ecological imbalance, and finally causing resource crunch.

The problem is quite severe in North-Eastern Region, Himachal Pradesh and Jammu & Kashmir. Lot of transhumance activity of migratory cattle and local biotic pressures for food, fuel wood, fodder, had resulted in deduction of forests.

Did u know? As per the available estimates, India's:

Total land mass: 328 m.ha.

Degraded land: 175 m.ha

Country losing: 1.3 m.ha annually

In addition, 75% of the area under forest is not fully productive and can also be categorized as degraded forests. Besides the above details 16.21% of total land in India is the waste lands. Thus, the major impact of the over-exploitation straightway leads towards degradation of resources like land, forests etc. those affecting the life of human and plants. The result of that prevailing system is the ecological imbalance including that of man and his environment. Again, degradation of forests and other natural resources changes their structural and functional aspects thereby leading towards degradation, which normally crosses the carrying capacity of that particular ecosystem.

3.4.2 Suggestions

Where the man lived the longest in organized societies there the land is in worst condition. This is true of farmlands, grass lands and forest lands, though the forest lands seem to be the first to be damaged and misused. Therefore it requires effective and sustainable management of resources. To achieve the proper management, steps must be taken for increasing production, soil conservation, containing deterioration of natural resources, development of harmonious systems. However, technical and socioeconomic knowledge must be available for successful management. The increasing depletion of forests gives rise to the necessity of afforestation, plantation and regenerating environment in order to protect and promote the livelihood and also to reduce drudgery of the people.

Development of hill areas in general and mountainous forests in particular has become a matter of National concern. Integrated watershed management, formulation of sustainable programme, conservation of area having rich biodiversities and upgradation of research and development activities are to be identified as the thrust area.

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Caution The conventional poverty-environment argument is that poorer families are more likely to clear the forest either to grow crops or to cut wood, because they have shorter time horizons. It is argued that poverty and under development lead to environmental degradation. In this regard there should be an alternative govt. policy to stop such process.

There is increasing realization that the forest not only provides multiple benefits to mankind but also helps in conserving the environment and has created global concern for their protection and preservation. Human resource being a greatest asset needs development and attitudinal change. Economically viable, biologically sustainable and socially acceptable system can be developed.

Self Assessment

Fill in the blanks:

13. Scientists estimate that India should ideally have ..... percent of its land under forests.
14. ..... became a major concern in British times when a large amount of timber was extracted for building their ships.
15. The major impact of the ..... straightway leads towards degradation of resources like land, forests etc. those affecting the life of human and plants.
16. ..... being a greatest asset needs development and attitudinal change.

Case Study

Forest Resource Entrepreneurship of Goalpara District of Assam

Goalpara district of Assam has no reserve forest and national parks. Even it has an area of 28% forest of the total level area of the district. Thus the district is rich in forest resources. Importance of forest and forest resources entrepreneurship is really great as they perform productive, productive and aesthetic functions and confer advantages to the community. The district is enriched with large group of forest wood resources from where entrepreneurs can avail financial benefits by using resources though their enterprises. Implications of the forest resource entrepreneurship in the district is sought to observe though this paper. However, it is kept in mind that there is much scope of development of forest resources entrepreneurship in this district depending on the proper management and sustainable use.

Goalpara district has no reserve forests and national parks. It has an area of 28% forest of the total land area of the district. The total forest area of this district is 36915.27 hectares. This district is potent and rich area for major forest timber products. These include valuable Wood- plant like sal, teak, simal, gamari, pome sonaru, koroi, etc. and minor forest products. Like different bamboo, cane thatch, etc. These forest resources mainly based on the entrepreneurship which are providing raw material to sawmill, furniture houses, cane cutter, etc. Wood is required for entrepreneurs for construction, furniture and paper pulp newsprint, Rayon, matches, etc. Moreover, forest resources like canes, grasses, bamboo,

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resins, gums, medicinal plants and tanning materials etc. are providing various minor products. All forest resource is being used for commercial and economic benefit.

A huge portion of Indian forests are not properly utilized due to their inaccessibility. The forest resources exploitation started in this Goalpara district since 1850 when the Bangal wood cutters began in discriminate exploitation of timbers on lump-sum payment of taxes. The Entrepreneurs are engaged in part a fully in saw mills. Plywood factories and furniture houses are established locally. They began to use mayor forest resources for railway sleepers and other wood product on internal and external demand. From the forest resources the entrepreneurs produces varieties of articles like Saldhuna, medicine, Laha, etc. The minor forest resources provide the entrepreneurs raw materials to produce broom (Jaru), canmets (sital pati), cane hats (japi), etc. Jaru Company of Dudhnoi in Goalpara district has a huge product of Jaru (bamboo broom) which are based only on different bamboo. The company supplies 4/5 trucks of Jaru weekly to the different parts of the country. Cane mats and cane hats (Japi) of Mornoi Dubapara is popular all over the state. These are made mainly from canes. The production of mats gives another source of livelihood to the people of that area of the Goalpara district.

In India there was no proper forest policy before independence. The central as well as the state Government in India have realized the necessity of developing forest in the country. Accordingly in 1950, Van Mahotsava programme was introduced in India. For the forest resources protection and development in the state, the state government as well as the central Government introduced the Forest policy 1952. New forest, 1988 and in 1981 the Government established an organization, namely the "Forest Survey of India", the state forest development corporation and planning project formulation for assessing and monitoring forest resources of the country. The policies provided by the central Govt. and state Govt. for protection conservation and development of forest resources are not found in a sound position. The existing provision of management has alienate the community participation the provision was never found conformity with the community right and aspirations of the natives. Continuous development of forest area and depletion of vegetation reveal the ineffective and inefficient management of forest resources. Besides failure to implement the afforestation, regeneration and replanting of forest resources up to the desired mark, emerge shifting the strategies for implementation of the policies and programmes. Official sources show a very negligible district wise physical achievement under various schemes of social forest in Goalpara district. In 1999-2000 physical achievement under SFG, TSP, SCCP, AOFFP are 32.5, 150.0 and 250 hectares respectively. These achievements are very negligible to the total deserted areas of forest. Alienation of the community from the forest department arising out from the existing forest management system stands harmful for protecting and conserving the forest resources.

Degradation of forest resources entrepreneurship mainly causes loss of sustainability. Causes of depletion of forest resources are several. A good number of poor are regularly cutting trees and selling firewood for earning their livelihood in district, e.g. in adjacent villages of Dhupdhara, Malangkona and Kurhiamari. Illegal cutting of trees is done with the sole intention to get illegal gratification by supplying timber, bamboo, etc. to different parts of the state. Increasing demand for raw materials (e.g. bamboo) for forest-based industries; use of wood plants in furniture houses (about 80 nos.) throughout the Goalpara district; uncontrolled population and illegal encroachment on forest land result in illegal felling of trees in the areas like Moylapota, Bhalukdubi, etc.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.caesjournals.org/splupload s/IJCAES-BASS-2012-192.pdf

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3.5 Summary

- Forests shape natural environment by influencing factors such as temperature, humidity and precipitation.
- Changing of forest resources can significantly influence the environment on which future performance of these resources depends.
- Forest products are used in our daily lives. All the activities listed above directly or indirectly involve forests.
- Over the past 50 years, about half the world's original forest cover has been lost, the most significant cause for that being humans beings' unsystematic use of its resources.
- Timber extraction, mining and dams are invariably parts of the needs of a developing country.
- Deforestation is the process of felling trees indiscriminately resulting in nude or seminude surface of the hill hitherto covered by thick forests.
- The National Forest Policy of 1988 now gives an added importance to JFM.
- With deforestation ecological balance maintain by nature breaks away.
- It is noticed that the devastating effects of deforestation in India include soil, water and wind erosions, estimated to cost over 16,400 crores every year.
- Deforestation has been causing tremendous land erosion and landslides.
- People who live in or near forests know the value of forest resources first hand because their lives and livelihoods depend directly on these resources.
- The practice of over-exploitation of forest resources has been increasingly observed in the Indian contemporary social scenario.
- Human resource being a greatest asset needs development and attitudinal change.

3.6 Keywords

Deforestation: It is the process of felling trees indiscriminately resulting in nude or seminude surface of the hill hitherto covered by thick forests.

Ecosystem: An ecosystem is a complex set of relationships among the living resources, habitats, and residents of an area.

Environment: The surroundings or conditions in which a person, animal, or plant lives or operates.

Foreign Exchange: Instruments, such as paper currency, notes, and checks, used to make payments between countries.

Forest: A forest can be defined as a biotic community predominant of trees, shrubs or any other woody vegetation usually in a closed canopy.

Harvesting: Harvesting is the process of collecting the mature rice crop from the field.

Landslides: A landslide is the movement of rock, earth, or debris down a sloped section of land.

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Mining: Mining is the extraction of valuable minerals or other geological materials from the earth from an ore body, lode, vein, seam, or reef, which forms the mineralized package of economic interest to the miner.

Overexploitation: Overexploitation, also called overharvesting, refers to harvesting a renewable resource to the point of diminishing returns.

Productivity: A measure of the efficiency of a person, machine, factory, system, etc., in converting inputs into useful outputs.

Soil Conservation: Soil conservation is a set of management strategies for prevention of soil being eroded from the Earth's surface or becoming chemically altered by overuse, salinization or other chemical soil contamination.

Timber Extraction: Timber extraction is when wood is extracted or taken from a rain forest.

Wind Erosion: Wind erosion is the movement of material by the wind and occurs when the lifting power of moving air is able to exceed the force of gravity and the friction which holds an object to the surface.

3.7 Review Questions

1. Define Forest.
2. What is the ecological significance of Forests?
3. Highlight the function of trees.
4. "Timber extraction, mining and dams are invariably parts of the needs of a developing country." Discuss.
5. Elucidate the importance of forest resources.
6. What do you understand by Deforestation?
7. Highlight the causes for Deforestation.
8. Describe the evil consequences of Deforestation.
9. Throw some light on the use of Forest Resources.
10. What are the effects of over-exploitation of Forest Resources?

Answers: Self Assessment

1.	True	2.	False
3.	False	4.	True
5.	Ecological Balance	6.	Hill-slopes
7.	Reduce	8.	Fodder
9.	False	10.	True
11.	False	12.	True
13.	33	14.	Deforestation
15.	Overexploitation	16.	Human Resource

3.8 Further Readings

Notes

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Unit 4: Water Resources

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Objectives

After studying this unit, you should be able to:

- Discuss the overview of Water Resources
- Explain the Use and Overutilisation of Surface and Ground Water
- Describe the Benefits and Problems of Dams
- Explain the Core Issues related to Water Resources

Introduction

In the previous unit, we dealt with the meaning, importance and overexploitation of Forest Resources along with the meaning of Deforestation. Water is essential for human civilisation, living organisms, and natural habitat. It is used for drinking, cleaning, agriculture, transportation, industry, recreation, and animal husbandry, producing electricity for domestic, industrial and commercial use. Due to its multiple benefits and the problems created by its excesses, shortages and quality deterioration, water as a resource requires special attention. On a global scale, total quantity of water available is about 1600 million cubic km. The hydrologic cycle moves enormous quantity of water around the globe. However, much of the world's water has little potential for

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human use because 97.5% of all water on earth is saline water. Out of the remaining 2.5% freshwater, most of which lies deep and frozen in Antarctica and Greenland, only about 0.26% fish in rivers, lakes and in the soils and shallow aquifiers which are readily usable for mankind. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the use, over-utilisation and core issues related to Water Resources along with the benefits and problems related to the Dams.

4.1 Water Resources: An Overview

Water claims to be an important resource. An important use of water in our country is for irrigation. Besides, water is also required in large amounts for industrial and domestic consumption. Water resources of a country constitute one of its vital assets. India receives annual precipitation of about 4000 km. The rainfall in India shows very high spatial and temporal variability and paradox of the situation is that Mousinram near Cherrapunji, which receives the highest rainfall in the world, also suffers from a shortage of water during the non-rainy season, almost every year. The total average annual flow per year for the Indian rivers is estimated as 1953 km. The total annual replenishable groundwater resources are assessed as 432 km.

The annual utilizable surface water and groundwater resources of India are estimated as 690 km and 396 km per year, respectively. With rapid growing population and improving living standards the pressure on our water resources is increasing and per capita availability of water resources is reducing day by day. Due to spatial and temporal variability in precipitation the country faces the problem of flood and drought syndrome. Overexploitation of groundwater is leading to reduction of low flows in the rivers, declining of the groundwater resources, and salt water intrusion in aquifers of the coastal areas. Over canal-irrigation in some of the command areas has resulted in waterlogging and salinity. The quality of surface and groundwater resources is also deteriorating because of increasing pollutant loads from point and non-point sources. The climate change is expected to affect precipitation and water availability. So far, the data collection, processing, storage and dissemination have not received adequate attention.

One of the basic conditions of living is availability of water. Adequate supply of safe water is essential for maintaining health and sanitary conditions. Not only this, water as a natural resource has influence on almost every aspect of development. Agriculture production, through irrigated cultivation needs water. Likewise, labour productivity can be increased if the labour force and their families have adequate safe water supply. Water management requires special efforts especially for water short basins. Besides providing water to household both in villages and cities, adequate water supply is essential for nation's industries. In developing countries, in early phases of development, water demand always increases. Some industries use more water than others. Development of water resources will continue to rise if we have to attain higher industrial and economic growth.

Sustainable management of water resources has implications for ecosystem, dams, silting of reservoirs, and submergence of forests, extinction of rare plants and animals and outbreak of disease. A systematic study of impact of water resource projects on environment has to be undertaken at national level. The people who are likely to be affected by projects - like river valley projects, water shed projects or dams - should be taken into confidence and even involved in project formulation and implementation.

Caution Since last few years, there has been a shift in water management from the perception that fresh water is a free and abundant resource to that of water being an economic good in scarce supply, threatened by pollution. The challenge of sustainable water use is serious, particularly for developing countries grappling to enhance standards of living and economic growth.

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Agenda 21 recognises that a key component of sustainable development is the efficient management of fresh water. Johannesburg Summit 2002 set the world target of halving the number of people without access to clean water and sanitation by 2015.

As per the Constitution of India, water and sanitation are state subjects, empowering the states to enact laws, frame policies or fix prices of related services. Planning and implementation of water development projects is currently handled both at the centre and state levels.

Did u know? One of the greatest challenges facing the world in this century is the need to rethink the overall management of water resources. The world population has passed the 6 billion mark. Based on the proportion of young people in developing countries, this will continue to increase significantly during the next few decades. This places enormous demands on the world's limited freshwater supply. The total annual freshwater withdrawals today are estimated at 3800 cubic kilometres, twice as much as just 50 years ago (World Commission on Dams, 2000). Studies indicate that a person needs a minimum of 20 to 40 liters of water per day for drinking and sanitation. More than one billion people worldwide have no access to clean water, and to many more, supplies are unreliable.

India is expected to face critical levels of water stress by 2025. At the global level 31 countries are already short of water and by 2025 there will be 48 countries facing serious water shortages. The UN has estimated that by the year 2050, 4 billion people will be seriously affected by water shortages. This will lead to multiple conflicts between countries over the sharing of water. Around 20 major cities in India face chronic or interrupted water shortages. There are 100 countries that share the waters of 13 large rivers and lakes. The upstream countries could starve the downstream nations leading to political unstable areas across the world.

Example: Ethiopia, which is upstream on the Nile and Egypt, which is downstream and highly dependent on the Nile. International accords that will look at a fair distribution of water in such areas will become critical to world peace. India and Bangladesh already have a negotiated agreement on the water use of the Ganges.

4.1.1 Significant of Water

The significant of water needs no elucidation. It is as under:

1. It is revealed by the history of human civilization that water supply and civilization are most synonymous.
2. Several cities and civilizations have disappeared due to water shortages originating from climatic changes.
3. Millions of people all over the world, particularly in the developing countries, are losing their lives every year from waterborne disease.
4. An understanding of water chemistry is the basis of knowledge of the multidimensional aspects of aquatic environment chemistry, which involve the sources, composition, reactions, and transport of the water.
5. About 97% of the earth's water supply is in the ocean, which is unfit of the remaining 3%, 2% is locked in the polar ice-caps and only 1% is available as fresh water in rivers, lakes, streams, reservoirs and ground water which is suitable for human consumption.

Unlike land, which remains available as it is, the availability of water varies from place to place and time to time. Our country is a monsoon land. The bulk of rainfall is confined to a brief

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period of 3-4 months that is from July to October. As such, large part of the country lacks surface water supply for a greater part of the year.

4.1.2 Main Sources of Water

Main sources of water for our use are:

1. ***Rainfall:*** India can be broadly divided into 15 ecological regions. The vast ecological diversity of this country is reflected in the diversity in available water resources. With an average annual rainfall of 1170 mm, India is one of the wettest countries in the world. However, there are large variations in the seasonal and geographical distribution of rainfall over the country. At one extreme are areas like Cherrapunji, in the northeast, which is drenched each year with 11,000 mm of rainfall, and at the other extreme are places like Jaisalmer, in the west, which receives barely 200 mm of annual rainfall. Though the average rainfall is adequate, nearly three quarters of the rain pours down in less than 120 days, from June to September.
2. ***Groundwater:*** India's groundwater resources are almost ten times its annual rainfall. According to the Central Groundwater Board of the Government of India, the country has an annual exploitable groundwater potential of 26.5 million hectare-meters. Nearly 85% of currently exploited groundwater is used only for irrigation. Groundwater accounts for as much as 70-80% of the value of farm produce attributable to irrigation. Besides, groundwater is now the source of four-fifths of the domestic water supply in rural areas, and around half that of urban and industrial areas. However, according to the International Irrigation Management Institute (IIMI), the water table almost everywhere in India is falling at between one to three meters every year. Furthermore, the IIMI estimates that India is using its underground water resources at least twice as fast they are being replenished. Already, excessive ground water mining has caused land subsidence in several regions of Central Uttar Pradesh.
3. ***Surface water:*** There are 14 major, 44 medium and 55 minor river basins in the country. The major river basins constitute about 83-84% of the total drainage area. This, along with the medium river basins, accounts for 91% of the country's total drainage. India has the largest irrigation infrastructure in the world, but the irrigation efficiencies are low, at around 35%.

Caselet

Narmada River Dams

For over a decade, villagers have waged an intense battle to stop dams on India's Narmada River. The Narmada Valley Development Project includes 30 major dams and 3,000 smaller dams. The Sardar Sarovar Project (SSP) has gained international notoriety due to intense opposition by villagers. Led by the Narmada Bachao Andolan (Save the Narmada movement), activists and villagers forced the World Bank to withdraw from the project in the early '90s. A case filed with the Indian Supreme Court stopped construction for nearly six years. However, on October 18, 2000, the Indian Supreme Court issued a controversial final ruling allowing construction to proceed. About 200,000 people would be displaced for the reservoir; hundreds of thousands more will lose land or livelihood due to related developments.

Thousands of people who have been resettled are struggling to survive on cramped plots with no arable land or source of livelihood. Faced with these future prospects, villagers

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have vowed to remain on their lands and face submergence behind the partly-built dam rather than face a life of certain destitution. People affected by the extensive canal system are not considered as project affected people and are not entitled to the same resettlement and compensation packages as those living in the reservoir area. There are no credible environmental studies or rehabilitation plans. Although the legal framework requires that affected people be given land-for-land compensation, there is no land available for resettlement.

The project is expected to generate only 50MW (of 1450 MW planned) after seasonal water flow and power consumption for pumping water is accounted for. The project is supposed to irrigate 1.9 million hectares and provide drinking water to over 20 million people. However, these benefits are based on overestimates of annual flow in the river and assume extremely high irrigation efficiency. The arid Kutch region will not receive any water supply benefits until 2025.

Source: http://www.angrau.ac.in/media/1653/BIRM301.pdf

Self Assessment

State whether the following statements are true or false:

1. Water claims to be an important resource.
2. The quality of surface and groundwater resources is also deteriorating because of decreasing pollutant loads from point and non-point sources.
3. India is expected to face critical levels of water stress by 2015.
4. India can be broadly divided into 15 ecological regions.

4.2 Water Resources—Use and Overutilisation of Surface and Ground Water

India is considered rich in terms of annual rainfall and total water resources available at the national level; however, the uneven distribution of the resource causes regional and temporal shortages. India's average annual rainfall equivalent of about 4000 billion cubic metres (BCM) is unevenly distributed both spatially as well as temporally. Levels of precipitation vary from 100 mm annually in western Rajasthan to over 9000 mm in the north-eastern state of Meghalaya. With 75% of the rainfall occurring over the four monsoon months and the other 1000 BCM spread over the remaining eight months, our rivers carry 90% of the water between June and November. Thus, only 10% of the river flow is available during the other six months.

The rapid increase in the country's population, from about 343 million at the time of the independence to over 1000 million in 2000, accompanied by growth of agriculture, industrialization, rapid urbanization, economic growth and improved access to basic services has resulted in an increase in the demand for water. A requirement of 629 BCM against the availability of 1122 BCM indicates surplus at the national level; however spatial and temporal variations give rise to shortages in some regions. The Western plains, the Kachchh region, and some pockets in the Northern plains face acute water shortages. The country's total water requirement is projected to grow to 1180 BCM by the year 2050 as against 629 BCM in 1997-98. The widening gap between demand and supply had led to a substantial increase in the share of groundwater consumption by the industrial; agricultural and domestic sectors. It may also be noted that the quality of water sources is threatened because of inadequate provisions for the treatment of waste water.

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With the growth of human population there is an increasing need for larger amounts of water to fulfil a variety of basic needs. Today in many areas this requirement cannot be met. Overutilisation of water occurs at various levels. Most people use more water than they really need. Most of us waste water during a bath by using a shower or during washing of clothes. Many agriculturists use more water than necessary to grow crops. There are many ways in which farmers can use less water without reducing yields such as the use of drip irrigation systems.

Example: Agriculture also pollutes surface water and underground water stores by the excessive use of chemical fertilizers and pesticides. Methods such as the use of biomass as fertilizer and non toxic pesticides such as neem products and using integrated pest management systems reduces the agricultural pollution of surface and ground water.

Industry tends to maximise short-term economic gains by not bothering about its liquid waste and releasing it into streams, rivers and the sea. In the longer term, as people become more conscious of using 'green products' made by ecosensitive industries, the polluter's products may not be used. The polluting industry that does not care for the environment and pays off bribes to get away from the cost needed to use effluent treatment plants may eventually be caught, punished and even closed down. Public awareness may increasingly put pressures on industry to produce only eco-friendly products which are already gaining in popularity.

As people begin to learn about the serious health hazards caused by pesticides in their food, public awareness can begin putting pressures on farmers to reduce the use of chemicals that are injurious to health.

4.2.1 Floods

Technically, flooding occurs when the water level in any stream, river, bay or lake rises above bank full. Bays may flood as the result of a tsunami or tidal wave induced by an earthquake or volcanic eruption; or as a result of a tidal storm surge caused by a hurricane or tropical storm moving inland. Streams, rivers and lakes may be flooded by high amounts of surface runoff resulting from widespread precipitation or rapid snowmelt. On a smaller scale, flash floods due to extremely heavy precipitation occurring over a short period of time can flood streams, creeks and low lying areas in a matter of a few hours. Thus, there are various temporal and spatial scales of flooding. Historical evidence suggests that flooding causes greater loss of life and property than any other natural disaster. The magnitude, seasonality, frequency, velocity, and load are all properties of flooding which are studied by meteorologists, climatologists and hydrologists.

Spring and winter floods occur with some frequency primarily in the mid-latitude regions of the earth, and particularly where continental climate is the norm. Five climatic features contribute to the spring and winter flooding potential of any individual year or region:

1. Heavy winter snow cover;
2. Saturated soils or soils at least near their field capacity for storing water;
3. Rapid melting of the winter's snow pack;
4. Frozen soil conditions which limit infiltration; and
5. Somewhat heavy rains, usually from large scale cyclonic storms.

Any combination of three of these five climatic features usually leads to some type of flooding. This type of flooding can cause hundreds of millions of dollars in property damage, but it can usually be predicted well in advance, allowing for evacuation and other protective action to be

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taken (sandbagging, for instance). In some situations, flood control measures such as stream or channel diversions, dams, and levees can greatly reduce the risk of flooding. This is more often done in floodplain areas with histories of very damaging floods. In addition, land use regulations, encroachment statutes and building codes are often intended to protect the public from the risk of flooding.

Flash flooding is generally caused by violent weather, such as severe thunderstorms and hurricanes. This type of flooding more frequently occurs during the warm season when convective thunderstorms develop more frequently. Rainfall intensity is so great that the carrying capacity of streams and channels is rapidly exceeded, usually within hours, resulting in sometimes life-threatening flooding. It is estimated that the average death toll in the United States exceeds 200 per year as a result of flash flooding. Many government weather services provide the public with flash flood watches and warnings to prevent loss of life.

Notes Many flash floods occur as the result of afternoon and evening thundershowers which produce rainfall intensities ranging from a few tenths of an inch per hour to several inches per hour. In some highly developed urban areas, the risk of flash flooding has increased over time as the native vegetation and soils have been replaced by buildings and pavement which produce much higher amounts of surface runoff. In addition, the increased usage of parks and recreational facilities which lie along stream and river channels has exposed the public to greater risk.

4.2.2 Drought

Drought is one of those natural disasters, which no one can predict and so when it occurs it is always difficult to manage it. Drought develops slowly unlike other natural disasters.

Drought is measured by decrease in the amount of subsoil moisture that causes crops to die or affects the yield. Drought reduces water level of aquifers and causes wells to go dry. Drought affects food and water supplies so people have to rely on relief or they migrate to another area.

The main cause for drought is continuous decrease in rainfall. Climate changes cause decrease in rainfall. It is believed that El Nino can also cause droughts around the world.

The scientists know that El Nino events cause droughts in specific areas; however they cannot yet predict when El Nino will occur. Decrease in rainfall can be said to be a man-made environmental problem caused due to cutting off trees or reducing forest cover and not allowing the soil to preserve soil moisture. Overgrazing by animals also contributes to the denuding of topsoil, which blows away in the wind. Loss of forest cover reduces the amount of water vapours given off into the atmosphere. The result is that local rainfall is reduced, and even the little bit rain available is not absorbed well. During severe drought, people migrate or die because food supplied by the government or relief agents does not reach on time.

In most arid regions of the world the rains are unpredictable. This leads to periods when there is a serious scarcity of water to drink, use in farms, or provide for urban and industrial use. Drought prone areas are thus faced with irregular periods of famine. Agriculturists have no income in these bad years, and as they have no steady income, they have a constant fear of droughts. India has 'Drought Prone Areas Development Programs', which are used in such areas to buffer the effects of droughts. Under these schemes, people are given wages in bad years to build roads, minor irrigation works and plantation programs.

Notes

Did u know? Drought has been a major problem in our country especially in arid regions. It is an unpredictable climatic condition and occurs due to the failure of one or more monsoons. It varies in frequency in different parts of our country. While it is not feasible to prevent the failure of the monsoon, good environmental management can reduce its ill effects. The scarcity of water during drought years affects homes, agriculture and industry. It also leads to food shortages and malnutrition which especially affects children. Several measures can be taken to minimise the serious impacts of a drought. However this must be done as a preventive measure so that if the monsoons fail its impact on local people's lives is minimised.

In years when the monsoon is adequate, we use up the good supply of water without trying to conserve it and use the water judiciously. Thus during a year when the rains are poor, there is no water even for drinking in the drought area. One of the factors that worsen the effect of drought is deforestation. Once hill slopes are denuded of forest cover the rainwater rushes down the rivers and is lost. Forest cover permits water to be held in the area permitting it to seep into the ground. This charges the underground stores of water in natural aquifers. This can be used in drought years if the stores have been filled during a good monsoon. If water from the underground stores is overused, the water table drops and vegetation suffers. This soil and water management and afforestation are long-term measures that reduce the impact of droughts.

4.2.3 Sustainable Water Management

'Save water' campaigns are essential to make people everywhere aware of the dangers of water scarcity. A number of measures need to be taken for the better management of the world's water resources. These include measures such as:

- Building several small reservoirs instead of few mega projects.
- Develop small catchment dams and protect wetlands.
- Soil management, micro catchment development and afforestation permits recharging of underground aquifers thus reducing the need for large dams.
- Treating and recycling municipal waste water for agricultural use.
- Preventing leakages from dams and canals.
- Preventing loss in Municipal pipes.
- Effective rain water harvesting in urban environments.
- Water conservation measures in agriculture such as using drip irrigation.
- Pricing water at its real value makes people use it more responsibly and efficiently and reduces water wasting.
- In deforested areas where land has been degraded, soil management by bunding along the hill slopes and making 'nala' plugs, can help retain moisture and make it possible to revegetate degraded areas.

Managing a river system is best done by leaving its course as undisturbed as possible. Dams and canals lead to major floods in the monsoon and the drainage of wetlands seriously affects areas that get flooded when there is high rainfall.

Notes

Self Assessment

Fill in the blanks:

5. The country's total water requirement is projected to grow to ..... BCM by the year 2050.
6. ..... also pollutes surface water and underground water stores by the excessive use of chemical fertilizers and pesticides.
7. ..... occurs when the water level in any stream, river, bay or lake rises above bank full.
8. ..... is measured by decrease in the amount of subsoil moisture that causes crops to die or affects the yield.

4.3 Dams: Benefits and Problems

Today there are more than 45,000 large dams around the world, which play an important role in communities and economies that harness these water resources for their economic development. Current estimates suggest some 30-40% of irrigated land worldwide relies on dams. Hydropower, another contender for the use of stored water, currently supplies 19% of the world's total electric power supply and is used in over 150 countries. The world's two most populous countries – China and India –have built around 57% of the world's large dams.

A number of big, medium and minor dams have been envisaged under different river valley projects. These dams have been undertaken for irrigation, power generation and water supply. These dams, hailed as the Temples of Modern India by the country's first Prime Minister, Jawaharlal Nehru, have increased agricultural production, power generation and reduced dependence on imports. A brief description of the dams and benefit accruing form them is as under:

4.3.1 Farakka Barrage Project

The Farakka Barrage Project is designed to subserve the need for preservation and maintenance of the Calcutta Port by improving the regime and navigability of the Bhagirathi- Hooghly River System. The Bhagirathi, the feeder canal and the navigation lock at the Farakka Barrage form part of the Haldi-Allahabad Inland Waterway for which an act has been passed.

The principles components of the Farakka Barrage Project are:

(a) 2,240 metre-long barrage across the Ganga, designed to pass a flood discharge of 76,455 cusec or 27 lakh, with rail-cum-road bridge, the necessary river draining works and a head regulator on the right side;

(b) 213 metre-long garrage across the Bhragirathi at Jangipur, designed to pass flood discharge of 1,700 cusecs or 60,000 cusecs;

(c) Feeder canal of 1,133 cusecs or 40,000 cusecs carrying capacity and 38.38 km-long taking off from the head regulator on the right-side of the Farakka Barrage, tailing off into the Bhagirathi below Jangipur Barrage;

(d) Navigation works such as locks, channels, shelter navigation lights and other infrastructures.

Notes

4.3.2 Various Dams in the Country and Benefits Therefrom

The benefits taken from various kinds of Dam are as follows:

1. ***Damodar River Valley Project:*** Damodar River Valley Project serves several objectives. This huge dam is, in fact, a series of small dams built on a river and its tributaries, serves as man-made lake that is now able to impound huge amount of rain water. In this way, it helps in flood control and soil protection. This water is used for irrigation during dry periods. Since catchments areas of dam are afforested, there is available additional wild land that helps to preserve ecosytems. The water stored here is used for power generation, *i.e.* hydle power or hydroelectricity. These projects also provide for inland water navigation, cheapest means of transport for heavy goods. They are also used to develop fish hatcheries and nurseries. Damodar Valley Project consists of series of small dams of the tributaries of Damodar, flowing from Chotanagpur in South Bihar to West Bengal. The hydle power has been integrated in a common grid.
2. ***Bhakra Nangal Project:*** This project has been built where two hills on either side of Satluj are very close to each other. It claims to be highest gravity dam in the world (height 226 metres from river bed). The project serves the states of Himachal Pradesh, Punjab, Haryana, Rajasthan and U.T. of Delhi.
3. ***Indira Gandhi Rajasthan Canal Project:*** It is ambitious plan to bring new areas under irrigation. The water of the Beas and Ravi has to be diverted to Satluj. The Pong Dam on the Beas impounds 690,000 ha metres water. This dam helped in the division of Beas into Satluj in a regulated manner. It enabled Rajasthan canal to irrigation Ganganagar, Bikaner and Jaiselmer Districts. The main canal is 468 km long.
4. ***Kosi Project:*** Kosi Project or river Kosi in North Bihar has a main canal to irrigate 873,000 ha of land in Bihar.
5. ***Hirakud Dam:*** Hirakud Dam in Orissa is longest serves Karnataka and Andhra Pradesh. This 2.5 km long dam irrigates nearly 400,000 ha land.
6. ***The Tungbhadra:*** The Tungbhadra Project serves Karnataka and Andhra Pradesh. This 2.5 km long dam irrigates nearly 400,000 ha land.
7. ***The Nagarjunasagar:*** The Nagarjunasagar Project is built on river Krishna in Andhra Pradesh. It irrigates 86,700 ha land.
8. ***The Chambal Project:*** The Chambal irrigation parts of M.P. and Rajasthan. There are many other such projects on different rivers in the country.

4.3.3 Problems Created by Dams

Large dams have had serious impacts on the lives, livelihoods, cultures and spiritual existence of indigenous and tribal peoples. They have suffered disproportionately from the negative impacts of dams and often been excluded from sharing the benefits. In India, of the 16 to 18 million people displaced by dams, 40 to 50% were tribal people, who account for only 8% of our nation's one billion people. They alter river flows, change nature's flood control mechanisms such as wetlands and flood plains, and destroy the lives of local people and the habitats of wild plant and animal species. Some of the problems are mentioned below:

- Dam construction and submersion leads to significant loss of arable farmland and forest and land submergence.
- Siltation of reservoirs, water logging and salination in surrounding lands reduces agricultural productivity.

Notes

- Serious impacts on ecosystems - significant and irreversible loss of species and ecosystems, deforestation and loss of biodiversity, affects aquaculture.
- Socio-economic problems for example, displacement, rehabilitation and resettlement of tribal people.
- Fragmentation and physical transformation of rivers.
- Displacement of people - People living in the catchment area, lose property and livelihood.
- Impacts on lives, livelihoods, cultures and spiritual existence of indigenous and tribal people.
- Dislodging animal populations.
- Disruption of fish movement and navigational activities.
- Emission of green house gases due to rotting of vegetation.
- Large landholders on the canals get the lion's share of water, while poor and small farmers get less and are seriously affected leading to conflicts. Irrigation to support cash crops like sugarcane produces an unequal distribution of water.
- Natural disasters – reservoirs induced seismicity, flash floods, etc. and biological hazards due to large-scale impounding of water – increased exposure to vectorborne diseases, such as malaria, schistosomiasis and filariasis.

Conflicts over dams have heightened in the last two decades because of their social and environmental impacts and failure to achieve targets for sticking to their costs as well as achieving promised benefits. Recent examples show how failure to provide a transparent process that includes effective participation of local people has prevented affected people from playing an active role in debating the pros and cons of the project and its alternatives. The loss of traditional, local controls over equitable distribution remains a major source of conflict.

Did u know? In India, a national assessment of dam projects cleared in the 1980s and 90s shows that in 90% of cases the project authorities have not fulfilled the environmental conditions under which environmental clearance was given by the GOI under the EPA of 1986.

Self Assessment

State whether the following statements are true or false:

9. Kosi Project consists of series of small dams of the tributaries of Damodar, flowing from Chotanagpur in South Bihar to West Bengal.
10. The Pong Dam on the Beas impounds 690,000 ha metres water.
11. The Tungbhadra Project serves Karnataka and Andhra Pradesh.
12. The Chambal Project is built on river Krishna in Andhra Pradesh. It irrigates 86,700 ha land.

4.4 Core Issues related to Water Resources

We are living today, in a water starved world. For many people in developing countries there is not enough water to meet the basic needs for drinking and sanitation purposes. Approximately

Notes

70% of water used world over is for the purpose of irrigation, 20% is used by the industry and the rest for domestic and other purposes.

From economic point of view, return on investment of water in industrial sector is many times more attractive than in agriculture. One thousand tonne of water may produce one ton of wheat worth US $200 whereas industrial output for the same amount of water may be worth US $ 1000 or more. There is a gain in industrial sector and subsequently economic growth in diverting water from agricultural sector to industrial sector. Besides industry, the demand for water is always increasing from domestic sector. As the people attain higher standards of living, they demand more food, such as dairy products which means more livestock. This would generate more demand for grains that require more water. But if the process of industrialization is to continue, it would be possible by diverting water from irrigation sector and not from domestic sector. This is what is happening now in most of the developing countries in Africa and Middle East. Diverting water from agricultural sector leads to loss in food production with the result that these countries have to import food. The world's grain market will become a place for competition for water. The noted author, Lester Brown, has said that "water shortage may soon become food shortage".

1. Management Issues

Management of shortage of water and management of water pollution are complex tasks. These issues have drawn the attention of the developed and developing countries as well as the various national and international organizations including the Johannesburg Summit 2002. Year 2003 has been declared as Year of Fresh Water.

Caution Today the situation is such that some acquifers get no replenishment from precipitation, the others though getting replenished by rain water, get depleted faster because of overpumping. The challenge is how to satisfy the thirst and hunger (food production depends upon water) of the world, especially the poor without further damaging our ecosystem.

So far as the management of pollution is concerned, groundwater that contains toxic substances and other pollutants are at best subjected to "end of pipe" solution, i.e., either filters have been installed or the water is treated before use. The environmental engineers have been favouring pump and treat method. In USA, at many places groundwater that is polluted is sucked out, chemically treated and injected back into the ground. This clean up system is expensive and time consuming, because large areas of acquifers need the treatment and this cannot be a practical solution. Thus, the best option is not to let the water get contaminated. This is possible if the toxic substances are not used in the industrial or agricultural practices. This means that we have to reconsider our concepts of social, industrial and agricultural systems of which business and industry are parts. It is the system of our transport and use of petrochemicals, the use of pesticides and fertilizers and the sewage system that call for reconsideration.

2. National Scenario

The CPCB has been monitoring water quality of national aquatic resources in collaboration with the concerned State Pollution Control Boards (SPCBs) since 1977. The monitoring programme started with 17 stations on the river Yamuna and has extended steadily over the years to 507 locations currently. The Central Water Commission also has a network to measure flow and monitor water quality at about 369 field stations. The Central Ground Water Board (CGWB) also monitors groundwater quality at 15355 locations.

Notes

Notes In an effort to assess the pollution of a water body, the CPCB has also initiated a bio-monitoring project under the Indo-Dutch Collaboration Programme on Environment and selected 215 locations for the introduction of bio-monitoring based on the interpretation of physicochemical data at different locations. Limited water quality, monitoring of wells is also being undertaken in different states to estimate violations total chloroform over desired levels. Source specific standards for discharge of wastewater have been laid down by the CPCB under the Water Act. The Act also empowers the SPCBs to lay down and maintain standards more stringent than those specified by CPCB depending on local conditions. The actual provisions for enforcement such as penalties, imprisonment, etc., are confined to source-specific standards for individual polluters.

Under the National River Action Plan (NRAP), an integrated approach is adopted by addressing not only river pollution but related factors like internal sewage, solid waste disposal, and low cost toilets. Sewage collection and treatment works are being installed to reduce the pollution load in rivers. These include schemes for better sewage interception and diversion, construction of sewage treatment plants, provision for low cost sanitation and other schemes. In the first phase, under the GAP (Ganga Action Plan), 29 towns were selected along the river and 261 schemes of pollution abatement sanctioned. At present 156 towns are being considered under the NRAP, out of which about 74 towns are located on the river Ganga, 21 on the river Yamuna, 12 on the Damodar, 6 on the Godavari, 9 on the Cauvery, 4 each on the Tungabhadra and Sutlej, 3 each on the Subarnrekha, Betwa, Wainganga, Brahmini, Chambal, Gomti, 2 on the Krishna and one each on the Sabarmati, Khan, Kshipra, Narmada, and Mahanadi. The National Lake Conservation Plan is also being given the same priority as the rivers. The Bhoj Lake of Madhya Pradesh is already getting assistance under funds provided by OECF of Japan for betterment of its water quality. Coastal towns are being given special attention due to the high possibility of sewage, solid waste, biomedical waste and the like being dumped into the sea.

A 'Water Quality Assessment Authority' has also been established recently under the Environment Protection Act, 1986. The Central Ground Water Board constituted the Central Ground Water Authority for regulating the development and management of groundwater resources has notified and banned fresh bores in areas affected by groundwater depletion. The Authority is also promoting rainwater harvesting and artificial recharge projects and has circulated guidelines for implementing artificial recharge projects.

Under the 1994 EIA Notification, an Environmental Impact Assessment has already been made mandatory for 30 categories of development activities involving investments of '500 million and above. Ministry of Environment and Forests gives Environmental clearance for industrial and other activities. Construction of Common Effluent Treatment Plants (CETP) for treatment of effluents from a cluster of industries particularly of small scale is also getting encouraging support. Under the World Bank aided Industrial Pollution Control project there is a provision of loan and grant for construction of CETPs in an industrial estate or a cluster of SSIs. The CWC also undertakes the environmental evaluation of completed water projects. The Environmental Monitoring Committee of the CWC is monitoring 85 projects at present according to the guidelines of the Environmental Management Plans for water resources projects.

Task How much water is needed by one person? Several international agencies and experts have proposed that 50 litres per person per day covers basic human water requirements for drinking, sanitation, bathing and food preparation. Estimate your average daily consumption.

Self Assessment

Notes

Fill in the blanks:

13. ..... of shortage of water and management of water pollution are complex tasks.
14. The ..... also monitors groundwater quality at 15355 locations.
15. A ..... has also been established recently under the Environment Protection Act, 1986.
16. Construction of ..... for treatment of effluents from a cluster of industries particularly of small scale is also getting encouraging support.

Case Study

Cauvery River Dispute

The Cauvery River is one of the most contentious water supplies in Southern India. The Cauvery watershed is divided between Karnataka and Tamil Nadu (both Southern Indian States). Tamil Nadu does not control any of the Cauvery headwaters, yet is in possession of the tributaries Bhavana and the Moyar. Similar to other divided watersheds (Mekong—Southeast Asia and Colorado—Western United States), there is peace in times of good rains. However, when the monsoons fail, violence erupts. There is a tendency now for water issues to reach a crisis which requires a quick fix, rather than pursuing a long term solution.

The Cauvery River Dispute has been a serious issue since 1974 when a 50 year old agreement between the Madras president and the princely Mysore state collapsed. Karnataka asserts that the 1924 agreement entailed a discontinuation of the water supply to Tamil Nadu after 50 years. The conflict between Tamil Nadu and Karnataka compounds a century old dispute over the vital interests of farmers in Tamil Nadu and Karnataka.

In light of the longevity and complexity of the Cauvery River dispute, it is appropriate to highlight the underlying positions of each of the states involved:

Tamil Nadu

While temples are the main attraction to Tamil Nadu, agriculture is the primary means of sustenance. Tamil Nadu relies on the Cauvery River to sustain its agricultural needs. Beyond the Cauvery, Tamil Nadu has very few resources for complex irrigation systems to maintain its water supply. Cauvery is the lifeblood of Tamil Nadu's agriculture, and agriculture is the lifeblood of Tamil Nadu. It is mandatory for Karnataka to abide by the decisions made by the Tribunal and Supreme Court. Karnataka is not above the law, and should be made to release at least 205 TMC of water to Tamil Nadu to save standing crops. Tamil Nadu asserts that water sharing is a national issue that requires the intervention of the Government of India.

Karnataka

Recently, the failed monsoons have created severe drought situations in much of Karnataka. The reservoirs of the Cauvery Basin only reached 23.2 TMC feet of water. The total requirement for Karnataka in 1994 was 24 TMC of water. Therefore, Southern Karnataka and Bangalore City are short of drinking water. Water is such a desperate issue that is Karnataka was to release water to Tamil Nadu it would be at the expense of Karnataka's economic growth and its own citizenry.

Contd....

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Karnataka contends that the shared river dispute should be made a national issue. It refuses to accept the decisions of the Tribunal because it is not an independent decision making body outside of the influence of either state. Karnataka asserts that it will not abide by any decisions until a National Water Policy is established that would apply to all shared water resources, not just the Cauvery.

After the elapse of the 50 year old agreement, the Cauvery River continued to be a source of conflict for the two states. In April 1991, the Supreme Court of the Government of India reassigned a tribunal to settle the dispute as mandated in the Inter-State River Water Disputes Act. The Tribunal heard arguments from both states, and reached the decision that Karnataka must release 205 TMC of water from the Cauvery reservoirs to Tamil Nadu on a monthly basis.

Karnataka declined to accept the ruling of the Tribunal. The Government of Karnataka argued that the Tribunal issued a decision that was not implementable. Due to failed monsoons, many parts of Karnataka were left without adequate water supplies. If the government were to release more than 100 TMC of water to Tamil Nadu, then it would be disadvantaging its own people.

The rejection of the Tribunal's decision pushed the negotiations on a downward spiralling path that eventually led to aborted talks. As mentioned previously however, water issues seem to only erupt when there is a lack of adequate rain. In 1992, 1993, and 1994, the rain was sufficient to pacify the dispute between Tamil Nadu and Karnataka.

The most recent conflict over the Cauvery River was in 1996, and continues still today. Beginning in 1995, the monsoons failed to fill the Cauvery tributaries possessed by Tamil Nadu. On January 1, 1996, Prime Minister P.V. Narasimha Rao asked Karnataka to release an immediate six tmcft (one thousand million cubic feet) of water to Tamil Nadu to save the standing crops. In addition, the Prime Minister announced the immediate formation of an expert council to "spot assess" the status of the standing crop of both states to include the level of water needed to sustain the crops.

Small and medium sized farmers are suffering due to a lack of water. Crops are withering as tempers flare. As a result of this desperation, threats have turned into acts of violence. Agitation is occurring in cities such as Mandya and Bangalore. Students from colleges in Bangalore rioted and smashed window panes of a Tamil Nadu government van. Rioting by citizens of Karnataka ended in attacks on Tamilians that resulted in death. The violence continued when officials from Karnataka threatened to block any release of water to Tamil Nadu. Farmers from Mandya besieged the banks of the Cauvery River as a precautionary measure to assure that no water was released. The Cauvery Action Committee headed by Mr. G. Made Gowda, Congressional MP from Manya, formed a "human chain" in Mysore City.

It should be noted that despite the stalemate in negotiations and the violence that erupts, Karnataka has been releasing water from the Cauvery River to Tamil Nadu in installments for the last twenty years. The dispute between the two states is over the quantity of water released. The conflict between the people, particularly the farmers, is that there is a release at all.

The inspection process and water dispute continues today. Karnataka still rejects the Tribunal. The state is now suggesting that an independent monitoring committee be established. The Committee would be called the Cauvery River Committee and should take the form of a regulatory authority. The experts on the Committee should be outside the control of either state or the Tribunal. The Karnataka Government has suggested that

Contd....

Notes

the Committee be comprised of high ranking people with expertise in law, administration, agriculture, and irrigation engineering .

Tamil Nadu is now shifting its case from the Supreme Court and Tribunal to the Parliament. Tamil Nadu Chief Minister M. Karunanidhi has threatened mass agitation if Karnataka does not comply with the Supreme Court's mandate.

As both states continue their struggle over the shared water dispute over the Cauvery River, it is likely that national intervention will be necessary. It has been noted by both states that the National Government of India must become involved in order to secure the future security of the farmers in both Karnataka and Tamil Nadu. Shared water is a national issue that goes beyond the Cauvery River. Numerous rivers in India are shared by two or more states. Similar to Cauvery, disputes and violence are a norm. Water supply is a national issue that is going to require a national response.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://gurukul.ucc.american.edu/ted/ice/cauvery.htm#anchor915511

4.5 Summary

- Sustainable management of water resources has implications for ecosystem, dams, silting of reservoirs, and submergence of forests, extinction of rare plants and animals and outbreak of disease.
- Water claims to be an important resource. An important use of water in our country is for irrigation.
- The quality of surface and groundwater resources is also deteriorating because of increasing pollutant loads from point and non-point sources.
- India is expected to face critical levels of water stress by 2025.
- The vast ecological diversity of this country is reflected in the diversity in available water resources.
- India's groundwater resources are almost ten times its annual rainfall.
- There are 14 major, 44 medium and 55 minor river basins in the country.
- India is considered rich in terms of annual rainfall and total water resources available at the national level; however, the uneven distribution of the resource causes regional and temporal shortages.
- Overutilization of water occurs at various levels.
- Industry tends to maximise short-term economic gains by not bothering about its liquid waste and releasing it into streams, rivers and the sea.
- Drought is one of those natural disasters, which no one can predict and so when it occurs it is always difficult to manage it.
- Today there are more than 45,000 large dams around the world, which play an important role in communities and economies that harness these water resources for their economic development.

Notes

4.6 Keywords

Dams: Dams are massive barriers built across rivers and streams to confine and utilize the flow of water for human purposes such as irrigation and generation of hydroelectricity.

Drought: Drought is an extended period of months or years when a region notes a deficiency in its water supply whether surface or underground water.

Flooding: Flooding is when the water level in a creek, river, lake or the sea rises and covers land that is usually dry.

Floods: A flood is an overflow of water that submerges or "drowns" land.

Groundwater: Ground water is the water that is found beneath the earth's surface.

Reservoirs: A reservoir, artificial lake, storage pond or impoundment from a dam is used to store water.

Soil Salination: Soil salinisation is the accumulation of soluble salts of sodium, magnesium and calcium in soil to the extent that soil fertility is severely.

Surface Water: Surface water is water collecting on the ground or in a stream, river, lake, wetland, or ocean; it is related to water collecting as groundwater or atmospheric water.

Water Pollution: Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water.

Water Resource Management: Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources.

Water Resources: Water resources are sources of water that are useful or potentially useful and include agricultural, industrial, household, recreational and environmental activities.

Water Supply: Water supply is the provision of water by public utilities, commercial organizations, community endeavors or by individuals, usually via a system of pumps and pipes. Irrigation is covered separately.

4.7 Review Questions

1. Write brief note on Water Resources in India.
2. Throw some light on the significant of Water.
3. What are the main sources of water?
4. Discuss Overutilization of Surface and Ground Water.
5. "Flooding occurs when the water level in any stream, river, bay or lake rises above bank full." Elucidate.
6. Write short note on Drought.
7. What is Sustainable Water Management?
8. Highlight the various types of Dams in the country and what are the benefits you gained from them.
9. Discuss the problems created by Dams.
10. Describe the Core Issues related to Water Resources.

Notes

Answers: Self Assessment

1.	True	2.	False
3.	False	4.	True
5.	1180	6.	Agriculture
7.	Flooding	8.	Drought
9.	False	10.	True
11.	True	12.	False
13.	Management	14.	Central Ground Water Board (CGWB)
15.	Water Quality Assessment Authority		
16.	Common Effluent Treatment Plants (CETP)		

4.8 Further Readings

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Unit 5: Mineral Resources

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Objectives

After studying this unit, you should be able to:

- Discuss the overview of Mineral Resources
- Explain the Importance of Mineral Resources in India
- Describe the Environment Problem Created by Extracting and Mineral Resources (Mining)

Introduction

In the previous unit, we dealt with the meaning, overutilisation of surface and ground water in mineral resources, floods, draught as well as benefits and problems related wit dams. Minerals are valuable natural resources being finite and nonrenewable. They constitute the vital raw materials for many basic industries and are a major resource for development. Management of mineral resources has, therefore, to be closely integrated with the overall strategy of development; arid exploitation of minerals is to be guided by long-term national goals and perspectives. India with diverse and significant mineral resources is the leading producer of some of the minerals. Of the 89 minerals produced in the country, 4 are fuel minerals, 11 metallic, 52 nonmetallic and 22 minor minerals. India is the largest producer of mica blocks and mica splitting; ranks third in the production of coal and lignite, barytes and chromite; 4th in iron ore, 6th in bauxite and manganese ore, and 10th in aluminium and 11th in crude steel. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the position of mineral resources in India along with the Environment Problem Created by Extracting and Mineral Resources (Mining).

5.1 Mineral Resources: An Overview

A mineral is a naturally occurring substance of definite chemical composition and identifiable physical properties. An ore is a mineral or combination of minerals from which a useful substance,

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such as a metal, can be extracted and used to manufacture a useful product. Minerals are formed over a period of millions of years in the earth's crust. Iron, aluminium, zinc, manganese and copper are important raw materials for industrial use. Important non-metal resources include coal, salt, clay, cement and silica. Stone used for building material, such as granite, marble, limestone, constitute another category of minerals. Minerals with special properties that humans value for their aesthetic and ornamental value are gems such as diamonds, emeralds, and rubies. The lustre of gold, silver and platinum is used for ornaments. Minerals in the form of oil, gas and coal were formed when ancient plants and animals were converted into underground fossil fuels.

Minerals and their ores need to be extracted from the earth's interior so that they can be used. This process is known as mining. Mining operations generally progress through four stages:

1. ***Prospecting:*** Searching for minerals.
2. ***Exploration:*** Assessing the size, shape, location, and economic value of the deposit.
3. ***Development:*** Work of preparing access to the deposit so that the minerals can be extracted from it.
4. ***Exploitation:*** Extracting the minerals from the mines.

In the past, mineral deposits were discovered by prospectors in areas where mineral deposits in the form of veins were exposed on the surface. Today, however, prospecting and exploration is done by teams of geologists, mining engineers, geophysicists, and geochemists who work together to discover new deposits. Modern prospecting methods include the use of sophisticated instruments like GIS to survey and study the geology of the area.

5.1.1 National Mineral Policy

In view of the above Nations Mineral Policy has been adopted which encompasses the various Policy Guidelines, which have been issued from time to time. The policy also emphasizes certain new aspects and elements as under:

1. Mineral Exploration in the seabed,
2. Development of proper inventory,
3. Proper linkage between exploitation of minerals and development of mineral industry,
4. Preference to members of the scheduled tribes for development of small deposits in scheduled area,
5. Protection of forests, environment and ecology from the adverse effects of mining,
6. Enforcement of mining plan for adoption of proper mining methods,
7. Optimum utilizations of minerals, export of minerals in value added form and recycling of metallic scrap and mineral waste.

   Under the constitution, mineral rights and administration of Mining Laws are vested in State Governments. The Central Government, however, regulated development of minerals under the Mines and Minerals (Regulation and Development) Act, 1957 and the rules and regulations framed under it. The statute empowers the Centre to formulate rules for the following:

   (i) The grant of prospective licences and mining leases;

   (ii) The conservation and development of minerals;

   (iii) The modification of old leases.

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The Mines and Minerals (Regulation and Development) Act, 1957, was amended in 1972 and major amendments were made in February 1987. The Mineral Concession Rules, 1960, 1958 was replaced by more comprehensive rules in 1988.

Caselet

NALCO's Ecological and Social Debt (NALCO's Bauxite Mine, Alumina Refinery and Aluminium Smelter)

The National Aluminium Company Ltd. (NALCO) is an integrated multi-locational aluminium complex that was incorporated in 1981 as a public company to exploit large deposits of bauxite discovered in the Eastern Ghats in Adivasi areas (Koraput) of Orissa, which possess 310 million tons of bauxite ore, and in Northern Orissa (Angul). While bauxite ores in India are harder and have a higher stripping ratio when compared with that of its Australian counterpart, the rich content of aluminium makes Indian bauxite ore attractive for aluminium refining. NALCO's bauxite reserves of 370 million tons are expected to last 75 years at current mining rate of 4.8 million tons per annum. The low silica content of India's bauxite makes it possible for NALCO to produce high quality aluminium at low cost.

The authorised capital of the company is ₹ 1300 million. The original project cost, particularly the construction of the refinery and the Talcher Super Thermal Power Project was partly financed by external commercial borrowings from a consortium of international bankers, French credit facilities and partly by equity subscribed by Government of India. The entire foreign currency loan, totalling US$1.755 billion, has been repaid as of 30 September 1998 and NALCO claims at present that it is a "zero debt-company" except for debt created out of equity.

Technical know-how and basic engineering for the project were supplied by AP International of France. Since 1985, NALCO operates a fully mechanised open cast bauxite mine in Panchpatmali, with a capacity of 4.8 million tons per annum. It feeds ore to the alumina refinery in Damanjodi, which churns out alumina, the fine white powder that goes into the making of aluminium metal at the aluminium smelter in Angul.

Built in 1986, the refinery has three parallel streams with a capacity of 525,000 tons per annum each; producing 886,000 tons of alumina powder in 1999-2000 for the company's smelter in Angul, out of which 479,620 tons were exported to overseas markets, mainly France, through the Visakhapatnam Port. NALCO has completed the expansion of the aluminium refinery from 800,000 tons to 1,050,000 tons. The planned capacity level of 1,575,000 tons is expected to be reached during the current year.

The refinery has a captive power plant with a capacity of 55.5 megawatts as against its actual need of 32 megawatts. For captive power, coal is mined elsewhere in Orissa (Dhenkanal district), displacing thousands of people and causing severe environmental degradation. When NALCO was first established, power was derived from a major hydroelectric power project which submerged 57 villages and displaced more than 50,000 people. The refinery's "red mud" and ash ponds were earlier large land tracts used by indigenous peoples for subsistence farming. Water for the refinery plant is drawn from the Upper Kolab reservoir, which is about 8 km from the plant.

With a capacity of 345,000 tons per annum, NALCO's aluminium smelter is located at Angul in Orissa and has been in operation since early 1987. Presently, the capacity is being

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expanded to 460,000 tons per annum. An export-oriented rolled products unit is set to produce foil stock, can stock, cable wraps, standard sheets, coils and other aluminium products. The smelter plant has a captive power plant containing 6 units of 120 megawatts. Coal, amounting to 3.5 millions tons per annum, is supplied to the captive power plants from the Talcher coalfield of MCL.

NALCO is one of the lowest cost producers of aluminium mainly on account of low cost captive power (access to cheap source of coal) and the high quality of its bauxite. The cost of power works out to ₹ 0.5 per kilowatt-hour (US$1.1 cents) as opposed to US$2 cents per kilowatt-hour for the low cost fossil fuel based energy producers in the Middle East.

Source: http://www.deudaecologica.org/publicaciones/Chapter5(125-168).pdf

Self Assessment

State whether the following statements are true or false:

1. An ore is a mineral or combination of minerals from which a useful substance.
2. The lustre of gold, silver and platinum is not used for ornaments.
3. The Mines and Minerals (Regulation and Development) Act, 1957, was amended in 1972.
4. The Central Government, however, regulated development of minerals under the Mines and Minerals (Regulation and Development) Act, 1956.
5. Mineral rights and administration of Mining Laws are vested in State Governments.

5.2 Importance of Mineral Resources in India

The mineral wealth of India as at present known, though by no means inexhaustible, comprises an adequate range of useful products that are necessary for the industrial development of the country. An appraisal of the reserves shows that while in respect of minerals essential for basic industries—coal and iron—the reserves are ample, the country is deficient in a fairly long list of vital minerals like ores of copper, tin, lead, zinc, nickel, cobalt and in sulphur and most important of all, petroleum. The position with regard to aluminium ore, refractoriness, abrasives, limestone, etc. may be considered as fairly adequate while in respect of titanium and thorium ores and of mica, the country has considerable reserves.

India has a large number of economically useful minerals and they constitute one-quarter of the world's known mineral resources. About two-thirds of its iron deposits lie in a belt along Orissa and Jharkhand border. Other hematite deposits are found in Madhya Pradesh, Karnataka, Maharashtra and Goa. Magnetite iron-ore is found in Tamil Nadu, Jharkhand and Himachal. India has the world's third largest deposits of coal. Bituminous coal is found in Jharia and Bokaro in Jharkhand and Ranigunj in West Bengal. Lignite coals are found in Neyveli in Tamil Nadu. Next to Russia, India has the largest supply of Manganese. The manganese mining areas are Madhya Pradesh, Maharashtra and Jharkhand-Orissa area. Chromite deposits are found in Jharkhand, Cuttack district in Orissa, Krishna district in Andhra Pradesh and Mysore and Hassan in Karnataka. Bauxite deposits are found in Jharkhand, southwest Kashmir, Central Tamil Nadu, and parts of Kerala, U.P, Maharastra and Karnataka. India also produces three quarters of the world's mica. Belts of high quality mica are Bihar, Andhra and Rajasthan. Gypsum reserves are in Tamil Nadu and Rajasthan. Nickel ore is found in Cuttack and Mayurbhanj in Orissa. Ileminite reserves are in Kerala and along the east and the west coastal beaches. Silimanite reserves are in Sonapahar of Meghalaya and in Pipra in M.P. Copper ore bearing areas are Agnigundala in Andhra Pradesh, Singhbum in Jharkhand, Khetri and Dartiba in Rajasthan and parts of Sikkim and Karnataka.

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Notes In India, over the years, a national mineral policy has evolved. The policy addresses certain new aspects and elements like mineral exploration in the seabed, development of proper inventory, proper linkage between exploitation of minerals and development of mineral industry, protection of forests environment and ecology from the adverse effects of mining, enforcement of mining plan for adoption of proper mining methods and optimum utilisation of minerals, export of minerals in value-added form and recycling of metallic scrap and mineral waste.

The method of mining has to be determined depending on whether the ore or mineral deposit is nearer the surface or deep within the earth. The topography of the region and the physical nature of the ore deposit are studied. Mines are of two types – surface (open cut or strip mines) or deep or shaft mines. Coal, metals and non-metalliferous minerals are all mined differently depending on the above criteria. The method chosen for mining will ultimately depend on how maximum yield may be obtained under existing conditions at a minimum cost, with the least danger to the mining personnel. Most minerals need to be processed before they become usable. Thus 'technology' is dependent on both the presence of resources and the energy necessary to make them 'usable'.

The Ramagiri fields in Andhra Pradesh, Kolar and Hutti in Karnataka are the important gold mines. The Panna diamond belt is the only diamond producing area in the country, which covers the districts of Panna, Chatarpur and Satna in Madhya Pradesh, as well as some parts of Banda in Uttar Pradesh. Petroleum deposits are found in Assam and Gujarat. Fresh reserves were located off Mumbai Coast. The potential oil bearing areas are Assam, Tripura, Manipur, West Bengal, Punjab, Himachal, Kutchch and the Andamans. India also possesses the all-too-valuable nuclear Uranium as well as some varieties of rare earths.

Until recently, mineral exploration and their utilisation in the country received little attention. Except for coal, iron ore and petroleum required for internal use, the majority of minerals were raised in India for purpose of bulk export without any dressing, processing and fabrication. These exports brought but a small return to the country. Nearly a hundred minerals are known to be produced or mined in India of which nearly 30 may be considered more important including several which although comparatively unimportant in quantity today, are capable of material development in future with the expansion of industries. It should be made dear at the outset that though progress has been made in the survey of mineralised areas in recent years and the principal mineral regions have been ascertained, exploration of mineral resources has not been thorough or complete in most cases and present estimates are just rough guesses. The power resources in India comprise coal, oil and hydro electricity. India's coal mining is centred mainly in Bihar and West Bengal.

Did u know? The total workable reserves of coal down to a depth of 1,000 ft are estimated at 20,000 million tonnes, of which the good quality coal would amount to 5,000 million tonnes. The reserves of coking coal, however, are small amounting to only 2,000 million tonnes. As against relatively meagre resources of coal and oil, the hydroelectric resources of India are considerable with estimates varying from about 30 million horse-powers to 40 million horse-powers. India possesses large quantities of high grade iron ore and may be classified as one of the countries which can reasonably expect along continued development of heavy industry though, in proportion to the population, these reserves are lower than in the main ore regions of the world. Likewise, there are large reserves of bauxite. India is also the world's main source of supply of mica.

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Task Make some comments about the use of elements required by you in one year or in one life time. Where do you use these elements? Do you believe it? Consider that a lot of industry may use these elements in support of our life style.

Self Assessment

Fill in the blanks:

6. The ..... wealth of India as at present known comprises an adequate range of useful products that are necessary for the industrial development of the country.
7. India has a large number of economically useful minerals and they constitute ..... of the world's known mineral resources.
8. Lignite coals are found in ..... in Tamil Nadu.
9. ..... reserves are in Tamil Nadu and Rajasthan.
10. The ..... resources in India comprise coal, oil and hydro electricity.

5.3 Environment Problem Created by Extracting and Mineral Resources (Mining)

Mining operations are considered one of the main sources of environmental degradation. The extraction of all these products from the lithosphere has a variety of side effects. Depletion of available land due to mining, waste from industries, conversion of land to industry and pollution of land, water and air by industrial wastes, are environmental side effects of the use of these non-renewable resources. Public awareness of this problem is of a global nature and government actions to stem the damage to the natural environment have led to numerous international agreements and laws directed toward the prevention of activities and events that may adversely affect the environment.

Rainforests are the biggest source of oxygen, wood and medicines on this earth. Amazon rainforest is known for alluvial gold deposits. Gold is found both in river channels and at the banks of the river after floods (floodplains). Hydraulic mining techniques are used for mining gold. The method involves blasting at the banks of the river. This has caused irreversible damage to trees, birds and animals. While separating the sediment and mercury from the gold-yielding gravel deposits, small-scale miners who are less equipped than industrial miners, may ignore release of some mercury into the river. This mercury enters the food chain through aquatic animals and their predators. Highly poisonous compound 'cyanide' is also used to separate gold from sediment and rock.

Caution In spite of all precautionary measures, it sometimes escapes into the surrounding environment. Those who eat fish are at greater risk of ingesting such toxins. The environment side effect of extracting and mineral resources projects can be studied below.

5.3.1 Effect on Land

1. ***Deforestation:*** Mining requires large areas of land to be cleared so that the earth could be dug into by the miners. For this reason, large-scale deforestation is required to be carried

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out in the areas where mining has to be done. Besides clearing the mining area, vegetation in the adjoining areas also needs to be cut in order to construct roads and residential facilities for the mine workers. The human population brings along with it other activities that harm the environment. For example, various activities at coal mines release dust and gas into the air. Thus, mining is one of the major causes of deforestation and pollution.

2. ***Loss of Biodiversity:*** The forests that are cleared for mining purposes are home to a large number of organisms. Indiscriminate clearing of the forests leads to loss of habitat of a large number of animals. This puts the survival of a large number of animal species at stake. The cutting down of trees in itself is a big threat to a number of plants, trees, birds and animals growing in the forests.

3. ***Pollution:*** Despite measures being taken to release the chemical waste into the nearby rivers through pipes, a large amount of chemicals still leak out onto the land. This changes the chemical composition of the land. Besides this, since the chemicals are poisonous, they make the soil unsuitable for plants to grow. Also, the organisms that live in the soil find the polluted environment hostile for their survival.

5.3.2 Effect on Water

1. ***Pollution:*** Chemicals like mercury, cyanide, sulphuric acid, arsenic and methyl mercury are used in various stages of mining. Most of the chemicals are released into nearby water bodies, and are responsible for water pollution. In spite of tailings (pipes) being used to dispose these chemicals into the water bodies, possibilities of leakage are always there. When the leaked chemicals slowly percolate through the layers of the earth, they reach the groundwater and pollute it. Surface run-off of just soil and rock debris, although non-toxic, can be harmful for vegetation of the surrounding areas.

2. ***Loss of Aquatic Life:*** Release of toxic chemicals into the water is obviously harmful for the flora and fauna of the water bodies. Besides the pollution, mining processes require water from nearby water sources. For example, water is used to wash impurities from the coal. The result is that the water content of the river or lake from which water is being used gets reduced. Organisms in these water bodies do not have enough water for their survival.

3. ***River dredging:*** It is a method adopted in case of gold mining. In this method, gravel and mud is suctioned from a particular area of the river. After the gold fragments are filtered out, the remaining mud and gravel is released back into the river, although at a location different from where they had been taken. This disrupts the natural flow of the river that may cause fish and other organisms to die.

Previously buried metal sulphides are exposed during mining activities. When they come in contact with the atmospheric oxygen, they get converted into strong sulphuric acid and metal oxides. Such compounds get mixed up in the local waterways and contaminate local rivers with heavy metals.

Example: **Environmental Impact of Mining**

In 1995, in Guyana, more than four billion litres of waste water that contained cyanide, slipped into a tributary of the Essequibo; when the tailings dam, which was filled with cyanide waste, collapsed. All the fish in the river died, plant and animal life was completely destroyed, and floodplain soils were heavily poisoned, making the land useless for agriculture. The main source of drinking water for the local people was also polluted. This was a major set-back for the ecotourism industry on the river. When trees are cut (forest clearing for the construction of roads and mines, wood for the immigrated people, workers,

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etc.) and water sources are contaminated, animal populations migrate or die. Moreover, hunters are hired to feed the people working at the mining sites.

The Kahuzi-Biega National Park, Congo, was declared as 'World Heritage Site' in 1980 because of its rich biodiversity. Conservation of several types of animals and plants was the aim behind this. As thousands of people started extracting tantalum and cassiterite at hundreds of sites throughout the park, most of the large animals were killed within 15-20 years. The number of Grauer's gorilla, the species which is found in this area only, decreased significantly. Statistics show that now, there are only 2-3 thousand Grauer's gorillas left.

The Indonesian government has sued a gold mining company for throwing away poisonous waste, such as arsenic and mercury, into the Buyat Bay. Fish in the bay was killed. People in the surrounding area can no more eat fish. They are already suffering from various illnesses like constant headache, skin rashes, tumours and breathing difficulty.

Effects of mining on the environment may not be evident immediately; they are usually noticed after some years. Although the developed countries have tight norms regarding mining, such rules can be easily flouted in countries which lack strict monitoring of the procedures being followed for mining. The effects in such cases can be devastating for the environment. Be it due to ignorance of the regulations or just a freak accident, incidents like the Guyana spill of 1995 may occur again. This highlights the fact that issues like mining's effect on the environment are worth some serious deliberation.

Self Assessment

State whether the following statements are true or false:

11. Mining operations are considered one of the main sources of environmental degradation.
12. Amazon rainforest is known for alluvial silver deposits.
13. Highly poisonous compound 'cyanide' is also used to separate gold from sediment and rock.
14. Indiscriminate clearing of the forests leads to loss of habitat of a large number of animals.
15. Pollution is a method adopted in case of gold mining.

Case Study

Wagholi Stone Quarry

As per population census 2001, Maharashtra State with 9.67 crore population, is the second most populous State in India. The percentage of urban population in the State was 42.4 per cent and Maharashtra was second most urbanized State among major states of India followed by Tamil Nadu (43.9 per cent). Among that the total population of the Pune district was 7,232,555 and the urban population of Pune comprises 58.08%. Pune is one of the district of Maharashtra and it well known for its high level educational facilities, it also known as "the Oxford of the East". Pune is divided into 13 different takulas, which are Junner, Ambegoan, Khed, Shiru, Maval, Mulshi, Velhe, Bhor, Purandar, Baramati, Indapur, Daund and Haveli. Pune City comes into Haveli taluka and it's a headquarter of Pune district.

Wagholi is well known for his stone quarries and a developing village of Haveli Taluka. It is only 20 km in north from Pune station; it takes only 30 to 45 minutes to reach at the

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place by vehicle. Wagholi the name is derived from the temple of 'WAGHESHWAR' which is on the entrance to this mining complex. There are around 15 and above stone quarries are given on lease by government but there are more than 25% quarries are running illegally, and its covering around 10 to 12 Km area of the village. There are around 5000 to 6000 and above people are working as daily wage labourers. At the Wagholi stone quarry area we can find all the religion and caste group communities are working together at one place without any kind of discrimination or hierarchy, which totally depending on stone quarry for their livelihood, but within that the "Vadar" community is constituted 70% population and seems more dominating caste group in all others. Vadar is one of the Nomadic Tribe (NT) community who are knows as a stone breakers community by caste occupation in Maharashtra, which they are doing from generation to generation.

The 99% per cent populations in the Wagholi stone quarry area are the migrated from the different places of Maharashtra like Buldhana, Nanded, Ahmednagar, Kolapur, Sangli, Satara, Nasik, Beed, Usmanabad and also from neighbouring state Karnataka. Above mention districts are comes under draught prone area or earthquake affected areas. The very common reason of migration is that all the stone workers in the quarry did not having land or any income sources for their livelihood in their own village. Last 10 to 15 year most of stone workers are working in quarry and they did not want back to their village from 10 to 12 years because they are daily wage earners, if they did not work for one day then they will not able to get food for next day, there are surviving on hand to mouth. In such condition they are not able to save money or send money to their relatives who are still staying in their native village. There are families in good numbers who are now settled in this area forever.

The migration is a continue process in the life of stone workers because some time they did not find job in one side or present quarry get closed or in the search of good wage they are always migrating one place to another place. The continue migration making stone workers more marginalise. Normally the workers are did not stay at one place more than 2 to 3 years and therefore they did not get enrolled their name in voting list or they did not getting rationing facilities from state government as well as local panchayat. But "Santulan" an organization is working in these stone quarries from 1997. The organization is helping this stone quarry workers to get voter identity card and because of this organization Wagholi stone quarry workers got their ration cards facility.

Santula started their school's call Pashan Shala (school in the quarries) in every part of the Wagholi Stone quarry area. It is recognize by the state government of Maharashtra and government of India. These schools are opened in the community with taking help of the stone quarry owners were stone workers are staying. In Wagholi there were three schools from nursery to 7th std are running (were researchers visited), the places are Wagheshwar Nagar, Gore Wasti and Suyog Nagar and all this schools are covering 240 children in age of 3 to 18 years. For the further education children's are going to residential school which is in Pune. Organization is providing all the facilities to the children's, they are getting good education and other facilities like books, bags, notebook etc. With this they are also getting nutritional food by midday meal scheme in the school. But still children's are going to quarries for work when they get weekly or public holidays from school. Parent's wants to send their child in to school but the poor economic situation of the workers make their child to work. But there are children how stopped to doing quarry work because of the school stared. One 13 years old boy told that "I use to go in the stone quarries with mother for work but from the time Pashan School has started in our area, I have stopped going for work".

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The migration is one of the cause which affecting children education. In 2004 -2005 there are 2055 children covered by that Santulan but in the same year 946 children are migrated to different places with their family.

The stone quarry workers are not staying one place and they are migrating different places it also impacting on their social life. This workers did not having any kind of government document which show their nationality or their caste so that they are not eligible to take any government facilities like NREGA, Indira Gandhi Niradhar Yojana or any national, state or local schemes as well as their children also not getting any educational facilities in the government school or scholarship from funding organization or government.

Every day there is 5 to 10 per cent children's are not attending the school because of the health reason. Normally children's are having Cough, Cold, Fever and Malaria; therefore they are not attending school. But the school teachers are giving every day visit to all the houses to take children in the school. If they found any child sick or not feeling well then they take that child to local PHC or teacher's gives medicine to that child. The First Aids Box is available in every school. The workers are starting doing work in stone quarry in the age of 14 or 15 years so that in the age of 45 to 50 normally they will die because of doing heavy work, in the accident in quarry or illness like tuberculosis, asthma or malaria. In this situation the orphan child is stay with their relatives. One 12 years girl told that, "My Father died due to illness and therefore I used to go with my mother in stone quarries to work" (she started crying).

One of the major causes of illness of workers is dust. The process of breaking stone and the crushers are generating lot of dust. In summer the situation of quarry goes at worst level and in this condition the stone workers and their families are doing work and staying at same place. With this the workers have habit of taking alcohol, smoking tobacco or Ganja, chewing tobacco or Gutkha which invites illness and death. The chances of an accident in quarry is very high every year there are 2 to 3 accident cases are taking places (which is registered in Santulan). The owner of the quarry always trying to close the matter at side only, they give some money for the treatment only if workers relatives asked more money or something then owners throw them out from quarry or send them back to village. Most of time if any worker dead in the accident the owner give money to other workers to throw or send back death body to workers village. If the owner feels that in the case there is more risk to him then only he gives more money. Recently one case took place in Wagheshwar stone quarry area were 20 years old boy got killed in an accident the owner gave some money to his family and send them back to their village.

In the Wagholi area there are around 60 private doctors are doing their practices. The stone workers have more belief on these doctors because when workers goes to this doctor they will get relief within a day and workers also want to recover as early as possible because he is getting lose. But the realities are these doctors are exploiting them. If doctor know that the patient having good money with him then they are giving injections, saline and extra dose of medicine in normal fever also without need or reason. Here the only purpose of doctors is to earn money. When Santulan doctor tell them this face the workers do not believe on them and they not taking any medication from him because they feels that the Santulan doctor is not good. Santulan's doctor only going to every school and doing check up of children regularly without taking any money.

From Wagholi PHC the Asha worker is coming for the immunization and polio campaigning. The PHC is 4 to 5 Km long from the quarry area and there is now vehicle facility available in the area because of road is not in good condition so small vehicle or

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government transport buses are not coming in the area. It will very difficult when any accident or pregnancy case take place. The parents are going to work at early morning 6 or 7 o'clock and they coming back at the evening 5 or 6 o'clock in the evening. Therefore the responsibility of children is to take care of house and siblings. Children in the age group of 2 to 10 years have to complete their household work before coming in to school. Normally they have to wash the cloths and vessel, cook food and take care of siblings. The boys in age group of 4 to 12 years are normally taking meals for their parents. If in home there is no girl then boys had to do same work which girls are doing. Children are coming to school with their sibling without that they are not able to attend school.

At Wagholi Stone quarry area the stone workers are getting very less wages then minimum wage. Again in wage structure there is gender discrimination which any one can see openly. Workers men and women starting doing work from 6 o'clock both are breaking stones and filling that stones in the tractor. Morning to evening in 12 hours hard job they are only able to fill 4 to 5 tractor. For every tractor per men is getting 30 rupees and per women is getting 25 rupees. So end of the day they are earning 100 to 120 rupees a day. They getting there wage every week so every week they are getting 700 to 800 rupees. Almost all the stone workers are taking alcohol every day as well as they have habit to smoking, chewing tobacco or Gutkha. When male workers get their wage they give only 400 to 500 rupees to run the house because remain money they are spending on drinking and their daily habits.

In the stone quarry area there are so many person and children are look more elder then their age. Children are suffering from anaemia and malnutrition, children are not growing according their age because of their low economic condition workers can't afford the nutritional food for own and their family. There is no any date available in Santulan and during the visit no one talk about sexual abuse of children, rape or molestation of women at working place or works are visiting to prostituted. But the situation in the quarry says that there are chances that all this thinks may be taking place in the quarry area but it's not coming in the light. Still Santulan doctor and local PHC did not identified any person with HIV/AIDS.

With the help of Santulan stone quarry workers got water facility in the quarry area. Wagholi village Panchayat build the water tank for workers but presently workers are not getting water from there because the village people cut of the tab connection. The village people were not willing to give any facilities to stone quarry area workers. The workers are using blocked quarry water which gather in the middle of quarry, they using this water for drinking, bathing and other use. In the summer workers have to be depend on mercy of village people, workers are did not taking bath and wash their cloths for 2 to 4 days. The owner is providing electricity facility to all the workers without taking money. Owner also provided place to workers to stay. Workers build up their houses by using tine, stone or plastic paper. It is very small places where they are staying it is only 8X10 house and in that whole family is staying. In one family normally husband wife two or three children and others relative are staying together. It means in one family 7 to 8 members are staying.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://dalitandtribe.wordpress.com/2011/03/03/a-case-study-of-wagholi-stone-workers-in-wagholi-stone-quarry-area-pune-maharashtra/

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5.4 Summary

- Mining refers to the process of extracting metals and minerals from the earth.
- Gold, silver, diamond, iron, coal and uranium are just a few of the vast array of metals and minerals that are obtained by this process.
- In fact, mining is the source of all the substances that cannot be obtained by industrial processes or through agriculture.
- Mining reaps huge profits for the companies that own them and provides employment to a large number of people.
- It is also a huge source of revenue for the government.
- Despite its economic importance, the effects of mining on the environment are a pressing issue.
- Mining industry being site-specific and located in tribal and interior areas provides employment to local people directly in mines.
- In fact mining activity can be a vehicle in the uplift of socio-economic status of the local people.
- The scale and level of requirement of minerals have increased manifold in our country and it is heading towards the stage where much larger consumption of minerals will be inevitable to sustain even the minimum growth rate of our economy.
- Although the area occupied for mining activity is small yet the damage to the environment on account of mining is causing grave concern.

5.5 Keywords

Biodiversity: Biodiversity, short for biological diversity, is the term used to describe the variety of life found on Earth and all of the natural processes.

Constitution: A constitution is a set of fundamental principles or established precedents according to which the state or other organization is governed.

Deforestation: Deforestation is people cutting down forests of trees whole, and making it even less likely for humans to survive.

Degradation: Degradation is the lowering of the riverbed over a period of time.

Depletion: Depletion is the movement of the cost of natural resources from the company's balance sheet to its income statements.

Dredging: Dredging is an excavation activity or operation usually carried out at least partly underwater, in shallow seas or fresh water areas with the purpose of gathering up bottom sediments and disposing of them at a different location.

Environment: The sum total of all surroundings of a living organism, including natural forces and other living things, which provide conditions for development and growth as well as of danger and damage.

Extraction: Extraction of metals is the separation of metals in a pure or relatively pure state from the minerals in which they naturally occur.

Guidelines: A guideline is a statement by which to determine a course of action.

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Inexhaustible: An inexhaustible resource is a natural resource that will never run out.

Lithosphere: The lithosphere is the solid, rocky layer covering the entire surface of the planet, composed of the crust and the hard uppermost mantle, and reacts to stresses as a brittle solid.

Mineral: A mineral is a naturally occurring substance that is solid and stable at room temperature, representable by a chemical formula, usually abiogenic, and has an ordered atomic structure.

Mining: Mining is the extraction of valuable minerals or other geological materials from the earth from an orebody, lode, vein, seam, or reef, which forms the mineralized package of economic interest to the miner.

Policy: The basic principles by which the government is guided.

Pollution: Pollution is the introduction of contaminants into the natural environment that causes adverse change.

5.6 Review Questions

1. Define Mining.
2. What are the four stages of Mining?
3. Write brief note on National Mineral Policy.
4. "India has a large number of economically useful minerals and they constitute one-quarter of the world's known mineral resources." Elucidate.
5. Discuss method of mining in India.
6. Highlight any five minerals and their position in India.
7. Describe the Environment Problem Created by Extracting and Mineral Resources on Land.
8. Explain the Problem Created by Extracting and Mineral Resources on Water.
9. Do you think that rainforests are the biggest source of oxygen, wood and medicines on this earth? If yes, give reason.
10. "Mining operations are considered one of the main sources of environmental degradation." Discuss.

Answers: Self Assessment

1.	True	2.	False
3.	True	4.	False
5.	True	6.	Mineral
7.	One-quarter	8.	Neyveli
9.	Gypsum	10.	Power
11.	True	12.	False
13.	True	14.	True
15.	False		

5.7 Further Readings

Notes

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Unit 6: Food Resources

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Objectives

After studying this unit, you should be able to:

- Discuss the overview of Food Resources
- Explain the World Food Problems and Environmental Concerns
- Describe the Effects of Modern Agriculture and Problems of Fertilizers and Pesticides

Introduction

In the previous unit, we dealt with the position of mineral resources in India along with the Environment Problem Created by Extracting and Mineral Resources (Mining). Human body needs food for various purposes. Food consumed by humans are of different types and a balanced diet is needed for all practical purposes, vitamins, proteins carbohydrates and minerals are primarily obtained from cereals, fruits, vegetables, pulses and spices, milk, butter, meat and eggs all of which obtained from different types of plants and animals. These are our main food resource. A large number of items are consumed by human either in their natural states or after proper processing and cooking. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the overview of food resources, world food problems as well as the Effects of Modern Agriculture and Problems of Fertilizers and Pesticides.

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6.1 Food Resources: An Overview

Today our food comes almost entirely from agriculture, animal husbandry and fishing. Although India is self-sufficient in food production, it is only because of modern patterns of agriculture that are unsustainable and which pollute our environment with excessive use of fertilizers and pesticides. The food consumed by human is influenced by wide range of cultural and individual differences, mainly due to ecological as well as personal reasons. The source of much of the food consumed by man is terrestrial agricultural, which represents the most manipulated of all the non-urban ecosystems. There are two main types of agriculture (1) Crop agriculture in which plant production is harvested for use by man, and (2) Animal agricultural where a crop from highly manipulated ecosystem is fed to domesticated animals.

The FAO (Food & Agricultural Organization of UN) defines sustainable agriculture as that which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable. Most of our large farms grow single crops (monoculture). If this crop is hit by a pest, the entire crop can be devastated, leaving the farmer with no income during the year. On the other hand, if the farmer uses traditional varieties and grows several different crops, the chance of complete failure is lowered considerably. Many studies have shown that one can use alternatives to inorganic fertilizers and pesticides. This is known as Integrated Crop Management.

Food consumption pattern is different in different regions. The most important feature is that rice to the staple food for most Asians. In general a strong and healthy human consumes about 1.4 kg of food every day. Such a food serves as a source of energy and replacement of uses. However, the excessive use of potential chemicals is being used at various stages of cultivation. By doing so, the food products are contaminated. The persistent pesticides are considered to be damaging and toxic. As a result of such a practice human population has to face a great problem so for as sources of food are concerned. Although by undergoing several good practices before cooking or consuming the food products it has been observed several kinds of diseases affect the health.

Caution In addition to pesticide problems, several heavy metals or their compounds have also led to serve toxicity problems and most of them have provide pathways for several fatal diseases, some examples of such an effect are cereals, spinach are the major sources of cadmium, fruits and vegetables account for 80% of lead intake, meat, fish, poultry and cereals constitute major sources of selenium and the dietary intake of mercury arises from the consumption of fish: when food sources supply heavy metals at levels higher than their daily tolerance limit, constituting, they cause a source of health disorders.

Our food comes almost entirely from agriculture, animal husbandry and fishing i.e., - 76% from crop lands, 17% from range lands i.e., meat from grazing livestock and 7% - marine and fresh water i.e., fisheries. The FAO (Food & Agricultural Organization of UN) also depicts the sustainable agriculture as the one which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable. The report, "The Food Gap –the Impacts of Climate Change on Food Production: A 2020 Perspective", produced after a year-long assessment by America's Universal Ecological Fund (FEU-US), revealed that:

1. Global food production would not meet the food requirements of the world's estimated 7.8 billion people by 2020.
2. Food prices are expected to jump by 20% in the next ten years as prolonged droughts and floods take their toll on food production.

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3. The report, which looked at the impact of climate change on four cereals - wheat, rice, maize and soybean, pointed out that:
   - global wheat production will experience a 14 percent deficit between production and demand
   - Rice production will experience 11 percent deficit
   - 9 percent deficit in maize production
   - Soybean is the only crop showing an increase in global production, with an estimated five percent surplus.
4. Current wheat production is estimated to decline to 663 million tons by 2020 yet 772.3 million tons is the estimated need at that time, creating a gap of 109 million tons.
5. Rice is estimated to grow to 692.1 million tons by 2020 yet demand at that time is estimated at 775.1 million –creating a shortage of 82.9 million tons.
6. Maize production stands at 826.2 million tons and is estimated to grow to 849.1 million tons by 2020 yet demand at that time is estimated at 933.7 million tons, creating a shortage of 85 million tons.

6.1.1 New Sources of Food

It has been conduced that even if the rapid development of conventional agriculture is sustained protein deficiency will continue to exist. Accordingly a search is in progress for supplementary sources of plant and animal proteins. Amongst these animal protein has been considered to be of more importance because of the similar amino acid composition of man. Besides, animal's flesh has the advantage that it more easily assailable. In case the animals are to be avoided, a food source which will yield plant protein in a digestible form or from which the majority of cellulose has been removed, fungi can be preferred.

These can be easily assimilated and contains a good amount of protein. Other sources are fish and beef. The advantage of using mushroom is that it does not absorb much human or fossil energy in production can be grown independently of environment factors.

Young seabirds, reptiles, amphibians, insects, molluscs, rodents and many other animals can be utilized as food. Fresh water and brackish water fish are other sources of animal proteins. It has been found that marine and fresh water fisheries provide best sources of animal protein.

6.1.2 Food Security

It is the ability of all people at all times to access enough food for an active and healthy life. It is estimated that 18 million people worldwide, most of whom are children, die each year due to starvation or malnutrition, and many others suffer a variety of dietary deficiencies. The earth can only supply a limited amount of food. If the world's carrying capacity to produce food cannot meet the needs of a growing population, anarchy and conflict will follow.

It is estimated that 18 million people worldwide, most of whom are children, die each year due to starvation or malnutrition, and many others suffer a variety of dietary deficiencies. The earth can only supply a limited amount of food. If the world's carrying capacity to produce food cannot meet the needs of a growing population, anarchy and conflict will follow. Thus food security is closely linked with population control through the family welfare program. It is also linked to the availability of water for farming.

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Notes Food security is only possible if food is equitably distributed to all. Many of us waste a large amount of food carelessly. This eventually places great stress on our environmental resources.

A major concern is the support needed for small farmers so that they remain farmers rather than shifting to urban centres as unskilled industrial workers. International trade policies in regard to an improved flow of food across national borders from those who have surplus to those who have a deficit in the developing world is another issue that is a concern for planners who deal with International trade concerns. 'Dumping' of underpriced foodstuffs produced in the developed world, onto markets in undeveloped countries undermines prices and forces farmers there to adopt unsustainable practices to compete.

6.1.3 Fisheries

Fish is an important protein food in many parts of the world. This includes marine and fresh water fish. While the supply of food from fisheries increased phenomenally between 1950 and 1990, in several parts of the world fish catch has since dropped due to overfishing. In 1995 FAO reported that 44% of the world's fisheries are fully or heavily exploited, 16% are already overexploited, 6% are depleted, and only 3% are gradually recovering. Canada had to virtually close down cod fishing in the 1990s due to depletion of fish reserves.

Modern fishing technologies using mechanized trawlers and small meshed nets lead directly to overexploitation, which is not sustainable. It is evident that fish have to breed successfully and need to have time to grow if the yield has to be used sustainably. The worst hits are the small traditional fishermen who are no match for organized trawlers.

Caselet

The Aral Sea Tragedy

The Aral sea, covering an area the size of Lithuania, started receding in the 1960s after Soviet state planners diverted its water sources, the Amu Dar ya and the Syr Dar' ya rivers, to irrigate cotton on other crop. From 1960 to 1990, the area of irrigated land in central Asia increased from 3.5 million hectares to 7.5 millin ha. Cotton production soared, making the region the world's fourth largest producer. But by 1980s, the annual flow of fresh water into the Aral was barely one-tenth of the 1950 supply. The salinity level increased, destroying the sea's flora and fauna. The change in water chemistry wiped out huge populations of fish. The decline of the fish populations in turn, wiped out the commercial fishing industry on the lake. Today, fishing boats sit in the desert many kilometres from the water's edge. The lakebed sediments that are now exposed on the desert floor become airborne quite easily, contributing to large dust storms in the region. In 1989, Aral Sea was divided into a smaller northern sea and a large southern one. Drinking water in the region contains four times more salt per litre than the recommended by the world health organization. This has caused increases in kidney disease, diarrhoea and other serious ailments. Tuberculosis has reached epidemic proportions. Cancers, lung diseases and infant mortality are 30 times higher than they used to be because the drinking water is heavily polluted with salt, cotton fertilizers and pesticides.

When the former Soviet Union diverted the Ama Dariya and the Syr Dariya (the rivers which fed the Aral Sea) to grow cotton in the desert, they created an ecological and human

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disaster. What was the fourth biggest inland sea is now mostly desert. All of this was done in the name of cotton (grow where it would not grow naturally). The worsening health and environmental problems of people living the Aral Sea basin, which consists of part of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, are the direct consequences of man-made environmental disaster in the region. The children of Muynak have made a playground out of the wrecks of ships, which might have provided food and a future for them. Experts say the disaster has left behind a 36,000 km^2 area of seabed covered with accumulated salts, which the wind carries away and deposits over thousand of squares kilometres of cultivated land. Pesticides and fertilizers have also found their way into water and irrigation channels, poisoning food and drinking water affecting the lives of about five million people.

After the collapse of the Soviet Union in 1991, international donor agencies rushed to the central Asian region to asses the environmental impact of the shrinking of the Aral Sea and to find ways of restoring it to its original level. Now, almost a decade later, after countless studies and reports have been written, experts say that restoration is impossible and efforts should now focus on avoiding a humanitarian catastrophe. The Aral Sea is not an example of a success in water resource management. In fact, it is a classic example of what can happen if we don't start to take action before a crisis begins. Still, the Aral Sea is very instructive sustainability case study, as it demonstrates how few environmental problems are not international in scope. The world is getting increasingly smaller and the problems require multinational solutions.

Source: http://www.angrau.ac.in/media/1653/BIRM301.pdf

Self Assessment

State whether the following statements are true or false:

1. Food consumption pattern is same in different regions.
2. The food consumed by human is influenced by wide range of cultural and individual differences.
3. Fresh water and brackish water fish are other sources of animal vitamins.
4. Dumping of underpriced foodstuffs produced in the developed world.
5. Fish is not an important protein food in many parts of the world.

6.2 World Food Problems and Environmental Concerns

One of the millennium development goals of the United Nations is halving the proportion of people living in extreme poverty by the year 2015. About 1.3 billion of the world population lives in severe poverty. Nearly 800 million people do not get enough food and 500 million people suffer from malnutrition. India accounts for 22 per cent of the total poor people in the world.

Did u know? In many developing countries where populations are expanding rapidly, the production of food is unable to keep pace with the growing demand. Food production in 64 of the 105 developing countries is lagging behind their population growth levels. These countries are unable to produce more food, or do not have the financial means to import it. India is one of the countries that have been able to produce enough food by cultivating a large proportion of its arable land through irrigation.

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The Green Revolution of the 60's reduced starvation in the country. However many of the technologies we have used to achieve this are now being questioned.

- Our fertile soils are being exploited faster than they can recuperate.
- Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological questions.
- Our fish resources, both marine and inland, show evidence of exhaustion.
- There are great disparities in the availability of nutritious food. Some communities such as tribal people still face serious food problems leading to malnutrition especially among women and children.

These issues bring in new questions as to how demands will be met in future even with a slowing of population growth. Today the world is seeing a changing trend in dietary habits. As living standards are improving, people are eating more non-vegetarian food. As people change from eating grain to meat, the world's demand for feed for livestock based on agriculture increases as well. This uses more land per unit of food produced and the result is that the world's poor do not get enough to eat.

Notes Women play an extremely vital role in food production as well as cooking the meal and feeding children. In most rural communities they have the least exposure to technical training and to health workers trained in teaching/learning on issues related to nutritional aspects. Women and girls frequently receive less food than the men. These disparities need to be corrected.

6.2.1 Change Caused by Agriculture

In India there is a shortage of cultivable productive land. Thus farm sizes are too small to support a family on farm produce alone. With each generation, farms are being subdivided further. Poor environmental agricultural practices such as slash and burn, shifting cultivation, or 'rab' (wood ash) cultivation degrade forests. Globally 5 to 7 million hectares of farmland is degraded each year. Loss of nutrients and overuse of agricultural chemicals are major factors in land degradation. Water scarcity is an important aspect of poor agricultural outputs. Salinisation and water logging has affected a large amount of agricultural land worldwide. Loss of genetic diversity in crop plants is another issue that is leading to a fall in agricultural produce. Rice, wheat and corn are the staple foods of two thirds of the world's people. As wild relatives of crop plants in the world's grasslands, wetlands and other natural habitats are being lost, the ability to enhance traits that are resistant to diseases, salinity, etc. is lost. Genetic engineering is an untried and risky alternative to traditional cross breeding.

Indian agricultural scientists and planners have, over the past 50 years, grappled variously with the problem of making two ends of the burgeoning belly line of the country meet. In most cases, an impatient socio-political system demanded that the scientist/planner hurry through with the solutions, without permitting extensive modelling of resources. A quick recapitulation shows that agricultural planning in India during the past five decades has three distinct phases or characters. The pre-green revolution period (1950 through 1965) is the first phase characterised by an extensive growth strategy.

Output had a significantly greater dependence on area increases, land reforms and expansion of irrigation. About two-thirds of the growth in output was due to area increases and only a third could be attributable to yield growth. When the extensive strategy began to stretch the resource limits of the country, particularly in the more productive regions, the new intensive strategy of

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technology led growth began to emerge. This is the second phase characterised by the introduction of the Borlaug seed-fertilizer-technology strategy. The post green revolution period upto the end 1980s saw an increasing reliance on high productivity regions as well as on productivity increasing strategies.

Since the early 90s, most thinkers have been showing considerable discomfort with the restricted productivity increasing strategies in practice. Considerations of social as well as inter-generational equity began to bother the scientists and planners, leading to the conclusion that the 90s may mark a new phase in the Indian agricultural planning. There were some scientists who did emphasize the need for giving careful thought to resource specific problems like soil erosion, salinity, water logging, siltation, falling groundwater levels and deforestation. However, they were not able to make much dent on the primacy of technology led growth strategy.

It was only much later somewhere during the early eighties, when in many areas, intensification of education through large-scale soil depletion well as salinity and deepening of underground water table that the policymakers started showing some concern about these adverse developments and the need for looking at the natural resource endowments in relation to technology. It is in the context that the initiation of agro-economic regional planning marks a qualitative improvement in plan strategy. This is because for the first time, natural resources were given explicit recognition and agricultural planning was sought to be designed within the framework of homogenous agro-economic regional planning.

Did u know? In modern times, countries are burdened with a variety of economic compulsions ranging from feeding large populations to competing with other industrial forces. Specifically, for agriculture, these imply extracting higher production and yields from given land and water resources. Some of the consequences of this have been deforestation, soil salinity, and water-logging and groundwater depletion, to name only a few.

6.2.2 Loss of Genetic Diversity

There are 50,000 known edible plants documented worldwide. Of these only 15 varieties produce 90% of the world's food. Modern agricultural practices have resulted in a serious loss of genetic variability of crops. India's distinctive traditional varieties of rice alone are said to have numbered between 30 and 50 thousand. Most of these have been lost to the farmer during the last few decades as multinational seed companies push a few commercial types. This creates a risk to our food security, as farmers can loose all their produce due to a rapidly spreading disease. A cereal that has multiple varieties growing in different locations does not permit the rapid spread of a disease. The most effective method to introduce desirable traits into crops is by using characteristics found in the wild relatives of crop plants. As the wilderness shrinks, these varieties are rapidly disappearing. Once they are lost, their desirable characteristics cannot be introduced when found necessary in future.

Caution Ensuring long-term food security may depend on conserving wild relatives of crop plants in National Parks and Wildlife Sanctuaries. If plant genetic losses worldwide are not slowed down, some estimates show that as many as 60,000 plant species, which accounts for 25% of the world's total, will be lost by the year 2025. The most economical way to prevent this is by expanding the network and coverage of our Protected Areas. Collections in germplasm, seed banks and tissue culture facilities, are other possible ways to prevent extinction but are extremely expensive.

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Scientists now believe that the world will soon need a second green revolution to meet our future demands of food based on a new ethic of land and water management that must be based on values which include environmental sensitivity, equity, and biodiversity conservation of cultivars preservation of wild relatives of crop plants. This must not only provide food for all, but also work out more equitable distribution of both food and water, reduce agricultural dependence on the use of fertilizers and pesticides (which have long term ill effects on human well-being) and provide an increasing support for preserving wild relatives of crop plants in Protected Areas. Pollution of water sources, land degradation and desertification must be rapidly reversed. Adopting soil conservation measures, using appropriate farming techniques, especially on hill slopes, enhancing the soil with organic matter, rotating crops and managing watersheds at the micro level are a key to agricultural production to meet future needs. Most importantly food supply is closely linked to the effectiveness of population control programs worldwide. The world needs better and sustainable methods of food production which is an important aspect of land use management.

Task At what point might the right to food lead to some kind of requirement for regional or global population control or wealth redistribution?

Self Assessment

Fill in the blanks:

6. India accounts for ..... per cent of the total poor people in the world.
7. Loss of ..... in crop plants is another issue that is leading to a fall in agricultural produce.
8. The ..... period (1950 through 1965) is the first phase characterised by an extensive growth strategy.
9. There are ..... known edible plants documented worldwide.
10. The world needs better and sustainable methods of food production which is an important aspect of ..... management.

6.3 Effects of Modern Agriculture and Problems of Fertilizers and Pesticides

Modern agriculture practices have been great promise for economic development of nation. Farm productivity is directly proportional to the use of agrochemicals as observed from the first green revolution. Improper and unsafe use of these agrochemicals, especially pesticides is not only harmful to environment but also human health. Pesticides cause 14 percent of all known occupational injuries in agriculture and 10 percent of all fatal injuries.

Agriculture is the mainstay of Indian economy. Agriculture and agriculture allied sectors contribute nearly 22 per cent of Gross Domestic Product (GDP) of India, while about 65 -70 per cent of population depends on agriculture for livelihood. The scenario of Indian agriculture has changed drastically after first green revolution in 1960. Vast majorities of the population in India is engaged in agriculture and are therefore, exposed to the pesticides used in agriculture. Indian farmer is using wide ranges of chemical pesticides to limit the losses from pests and diseases, in which insecticides account for 73 per cent, herbicides 14 per cent, fungicides 11 per cent and others 2 per cent. Chemical pesticide use is associated with risk and health hazards if

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not handled properly. Improper handling and unsafe spraying of the agrochemicals cause high risk of health hazards reported in the past studies. Centre for Science and Environment (CSE) reported that pesticide exposure causes acute poisoning, cancer and neurological impairment, reproductive and developmental problems.

Post-Independence, population was growing at a much faster rate than food production. This called for drastic action to increase yield. Action came in the form of Green Revolution involving expansion of farming areas, double cropping, existing farmland using irrigation and using High Yielding Variety (HYV) seeds. The 'Green Revolution' of the 1960s was confined to the Northern States of Punjab, Haryana and parts of Uttar Pradesh, and to strategic crops, mainly wheat and rice. Over 70 per cent of the country's farmland remains rain-fed, whilst a significant proportion of agricultural land (150 million hectares) is now classified as 'wasteland'. The liberalisation of Indian agricultural economy started in 1991. The major impact has been the shift from "lower value" or subsistence food crops to higher value cash crops (like cotton or oilseeds). This shift had created massive impact especially on the use of pesticides in Indian agriculture.

6.3.1 Effects of Modern Agriculture

Modernisation of agriculture was to lead to changes in relations of production from a feudal system to capitalist mode. In India, factors such as caste, colonial influence and uneven development meant that complex relations developed. The debate on mode of production in the 60s and 70s indicated that the relations were characterised variously viz., semi-feudal, semi-colonial, early capitalist, to semi-colonial systems. The new seed fertiliser technology especially, those arising from the Green Revolution resulted in the increase in land rents and lower labour wages (in real terms). Only big farmers, mainly those who are producing for the market, could make use of Government support. Marginal farmers have in fact been further marginalised under the new regime of modern agriculture and green revolution. In fact most farmer suicides have been connected to pauperisation and indebtedness which so called government support in the form of part subsidies for seeds, credit, fertilisers have brought in.

Modern Agricultural Paradigms

Important principles and strategies for the future of India's agriculture that can be distilled from the many grassroots initiatives include the following:

- Localised production or availability of basic inputs including seeds/livestock/fingerlings, manure, water, fodder, technologies, knowledge, and, where necessary, credit; this requires a focus on production systems that are in tune with local agro-ecological conditions, especially soil types, climate, and water availability.
- Integration of crops, livestock, fodder, and/or fish production, and of forest conservation and use to optimise production from a given landscape; this necessitates greater coordination amongst farmers and amongst various government departments. And, in many places, ecological restoration through watershed management, regeneration of forests, etc.
- Financial or technological assistance to farmers to switch from chemical-dependent farming to organic farming, including by converting current fertiliser subsidies into credit for organic farming.
- Linking the public distribution system and other food security schemes such as the midday meals scheme and food-for-work scheme to locally produced food rather than obtaining grain from hundreds or thousands of kilometres away; this may necessitate building up

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relations between clusters of villages as a single village may not have adequate production to supply.

- Building on local agricultural, forestry, and aquatic produce to generate additional livelihoods through village-based industry; prioritising local markets and feeding distant markets after local needs are satisfied.
- Feeding agriculture's energy needs through decentralised, renewable energy sources.
- Facilitating empowerment of the most marginalised, including landless and marginal farmers, and women, through micro-credit, cooperatives, self-help groups, etc.
- Encouraging urban agriculture, including rooftop and backyard production, and common plots in low-income colonies to meet basic household needs.
- Decentralised R&D in the form of joint, on-field programs by farmers and modern agricultural scientists, with priorities defined by the former.
- Facilitating direct producer-consumer links amongst villages and between villages and cities, with programs that create awareness about each other's needs and build networks of trust that could take up the task of local 'certification' of organic, healthy produce.

6.3.2 Impact of Pesticides use in Agriculture

The term pesticide covers a wide range of compounds including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others. Among these, organochlorine (OC) insecticides, used successfully in controlling a number of diseases, such as malaria and typhus, were banned or restricted after the 1960s in most of the technologically advanced countries. The introduction of other synthetic insecticides – organophosphate (OP) insecticides in the 1960s, carbamates in 1970s and pyrethroids in 1980s and the introduction of herbicides and fungicides in the 1970s–1980s contributed greatly to pest control and agricultural output. Ideally a pesticide must be lethal to the targeted pests, but not to non-target species, including man. Unfortunately, this is not the case, so the controversy of use and abuse of pesticides has surfaced. The rampant use of these chemicals, under the adage, "if little is good, a lot more will be better" has played havoc with human and other life forms. The problems crested by Pesticides are as follows:

1. ***Direct Impact on Humans:*** If the credits of pesticides include enhanced economic potential in terms of increased production of food and fibre, and amelioration of vector-borne diseases, then their debits have resulted in serious health implications to man and his environment. There is now overwhelming evidence that some of these chemicals do pose a potential risk to humans and other life forms and unwanted side effects to the environment. No segment of the population is completely protected against exposure to pesticides and the potentially serious health effects, though a disproportionate burden is shouldered by the people of developing countries and by high risk groups in each country. The worldwide deaths and chronic diseases due to pesticide poisoning are around 1 million per year.

Notes The high risk groups exposed to pesticides include production workers, formulators, sprayers, mixers, loaders and agricultural farm workers. During manufacture and formulation, the possibility of hazards may be higher because the processes involved are not risk free. In industrial settings, workers are at increased risk since they handle various toxic chemicals including pesticides, raw materials, toxic solvents and inert carriers.

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2. ***Impact through Food Commodities:*** In India the first report of poisoning due to pesticides was from Kerala in 1958, where over 100 people died after consuming wheat flour contaminated with parathion. This prompted the Special Committee on Harmful Effects of Pesticides constituted by the ICAR to focus attention on the problem. In a multi-centric study to assess the pesticide residues in selected food commodities collected from different states of the country, DDT residues were found in about 82% of the 2205 samples of bovine milk collected from 12 states. About 37% of the samples contained DDT residues above the tolerance limit of 0.05 mg/kg (whole milk basis). The highest level of DDT residues found was 2.2 mg/kg. The proportion of the samples with residues above the tolerance limit was highest in Maharashtra (74%), followed by Gujarat (70%), Andhra Pradesh (57%), Himachal Pradesh (56%), and Punjab (51%). In the remaining states, this proportion was less than 10%. Data on 186 samples of 20 commercial brands of infants formulae showed the presence of residues of DDT and HCH isomers in about 70 and 94% of the samples with their maximum level of 4.3 and 5.7 mg/kg (fat basis) respectively. Measurement of chemicals in the total diet provides the best estimates of human exposure and of the potential risk. The risk of consumers may then be evaluated by comparison with toxicologically acceptable intake levels. The average total DDT and BHC consumed by an adult were 19.24 mg/day and 77.15 mg/day respectively.

Example: Fatty food was the main source of these contaminants.

In another study, the average daily intake of HCH and DDT by Indians was reported to be 115 and 48 mg per person respectively, which were higher than those observed in most of the developed countries.

3. ***Impact on Environment:*** Pesticides can contaminate soil, water, turf, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms.

4. ***Effect on Soil Fertility (beneficial soil microorganisms):*** Heavy treatment of soil with pesticides can cause populations of beneficial soil microorganisms to decline. Overuse of chemical fertilizers and pesticides have effects on the soil organisms that are similar to human overuse of antibiotics. Indiscriminate use of chemicals might work for a few years, but after awhile, there aren't enough beneficial soil organisms to hold onto the nutrients.

Example: Plants depend on a variety of soil microorganisms to transform atmospheric nitrogen into nitrates, which plants can use. Common landscape herbicides disrupt this process: triclopyr inhibits soil bacteria that transform ammonia into nitrite; glyphosate reduces the growth and activity of free-living nitrogen-fixing bacteria in soil and 2, 4-D reduces nitrogen fixation by the bacteria that live on the roots of bean plants, reduces the growth and activity of nitrogen-fixing blue-green algae, and inhibits the transformation of ammonia into nitrates by soil bacteria.

Mycorrhizal fungi grow with the roots of many plants and aid in nutrient uptake. These fungi can also be damaged by herbicides in the soil. One study found that oryzalin and trifluralin both inhibited the growth of certain species of mycorrhizal fungi. Roundup has been shown to be toxic to mycorrhizal fungi in laboratory studies, and some damaging effects were seen at concentrations lower than those found in soil following typical applications. Triclopyr was also found to be toxic to several species of mycorrhizal fungi and oxadiazon reduced the number of mycorrhizal fungal spores.

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5. ***Contamination of air, soil, and non-target vegetation and organism:*** Pesticide sprays can directly hit non-target vegetation, or can drift or volatilize from the treated area and contaminate air, soil, and non-target plants. Some pesticide drift occurs during every application, even from ground equipment. Drift can account for a loss of 2 to 25% of the chemical being applied, which can spread over a distance of a few yards to several hundred miles. As much as 80%–90% of an applied pesticide can be volatilised within a few days of application. Many pesticides have been detected in air at more than half the sites sampled nationwide. Herbicides are designed to kill plants, so it is not surprising that they can injure or kill desirable species if they are applied directly to such plants, or if they drift or volatilise onto them. Many ester-formulation herbicides have been shown to volatilise off treated plants with vapours sufficient to cause severe damage to other plants. Pesticides are found as common contaminants in soil, air, water and on non-target organisms in our urban landscapes. Once there, they can harm plants and animals ranging from beneficial soil microorganisms and insects, non-target plants, fish, birds, and other wildlife. Chlorpyrifos, a common contaminant of urban streams is highly toxic to fish, and has caused fish, kills in waterways near treated fields or buildings.

Notes Several cases of pesticide poisoning of dolphins have been reported worldwide. Because of their high trophic level in the food chain and relatively low activities of drug-metabolising enzymes, aquatic mammals such as dolphins accumulate increased concentrations of persistent organic pollutants and are thereby vulnerable to toxic effects from contaminant exposures.

6.3.2 Impact of Fertilizers use in Agriculture

One of India's biggest economic burdens is the huge government subsidy on synthetic fertilisers. From about ₹ 60 crore in 1976-77, it catapulted to around ₹ 120,000 crore in 2008-09. Everyone acknowledges this burden, but it is justified in the name of increased agricultural productivity. The subsidy encourages widespread fertiliser use, so much so that from only 0.07 million tonnes (Mt) in 1950-51, consumption in India is now well over 23 Mt!

What is becoming increasingly clear, however, is that this subsidy is not only a financial millstone around our neck; it is also slowly killing off agriculture. This may sound paradoxical, considering that fertilisers have always been revered as an important pillar of the Green Revolution, and that any talk of doing away with the subsidy amounts to political hara-kiri, given the fear (very real) of a massive farmer backlash. And yet, more and more farmers themselves are questioning the policy, having experienced a host of problems with unrestricted and sustained fertiliser use.

A report conducted by two Indian and a Spanish scientist puts together evidence of how counterproductive fertilisers have become; the havoc they are playing with India's soils; and the alternatives that already exist. Dr B C Roy and Professor G N Chattopadhyay of Viswa Bharti's Institute of Agriculture, and Dr Reyes Tirado of the University of Exeter, have authored 'Subsidising Food Crisis: Synthetic Fertilisers Lead to Poor Soil and Less Food', produced by the environmental NGO Greenpeace India.

The report argues, on the basis of several scientific studies and solid data, that while fertilisers did raise productivity in the early years of the Green Revolution, they are no longer doing so. In fact, they may be reducing productivity in many areas due to several factors: soil degradation caused by destruction of organic matter, nutrient imbalances, and micronutrient deficiencies.

The report offers a number of scientifically documented examples. In Punjab, which is the highest user of synthetic fertiliser in India, grain output has "not only practically stagnated but

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also showed a declining trend with fertiliser application" after 1992 (before which it had been consistently rising since the 1960s). A 33-year study at the Central Research Institute for Jute and Allied Fabrics (part of the Indian Council of Agricultural Research) showed that continuous use of synthetic fertiliser on the rice-wheat-jute system resulted in severe soil compacting and loss of organic content and nitrogen. And that switching to organic fertiliser helped revive the soil.

The report also pegs emissions from nitrogen fertiliser production and use at about 6% of India's greenhouse gas emissions. And though the authors do not discuss this, another impact of fertiliser use is widespread pollution of water (both surface and ground), which has led to serious eutrophication of freshwater areas — a process in which lakes start dying as the organisms in them, artificially boosted by nutrients from fertilisers, demand more oxygen than the water can provide. It is reported that at least 11 states in India have nitrate concentrations in their groundwater that are above permissible limits. In marine areas, fertiliser run-off is known to cause 'algal blooms' — an explosion of some algae species that upsets the delicate balance of life, causing a decline in other species.

The human health impacts of fertiliser pollution are also serious. Another study by Greenpeace India, in Punjab, found that most wells were contaminated with nitrates; 20% of all sampled wells had nitrate levels above the safety limit of 50 mg per litre as established by the World Health Organisation. Such high levels are known to cause diseases like blue baby syndrome in infants and cancers of the digestive tract, bladder and ovaries. The Indian Medical Association joined Greenpeace recently in expressing concern over this form of pollution. Fertilisers also release heavy metals and cause air pollution of various kinds.

Self Assessment

Fill in the blanks:

11. Pesticides cause 14 per cent of all known ..... injuries in agriculture.
12. ..... is the mainstay of Indian economy.
13. The ..... of the 1960s was confined to the Northern States of Punjab, Haryana and parts of Uttar Pradesh, and to strategic crops, mainly wheat and rice.
14. The liberalisation of Indian agricultural economy started in .....
15. ..... sprays can directly hit non-target vegetation, or can drift or volatilize from the treated area and contaminate air, soil, and non-target plants.

Case Study

Drought and Deaths due to Food Problems

The case which follows deals with the starving people of Rajasthan, and is taken from the April, 2001

Veera Hona (29), Mala (65) and Rota (75) of Medi panchayat in Kotada tehsil of Udaipur district, whose lives hunger claimed in February. The district administration was quick to claim that the death of these persons, all belonging to the Gamar tribe, was not owing to any famine.

What unfolds is a tale of growing unemployment, vanishing livelihoods, mounting debts, dwindling food resources and falling nutrition levels. This is the stark profile of poverty

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and hunger that you would come across anywhere in the southern and western parts of Rajasthan where acute famine conditions prevail as a result of three successive years of drought.

Veera of Nakola village, mortgaged his only piece of land, which measured just one bigha (one bigha is an extent of one-third to two-thirds of an acre), when it stopped yielding anything. Early this year, he could find no work in neighbouring Gujarat where he goes in search of work during what is for him the lean labour season every year. With no money for the return trip, Veera trekked 70 km to reach Nakola on February 2, only to see an empty barn and his wife and three children with empty stomachs. With no work in the village - or in the fields or at government relief sites, where relief work was yet to start - and not enough forests around to sustain the village, he was worried about his family.

For two days he and his family tried to live off kajari seeds which they gathered from the forests and sold to the local shopkeepers. Soon, there were no more of these seeds, from which oil is extracted to make soap. They were again left with no work and hence no food. The children kept crying for food. Unable to stand this agony, Veera committed suicide by consuming a pesticide. In accordance with the local tribal custom, beside his grave were kept for a few days two earthen cups, one filled with offerings of a little rice and another with milk, both luxuries for Veera when alive.

In the case of Mala of Medi village, drought and illness together forced him to mortgage two years ago the only piece of land (two bighas) in his possession. Last year his child's illness saw his debt mount by ₹ 2,000 more. Malnutrition claimed the lives of three of his children, aged between one year and five years, in the last five years. Out of his four surviving children, Makana (14) has a walking disability. With no crop in the field and no employment, Makana left for Gujarat. When he could find no work there, he trekked 80 km to return home. Mala had also gone to Gujarat on an errand and returned disappointed only a fortnight before his son's home-coming. By then Mala, who had six dependents, had spent all the ₹ 600 he had received in December as arrears of his old-age pension. He had no cash, food or work. As if it were not enough, he had a swollen foot. Left with no option, he became a beggar. His wife Jeeja collected firewood from the fast-shrinking forests, and that fetched her ₹ 10 or 15 once in two or three days, barely enough for the family to prepare corn gruel (raabri) on alternate days. Meanwhile, the swelling on Mala's foot worsened, and he fell ill. He died on February 10.

The story of Rota Gamar of Koldara is no different. He and wife Jeera lived with their nephew Limba and his family. Driven by the drought, Limba migrated with his family to Gujarat around Deepavali last year. He left behind his 10-year-old daughter to take care of the old couple. Suffering from polio in one foot, Rota had a mule to take him to his kuccha house on the hill. The mule was the first to fall victim to the drought. Its death forced Rota to live in a one-room thatched hut at the foot of the hill. Rota's food stocks exhausted, and he could get no help from Limba. With a meagre daily earning of ₹ 20-25, which he had to share with five family members, Limba could hardly send any money to his daughter and the old couple back home. Rota ran out of money when he had spent the old age pension of ₹ 100 he had drawn in January. (That Rota had to spend ₹ 50 every time he had to visit the tehsil headquarters, 25 km away to receive this ₹ 100 is another story.) He turned a beggar, but could not get enough to eat. He fell ill, and died on February 10.

Like their deaths, the belongings as well as the debts the three persons left behind reveal a pattern. Their belongings, like those of many of their fellow villagers, were a single-room kuccha hut, a rickety charpoy (cot), a rag for the whole family to sleep on, one or two earthen pots, one or two aluminium or stainless steel utensils, a grinding stone and a slab,

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a small structure made of bamboo and mud to store food grain, a stone chakki, and a bigha or two of mortgaged land. The poorest of the three, Rota, had even less.

All three are left behind debts running to not less than ₹ 10,000. Their debts too shared a pattern with those of most others in their villages. But for three government employees (two teachers and a postman) and a handful of non-tribal shopkeepers, almost everyone in the three villages has incurred a debt that ranges from ₹ 10,000 to ₹ 40,000. The loans are of three kinds: sarkars, sahukars and sunars, that is, from the government (mostly from cooperative land banks) for digging wells and for other similar capital investments), from moneylenders (usually local shopkeepers), for mostly health reasons, and from pawn brokers (against their women's jewellery), as a last resort.

While extreme hunger is always there in India, natural disasters such as floods and droughts bring more hunger because so many of the people are so vulnerable, living at the edge of hunger all the time.

Like many other developing countries, India has a wide variety of feeding programs, food subsidies, and other sorts of "schemes" to alleviate hunger, but somehow these programs are never quite enough. Lacking political power, marginalised people stay marginalised despite such efforts to help them. They can be empowered, however, through clear acknowledgment of their human rights. People have a right to adequate food. The following article on "The Human Right to Food in India" tells the story of the controversy over emerging recognition of this right. Over the centuries, many millions of people have gone hungry in India. Now, for the first time, the claim has been made that the government has a positive obligation to do something enforce this right, and if government does not meet its obligation, it can be called to account in the nation's courts.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.earthwindow.com/grc2/foodrights/

6.4 Summary

- The FAO (Food & Agricultural Organization of UN) defines sustainable agriculture as that which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable.
- Food consumption pattern is different in different regions.
- It is the ability of all people at all times to access enough food for an active and healthy life.
- Fish is an important protein food in many parts of the world which includes marine and fresh water fish.
- Modern fishing technologies using mechanized trawlers and small meshed nets lead directly to overexploitation, which is not sustainable.
- One of the millennium development goals of the United Nations is halving the proportion of people living in extreme poverty by the year 2015.
- Indian agricultural scientists and planners have, over the past 50 years, grappled variously with the problem of making two ends of the burgeoning belly line of the country meet.

Notes

- In modern times, countries are burdened with a variety of economic compulsions ranging from feeding large populations to competing with other industrial forces.
- Agriculture and agriculture allied sectors contribute nearly 22 per cent of Gross Domestic Product (GDP) of India, while about 65 -70 per cent of population depends on agriculture for livelihood.
- Modernisation of agriculture was to lead to changes in relations of production from a feudal system to capitalist mode.
- The term pesticide covers a wide range of compounds including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others.
- One of India's biggest economic burdens is the huge government subsidy on synthetic fertilisers. From about ₹ 60 crore in 1976-77, it catapulted to around ₹ 120,000 crore in 2008-09.

6.5 Keywords

Animal Husbandry: Animal husbandry is the science of taking care of animals used for food or products.

Fertilizers: Fertilizer is any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more plant nutrients essential to the growth of plants.

Fisheries: A fishery is an entity engaged in raising or harvesting fish which is determined by some authority to be a fishery.

Food Resources: It defines sustainable agriculture as that which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable.

Food Security: It is the ability of all people at all times to access enough food for an active and healthy life.

Genetic Diversity: Genetic diversity, the level of biodiversity, Refers to the total number of genetic characteristics in the genetic makeup of a species.

Green Revolution: Green Revolution is development in the field of agriculture to have more from less that is by introducing modern farming methods and HYV (High yielding variety seeds) to increase the produce.

Land Reforms: Land reform involves the changing of laws, regulations or customs regarding land ownership.

Pesticides: A pesticide is a chemical used to Prevent, destroy, or repel pests.

Salinisation: Salinisation is a process that results from high levels of salt in the water.

Water Logging: Water logging (agriculture), saturation of the soil by groundwater sufficient to prevent or hinder agriculture.

6.6 Review Questions

1. What is Food Resources according to FAO?
2. Discuss the New Sources of Food.
3. Describe Food Security.

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4. Do you agree with the statement that fish is an important protein food in many parts of the world? If yes, give reason.
5. Throw some light on the change caused by agriculture.
6. Explain Loss of Genetic diversity.
7. "Agriculture is the mainstay of Indian economy." Elucidate.
8. Highlight the effects of Modern Agriculture.
9. Discuss the impact of Pesticides use in Agriculture.
10. Explain the impact of Fertilizers use in Agriculture.

Answers: Self Assessment

1.	False	2.	True
3.	False	4.	True
5.	False	6.	22
7.	Genetic Diversity	8.	Pre-green Revolution
9.	50,000	10.	Land use
11.	Occupational	12.	Agriculture
13.	Green Revolution	14.	1991
15.	Pesticide		

6.7 Further Readings

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Unit 7: Energy Resources

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Objectives

After studying this unit, you should be able to:

- Discuss the overview of Energy Resources
- Explain the crises of growing energy needs in Energy Resources
- Describe the types of energy that is Renewable (Conventional), Non-Renewable (Non-Conventional Sources of Energy) and Nuclear Energy
- Discuss the Alternative Energy Sources

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Introduction

In the previous unit, we dealt with the overview of food resources, world food problems as well as the Effects of Modern Agriculture and Problems of Fertilizers and Pesticides. We use energy for household use, agriculture, production of industrial goods and for running transport. Modern agriculture uses chemical fertilizers, which require large amounts of energy during their manufacture. Industry uses energy to power manufacturing units and the urban complexes that support it. Energy-demanding roads and railway lines are built to transport products from place to place and to reach raw materials in mines and forests. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the overview of Energy resources, crises of growing energy needs in Energy Resources and various types of energy resources in India.

7.1 Energy Resources: An Overview

Energy is defined by physicists as the capacity to do work. Energy is found on our planet in a variety of forms, some of which are immediately useful to do work, while others require a process of transformation. The sun is the primary energy source in our lives. We use it directly for its warmth and through various natural processes that provide us with food, water, fuel and shelter. The sun's rays power the growth of plants, which form our food material, give off oxygen which we breathe in and take up carbon dioxide that we breathe out. Energy from the sun evaporates water from oceans, rivers and lakes, to form clouds that turn into rain. Today's fossil fuels were once the forests that grew in prehistoric times due to the energy of the sun.

Chemical energy, contained in chemical compounds is released when they are broken down by animals in the presence of oxygen. In India, manual labour is still extensively used to get work done in agricultural systems, and domestic animals used to pull carts and ploughs. Electrical energy produced in several ways, powers transport, artificial lighting, agriculture and industry. This comes from hydel power based on the water cycle that is powered by the sun's energy that supports evaporation, or from thermal power stations powered by fossil fuels. Nuclear energy is held in the nucleus of an atom and is now harnessed to develop electrical energy.

Caution No energy related technology is completely 'risk free' and unlimited demands on energy increase this risk factor many fold. All energy use creates heat and contributes to atmospheric temperature. Many forms of energy release carbon dioxide and lead to global warming.

Nuclear energy plants have caused enormous losses to the environment due to the leakage of nuclear material. The inability to effectively manage and safely dispose of nuclear waste is a serious global concern. Thus when we use energy wastefully, we are contributing to a major environmental disaster for our earth. We all need to become responsible energy users. An electrical light that is burning unnecessarily is a contributor to environmental degradation.

Notes Energy is a key input in economic growth there is a close link between the availability of energy and the future growth of a nation. However, in a developing country like India greater the availability of energy the more is its shortage. In spite of the increase in power generating capacity from 2000 MW in 1950 to 91,190 MW by the end of 2000, the peak shortage is expected to touch 30 per cent.

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Energy is consumed in a variety of forms in India. Fuel wood, animal waste and agricultural residues are traditional sources of energy that continue to meet the bulk of energy requirement 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 fuel accounts for 60 per cent of the total primary energy supply in India with the balance 40 per cent coming from non-commercial fuels. Of the total commercial energy produced in the form of power or electricity, 69% is from coal or thermal power, 25% is from hydel power, 2% is from nuclear power, 4% is from diesel and gas and less than 1% is from non-conventional sources like solar, wind, bio-gas, mini hydel, etc. Petroleum and its products are the other large sources of energy.

7.1.1 Importance of Energy Resources

The Importance of Energy Resources is as follows:

- Power is the main input for agriculture and industry.
- Energy sources are the backbone of economic development.
- The resources which are widely used and constitute the major source of energy are called conventional resources of energy.
- Energy is required to run machines and vehicles, to cook our food, to light our streets, to warm or cool our houses and offices, and to recycle various materials for further use.
- Energy resources are the chief sources of fuel and power in India.

7.1.2 Energy Policy of India

The Government of India has formulated an energy policy with the objective 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 the policy are:

- Accelerated exploitation of domestic conventional energy resources—oil, coal, hydro and nuclear power.
- Intensification of exploration to achieve indigenous production of oil and gas.
- Management of demand of oil and other forms of energy.
- Energy conservation and management.
- optimization of utilisation of existing capacity in the country.
- Development and exploitation of renewable sources of energy to meet energy requirements of rural communities.
- Intensification of resources and development activities in new and renewable energy resources.
- Organization of training for personnel engaged at various levels in the energy sector.
- Bio-diesel, CNG and LPG are preferred fuels for rest of transport sector.
- Domestic and commercial sectors shall be supplied with piped natural gas for meeting heating and catering requirements.
- Cross country natural gas pipe lines and city gas distribution piping network are to be constructed to supply natural gas to all users.

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- All available energy resources other than liquid and gaseous fuels should be used for electricity generation. The means of electricity generation shall be based on the delivery cost of electricity at user door step taking in to account generation and transmission costs.
- For transporting coal to long distant power stations, cross country coal slurry pipe lines are to be constructed to reduce the cost of coal transport.
- Since coal is abundantly available, underground coal gasification technology is to be developed on commercial scale to convert coal in to gaseous fuel not only for electricity generation and but also for other energy requirements.
- There shall be technology mission to commercialize bio-diesel production from Algae and Koroch cultivation to replace the conventional transport fuels.
- There shall be extensive efforts to popularize biomass gasification and biomass pirolysis to serve as chemical feed stocks, raw material in Urea production, and heating fuels.

The development and promotion of non-conventional/alternate/new and renewable sources of energy such as solar, wind, bio-energy etc. are getting sustained attention from the Department of Non-conventional Energy Sources set-up in 1982.

Caselet

Urban Promise Academy Uses Energy Modelling to Exceed CHPS Requirements

The new multi-purpose building at the Urban Promise Academy consists of approximately 11,000 SF of new construction including a multi-purpose gymnasium with raised platform stage, office, conference room, equipment storage, rest rooms, a lobby, and art/music classrooms. The project is located within the Oakland Unified School District. In the spring of 2007, the Oakland Unified School District's Board of Education passed a District Sustainability and High Performance Schools Resolution. A key component of this resolution is the requirement that all new school building projects in the district meet sustainability requirements defined by the Collaborative for High Performance Schools (CHPS). The CHPS criteria are a flexible yardstick that allows project teams to implement sustainable design and construction practices based on their particular project opportunities and constraints. Like other green building rating systems, CHPS addresses a range of environmental and occupant health concerns. CHPS criteria include Sustainable Sites, Water, Energy, Materials, and Indoor Environmental Quality.

CHPS has a prerequisite (EE1.0) for minimum energy performance stipulating that projects must exceed 2005 Title 24 requirements by at least 10 percent on a Time-Dependent Valuation (TDV) basis. This is a prerequisite that all CHPS projects must achieve, which underscores the importance of using energy modelling during early project phases to determine if the proposed design is anticipated to meet this requirement. CHPS credit EE1.1 "Superior Energy Performance" offers up to 13 points for going 12 to 36 percent beyond the requirements of 2005 Title 24. The documentation necessary for the CHPS submittal consists of the PERF-1 documentation from a State approved Title 24 compliance software program.

The design team for the Urban Promise Academy used energy modelling at key stages of project design and construction to ensure they were on course to meet their energy efficiency goals. During early design development, the model was used to verify that the proposed building would meet the CHPS prerequisite for minimum energy performance. The model demonstrated that the project was performing far better than the minimum requirement

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of 10 percent better than 2005 Title 24 requirements—in fact, the project was approaching a compliance margin closer to 20 percent. Building features that contributed to this level of performance included high performance glazing, a variety of daylight-friendly features such as clerestories and skylights, high efficiency interior lighting, and efficient rooftop HVAC units with air-side economizers. As part of their participation in the California Energy Commission's Bright Schools program, the design team was committed to achieving performance at least 20 percent better than 2005 Title 24 requirements. While the proposed design was close to this level of performance, the team used the energy model to evaluate design enhancements that could provide the last few percentage points of improvement necessary to exceed their goal. The energy model results confirmed that the project could meet its goal by specifying higher performance glass, enhanced lighting controls, and an improved control strategy (enthalpy control) for the HVAC economizers. These measures, in conjunction with the various energy efficiency features already incorporated in the design, were predicted to provide a 21.7 percent improvement in energy performance versus Title 24 requirements.

During project construction, the energy model was used to confirm that a proposed product substitution for the skylights would not push the project below the 20 percent threshold (the originally specified product was no longer available). The Urban Promise Academy project serves as an excellent example of how appropriate use of energy modelling can support the high performance building process at key stages of design and construction.

Source: http://www.energydesignresources.com/media/2323/ArchSIM_Case_Study_05.pdf

Self Assessment

State whether the following statements are true or false:

1. Energy is consumed in only one of form in India.
2. Power is the main input for agriculture and industry.
3. Energy resources are the chief sources of fuel and power in India.
4. Bio-diesel, CNG and LPG are not preferred fuels for rest of transport sector.

7.2 Crises of Growing Energy Needs

Energy has always been closely linked to man's economic growth and development. Present strategies for development that have focused on rapid economic growth have used energy utilization as an index of economic development. This index however, does not take into account the long-term ill effects on society of excessive energy utilisation. In 1998, the World Resources Institute found that the average American uses 24 times the energy used by an Indian.

Between 1950 and 1990, the world's energy needs increased four fold. The world's demand for electricity has doubled over the last 22 years! The world's total primary energy consumption in 2000 was 9096 million tons of oil. A global average per capita works out to be 1.5 tons of oil. Electricity is at present the fastest growing form of end-use energy worldwide. By 2005 the Asia-Pacific region is expected to surpass North America in energy consumption and by 2020 is expected to consume some 40% more energy than North America.

Did u know? In 1998, the World Resources Institute found that the average American uses 24 times the energy used by an Indian.

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For almost 200 years, coal was the primary energy source fuelling the industrial revolution in the 19th century. At the close of the 20th century, oil accounted for 39% of the world's commercial energy consumption, followed by coal (24%) and natural gas (24%), while nuclear (7%) and hydro/renewables (6%) accounted for the rest.

Among the commercial energy sources used in India, coal is a predominant source accounting for 55% of energy consumption estimated in 2001, followed by oil (31%), natural gas (8%), hydro (5%) and nuclear (1%). In India, biomass (mainly wood and dung) accounts for almost 40% of primary energy supply. While coal continues to remain the dominant fuel for electricity generation, nuclear power has been increasingly used since the 1970s and 1980s and the use of natural gas has increased rapidly in the 80s and 90s.

India's energy demand is on the rise, driven by high population growth, the modernisation of lifestyles, higher electrification rates and a rapidly growing economy. Annual growth in energy demand reached 8% recently, doubling the historical average annual growth rates of the past 30 years. With GDP expected to grow by 7.5% and energy demand expected to nearly double by 2030, India is set to surpass Japan and Russia to become the world's third largest energy consumer after the U.S. and China. This in turn will increase the GHG emissions by roughly three or four fold compared to 2005 levels with the power sector being the key driver of GHG (Green House Gases) increases.

Surging energy demand is outstripping supply, raising concerns over the country's energy security. India already faces chronic electricity shortages, a situation that underscores the country's need for additional electricity generating capacity and the county's power demand is likely to increase by more than five-fold by 2030.

Caution With coal being the dominant fuel used to produce energy in India, the country faces severe public health, environmental and economic impacts that make coal's use unsustainable to say the least. Despite their abundance, renewable energy sources represent only 11% of the country's electricity capacity. Biomass represents just 13% of renewable-based electricity capacity.

India's poverty reduction efforts and future economic development are inextricably linked to the expansion of modern energy availability to the poor and the elimination of chronic energy shortages. Therefore solving the energy shortage through sustainable solutions that enable social and environmental development as well as economic is key to the problem. Biomass Power offers one such scalable solution.

Notes Despite India's rapid economic development 70% of the population still lives in rural areas and around 50% of the population is employed in agriculture, accounting for 16% of GDP (based on 2009-10 figures). Its arable land area of 157.9 million hectares (390.2 million acres) is second only to the United States. This has enabled India to become the world's second largest producer of paddy rice and wheat, among other agricultural products.

Self Assessment

Fill in the blanks:

5. ..... has always been closely linked to man's economic growth and development.

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6. Between 1950 and 1990, the world's energy needs increased ..... fold.
7. ..... is at present the fastest growing form of end-use energy worldwide.
8. For almost 200 years, ... was the primary energy source fuelling the industrial revolution in the 19th century.

7.3 Types of Energy: Renewable (Conventional), Non-Renewable (Non-Conventional Sources of Energy) and Nuclear Energy

There are three main types of energy; those classified as **non-renewable;** those that are said to be **renewable;** and **nuclear energy,** which uses such small quantities of raw material (uranium) that supplies are to all effect, limitless. However, this classification is inaccurate because several of the renewable sources, if not used 'sustainably', can be depleted more quickly than they can be renewed.

7.3.1 Renewable Energy

Renewable energy systems use resources that are constantly replaced and are usually less polluting. We also get renewable energy from burning trees and even garbage as fuel and processing other plants into biofuels. One day, all our homes may get their energy from the sun or the wind. Your car's gas tank will use biofuel. Your garbage might contribute to your city's energy supply. Renewable energy technologies will improve the efficiency and cost of energy systems. We may reach the point when we may no longer rely mostly on fossil fuel energy.

Example: Renewable energy sources include:

1. Hydro Power,
2. Solar Power,
3. Wind Power
4. Wave Power
5. Geothermal (energy from the heat inside the earth)
6. Fuel cells
7. Bio-fuels-also known as biomass fuels-such as alcohol form, sugar, methane from organic waste or charcoal from trees and biodiesel.
8. Ocean Thermal Exchange Capacity (OTEC) - based on temperature differences in ocean layers.

The key characteristics of renewable energies is that the energy sources are continually available, still some cases such as with hydro power and biomass, continuing availability requires good management – for example tree planting or river management. Other renewable like solar and wind power are available for the foreseeable future without any human intervention.

7.3.2 Non-Renewable Energy

To produce electricity from non-renewable resources the material must be ignited. The fuel is placed in a well contained area and set on fire. The heat generated turns water to steam, which moves through pipes, to turn the blades of a turbine. This converts magnetism into electricity, which we use in various appliances. These consist of the mineral based hydrocarbon fuels coal,

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oil and natural gas, that were formed from ancient prehistoric forests. These are called 'fossil fuels' because they are formed after plant life is fossilized. At the present rate of extraction there is enough coal for a long time to come. Oil and gas resources however are likely to be used up within the next 50 years. When these fuels are burnt, they produce waste products that are released into the atmosphere as gases such as carbon dioxide, oxides of sulphur, nitrogen, and carbon monoxide, and all causes of air pollution. These have led to lung problems in an enormous number of people all over the world, and have also affected buildings like the Taj Mahal and killed many forests and lakes due to acid rain. Many of these gases also act like a green house letting sunlight in and trapping the heat inside. This is leading to global warming, a raise in global temperature, increased drought in some areas, floods in other regions, the melting of icecaps, and a rise in sea levels, which is slowly submerging coastal belts all over the world. Warming the seas also leads to the death of sensitive organisms such as coral. Non-renewable types of energy include all the fossil fuels – coal, oil, gas and their derivatives such as petrol and diesel. The non-renewable are finite in supply because their rate of formation is so low that they are, in reality, finite sources.

Oil and its Environmental Impacts

India's oil reserves which are being used at present lie off the coast of Mumbai and in Assam. Most of our natural gas is linked to oil and, because there is no distribution system, it is just burnt off. This wastes nearly 40% of available gas. The processes of oil and natural gas drilling, processing, transport and utilisation have serious environmental consequences, such as leaks in which air and water are polluted and accidental fires that may go on burning for days or weeks before the fire can be controlled. During refining oil, solid waste such as salts and grease are produced which also damage the environment. Oil slicks are caused at sea from offshore oil wells, cleaning of oil tankers and due to shipwrecks.

Did u know? The most well-known disaster occurred when the Exxon Valdez sank in 1989 and birds, sea otters, seals, fish and other marine life along the coast of Alaska was seriously affected. Oil powered vehicles emit carbon dioxide, sulphur dioxide, nitrous oxide, carbon monoxide and particulate matter which is a major cause of air pollution especially in cities with heavy traffic density. Leaded petrol, leads to neuro damage and reduces attention spans. Running petrol vehicles with unleaded fuel has been achieved by adding catalytic converters on all the new cars, but unleaded fuel contains benzene and butadene which are known to be carcinogenic compounds.

Delhi, which used to have serious smog problems due to traffic, has been able to reduce this health hazard by changing a large number of its vehicles to CNG, which contains methane. Dependence on dwindling fossil fuel resources, especially oil, results in political tension, instability and war. At present 65 percent of the world's oil reserves are located in the Middle East.

Coal and its Environmental Impacts

Coal is the world's single largest contributor of green house gases and is one of the most important causes of global warming. Many coal-based power generation plants are not fitted with devices such as electrostatic precipitators to reduce emissions of suspended particulate matter (SPM) which is a major contributor to air pollution. Burning coal also produces oxides of sulphur and nitrogen which, combined with water vapour, lead to 'acid rain'. This kills forest vegetation, and damages architectural heritage sites, pollutes water and affects human health. Thermal power stations that use coal produce waste in the form of 'fly ash'. Large dumps are required to dispose off this waste material, while efforts have been made to use it for making

bricks. The transport of large quantities of fly ash and its eventual dumping are costs that have to be included in calculating the cost-benefits of thermal power.

Environmental Impacts of Fossil Fuels in General

Extraction of fuel by mining, drilling, quarrying and/or excavation leads to significant impacts on the surrounding environment and landscape (habitat modification and destruction, pollution etc.)

- Spoil and solid wastes from mining and extraction have both visual and environmental impacts.
- Wastewater and leachates from mining, drilling and excavation, and gas leaks from pipelines can pollute surrounding waters, air and land.
- Purification or modification of raw products for use as fuels requires energy, and may lead to secondary sources of pollution.
- Transportation of fuels to energy production sites uses fuel (causes air pollution) and possibly a pollution risk, e.g. oil tankers are at risk from accidents and may lead to oil spills at sea.
- Combustion of fuels to produce energy leads to air pollution (carbon, nitrogen and sulphur oxides) and in some cases, the production of solid wastes (in the form of ash).

7.3.3 Sustainable or Nuclear Power Energy

Sustainable energy is a term sometimes applied to nuclear power. The supplies are not exactly renewable but they will be lost for a very long time because a great of electricity is produced from a small amount of radioactive material. In 1938 two German scientists Otto Hahn and Fritz Strassman demonstrated nuclear fission. They found they could split the nucleus of a uranium atom by bombarding it with neutrons. As the nucleus split, some mass was converted to energy. The nuclear power industry however was born in the late 1950s. The first large-scale nuclear power plant in the world became operational in 1957 in Pennsylvania, US. Dr. Homi Bhabha was the father of Nuclear Power development in India. The Bhabha Atomic Research Centre in Mumbai studies and develops modern nuclear technology. India has 10 nuclear reactors at 5 nuclear power stations that produce 2% of India's electricity. These are located in Maharashtra (Tarapur), Rajasthan, Tamil Nadu, Uttar Pradesh and Gujarat. India has uranium from mines in Bihar. There are deposits of thorium in Kerala and Tamil Nadu.

The nuclear reactors use Uranium 235 to produce electricity. Energy released from 1 kg of Uranium 235 is equivalent to that produced by burning 3,000 tons of coal. U235 is made into rods which are fitted into a nuclear reactor. The control rods absorb neutrons and thus adjust the fission which releases energy due to the chain reaction in a reactor unit. The heat energy produced in the reaction is used to heat water and produce steam, which drives turbines that produce electricity. The drawback is that the rods need to be changed periodically. This has impacts on the environment due to disposal of nuclear waste. The reaction releases very hot waste water that damages aquatic ecosystems, even though it is cooled by a water system before it is released.

The disposal of nuclear waste is becoming an increasingly serious issue. The cost of Nuclear Power generation must include the high cost of disposal of its waste and the decommissioning of old plants. These have high economic as well as ecological costs that are not taken into account when developing new nuclear installations.

Example: For environmental reasons, Sweden has decided to become a Nuclear Free Country by 2010.

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Although the conventional environmental impacts from nuclear power are negligible, what overshadows all the other types of energy sources is that an accident can be devastating and the effects last for long periods of time. While it does not pollute air or water routinely like oil or biomass, a single accident can kill thousands of people, make many others seriously ill, and destroy an area for decades by its radioactivity which leads to death, cancer and genetic deformities. Land, water, vegetation are destroyed for long periods of time. Management, storage and disposal of radioactive wastes resulting from nuclear power generation are the biggest expenses of the nuclear power industry. There have been nuclear accidents at Chernobyl in USSR and at the Three Mile Island in USA. The radioactivity unleashed by such an accident can affect mankind for generations.

7.3.4 Advantages and Disadvantages of Various Energy Types

In general, the three types of energy have very different characteristics. This means there is no 'ideal' energy source. The future will be most likely to be a mix of sources with increase in emphasis on the renewable.

Table 7.1: Advantages and Disadvantages of various Energy Types

Energy type	Advantages	Disadvantages
Renewable	• Wide availability • Lower running cost • Decentralized power production • Low Pollution • Available for the foreseeable future	• Unreasonable supply • Usually produced in small quantities • Often very difficult to store • Currently per unit cost of energy is more compared to other types.
Non-renewable	• Available in highly concentrated form • Easy to store • Reliable supply • Lower cost per unit of energy produced as the technology is matured	• Highly polluting • Available only in few places • High running cost • Limited supply and will one day get exhausted
Sustainable (Nuclear Power)	• Highly reliable • Produces large amounts of energy with very little CO_2 emissions • Use small amount of raw material per unit energy production.	• Risk of radioactive • High waste disposal costs • High capital investment and maintenance cost

Source: http://www.angrau.ac.in/media/1653/BIRM301.pdf

Self Assessment

State whether the following statements are true or false:

9. Renewable energy systems use resources that are constantly replaced and are usually less polluting.

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10. The key characteristic of renewable energies is that the energy sources are not continually available.
11. To produce electricity from non-renewable resources the material must be ignited.
12. The nuclear reactors use Uranium 236 to produce electricity.

7.4 Alternative Energy Sources

Various Alternative Energy Sources are as follows:

7.4.1 Hydroelectric Power

Water flowing down a natural gradient is used to turn turbines to generate electricity known as 'hydroelectric power' by constructing dams across rivers. Between 1950 and 1970, Hydropower generation worldwide increased seven times. The long life of hydropower plants, the renewable nature of the energy source, very low operating and maintenance costs, and absence of inflationary pressures as in fossil fuels, are some of its advantages.

Advantages

- The long life of hydropower plants,
- The renewable nature of the energy source
- Very low operating and maintenance costs, and
- Absence of inflationary pressures as in fossil fuels

Drawbacks

Although hydroelectric power has led to economic progress around the world, it has created serious ecological problems.

- To produce hydroelectric power, large areas of forest and agricultural lands are submerged. These lands traditionally provided a livelihood for local tribal people and farmers. Conflicts over land use are inevitable.
- Silting of the reservoirs (especially as a result of deforestation) reduces the life of the hydroelectric power installations.
- Water is required for many other purposes besides power generation. These include domestic requirements, growing agricultural crops and for industry. This gives rise to conflicts.
- The use of rivers for navigation and fisheries becomes difficult once the water is dammed for generation of electricity.
- Resettlement of displaced persons is a problem for which there is no ready solution. The opposition to many large hydroelectric schemes is growing as most dam projects have been unable to resettle people that were affected and displaced.
- In certain regions large dams can induce seismic activity which will result in earthquakes. There is a great possibility of this occurring around the Tehri dam in the Himalayan foothills. Shri Sunderlal Bahuguna, the initiator of the Chipko Movement has fought against the Tehri Dam for several years.

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With large dams causing social problems, there has been a trend to develop small hydroelectric generation units. Multiple small dams have less impact on the environment. China has the largest number of these - 60,000, generating 13,250 megawatts, i.e. 30% of China's electricity. Sweden, the US, Italy and France also have developed small dams for electrical power generation. The development of small hydroelectric power units could become a very important resource in India, which has steeply falling rivers and the economic capability and technical resources to exploit them.

Example: The Narmada Bachao Andolan in India is an example of a movement against large dams. The gigantic Narmada River Project has affected the livelihoods of hundreds of extremely poor forest dwellers. The rich landholders downstream from the Sardar Sarovar dam will derive the maximum economic benefit, whereas the poor tribal people have lost their homes and traditional way of life. The dam will also destroy the livelihood of fishermen at the estuary. The disastrous impact that this project has on the lives of the poor, and the way in which they are being exploited, need to be clearly understood.

7.4.2 Solar Power

Sun is the primary source of energy. Sun's energy each day is 600 times greater than produced from all other sources (1/5 of known reserves of fossil fuels). If it was possible to harness this colossal quantum of energy, humanity would need no other source of energy. Several methods were developed for collecting this energy for heating water and generating electricity. Readily available source of energy and is free. The major problem with solar energy is its intermittent nature, during day less in cloudy weather. Hence, supplementary source of energy is essential. It needs people's initiatives and high initial expenses. After dramatic rise in oil prices during 1970s, several countries started research and developmental programmes to exploit the solar energy. Today we have developed several methods of collecting this energy for heating water and generating electricity.

Solar Heating for Homes

Modern housing that uses air conditioning and/or heating are extremely energy dependant. A passive solar home or building is designed to collect the sun's heat through large, south-facing glass windows. In solar heated buildings, sunspaces are built on the south side of the structure which act as large heat absorbers. The floors of sunspaces are usually made of tiles or bricks that absorb heat throughout the day, then release heat at night when it's cold. In energy efficient architecture the sun, water and wind are used to heat a building when the weather is cold and to cool it in summer. This is based on design and building material. Thick walls of stone or mud were used in traditional architecture as an insulator. Small doors and windows kept direct sunlight and heat out. Deeply set glass windows in colonial homes, on which direct sunlight could not reach, permitted the glass from creating a green house effect. Verandahs also served a similar purpose.

Solar Water Heating

Most solar water-heating systems have two main parts: the solar collector and the storage tank. The solar energy collector heats the water, which then flows to a well insulated storage tank. A common type of collector is the flat-plate collector, a rectangular box with a transparent cover that faces the sun, usually mounted on the roof. Small tubes run through the box, carrying the water or other fluid, such as antifreeze, to be heated. The tubes are mounted on a metal absorber plate, which is painted black to absorb the sun's heat. The back and sides of the box are insulated

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to hold in the heat. Heat builds up in the collector, and as the fluid passes through the tubes, it too heats up. Solar water-heating systems cannot heat water when the sun is not shining. Thus homes must also have a conventional backup system. About 80% of homes in Israel have solar hot water heaters.

Solar Cookers

The heat produced by the sun can be directly used for cooking using solar cookers. A solar cooker is a metal box which is black on the inside to absorb and retain heat. The lid has a reflective surface to reflect the heat from the sun into the box. The box contains black vessels in which the food to be cooked is placed. India has the world's largest solar cooker program and an estimated 2 lakh families that use solar cookers. Although solar cookers reduce the need for fuel wood and pollution from smoky wood fires, they have not caught on well in rural areas as they are not suitable to traditional cooking practices. However, they have great potential if marketed well.

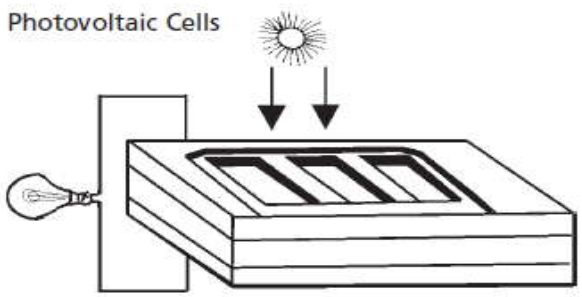
7.4.3 Photovoltaic Energy

The solar technology which has the greatest potential for use throughout the world is that of solar photo voltaic cells which directly produce electricity from sunlight using photovoltaic (PV) (also called solar) cells. Solar cells use the sun's light, not its heat, to make electricity. PV cells require little maintenance; have no moving parts, and essentially no environmental impact. They work cleanly, safely and silently. They can be installed quickly in small modules, anywhere there is sunlight. Solar cells are made up of two separate layers of silicon, each of which contains an electric charge.

Notes Space technology required solar energy and the space race spurred the development of solar cells. Only sunlight can provide power for long periods of time for a space station or long distance spaceship.

When light hits the cells, the charges begin to move between the two layers and electricity is produced. PV cells are wired together to form a module. A module of about 40 cells is enough to power a light bulb. For more power, PV modules are wired together into an array. PV arrays can produce enough power to meet the electrical needs of a home. Over the past few years, extensive work has been done in decreasing PV technology costs, increasing efficiency, and extending cell lifetimes. Many new materials, such as amorphous silicon, are being tested to reduce costs and automate manufacturing.

Figure 7.1: Photovoltaic Cells



Source: http://www.angrau.ac.in/media/1653/BIRM301.pdf

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PV cells are commonly used today in calculators and watches. They also provide power to satellites, electric lights, and small electrical appliances such as radios and for water pumping, highway lighting, weather stations, and other electrical systems located away from power lines. Some electric utility companies are building PV systems into their power supply networks. PV cells are environmentally benign, i.e. they do not release pollutants or toxic material to the air or water, there is no radioactive substance, and no catastrophic accidents.

Did u know? In 1981, a plane called 'The Solar Challenger' flew from Paris to England in 5 hours, 20 minutes. It had 16,000 solar cells glued to the wings and tail of the plane and they produced enough power to drive a small electric motor and propeller. Since 1987, every three years there is a World Solar challenge for solar operated vehicles in Australia where the vehicles cover 3000 kms.

Some PV cells, however, do contain small quantities of toxic substances such as cadmium and these can be released to the environment in the event of a fire. Solar cells are made of silicon which, although the second most abundant element in the earth's crust, has to be mined. Mining creates environmental problems. PV systems also of course only work when the sun is shining, and thus need batteries to store the electricity.

Example: Japanese farmers are substituting PV operated insect killers for toxic pesticides.

7.4.4 Biomass Energy

When a log is burned we are using biomass energy. Because plants and trees depend on sunlight to grow, biomass energy is a form of stored solar energy. Although wood is the largest source of biomass energy, we also use agricultural waste, sugarcane wastes, and other farm by-products to make energy. There are three ways to use biomass. It can be burned to produce heat and electricity, changed to a gas-like fuel such as methane, or changed to a liquid fuel. Liquid fuels, also called bio fuels, include two forms of alcohol: ethanol and methanol. Because biomass can be changed directly into liquid fuel, it could someday supply much of our transportation fuel needs for cars, trucks, buses, airplanes and trains with diesel fuel replaced by 'biodiesel' made from vegetable oils. In the United States, this fuel is now being produced from soybean oil. Researchers are also developing algae that produce oils, which can be converted to biodiesel and new ways have been found to produce ethanol from grasses, trees, bark, sawdust, paper, and farming wastes. Organic municipal solid waste includes paper, food wastes, and other organic non-fossil-fuel derived materials such as textiles, natural rubber, and leather that are found in the waste of urban areas. Currently, in the US, approximately 31% of organic waste is recovered from municipal solid waste via recycling and composting programs, 62% is deposited in landfills, and 7% is incinerated. Waste material can be converted into electricity by combustion boilers or steam turbines.

Notes Like any fuel, biomass creates some pollutants, including carbon dioxide, when burned or converted into energy. In terms of air pollutants, biomass generates less relative to fossil fuels. Biomass is naturally low in sulphur and therefore, when burned, generates low sulphur dioxide emissions. However, if burned in the open air, some biomass feedstocks would emit relatively high levels of nitrous oxides (given the high nitrogen content of plan material), carbon monoxide, and particulates.

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Biogas

Biogas is produced from plant material and animal waste, garbage, waste from households and some types of industrial wastes, such as fish processing, dairies, and sewage treatment plants. It is a mixture of gases which includes methane, carbon dioxide, hydrogen sulphide and water vapour. In this mixture, methane burns easily. With a ton of food waste, one can produce 85 Cu. M of biogas. Once used, the residue is used as an agricultural fertilizer. Denmark produces a large quantity of biogas from waste and produces 15,000 megawatts of electricity from 15 farmers' cooperatives. London has a plant which makes 30 megawatts of electricity a year from 420,000 tons of municipal waste which gives power to 50,000 families. In Germany, 25% of landfills for garbage produce power from biogas. Japan uses about 85% of its waste and France uses about 50%.

Did u know? The National Project on Biogas Development (NPBD), and Community/ Institutional Biogas Plant Program promote various biogas projects. By 1996 there were already 2.18 million families in India that used biogas. However China has 20 million households using biogas.

Biogas plants have become increasingly popular in India in the rural sector. The biogas plants use cowdung, which is converted into a gas which is used as a fuel. It is also used for running dual fuel engines. The reduction in kitchen smoke by using biogas has reduced lung conditions in thousands of homes. The fibrous waste of the sugar industry is the world's largest potential source of biomass energy. Ethanol produced from sugarcane molasses is a good automobile fuel and is now used in a third of the vehicles in Brazil.

Task What you may throw out in your garbage today could be used as fuel for someone else. Municipal solid waste has the potential to be a large energy source. Garbage is an inexpensive energy resource. Unlike most other energy resources, someone will collect garbage, deliver it to the power plant, and even pay to get rid of it. This helps cover the cost of turning garbage into energy. Garbage is also a unique resource because we all contribute to it. Keep a record of all the garbage that you and our family produce in a day. What proportion of it is in the form of biomass? Weigh this. How long would it take you to gather enough waste biomass to make a tankful (0.85 cu.m.) of biogas? (Remember one ton of biomass produces 85 cu.m. of biogas)

7.4.5 Wind Power

Wind was the earliest energy source used for transportation by sailing ships. Wind energy produces electricity at low cost, capital costs are moderate and there are no emissions. Some 2000 years ago, windmills were developed in China, Afghanistan and Persia to draw water for irrigation and grinding grain. Most of the early work on generating electricity from wind was carried out in Denmark, at the end of the last century. Five nations Germany, USA, Denmark, Spain and India 80% of world's wind energy capacity. Today, Denmark and California have large wind turbine cooperatives which sell electricity to the government grid. Wind Farms – cluster of wind turbines (aero generators) to charge large batteries. The power in wind is a function of the wind speed and therefore the average wind speed of an area is an important determinant of economically feasible power. Wind speed increases with height.

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Environmental Impact

Wind power has few environmental impacts, as there are virtually no air or water emissions, or radiation, or solid waste production. The principal problems are bird kills, noise, effect on TV reception etc. Although large areas of land are required for setting up wind farms, the amount used by the turbine bases, the foundations and the access roads is less than 1% of the total area covered by the wind farm. The rest of the area can also be used for agricultural purposes or for grazing. Setting windmills offshore reduces their demand for land and visual impact. Wind is an intermittent source and the intermittency of wind depends on the geographic distribution of wind. Wind therefore cannot be used as the sole resource for electricity, and requires some other backup or stand-by source (as in solar system).

7.4.6 Tidal and Wave Power

The energy of waves in the sea that crash on the land of all the continents is estimated at 2 to 3 million megawatts of energy. From the 1970s, several countries have been experimenting with technology to harness the kinetic energy of the ocean to generate electricity. Water flows from a higher level to lower level, greater the difference between high and low tides more energy can be extracted. Tidal power is tapped by placing a barrage across an estuary and forcing the tidal flow to pass through turbines. In a one-way system the incoming tide is allowed to fill the basin through a sluice, and the water so collected is used to produce electricity during the low tide. In a two way system power is generated from both the incoming as well as the outgoing tide.

Environmental Impact

Tidal power stations bring about major ecological changes in the sensitive ecosystem of coastal regions and can destroy the habitats and nesting places of water birds and interfere with fisheries. A tidal power station at the mouth of a river blocks the flow of polluted water into the sea, thereby creating health and pollution hazards in the estuary. Other drawbacks include offshore energy devices posing navigational hazards. Residual drift current could affect spawning of some fish, whose larvae would be carried away from spawning grounds. They may also affect the migration patterns of surface swimming fish.

7.4.7 Thermal Energy

Ocean collects and store huge quantities of solar radiations in the form of heat. This is another developing concept to harnesses energy due to the differences in temperature between the warm upper layers of the ocean and the cold deep sea water.

Geothermal Energy

It is the energy stored within the earth ("geo" for earth and "thermal" for heat). Geothermal energy starts with hot, molten rock (called magma) deep inside the earth which surfaces at some parts of the earth's crust. The heat rising from the magma warms underground pools of water known as geothermal reservoirs. If there is an opening, hot underground water comes to the surface and forms hot springs, or it may boil to form geysers. With modern technology, wells are drilled deep below the surface of the earth to tap into geothermal reservoirs. This is called direct use of geothermal energy, and it provides a steady stream of hot water that is pumped to the earth's surface. In the 20th century geothermal energy has been harnessed on a large scale for space heating, industrial use and electricity production, especially in Iceland, Japan and New Zealand. Geothermal energy is nearly as cheap as hydropower and will thus be increasingly utilised in future. However, water from geothermal reservoirs often contains minerals that are

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corrosive and polluting. Geothermal fluids are a problem which must be treated before disposal. Geothermal energy starts with hot, molten rock (called magma) deep inside the earth which surfaces at some parts of the earth's crust (volcanoes). With modern technology, wells are drilled deep below the surface of the earth to tap into geothermal reservoirs. This is called direct use of geothermal energy, and it provides a steady stream of hot water that is pumped to the earth's surface. Geothermal energy is nearly as cheap as hydropower and will thus be increasingly utilised in future.

Environmental Impact

Water from geothermal reservoirs often contains minerals that are corrosive and polluting and they may be toxic to fishes. Steam contains H_2S gas which gives rotten egg smell and cause air pollution. Geothermal fluids are a problem which must be treated before disposal.

7.4.8 Energy Conservation

Conventional energy sources have a variety of impacts on nature and human society. India needs to rapidly move into a policy to reduce energy needs and use cleaner energy production technologies. A shift to alternate energy use and renewable energy sources that are used judiciously and equitably would bring about environmentally friendly and sustainable lifestyles. India must reduce its dependency on imported oil. At present we are under-utilizing our natural gas resources. We could develop thousands of mini dams to generate electricity. India wastes great amounts of electricity during transmission. Fuel wood plantations need to be enhanced and management through Joint Forestry Management (JFM) has a great promise for the future.

Energy efficient cooking stoves or 'chulas' help the movement of air through it so that the wood is burnt more efficiently. They also have a chimney to prevent air pollution and thus reduce respiratory problems. While over 2 lakh improved chulas have been introduced throughout the country, the number in active use is unknown as most rural people find it to be unusable for several reasons. TERI in 1995 estimated that in India 95% of rural people and 60% of urban poor still depend on firewood, cattle dung and crop residue for cooking and other domestic purposes. Biomass can be converted into biogas or liquid fuels i.e. ethanol and methanol. Biogas digesters convert animal waste or agricultural residues into gas. This is 60% methane and 40% CO_2 generated by fermentation. The commonly used agri waste is dung of domestic animals and rice husk, coconut shells, straw or weeds. The material left after the gas is used acts as a fertilizer. Small hydro-generation units are environment friendly. They do not displace people, destroy forests or wildlife habitats or kill aquatic and terrestrial biodiversity. They can be placed in several hill streams, on canals or rivers. The generation depends on flowing water due to gravity. However, this fails if the flow is seasonal. It is easy to waste energy but cheaper to save it than generate it. We can conserve energy by preventing or reducing waste of energy and by using resources more efficiently. People waste energy because government subsidises it. If the real cost was levied, people would not be able to afford to waste it carelessly.

Notes Industry and transport are the main growing users of energy in India. Industries that are known for generating pollution also waste the most energy. These include chemical industries, especially petrochemical units, iron and steel, textiles, paper, etc. Unplanned and inefficient public transport systems, especially in cities, waste large amount of energy. Using bicycles is an excellent method to reduce the use of energy. In agriculture, irrigation pumps to lift water are the most energy intensive agricultural use. These are either electrical or run on fossil fuels.

Notes

Self Assessment

Fill in the blanks:

13. Silting of the ..... reduces the life of the hydroelectric power installations.
14. The heat produced by the sun can be directly used for cooking using solar .....
15. When a log is burned we are using ..... energy.
16. ..... was the earliest energy source used for transportation by sailing ships.

Case Study

Energy Resources

Lepelsfontein is a small village in the Northern Cape, some 500 km north of Cape Town in South Africa. It has a population of roughly 450 people. The physical infrastructure comprises gravel roads, manual telephones and a primary school. The water supply system in the Lepelsfontein area comprises a number of sources. The main source is groundwater from a borehole. A three-phase PV submersible centrifugal pump is used to pump water. There is also a diesel pump which is used as a back up to the PV pump in the event of PV pump failure or in times of extended cloud cover. The PV system is situated about 2 km to the south west of Lepelsfontein village. The PV pump operates seven days a week. A diesel pump becomes operational only when PV pump is not working (when it is faulty, being maintained or during extended cloud cover). Water is pumped to 2 storage tanks located in the village. Each storage tank has a capacity of 30 kl.

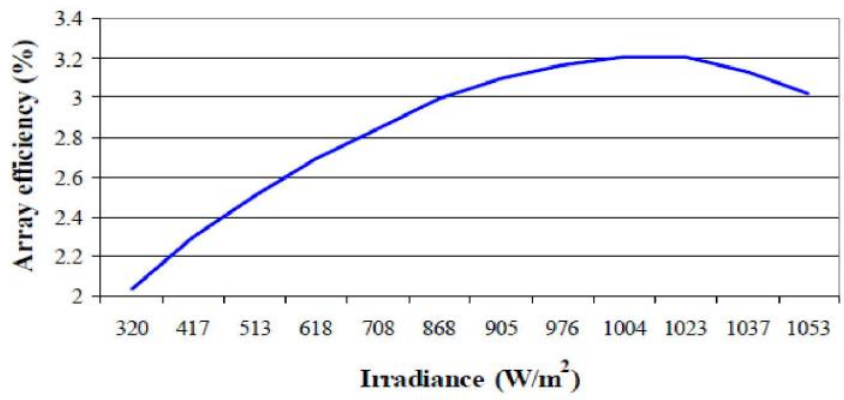
Water from storage tanks is gravitated to a diesel pump located at about 300 m down the hill. Purifying/desalinating chemicals are added before water is pumped to the supply tanks. Water has to be desalinated as it is being claimed that the sea, which is about 10 km to the south east of the settlement, affects the quality of underground water and therefore it is not readily available for consumption. There are four supply tanks of 10 kl each located at about 400 m from the diesel desalinating pump house uphill. Water from the supply tank is gravitated to the village and is accessed through standpipes. The PV water pumping facility at Lepelsfontein comprises three subsystems namely, a set of PV panels, an inverter and a three-phase submersible centrifugal pump.

Efficiency of an array is the amount of solar energy the module can convert into electrical energy. Figure 1 shows the efficiency of the array at different times of the trial period. The array efficiency is dependant on several factors such as; time of day, weather conditions, wind speed, and irradiance as well as the temperature of the array. The maximum array efficiency obtained was 3.9%. The obtained efficiency of 3.0% is quite low and the discrepancy of the results at high solar intensities is in part attributed to the temperature effects of solar cells at elevated cell temperatures. These high temperatures increase the irradiance power thus having a negative impact on array power generation. If the assumed optimum efficiency point of the pump is considered, the expected array efficiency of 22% can be taken, which will affect the overall system efficiency proportionately. At the operating condition of 2.6 m^3/day, the efficiency is as low as 15%.

Contd....

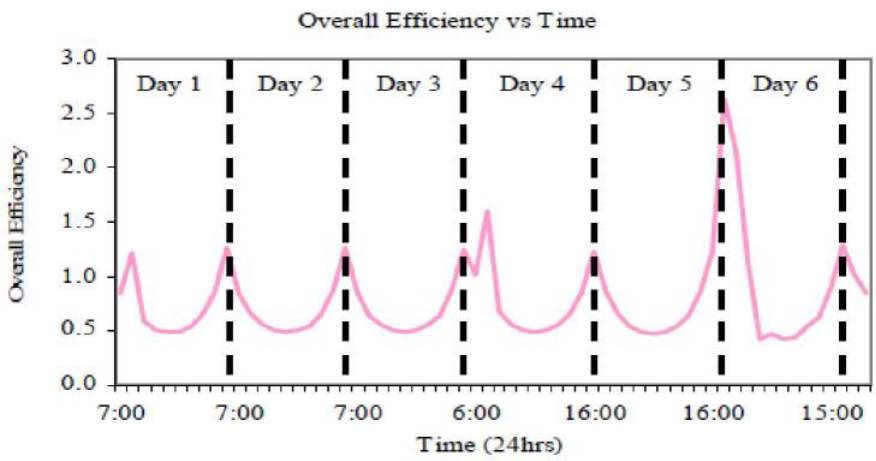
Notes

Figure 1: Array efficiency versus irradiance



The overall efficiency of the system is determined by the power delivered by the pump and power from the sun (irradiance power). Figure 2 shows the efficiencies ranging to a maximum of 3.2%, which is acceptable when one considers an overall system efficiency of 3% and 4% from the Intermediate Technology Development Group Manual and other literature.

Figure 2: Overall Efficiency Versus Time



A summary of the field results (actual and design) is shown in table 1 below.

Table 1: Summary of Field Results

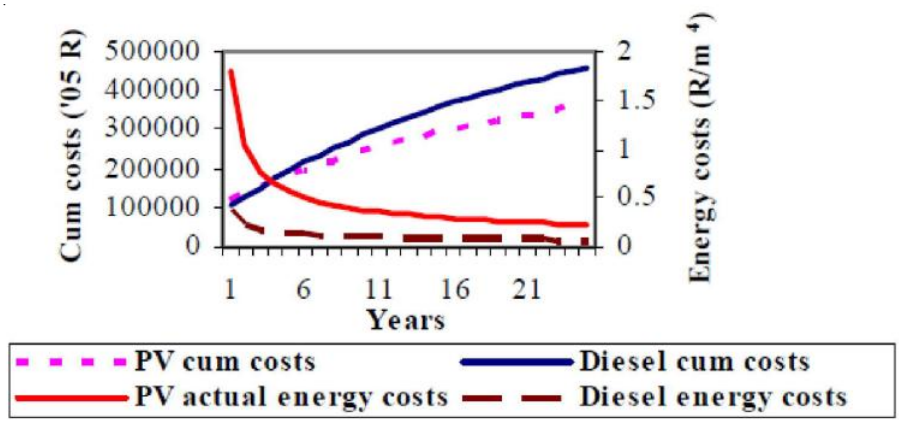
Component	Array	System	Overall
Actual efficiency	4.0%	32.0%	1.3%
Design efficiency	20.0%	30-40%	6-8%

In order to establish whether this PV pumping system is economically viable when it is compared with other pumping technologies, the results from this system were used to perform a life cycle costing and a comparison was made with a comparably-sized diesel

Notes

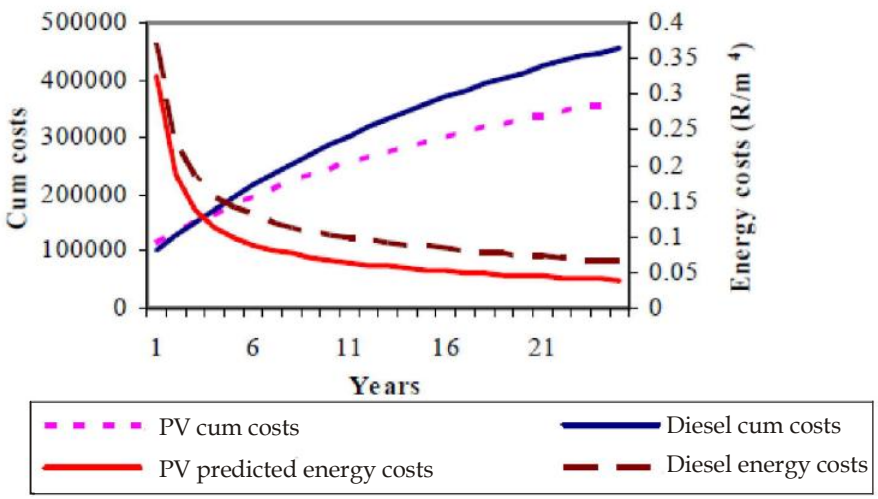
system. A 15, 20, 25 year life-cycle costing of the field PV and diesel systems was performed. Included in the analysis, is also a prediction of unit (R/m^3) and pumping costs (R/m^4) if design conditions were achieved, i.e. flow of 20m^3/day. Figure 3 below shows the comparison of PV actual and diesel systems cumulative and energy costs.

Figure 3: PV Actual and Diesel Systems Cumulative and Energy Costs



The life cycle cost analysis of the PV pumping system indicates that the average pumping costs over 25 years are likely to be below 22 cents/m^4, while pumping costs of diesel are likely to be below 7 cents/m^4 when the pump operates at 3.6m^3/day.

Figure 4: PV Predicted and Diesel Systems Cumulative and Energy Costs



However, if the pump operated at its optimum design conditions (20m^3/day), then the pumping costs of PV would reduce to 4 cents/m^4, 43% less than that of diesel (figure 4). From the two water-pumping technologies, the unit water cost for Lepelsfontein is about five times the unit cost of Rooifontein. These could be caused by a number of factors, including a high capital cost for Lepelsfontein, very low pump output as well as high operating costs (salary of a pump caretaker). The pumping costs for Lepelsfontein are about three times higher than those of Rooifontein. In contrast, the unit water cost is 90%

Contd....

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that of diesel and the pumping cost is about 60% that of diesel when the design conditions for PV are assumed.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.dlist.org/sites/default/files/doclib/Module_4_Energy_Resources_Case_Study.pdf

7.5 Summary

- Energy is defined by physicists as the capacity to do work.
- The sun is the primary energy source in our lives.
- No energy related technology is completely 'risk free' and unlimited demands on energy increase this risk factor many fold.
- Energy is consumed in a variety of forms in India.
- The Government of India has formulated an energy policy with the objective 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.
- Energy has always been closely linked to man's economic growth and development.
- India's energy demand is on the rise, driven by high population growth, the modernisation of lifestyles, higher electrification rates and a rapidly growing economy.
- India's poverty reduction efforts and future economic development are inextricably linked to the expansion of modern energy availability to the poor and the elimination of chronic energy shortages.
- Renewable energy systems use resources that are constantly replaced and are usually less polluting.
- Coal is the world's single largest contributor of green house gases and is one of the most important causes of global warming.
- Extraction of fuel by mining, drilling, quarrying and/ or excavation leads to significant impacts on the surrounding environment and landscape.
- Sustainable energy is a term sometimes applied to nuclear power.

7.6 Keywords

Biogas: It is a mixture of gases which includes methane, carbon dioxide, hydrogen sulphide and water vapour.

Energy: Energy is defined by physicists as the capacity to do work.

Fossil Fuels: Fossil fuels are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms.

Geothermal Energy: It is the energy stored within the earth.

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Hydroelectric Power: It is the process of changing the kinetic energy of flowing water in a river into electrical power that we can use.

Non-Renewable Energy: Non-renewable energy is energy from fossil fuels (coal, crude oil, natural gas) and uranium.

Nuclear Energy: Nuclear energy originates from the splitting of uranium atoms in a process called fission.

Photovoltaic Energy: Photovoltaic energy is produced when sunlight is converted into energy with solar cells or semiconductors.

Renewable Energy: Renewable energy is energy comes from that which resources are continually replenished such as sunlight, wind, rain, tides, waves and geothermal heat.

Solar cookers: A solar cooker, or solar oven, is a device which uses the energy of direct sunlight to heat, cook or pasteurize food or drink.

Solar Power: Solar power is the conversion of sunlight into electricity, Either Directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP).

Wind Power: Wind power or wind energy describes the process by which the wind is used to generate mechanical power or electricity.

7.7 Review Questions

1. Define Energy.
2. Discuss the importance of energy on our planet.
3. Write brief note on Energy Policy of India.
4. "Energy has always been closely linked to man's economic growth and development." Explain.
5. Differentiate between Renewable and Non-Renewable sources of energy.
6. Throw some light on the environmental impacts of fossil fuels.
7. Write short note on Nuclear Power Energy.
8. Describe the advantages and drawbacks of Hydroelectric Power.
9. What do you understand by Photovoltaic Energy?
10. Define Biogas.
11. Highlight the environmental impact of wind power.
12. "Conventional energy sources have a variety of impacts on nature and human society." Elucidate.

Answers: Self Assessment

1.	False	2.	True
3.	True	4.	False
5.	Energy	6.	Four
7.	Electricity	8.	Coal

Notes

9.	True	10.	False
11.	True	12.	False
13.	Reservoirs	14.	Cookers
15.	Biomass	16.	Wind

7.8 Further Readings

Books

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Unit 8: Land Resources

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Objectives

After studying this unit, you should be able to:

- Discuss the Land Resources in India
- Explain Land as a Resource
- Describe the Land Degradation
- Explain the Soil Erosion in India
- Understand the Desertification in India
- Discuss the Role of an Individual in Conservation of Natural Resources and Equitable Use of Resources for Sustainable Lifestyles

Introduction

In the previous unit, we dealt with the meaning, importance and overexploitation of Forest Resources along with the meaning of Deforestation. Land Resources in India envelop approximately 1.3 million sq miles and is a cape protruding into the Indian Ocean in between

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the Bay of Bengal on the east and Arabian Sea on the west. In spite of sufficient accessibility of landed topography, population pressure in the country is excessive and that makes space for both food production and the real estate market. However, land resources in India are both essential and at shortage in present days. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the land as a resource, concepts regarding Land Degradation, Soil Erosion and Desertification along with the Role of an Individual in Conservation of Natural Resources and Equitable Use of Resources for Sustainable Lifestyles.

8.1 Land Resources in India

Understanding land resources, its potential, utilization and management of any area reflect the levels of development and standard of living of the locality. Improper use of land due to anthropogenic pressure has created many problems like shrinkage of arable land due to encroachment, decline in fertility due to over use of inorganic fertilizers without soil test information and land degradation. In land resource management approach, spatial distribution of land use, intervention of local and scientific decision support system and control and conservation measures are of primary importance.

Land may be defined as a physical environment consisting of relief, soil, hydrology, climate and vegetation in so far as they are determined by the land use. Value of land depends on its size, location, distance from the market and nature of potential use besides productivity. The sum total of characteristics that distinguish a certain kind of area in the earth's surface in contrast to other kind of areas to give it a distinguishing pattern is a landscape.

Land resources in India are considered as non-renewable energy reserve. Further, they are associated with a host of several other elements such as agrarian base of rural as well as urban economy, accessibility of water, and other factors. Speedy urban expansion and the rising land usages have changed because of the increasing population growth and economic development in some selected landscapes is being observed in India of late. The monitoring of land use changes is essential to understand land use over different sequential or spatial time scales for successful land management. Today, with increasing urbanization as well as industrialisation, an increased pressure has been witnessed on land, water and other environment resources, mainly in big metropolitan cities.

In order to utilize available land resources in India effectively, the country is reorganising efforts in the areas of land resource management. Thus, there has been a growth in land resource companies as well as in other service providers across the country. India occupies a land area of around 3,287,263 sq km. There are different types of land in India, of which 54.7 percent of it is civilised land. The several types of land resources in India include agricultural land, farmland, barren land, real estate land, commercial land and residential land. Majority of the population of Indian are engaged in agricultural and allied activities and thus agricultural land accounts for near about 54.7 percent of the total land area of the country.

Did u know? Much of India's area of almost 1.3 million square miles is a peninsula jutting into the Indian Ocean between the Arabian Sea on the west and the Bay of Bengal on the east.

In a country like ours, despite ample availability of landed terrain, the pressure of the population on land is too much to make room for both food production as well as the realty market. India housing offers information on Land Resource. Land as a non- renewable energy reserve is in itself related to a host of other elements as availability of water, agrarian structure of the rural

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and urban economy, etc. Rapid urban development and increasing land use changes due to increasing population and economic growth in selected landscapes is being witnessed of late in India and other developing countries. The monitoring of land use changes is crucial to understand land use over different temporal - spatial time scales for effective land management.

Today, with rapid urbanization and industrialization, there is increasing pressure on land, water and environment, particularly in the big metropolitan cities. Land Resource is further connected to urban sprawl. Hence, the etymology embraces a host of implications, for which you need to browse India housing. In order to utilize available land resources in India effectively, the country is streamlining efforts in the areas of land resource management. As result, we see a rise in the number of land resource companies, groups and other service providers across the nation.

8.1.1 Seven Essential Methods for Conserving Land Resources

According to Natural Resources Management Division, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, we can conserve our land resources by adopting the following measures:

1. By educating, informing and sensitizing all landholders about various aspects of this precious resources and their sustainable use.
2. Contour ploughing is another measure to conserve our land. By this method, the fields are ploughed, harrowed and sown along the natural contour of the hills.
3. By terracing method: A series of wide steps are made along the slop following the contours. This method is very common in rice growing regions.
4. Under the afforestation and reforestation programmes, planting of trees, bushes and grass help to check the soil erosion,
5. Strict actions are taken to check reckless felling of trees and overgrazing.
6. Shelter belts (rows of trees) are planted on the margins of desert areas to check the fury of wind.
7. Construction of dams and gully-trap inculcate the water-harvesting.

Caselet

The Sahel Desert

In the Sahel Desert, desertification is becoming a huge problem. Around the 1950s, people settled into the Sahel region, in areas where there was water. This resulted in overgrazing, which is one of the greatest causes of desertification. Eventually, the perennial shrubs were destroyed because of grazing, and they were replaced by annuals. Then, the annuals were grazed out which left bare soil. A lot of the topsoil was washed away, and all that was left were rocks. Silt turned hard when it was hit by rain. Therefore, plants were not able to grow because there roots could not penetrate this hard layer. Now this region has turned to desert and it continues to expand. (Desertification, The Sahel, 2004) Records show that rainfall in Sahel has decreased and sands have shifted about sixty miles south into the area. Sahel is expanding due to lack of vegetation in the area. (Sahel, 2005) Another reason desertification is occurring in the Sahel region is because people are using the slashing and burning method to clear land. This degrades the quality of soil just like overgrazing. (Desertification–a Threat to the Sahel, 2000)

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Short Term Effects of Desertification in the Sahel:

1. Soil loses its nutrients which makes it not useful
2. Overgrazing destroys vegetation and without it erosion occurs
3. Land becomes salty which makes it difficult to grow crops

Long Term Effects of Desertification in the Sahel:

1. People die of starvation
2. Cattle die of starvation
3. The soil becomes completely useless

Source: http://desertificationb.tripod.com/id3.html

Self Assessment

State whether the following statements are true or false:

1. Value of land depends on its size, location, distance from the market and nature of potential use besides productivity.
2. Land resources in India are considered as a renewable energy reserve.
3. Contour ploughing is another measure to conserve our land.

8.2 Land as a Resource

Land forms such as hills, valleys, plains, river basins and wetlands include different resource generating areas that the people living in them depend on. Many traditional farming societies had ways of preserving areas from which they used resources. The roots of trees and grasses bind the soil. If forests are depleted, or grasslands overgrazed, the land becomes unproductive and wasteland is formed. Intensive irrigation leads to water logging and salination, on which crops cannot grow. Land is also converted into a non-renewable resource when highly toxic industrial and nuclear wastes are dumped on it. Land on earth is as finite as any of our other natural resources. While mankind has learnt to adapt his lifestyle to various ecosystems world over, he cannot live comfortably for instance on polar ice caps, on under the sea, or in space in the foreseeable future. Man needs land for building homes, cultivating food, maintaining pastures for domestic animals, developing industries to provide goods, and supporting the industry by creating towns and cities. Equally importantly, man needs to protect wilderness area in forests, grasslands, wetlands, mountains, coasts, etc. to protect our vitally valuable biodiversity. Thus a rational use of land needs careful planning. One can develop most of these different types of land uses almost anywhere, but Protected Areas (National Park's and Wildlife Sanctuaries) can only be situated where some of the natural ecosystems are still undisturbed. These Protected Areas are important aspects of good land use planning.

Example: In the 'sacred groves' of the Western Ghats, requests to the spirit of the Grove for permission to cut a tree, or extract a resource, were accompanied by simple rituals. The outcome of a chance fall on one side or the other of a stone balanced on a rock gave or withheld permission. The request could not be repeated for a specified period. If land is utilized carefully it can be considered a renewable resource.

Soil is a dynamic natural body developed as a result of pedogenic processes during and after weathering of rocks, consisting of minerals and organic constituents, possessing definite chemical,

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physical, mineralogical and biological properties having a variable depth over the surface of earth and providing a medium for plant growth. Soils are formed by interaction of many factors, viz., climate, relief, organisms, parent materials and time etc. Soils are derived from their parent materials which are invariably derived from different rocks. There are three main kinds of rocks, viz. igneous rock, Sedimentary rock and metamorphic rock. Rocks are chemically composed of oxides of Si, Al, Fe, Ca, Mg, Mn, K, P, etc. Chemical and physical disintegration and decomposition of rocks under different temperature, pressure and moisture condition results in the formation of parent material (C horizon or regolith) over which soil formation takes place. Afterwards both weathering and soil formation processes proceed simultaneously leading further development of soil. The physical properties of soil are important since this determine the manner in which it can be used either for agriculture, forestry etc., and non agriculture purposes like habitat, recreation site etc. Properties viz. infiltration rate, water holding capacity, aeration, plasticity and nutrient supplying ability are influenced by the size, proportion, arrangement and mineral composition of the soil particles. Four major components of soil viz. inorganic or mineral particles, organic matter, water and air vary with different regions. Based on soil water plant relation, the soil water may be classified as gravitational water, capillary water, hygroscopic water etc. Water mostly available to plant growth held as capillary water within - 15 bars. Soil chemical properties are mainly due to most reactive part of the soil namely soil colloids consisting of organic and inorganic phases. The organic phase consists of either fresh or decomposed residues of plants, animals, and microbes (fungi, bacteria, actinomycetes, etc.) which may remain associated with inorganic phase or may be present in free form.

The life of mankind and almost all the flora and fauna on the earth is continuously influenced by an unending flux of water known as hydrologic cycle. In hydrologic cycle, soil act as a reservoir and water is always in transitory storage in soils. There are two interlocking cycles both starting with evaporation, from sea to atmosphere. The first shorter cycle is from rainfall into the soil and then as evaporation and transpiration back to atmosphere. This is sometimes called green water. The second cycle is blue water follows the longer part from rainfall through soil moisture, ground water and rivers to sea. It may be noted that hydrologic cycle is not always punctual and uniform in delivering precipitation to earth surface. India is a vast country with a total area of 328.72 million hectare of which approximately 30 per cent is occupied by mountains and hills, 25 per cent by plateau and 45 per cent is occupies by plain valley. Out of the total geographical area forest covers an area of 69.02 m ha, area not available for cultivation 28.48 m ha, other uncultivated land including fallow land 53.38 m ha, cultivable wasteland 13.83 m ha, permanent pasture and grazing land 11.04 m ha, fallow land including current fallow 24.90 m ha, area not available for agriculture, forest etc. 50.19 m ha and net area under cultivation is 189.74 m ha. Out of the total geographical area, around 45 per cent of total geographical area is subjected to degradation problems.

Notes The area suffering due to water erosion, wind erosion, water logging, salinity/ alkalinity, acidity and other complex problems are 93.6, 9.4, 14.3, 5.9, 16.0 and 7.4 million hectare, respectively.

India has a diverse geology. Different regions of India contain rocks of various types belonging to different geologic periods. Some of the rocks are severely distorted and transmuted while others are lately deposited alluvium. Great variety of mineral deposits in huge quantity is found in the Indian Geological survey. India's geographical land area can be categorized into Deccan Trap, Gondwana and Vindhyan. The Deccan Trap covering almost the entire state of Maharashtra, a part of Gujarat, Karnataka, Madhya and Andhra Pradesh. Indian soils are normally divided into four broad groups. These comprise of alluvial soil, black soil, red soil and laterite soil. Alluvial soils are derived from the deposition led by different tributaries of Indus, Ganges

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and the Brahmaputra system. It includes soils in deltic alluvium, calcarious alluvium and coastal alluvium. It covers 40 per cent of land area. Black soils are dark in colour gently calcarious low in organic matter, high in clay content, high in cation exchange capacity. They are sticky and plastic. It covers about 22.2 per cent of total land area. Red soil of India covers almost all the states. The colour of red soil is due to wide diffusion of iron. These soils are poor in nitrogen, phosphorus and humus. Kaolinitic type of mineral is prevalent in red soil. Laterite soils are highly weathered materials rich in secondary oxides of iron, aluminium or both. It contains large amount of quartz and kaolinite.

The land system of our country is affected by influences of man interventions well as various natural processes. The removal of top soil, deforestation and banned agricultural practices would, many a time, force us to live in environmentally adverse conditions. The environmental degradation of land makes our country stressful situations, which has become concern for us to think over and act for sustainable development. Our future generation is in stake as a result of interference with natural processes causing many situations unfit for our well being and also for the well being of future generation. Therefore, the database on the past and present land use practices will lead us to predict the future pattern of change which will enrich us towards sustainable development.

Self Assessment

Fill in the blanks:

4. ..... is a dynamic natural body developed as a result of pedogenic processes during and after weathering of rocks.
5. India has a diverse .....
6. The ..... system of our country is affected by influences of man interventions well as various natural processes.

8.3 Land Degradation

Land degradation refers to a decline in the overall quality of soil, water or vegetation condition commonly caused by human activities. The Vegetation Management Act 1999 states that the phrase includes soil erosion, rising water tables, the expression of salinity, mass movement by gravity of soil or rock, stream bank instability and a process that results in declining water quality. At India housing, you can access information pertaining to Land Degradation. Degradation is also considered to include a change in the ground cover to less palatable species, or a change from predominantly perennial grasses to predominantly annual grasses. Environmental dilapidation is brought about by pollution especially in urban areas, which not only experience a rapid growth of population due to high fertility rates, low mortality and increasing rural-urban migration, but also due to the rapid industrialization.

Major ecological and socio-economic crisis are perpetrated by land/soil degradation. Direct impacts of agricultural development on the environment arise from farming activities, which contribute to soil erosion, salinity/brackishness of land and loss of nutrients. The Green Revolution has been accompanied by over exploitation of land and water resources and use of fertilizers and pesticides have increased manifold. In the race to urbanize virgin territory, there has been random violation of the land laws. The current trend of economic and industrial development coupled with the steady growth of human as well as livestock population has been the major reasons behind the incidence of land gradation in India. These factors exert pressure on limited land resources of the country for agricultural, industrial and housing needs of the growing population. It is the lands under cultivation which face the biggest challenge of land degradation in India. Go through India housing to know all about Land Degradation.

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At present, there are about 130 million hectares of degraded land in India. Approximately, 28 per cent of it belongs to the category of forest degraded area, 56 per cent of it is water eroded area and the rest is affected by saline and alkaline deposits. Some human activities such as deforestation, over grazing, mining and quarrying too have contributed significantly in land degradation. Mining sites are abandoned after excavation work is complete leaving deep scars and traces of overburdening. In states like Jharkhand, Chhattisgarh, Madhya Pradesh and Orissa deforestation due to mining have caused severe land degradation. In states like Gujarat, Rajasthan, Madhya Pradesh and Maharashtra overgrazing is one of the main reasons for land degradation. In the states of Punjab, Haryana, western Uttar Pradesh, over irrigation is responsible for land degradation due to water logging leading to increase in salinity and alkalinity in the soil. The mineral processing like grinding of limestone for cement industry and calcite and soapstone for ceramic industry generate huge quantity of dust in the atmosphere. It retards the process of infiltration of water into the soil after it settles down on the land. In recent years, industrial effluents as waste have become a major source of land and water pollution in many parts of the country.

Land degradation will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life. Productivity impacts of land degradation are due to a decline in land quality on site where degradation occurs (e.g. erosion) and off site where sediments are deposited. However, the on-site impacts of land degradation on productivity are easily masked due to use of additional inputs and adoption of improved technology and have led some to question the negative effects of desertification. The relative magnitude of economic losses due to productivity decline versus environmental deterioration also has created a debate. Some economists argue that the on-site impact of soil erosion and other degradative processes are not severe enough to warrant implementing any action plan at a national or an international level. Land managers (farmers), they argue, should take care of the restorative inputs needed to enhance productivity. Agronomists and soil scientists, on the other hand, argue that land is a non-renewable resource at a human time-scale and some adverse effects of degradative processes on land quality are irreversible, e.g. reduction in effective rooting depth. The masking effect of improved technology provides a false sense of security.

Notes The productivity of some lands has declined by 50% due to soil erosion and desertification. Yield reduction in Africa due to past soil erosion may range from 2 to 40%, with a mean loss of 8.2% for the continent.

Only about 3% of the global land surface can be considered as prime or Class I land and this is not found in the tropics. Another 8% of land is in Classes II and III. This 11% of land must feed the six billion people today and the 7.6 billion expected in 2020. Desertification is experienced on 33% of the global land surface and affects more than one billion people, half of whom live in Africa.

Land degradation, a decline in land quality caused by human activities, has been a major global issue during the 20th century and will remain high on the international agenda in the 21st century. The importance of land degradation among global issues is enhanced because of its impact on world food security and quality of the environment. High population density is not necessarily related to land degradation; it is what a population does to the land that determines the extent of degradation. People can be a major asset in reversing a trend towards degradation. However, they need to be healthy and politically and economically motivated to care for the

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land, as subsistence agriculture, poverty, and illiteracy can be important causes of land and environmental degradation.

Example: In South Asia, annual loss in productivity is estimated at 36 million tons of cereal equivalent valued at US$5,400 million by water erosion, and US$1,800 million due to wind erosion. It is estimated that the total annual cost of erosion from agriculture in the USA is about US$44 billion per year, i.e. about US$247 per ha of cropland and pasture. On a global scale the annual loss of 75 billion tons of soil costs the world about US$400 billion per year, or approximately US$70 per person per year.

Land degradation can be considered in terms of the loss of actual or potential productivity or utility as a result of natural or anthropic factors; it is the decline in land quality or reduction in its productivity. In the context of productivity, land degradation results from a mismatch between land quality and land use. Mechanisms that initiate land degradation include physical, chemical, and biological. Important among physical processes are a decline in soil structure leading to crusting, compaction, erosion, desertification, anaerobism, environmental pollution, and unsustainable use of natural resources. Significant chemical processes include acidification, leaching, salinization, decrease in cation retention capacity, and fertility depletion. Biological processes include reduction in total and biomass carbon, and decline in land biodiversity. The latter comprises important concerns related to eutrophication of surface water, contamination of groundwater, and emissions of trace gases (CO_2, CH_4, N_2O, NOx) from terrestrial/aquatic ecosystems to the atmosphere. Soil structure is the important property that affects all three degradative processes. Thus, land degradation is a biophysical process driven by socioeconomic and political causes.

Did u know? Different processes of land degradation also confound the available statistics on soil and/or land degradation. Principal processes of land degradation include erosion by water and wind, chemical degradation (comprising acidification, salinization, leaching etc.) and physical degradation (comprising crusting, compaction, hard-setting etc.). Some lands or landscape units are affected by more than one process, of water and wind erosion, salinization, and crusting or compaction. Unless a clear distinction is made, there is a considerable chance of overlap and double accounting.

Factors of land degradation are the biophysical processes and attributes that determine the kind of degradative processes, e.g. erosion, salinization, etc. These include land quality (Eswaran *et al.*, 2000) as affected by its intrinsic properties of climate, terrain and landscape position, climax vegetation, and biodiversity, especially soil biodiversity. Causes of land degradation are the agents that determine the rate of degradation. These are biophysical (land use and land management, including deforestation and tillage methods), socioeconomic (e.g. land tenure, marketing, institutional support, income and human health), and political (e.g. incentives, political stability) forces that influence the effectiveness of processes and factors of land degradation.

Depending on their inherent characteristics and the climate, lands vary from highly resistant, or stable, to those that are vulnerable and extremely sensitive to degradation. Fragility, extreme sensitivity to degradation processes, may refer to the whole land, a degradation process (e.g. erosion) or a property (e.g. soil structure). Stable or resistant lands do not necessarily resist change. They are in a stable steady state condition with the new environment. Under stress, fragile lands degrade to a new steady state and the altered state is unfavourable to plant growth and less capable of performing environmental regulatory functions.

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Caution Farmland is under threat due to more and more intense utilisation. Every year, between 5 to 7 million hectares of land worldwide is added to the existing degraded farmland. When soil is used more intensively by farming, it is eroded more rapidly by wind and rain.

Over irrigating farmland leads to salinisation, as evaporation of water brings the salts to the surface of the soil on which crops cannot grow. Over irrigation also creates water logging of the topsoil so that crop roots are affected and the crop deteriorates. The use of more and more chemical fertilizers poisons the soil so that eventually the land becomes unproductive. As urban centres grow and industrial expansion occurs, the agricultural land and forests shrink. This is a serious loss and has long term ill effects on human civilisation.

Self Assessment

State whether the following statements are true or false:

7. Environmental dilapidation is brought about by pollution especially in urban areas.
8. Major ecological and socio-economic crisis are not perpetrated by land/soil degradation.
9. At present, there are about 150 million hectares of degraded land in India.

8.4 Soil Erosion in India

Soil is the thin surface layer on the earth comprising mineral particles formed by the break-down of rocks, decayed organic materials, living organisms, water and air. Soil is formed under specific natural conditions and each of the elements of the natural environment contributes to the soil formation. Soil is also very important natural resources of India because agricultural production is basically dependent on the fertility of the soil. Indian soils as well as soil all over the world suffer from a number of problems and among them soil erosion, soil deficiency, desertification are major problems. However soil erosion is the removal of soil by the process of nature particularly wind and water and also by human factors. Two natural agents i.e. water and winds are constantly at work indulging in soil erosion.

Practically nothing has been done so far to assess the seriousness of this calamity in India, where her vast expanse of lands, cultivated since the prehistoric times and with conspicuous topographic variations under a variety of climatic regimes, are characterised by tremendous loss of soil. In the steep slopes of the Himalayan Siwaliks, Western Ghats, Nilgiris, as also in Assail hills, wanton destruction of forest cover and reckless grazing for unlimited time have invite serious erosion, giving rise to networks of yawning ravines and gaping gullies which are continual; cutting back through the fertile agricultural lands. Even the moderately sloping cultivated fields the Deccan tableland, Eastern Ghats, Aravali and the Chota Nagpur Plateau, experience tremendous losses in soil, rightly attributed to ever-grazing and uncontrolled deforestation in the higher slopes and catchment basins. Sheet washing in an extensive scale is going on unnoticed ii the whole of upper Gangetic plains.

Soil losses in colossal scale in Central Indian highlands and in humid sub-Himalayan hills of eastern India, are reflected in the stupendous silting of the river beds and low lands in the lower reaches of the Ganges and Brahmaputra, where mounting of flood heights with occasional floods, frequent change of river courses, total impedance of drainage systems giving rise to swamps, marshes and malaria, are some of the perennial menaces to inhabitants. No province other than West Bengal suffers more seriously from the aftermath of soil erosion. In West

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Bengal, due to uncontrolled grazing, and unchecked burning and cutting down of forest cover in the Himalayas, especially in Sikkim and Bhutan Hills, soil erosion and soil creeps are rampant near the lower foothills. In North West Bengal, the silting of all the riverbeds, the diversion of river courses with rising flood heights and frequent submergence of low-lying riverine tracts with damage to crops, all may be rightly attributed to the same erosion of soils in the upper hills.

Did u know? ***Selenium – Punjab:*** In 1981-82, farmers from Hoshirapur and Nawanshehar Districts approached scientists of the Punjab Agricultural University (PAU), Ludhiana, as wheat crops had turned white. Soil analysis indicated selenium (Se) levels in the area were above toxic limits. Se is a naturally occurring trace element, essential for animal and human health, but the gap between requirement and excess is narrow. Soils containing 0.5 microgrammes (ug) of Se per kg or more are injurious to health. In some areas of Punjab, Se levels range from 0.31 ug/kg to 4.55ug/kg. Rice cultivation requires the presence of standing water. Being highly soluble, Se dissolves and comes to the surface. The water then evaporates leaving the Se behind.

The western fringes of West Bengal, just adjoining the Chota Nagpur Plateau suffer from serious gully erosion. The silting up of the rivers of Western Bengal with frequent violent floods, submerging vast extent of croplands are too well-known facts, especially in the case of the notorious Damodar River.

While East Bengal does not suffer from the danger of silting up of rivers and impedance of drainage, Central Bengal excepting the active deltaic land around the mouth of Padma and Meghan, represent a land of dying rivers, characterised by clogged river beds, marshy lands, dense jungles and malaria.

In short, almost the whole of West Bengal suffers from the ravages of soil erosion in one form or another, consequent upon the indiscreet tampering with the natural cover in the hills and basins beyond the area. In the Shiwalik Hills of Western Himalayas, high aridity coupled with denudation of the natural cover of forests and pastures, has induced continual invasion of vast expanse of fertile fields at the foot hills by a thick cover of erosional debris or 'chos', which is always tending to transform the landscape into a desolate and dreary waste.

In fact, evidences of overgrazing, gully and ravine erosion can be noticed on the banks of almost every river and stream of India. In the West-Central India around the Sind-Rajputana deserts, progressive desiccation, together with the denudation of vegetative cover has induced terrific wind erosion, constantly threatening the smiling agricultural fields of the west. The infertile 'blur' lands of U.P. are examples of blown sands. In each case, in addition to the loss of the fertile top soil, there is a marked fall in the water table, decrease in the sub soil supply of river water in cold sessions, thus putting the irrigation facilities and hydroelectric developments in a precarious position.

Caution A detailed erosion survey over the length and breadth of India, conducted with the help of trained geographers, conversant with the climatography and physiographic of the land, will surely reveal facts and figures much more staggering than could be expected now.

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8.4.1 Types of Soil Erosion

Two prominent soil erosions are: (i) water erosion and (ii) wind erosion.

(i) ***Water Erosion:*** During the heavy rain water removes a lot of soil. The soils which readily detached by rain drop splash are sands and silts but coarser particles are not shifted because of their greater volume and weight. Run off water is more responsible for soil erosion. There are various types of soil erosion caused by water such as riling, gulling, sheet wash, rain peeling etc. It erosion unchecked for a sufficient time, numerous finger shaped grooves may develop all over the area.

The whole pattern resembles that of the twigs branches and trouble of trees, called rill erosion with further erosion it turned into gullies. The further cutting of soil by rain water flow ultimately turns the whole land area into band land topography and ravines. In coastal areas, tidal waves dash along the coast and cause heavy damage to soil. In the higher reaches of Himalayan soil erosion is on a large scale caused by rainwater and glaciers.

(ii) ***Wind Erosion:*** This takes place in arid and semi arid lands with little rainfall, the wind acts as a powerful agent of soil erosion causing heavy loss to agricultural land. Winds blowing at considerable speed, remove the fertile, arable top soil. Wind erosion is further accentuated when the soil is dry, devoid of vegetation cover along with over grazing.

Apart from these natural factors human factors are also responsible for soil erosion such as deforestation; overgrazing, faulty method of agriculture with increasing population, the pressure on forest resource is increasing. This has resulted in reckless cutting of forests which has led to the problem of soil erosion as roots of trees and plants bind the soil particles and regulate the flow of water.

The deforestation also results in floods. The large scale damage to soil in Shiwalik range, the Chos of Punjab parts of Haryana, M.P, UP, Rajasthan is largely due to deforestation. Overgrazing along the mountain slope in hilly areas is causing soil erosion such as Himachal Pradesh, Jammu and Kashmir, etc.

Much of soil erosion in India is also caused by faulty method of agriculture. The most outstanding faulty methods include wrong plaguing, lack of crop rotation and practice of shifting cultivation. Another example of faulty method of agriculture is the shifting cultivation practiced in some areas of North-eastern states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, M.P. etc.

Self Assessment

Fill in the blanks:

10. The ..... fringes of West Bengal, just adjoining the Chota Nagpur Plateau suffer from serious gully erosion.
11. ..... takes place in arid and semi arid lands with little rainfall, the wind acts as a powerful agent of soil erosion causing heavy loss to agricultural land.
12. Apart from these natural factors, ... factors are also responsible for soil erosion.

8.5 Desertification in India

Desertification was defined at the Rio Earth Summit in 1992 as degradation of drylands, the point at which that land no longer can be returned to a productive state. It results from complex

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interactions between unpredictable climate variations but primarily human activities. The term desertification was first coined by French scientists and explorer Louis Lavauden in 1927. It involves the depletion of vegetation and soil. Desertification is taking place much faster in the present world as compared to the past due to the increase of population that requires growing crops and grazing animals for survival. About one third of the world's land surface is arid or semi-arid. It is predicted that global warming will increase the area of desert climates by 17% in the next century. Worldwide desertification is making approximately 12 million hectares. This is equal to 10% of the total area of South Africa or 87% of the area of cultivated lands in our country. It is also devouring more than 20,000 square miles of land worldwide every year. Even the Sahara desert is advancing Southwards by about 5-10 kilometres per year.

Desertification can be stopped, but unfortunately is usually brought to public attention when the process is well underway. Both individuals and governments can help to reclaim and protect their lands. Covering the dunes with large boulders or petroleum will interrupt the wind regime near the face of the dunes and prevent the sand from moving in areas of sand dunes. Shrubs and trees planted on the dune will also decrease the wind velocity and prevents much of the sand from moving. More efficient use of existing water resources and control of salinization are other effective tools for improving arid lands. On a much larger scale, a "Green Wall," which will eventually stretch more than 5,700 kilometres in length, much longer than the famous Great Wall, is being planted in north-eastern China to protect "sandy lands"—deserts believed to have been created by human activity. The World Day to Combat Desertification is celebrated every year on June 17 all over the world to highlight the urgent need to curb the process of desertification and to strengthen the visibility of this dry lands issue on the international environmental agenda. The United Nations Convention to Combat Desertification (UNCCD) is the only internationally recognized, legally binding body that addresses the problem of land degradation in the dry lands and which enjoys a truly universal membership of 191 countries. It plays a key role in global efforts to eradicate poverty, achieve sustainable development and reach the Millennium Development Goals, in particular with regard to the eradication of extreme poverty. The need of the hour is to treat desertification as a wake-up call and to try and take it through strengthened community participation and cooperation at all levels.

Notes Global Warming is produced by the increase of Green House Gases (Carbon dioxide, Nitrous oxides and Methane) in the atmosphere. Carbon dioxide, the main Green House Gas is produced by burning of fossil fuels in power plants and automotive sectors. Large forest fires too add up Carbon dioxide to the atmosphere. The increase of Carbon dioxide has been significantly high during last three hundred years, after the Industrial Revolution and has risen from 200 ppm (parts per million) to 280 ppm in the atmosphere. At the present rate of increase, the atmospheric carbon is slated to rise to 350 ppm by mid century and to more than 500 ppm by the century end. Such an increase of atmospheric Carbon dioxide is going to raise the global average temperature by 2.5 to 4 degree Centigrade. Rise of average global temperature melts polar ice and mountain glaciers, raises sea-level and endangers coastal submersion. A decrease or nil in the total amount of rainfall in dry lands result in the destruction of topsoil and vital soil nutrients needed for food production also leading to desertification. Deforestation and incorrect irrigation practices in arid areas causing salinisation can prevent plant growth which in turn triggers desertification when coinciding with drought.

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8.5.1 Four Important Causes of Desertification

In order to understand desertification processes in the Indian context, it is necessary to know the geomorphic processes under natural set-up and acceleration to the processes through human interventions.

1. ***Water Erosion:*** Soil erosion through fluvial processes affects large areas in the Saurashtra and Kutch uplands, and along the eastern margin of the Thar Desert where the average annual rainfall varies from 350 to 500 mm, but has very few occurrences to the west of 250 mm isohyets in the Thar. The manifestations can be deciphered the pattern of sheet, rill and gully erosion features. Increased ploughing and destruction of vegetation cover for fuelwood, overgrazing and other destructive uses, must have accelerated the erosion in recent decades, but in the absence of specific data, it is difficult to suggest how much of the gulling activity is due to human activities alone and how much due to the natural processes. In Kutch region, a part of the problem is related to a slow natural uplift of the terrain over the centuries, which leads to a change in base level and increased erosion.

2. ***Wind Erosion/Deposition:*** The most vulnerable landforms to wind erosion/deposition are the sand dunes and other sandy landforms in the Thar. A closer look, however, indicates that the sandy landforms in the east are more stable than the similar landforms in the west. Rainfall gradient and wind strength are both responsible for the spatial variability in sand reactivation pattern.

   The introduction of the tractor for deep ploughing, instead of the traditional animal-driven wooden plough, has increased the sand load manifold for the Aeolian processes in large parts of the desert, and accelerated the mobility of sand. Increased destruction of the natural land cover in grazing lands for fuel and fodder and enlarging the frontiers of cultivation to less suitable sandy areas are also the responsible factors. In the foothills of the Aravali hill ranges along the wetter eastern part of the desert, such activities are also leading to accelerated water erosion, as manifested through the formation of rills and gullies.

   The farmers are aware of headword progress of the gullies in the east, but do not believe that their agricultural activities hasten the process, unless tractors are used to loosen the soil. Many of them believe that the agricultural crop residues which they leave in the field are good sand binders and whatever land is being lost through gully erosion is a slow natural phenomenon. In other parts of the desert, farmers agree that deep ploughing with tractors, cultivation along dune slopes, or non-practising of long fallow systems and other traditional farming systems lead to accelerated sand movement and land degradation, but they have very few choices, as population pressure and economic consideration override environment consideration.

3. ***Mining:*** In western Rajasthan, about twenty major minerals and nine minor minerals are being mined. More than 90 per cent of the mine owners have open cast mining. The rest are underground mines. The area occupied by the mines is increasing and by 2000 AD 0.05 per cent of Jaisalmer district and 1.15 per cent of Jhunjhunu district are reportedly under mining activities. The surface mining activity causes immediate degradation of land. The mining sites are abandoned after the excavation work is over, without adopting any reclamation measure. Mining on agricultural land, either surface or underground, reduces the productivity of land by way of excavation, disposal of debris and tailing. Mineral processing like grinding of limestone for cement industry, calcite and soapstone for ceramic industry, have three-fold adverse effects.

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The fine dust, generated and released in the atmosphere, leads to surface scaling of the adjacent land after it settles down, consequently the infiltration rate is reduced and the run-off increases. Mining activity restricts the sub-surface movement of water. With the removal of vegetation, the rate of evapotranspiration is reduced and as a result, there is a change in the hydrological balance in the area. Due to this change, the perched water table rises and causes salinity. When the mining debris of minerals like ball clay, china clay, Fuller's earth, bentonite and gypsum are dumped on the sandy plain, a semi-impermeable surface layer is developed. These areas get flooded during the monsoon and gradually develop salinity. Sodium salt mining activity increases the surface salt concentration, causing total loss of vegetation.

4. ***Vegetation Degradation:*** One of the first casualties of desertification is natural vegetation. Degradation of natural vegetation is also one of its major causes. With increasing pressure on land vegetation, degradation is increasing at an alarming rate. The common grazing lands around the villages are now some of the very severely degraded sites, as these are highly exploited and most neglected. Many good grazing lands have also been encroached upon for agriculture.

8.5.2 The Effects of Desertification

The effects of Desertification are as follows:

1. ***Soil becomes less usable:*** The soil can be blown away by wind or washed away rain. Nutrients in the soil can be removed by wind or water. Salt can build up in the soil which makes it harder for plant growth.
2. ***Vegetation is Lacked or Damaged:*** Loosened soil may bury plants or leave their roots exposed. Also, when overgrazing occurs, plant species may be lost.
3. ***Causes Famine:*** Places that have war and poverty are most likely to have famine occur. Drought and poor land management contribute to famine.
4. ***Food Loss:*** The soil is not suited for growing food; therefore the amount of food being made will decline. If the population is growing, this will cause economic problems and starvation.
5. ***People near Affected Areas:*** Desertification can cause flooding, poor water quality, dust storms, and pollution. All of these effects can hurt people living near an affected region.

Task Critically analyse how widespread is desertification in the World and in India?

Self Assessment

State whether the following statements are true or false:

13. Desertification can be stopped, but unfortunately is usually brought to public attention when the process is well underway.
14. Desertification is celebrated every year on June 11 all over the world.
15. Wind erosion through fluvial processes affects large areas in the Saurashtra and Kutch uplands.

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8.6 Role of an Individual in Conservation of Natural Resources and Equitable Use of Resources for Sustainable Lifestyles

Until fairly recently mankind acted as if he could go on for ever exploiting the ecosystems and natural resources such as soil, water, forests and grasslands on the Earth's surface and extracting minerals and fossil fuels from underground. But, in the last few decades, it has become increasingly evident that the global ecosystem has the capacity to sustain only a limited level of utilization. Biological systems cannot go on replenishing resources if they are overused or misused. At a critical point, increasing pressure destabilizes their natural balance. Even biological resources traditionally classified as 'renewable' - such as those from our oceans, forests, grasslands and wetlands, are being degraded by overuse and may be permanently destroyed. And no natural resource is limitless. 'Non-renewable' resources will be rapidly exhausted if we continue to use them as intensively as at present.

The two most damaging factors leading to the current rapid depletion of all forms of natural resources are increasing 'consumerism' on the part of the affluent sections of society, and rapid population growth. Both factors are the results of choices we make as individuals. As individuals we need to decide;

- What will we leave to our children? (Are we thinking of short-term or long-term gain?)
- Is my material gain someone else's loss?

Greed for material goods has become a way of life for a majority of people in the developed world. Population growth and the resulting shortage of resources most severely affect people in the developing countries. In nations such as ours, which are both developing rapidly, and suffering from a population explosion; both factors are responsible for environmental degradation. We must ask ourselves if we have perhaps reached a critical flash point, at which economic 'development' affects the lives of people more adversely than the benefits it provides.

8.6.1 What can you do to Save Electricity?

- Turn off lights and fans as soon as you leave the room.
- Use tube lights and energy efficient bulbs that save energy rather than bulbs. A 40-watt tube light gives as much light as a 100 watt bulb.
- Keep the bulbs and tubes clean. Dust on tubes and bulbs decreases lighting levels by 20 to 30 percent.
- Switch off the television or radio as soon as the program of interest is over.
- A pressure cooker can save up to 75 percent of energy required for cooking. It is also faster.
- Keeping the vessel covered with a lid during cooking, helps to cook faster, thus saving energy.

8.6.2 Equitable Use of Resources for Sustainable Lifestyles

Reduction of the unsustainable and unequal use of resources and control of our population growth are essential for the survival of our nation and indeed of human kind everywhere. Our environment provides us with a variety of goods and services necessary for our day-to-day lives, but the soil, water, climate and solar energy which form the 'abiotic' support that we derive from nature, are in themselves not distributed evenly throughout the world or within countries. A new economic order at the global and at national levels must be based on the ability to distribute benefits of natural resources by sharing them more equally among the countries as

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well as among communities within countries such as our own. It is at the local level where people subsist by the sale of locally collected resources, that the disparity is greatest. 'Development' has not reached them and they are often unjustly accused of 'exploiting' natural resources. They must be adequately compensated for the removal of the sources to distant regions and thus develop a greater stake in protecting natural resources.

There are several principles that each of us can adopt to bring about sustainable lifestyles. This primarily comes from caring for our Mother Earth in all respects. A love and respect for Nature is the greatest sentiment that helps bring about a feeling for looking at how we use natural resources in a new and sensitive way. Think of the beauty of a wilderness, a natural forest in all its magnificence, the expanse of a green grassland, the clean water of a lake that supports so much life, the crystal clear water of a hill stream, or the magnificent power of the oceans, and we cannot help but support the conservation of nature's wealth. If we respect this we cannot commit acts that will deplete our life supporting systems.

Self Assessment

Fill in the blanks:

16. ..... resources will be rapidly exhausted if we continue to use them as intensively as at present.
17. ..... for material goods have become a way of life for a majority of people in the developed world.
18. The two most damaging factors leading to the current rapid depletion of all forms of natural resources are increasing ..... on the part of the affluent sections of society, and rapid population growth.

Case Study

Water and Population Dynamics in a Rural Area of Tumkur District, Karnataka State

Karnataka State is situated in the west central part of peninsular India with a 400 kilometre coastline. The physiographic divisions include the coastal belt (subdivided into the coastal plains and the Western Ghats), the Karnataka plateau (subdivided into the Malnad hills and the Maidan plains), and the central plains. The state is located between 11*f* and 18*f* North latitude and 74*f* and 78*f* East longitude. It has a total area of 192,204 square kilometres (km^2) and occupies 5.35 percent of the total geographical area of India. The present population of the state is 45 million people. The geology is largely composed of greenstone belts, high-grade schists, and charnockites set in a vast expanse of migmatitic gneisses, all forming part of the shield area of peninsular India. The coastal margins of the state, bounded by the Arabian Sea, show a thin cover of recent and sub-recent sediments.

Karnataka has numerous rivers and streams contributing to surface water systems. Groundwater, especially in the regions east of the Western Ghats, is limited. The rivers and river systems conform to physiographic divisions, the principal water divide being the Western Ghats. The rivers swell during the monsoon; thereafter, many of them thin to a mere trickle. The streams of the Maidan are generally dry. The rivers of the coastal region include the Sharavati, Kalinadi, Nethravati, Bedthi, and the Aghanashini, which flow into the Arabian Sea. In the northern Maidan, the major rivers are the Tungabhadra,

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the Krishna, the Malaprabha, the Ghataprabha, and the Bheema. In the southern Maidan, the Cauvery, the Tungabhadra, the North and South Penner, and the Palar flow into the Bay of Bengal.

In 1901, the population of the state was 13 million. It has grown to 45 million in 1996. Between 1901 and 1981, the rate of increase was 183.75 percent. The sex ratio was 963 females to 1,000 males in 1981 and 958 females to 1,000 males in 1991. The population density in India as a whole was 178 per km^2 in 1981, and the density of population in the state was 193 persons per km^2. It has increased to 217 persons per km^2 in 1991. The literacy rate in the state was 38.46 percent in 1981 and 55.8 percent in 1991. The state of Karnataka is divided into 20 districts. The districts are further divided into taluks (blocks) for administrative convenience. The district of Tumkur adjoining the Bangalore district has ten taluks. The district has an area of 10,596 km^2 and had a population of 2.3 million in 1991. The literacy rate in 1981 was 36.92 percent and 46.2 percent in 1991. The major sources of employment are agriculture, horticulture, and animal husbandry, which engage almost 80 percent of the workforce.

The study area of Karnataka falls in Chikkanayakanahalli taluk (or district), which has a total area of 112,998 hectares. It had a population of 193,419 persons in 1991. The population density was 152 persons per km^2 in 1981 and 173 persons per km^2 in 1991. The literacy rate in 1981 was 41.47 percent and 49.4 percent in 1991.

The Chikkanayakanahalli taluk has two towns. The town of Huliyar has small industries that manufacture bricks and tiles, coir rope, and agricultural implements. A few villages such as Dasudi have small coir units. Agriculture, horticulture, and animal husbandry are the predominant economic activities in the taluk. They are not well developed due to the shortage of water. Agriculture provides only seasonal employment and the economic returns from the land are low. Non-agricultural economic activities are poorly developed.

The natural resource base of the taluk has steadily declined. Traditionally-used surface storage tanks, an important source of water for all purposes, have been silted up and many are defunct. Poor and erratic rainfall coupled with poor water management practice has resulted in a steady depletion of groundwater resources. In recent decades, the decrease in biomass availability, both fuelwood and green manure from forests, has had a negative impact on the livelihood of many rural communities. The type of fuel used for domestic purposes has shifted from firewood to the coconut fronds and leaves obtained from coconut plantations. Traditional community water management systems, based on efficient water harvesting in earthen barraged tanks, provided a balance between availability and use. These systems also provided a fairly equitable distribution of water. The Gram Sabha (village elected representation) consisting of village members, made decisions, with every family contributing labour for general maintenance.

Traditional farming systems, which propagated the use of appropriate crops and practices like green manuring and organic recycling, have declined. Even though the shift during the 1960's from traditional sustainable farming system to the chemical "Green Revolution" agriculture brought about a marked increase in food production all over the country, it also resulted in soil depletion and the spread of monocultural crops. The hybrids, high-response varieties that react to conditions of plentiful water and chemical nutrition, have failed to make an impact in stressful dry land agricultural conditions. The collapse of traditional farming resulted in the neglect of community-used forests, which were the sources of green manure. Encroachment on public land for cultivation is a common feature in Karnataka and has resulted in more land being brought under cultivation at the expense

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of tree cover. Excessive irrigation for cash crops, especially plantations, has led to water stress in the region.

Most of the rain falls during the months of August and September. Pre-monsoon showers are common in May and September. The spatial and temporal variations in rainfall are very high. Although rainfall is spread over these months, there are few rainy days. Rain falls in roughly 20 of these days, with one or two showers having accumulations of more than 100 millimetres (mm) of water in 24 hours. The decline in rainfall in the area from 600 mm to 400 mm on average could be attributed to a micro-climatic change. The possible reasons are local deforestation and global warming. The government continues to play a major role in the development process in the district. The development programs are conceived and implemented by the government with little local interaction. Efforts to address this issue have shown promise with the provision of Constitutional guarantees to the gram panchayats (GPs), the lowest level of elected representation, in 1995. They now require institutional support to discharge their responsibilities. However, the Non-Governmental Organization (NGO) sector is not very well represented in the district, with Development Alternatives (DA) and Bharatiya Agro-Industries Foundation comprising the majority.

The case study area has four physiographic zones: the hilly regions, undulating highlands, gently sloping pediments, and pedeplains. The taluk is drained by the Tore Halla River which joins the Kare Tore River, a tributary of Suvarnamukhi. The natural vegetation is mostly poor scrub in the hills. A large proportion of the land is under different forms of wasteland (Table 1). Agriculture in the taluk is mostly single crop, and productivity is low. The average rainfall is roughly 600 mm a year. The temperature ranges from 15*f* to 41*f* Celsius.

Table 1: Land Use in Chikkanayakanahalli Taluk

Land Use	Area in Hectares	Percent of Total
Total geographical area	112,998	
Forests	8,235	7.29
Waste land	7,773	6.87
Land for Other Purposes	6,005	5.31
Cultivable Waste lands	19,664	17.4
Permanent Pastures	5,854	5.18
Orchards and Plantations	2,710	2.4
Fallow (under use)	5,298	4.69
Fallow (under other use)	1,092	0.96
Area under Cultivation	56,367	49.88

Source: Primary data collection and village records

The taluk has 234 villages, which constitute 28 GPs. The population growth rate between 1981 and 1991 was 12.6 percent, a decline from 18.96 percent for the decade between 1971 and 1981 (Table 2). The main reason for the decline in growth rate is out-migration to the nearby city of Bangalore. Temporary migration by marginal farmers and landless people in search of work is common during the summer season. Some of the well-to-do farmers

Contd....

Notes

also live in nearby towns because they offer better educational facilities and employment. A few labour-class families have also migrated permanently to work in factories and mines. The sex ratio (the number of females/1,000 males) for the taluk was 0.97 for 1994.

Table 2: Population Growth in Chikkanayakanahalli Taluk: 1901-1991

1901	51,286	**1951**	91,889
1911	57,484	**1961**	115,657
1921	60,498	**1971**	144,396
1931	68,734	**1981**	171,770
1941	76,748	**1991**	193,419

Source: Census Data and Village Records

The study area includes three GPs out of the 28 in the taluk covering almost one fifth of its area. A brief description of these GPs follows. Table 3 provides an overview of the villages within the GPs.

Table 3: Overview of Village Selected for the Case Study

GP	Village	Area (hectares)	Population: 1991
Dasudi	1. Dasudi	3,656	3,221
	2. Marenadu	2,391	1,294
	3. Dabbagunte	785	1,666
	Total	**6,832**	**6,181**
Hoyisalakatte	1. Hoyisalakatte	388	1,507
	2. Nulenoor	972	1,098
	3. Lakkenahelli	409	734
	4. Kallenahalli	593	870
	5. Bellera	1,641	1,995
	6. Ambarapura	761	330
	7. Muthugadahalli	856	190
	8. Kurihallikaval	228	81
	9. Boranakanive	563	254
	Total	**6,408**	**7,059**
Gandalu	1. Gandalu	625	1,257
	2. Yagachihalli	331	435
	3. Guruvapura	858	554
	4. Somanahalli	870	1,147
	5. Melanahalli	864	1,287
	6. Kampanahalli	855	460
	7. Maruhole	434	654
	8. Karehalli	185	142
	9. Kurihatti	6.7	591
	Total	**5,629**	**6,527**
	Total for 3 Gps	**18,869**	**19,767**

Source: Census and Village Records

Contd....

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The Dasudi GP lies on the border of Chikkanayakanahalli taluk and the Tumkur district. Towards the north is Hiriyur taluk of the Chitradurga district. This GP has three villages which provide revenue—comprising Marenadu, Dabbagunte and Dasudi—and 13 hamlets. Development Alternatives runs a forestry nursery in Dabbagunte and is involved in forestation of wastelands in this GP. Being a border area, this GP receives less attention and development funds from the district and taluk administrations. The Hoyisalakatte GP has nine villages and four hamlets, lying on either side of the state highway between Huliyar and Sira. A part of the Muthugadahalli village falls within the Bukkapatna State Forest. Hoyisalakatte village is prominent due to its location at the road head to the interior villages. The Junior College at Boranakanive offers pre-university and job-oriented courses. Students from neighbouring GPs, including Dasudi and Gandalu, study at this college. The people of Hoyisalakatte have access to adequate health, education, and transportation infrastructure. During the non-agricultural season, however, people do not have much work.

The Gandalu GP is situated between Hoyisalakatte and Huliyar town in the west. It has nine villages and three hamlets. The community is involved in the management of natural resources and infrastructure development. They have initiated and implemented many community programs such as the construction of a school building, the GP office, and tree planting.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.aaas.org/international/ehn/waterpop/india.htm

8.7 Summary

- Land may be defined as a physical environment consisting of relief, soil, hydrology, climate and vegetation in so far as they are determined by the land use.
- Land resources in India are considered as non-renewable energy reserve.
- Landforms such as hills, valleys, plains, river basins and wetlands include different resource generating areas that the people living in them depend on.
- Soil is a dynamic natural body developed as a result of pedogenic processes during and after weathering of rocks, consisting of minerals and organic constituents, possessing definite chemical, physical, mineralogical and biological properties having a variable depth over the surface of earth and providing a medium for plant growth.
- The life of mankind and almost all the flora and fauna on the earth is continuously influenced by an unending flux of water known as hydrologic cycle.
- The land system of our country is affected by influences of man interventions well as various natural processes.
- Land degradation refers to a decline in the overall quality of soil, water or vegetation condition commonly caused by human activities.
- Land degradation will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life.

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- Land degradation can be considered in terms of the loss of actual or potential productivity or utility as a result of natural or anthropic factors; it is the decline in land quality or reduction in its productivity. In the context of productivity, land degradation results from a mismatch between land quality and land use.
- Desertification was defined at the Rio Earth Summit in 1992 as degradation of drylands, the point at which that land no longer can be returned to a productive state.
- Soil erosion through fluvial processes affect large areas in the Saurashtra and Kutch uplands, and along the eastern margin of the Thar Desert where the average annual rainfall varies from 350 to 500 mm, but has very few occurrences to the west of 250 mm isohyets in the Thar.
- The two most damaging factors leading to the current rapid depletion of all forms of natural resources are increasing 'consumerism' on the part of the affluent sections of society, and rapid population growth.

8.8 Keywords

Conservation: Conservation is concerned with the long-term preservation of cultural property through examination, documentation, treatment, and preventive care.

Desertification: The process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture.

Industrialisation: Industrialisation is the period of social and economic change that transforms a human group from an agrarian society into an industrial one.

Land: It may be defined as a physical environment consisting of relief, soil, hydrology, climate and vegetation in so far as they are determined by the land use.

Land degradation: It refers to a decline in the overall quality of soil, water or vegetation condition commonly caused by human activities.

Lifestyles: A way of living of individuals, families (households), and societies, which they manifest in coping with their physical, psychological, social, and economic environments on a day-to-day basis.

Mining: Mining is the extraction of valuable minerals, liquids and gases from the earth which are present as orebodies, veins, seams or liquids.

Natural Resources: Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain.

Non-Renewable Energy: Non-renewable energy is energy that comes from the ground and is not replaced in a relatively short amount of time.

Resource: A resource is a source or supply from which benefit is produced.

Salinization: Salinization is having a high salt level in top soil which causes a lot of problems because germination cannot occur in soil with a high salt content.

Soil: The unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants.

Soil Erosion: Soil erosion is a natural process. It becomes a problem when human activity causes it to occur much faster than under natural conditions.

Urbanization: Urbanization is the physical growth of urban areas as a result of rural migration and even suburban concentration into cities, particularly the very largest ones.

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Water Erosion: Water Erosion is what destroys houses and landscapes due to rain, which erodes the soil and causes things like rill, gulley and stream erosion.

Wind Erosion: Wind erosion is the movement of material by the wind and occurs when the lifting power of moving air is able to exceed the force of gravity and the friction which holds an object to the surface.

8.9 Review Questions

1. Write brief note on Land Resources in India.
2. What are the seven essential methods for conserving land resources?
3. Throw some light on the role of Land as a Resource.
4. "India has a diverse geology." Elucidate.
5. Define Land degradation.
6. Describe the factors that lead to land degradation.
7. Write short note on Soil Erosion in India.
8. Explain the types of types of Soil Erosion.
9. Define Desertification in India.
10. Highlight the four important causes of Desertification.
11. What are the effects of Desertification?
12. Discuss the Role of an Individual in Conservation of Natural Resources.

Answers: Self Assessment

1.	True	2.	False
3.	True	4.	Soil
5.	Geology	6.	Land
7.	True	8.	False
9.	False	10.	Western
11.	Wind Erosion	12.	Human
13.	True	14.	False
15.	False	16.	Non-renewable
17.	Greed	18.	Consumerism

8.10 Further Readings

Books

Allaby, Michael, (2002), *Basics of Environmental Science,* Routledge

Byrne, Kevin, (2001), *Environmental Science,* Nelson Thornes

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Kaushik, Anubha, (2006), *Perspectives in Environmental Studies,* New Age International

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Singh, Y. K., (2006), *Environmental Science,* New Age International

Online links

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http://soils.usda.gov/use/worldsoils/papers/land-degradation-overview.html

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http://www.preservearticles.com/201104195610/7-essential-methods-for-conserving-our-land-resources.html

http://www.rrcap.ait.asia/pub/soe/india_land.pdf

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Unit 9: Ecosystem

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Objectives

After studying this unit, you should be able to:

- Discuss the meaning, structure and functions of Ecosystem
- Explain the Energy Flow on Ecosystem
- Describe the Food Chain
- Understand the Food Webs
- Discuss the Ecological Pyramid

Introduction

In the previous unit, we dealt with the land as a resource, concepts regarding Land Degradation, Soil Erosion and Desertification along with the Role of an Individual in Conservation of Natural Resources and Equitable Use of Resources for Sustainable Lifestyles. Everything in the natural world is connected. An ecosystem is a community of living and non-living things that work together. Ecosystems have no particular size. An ecosystem can be as large as a desert or a lake or as small as a tree or a puddle. If you have a terrarium, that is an artificial ecosystem. The water, water temperature, plants, animals, air, light and soil all work together. If there isn't enough light or water or if the soil doesn't have the right nutrients, the plants will die. If the plants die, animals that depend on them will die. If the animals that depend on the plants die,

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any animals that depend on those animals will die. Ecosystems in nature work the same way. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the meaning, structure, functions, energy flow of Ecosystem along with the food chain, food webs and Ecological Pyramid.

9.1 Ecosystem: Meaning, Structure and Functions

Both the living (plants and animals) and the non-living (atmosphere, water, mountains and other physical components) components of environment interact and function together as a unit called ecosystem. A pond, a lake, a river, an ocean, a forest or a desert is considered as an ecosystem. In any ecosystem, both the living organisms and its environment influence each other and both are necessary for survival of life (the living environment is also called biotic environment and the non living, abiotic). Abiotic components like air or water enter the body of living beings and then return to the environment in a changed form.

An ecosystem consists of the biological community that occurs in some locale, and the physical and chemical factors that make up its non-living or abiotic environment. There are many examples of ecosystems — a pond, a forest, an estuary, grassland. The boundaries are not fixed in any objective way, although sometimes they seem obvious, as with the shoreline of a small pond. Usually the boundaries of an ecosystem are chosen for practical reasons having to do with the goals of the particular study.

The study of ecosystems mainly consists of the study of certain processes that link the living, or biotic, components to the non-living or abiotic components. Energy transformations and biogeochemical cycling are the main processes that comprise the field of ecosystem ecology. As we learned earlier, ecology generally is defined as the interactions of organisms with one another and with the environment in which they occur. We can study ecology at the level of the individual, the population, the community, and the ecosystem.

Studies of individuals are concerned mostly about physiology, reproduction, development or behavior, and studies of populations usually focus on the habitat and resource needs of individual species, their group behaviors, population growth, and what limits their abundance or causes extinction. Studies of communities examine how populations of many species interact with one another, such as predators and their prey, or competitors that share common needs or resources.

In ecosystem ecology we put all of this together and, insofar as we can, we try to understand how the system operates as a whole. This means that, rather than worrying mainly about particular species, we try to focus on major functional aspects of the system. These functional aspects include such things as the amount of energy that is produced by photosynthesis, how energy or materials flow along the many steps in a food chain, or what controls the rate of decomposition of materials or the rate at which nutrients are recycled in the system.

9.1.1 Meaning of Ecosystem

Ecological system or ecosystem is an open space built by physical and biological components of an environment. Ecosystem is result of an active interaction between living and non-living components. Ecosystem is where community of plants, animals and their environment function as a whole, and relationship between organism and environment thrives blissfully.

The term ecosystem (a contraction of ecological system) is generally understood as to the entire assemblage of organisms (plant, animal and other living beings—also referred to as a biotic community or biocoenosis) living together in a certain space with their environment (or biotope), functioning as a loose unit. Together, these components and their interactions with and relationships to each other form a dynamic and complex new whole, functioning as an "ecological

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unit", with additional characteristics that can't be found in the individual components. Nor could any organism live completely on its own without involving any other species of organism.

There are no conceptual restrictions on how large or small a space or an area must be to host an ecosystem, or on the minimum numbers species or individual organisms to be present. Early conceptions of an ecosystem were as a structured functional unit in equilibrium of energy and matter flows among constituent elements. Some considered this vision limited, and preferred to view an ecosystem in terms of cybernetics, which, like any other type of system, is governed by the rules of systems science and cybernetics, as applied specifically to collections of organisms and relevant abiotic components. The branch of ecology that gave rise to this view has become known as systems ecology.

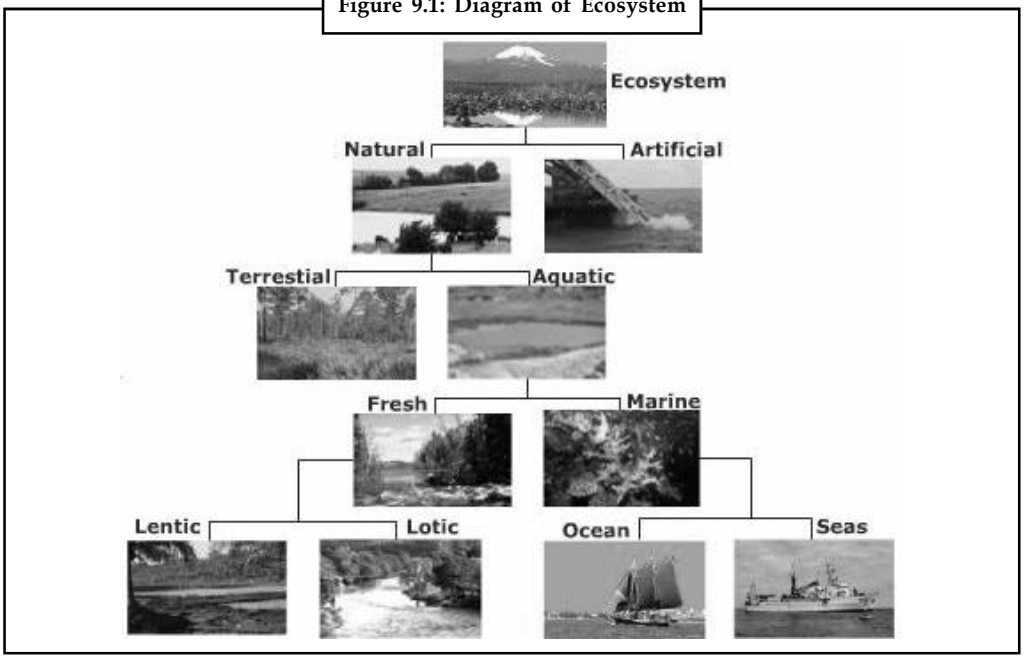
An ecosystem can be defined as 'a structural and functional unit of biosphere or segment of nature consisting of community of living beings and the physical environment, both interacting and exchanging materials between them'.

- E. P. Odum, an American ecologist, defined ecology as, 'the study of the structure and function of nature, which includes the living world'. He referred ecosystem as the basic fundamental unit of ecology.
- Charles Elton, a British ecologist, defines ecology as, 'the study of scientific natural history'.
- Andrewartha, an Australian ecologist, defined ecology as, 'the study concerned with the distribution of organisms'.
- According to S. Mathavan, 'an ecosystem is a sum total of living organisms, the environment and the process of interaction between the various components of the ecosystem'.

Besides a mechanical system or a living body, the ecosystem usually has a boundary within which the component parts function together as one unit.

An ecosystem may be natural (like forest, lake, ocean, etc.) or man-made (such as an aquarium, a crop field, etc.), temporary (like a rainfed pond) or permanent (like a lake, forest, etc.), aquatic (such as pond, ocean etc.) or terrestrial (like grassland, forest, etc.).

Figure 9.1: Diagram of Ecosystem



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/ecosystem-definition.php

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An ecosystem may be as small as a drop of pond water and as large as an ocean. Ecosystems can be recognised as self-regulating and self-sustaining units.

9.1.2 Components of Ecosystem

An ecosystem comprises of two basic components:

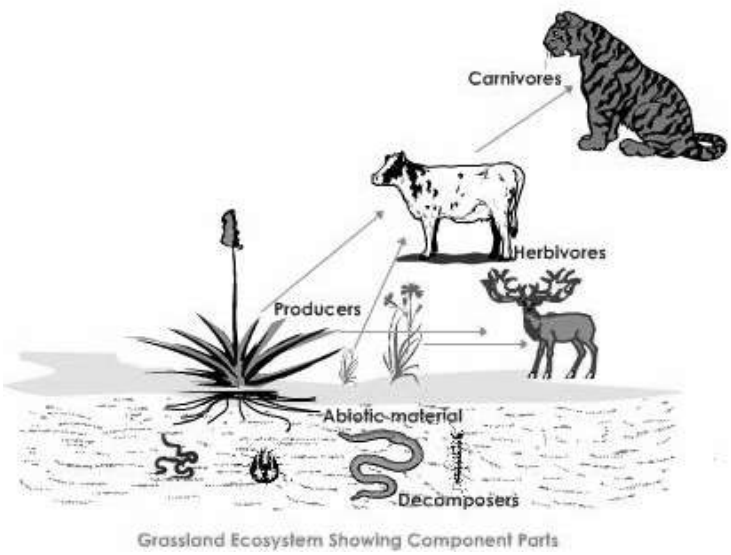
(i) Abiotic components, and

(ii) Biotic components

The relationship between the biotic components and abiotic components of an ecosystem is called 'holocoenosis'.

1. ***Abiotic components:*** These include the non-living, physico-chemical factors such as air, water, soil, the basic elements and compounds of the environment. Abiotic factors are broadly classified under three categories.
   - Climatic factors which include the climatic regime and physical factors of the environment like light, humidity, atmospheric temperature, wind, etc.
   - Edaphic factors which are related to the structure and composition of soil including its physical and chemical properties, like soil and its types, soil profile, minerals, organic matter, soil water, soil organisms.
   - Inorganic substances like water, carbon, sulphur, nitrogen, phosphorus and so on. Organic substances like proteins, lipids, carbohydrates, humic substances, etc.
2. ***Biotic Components:*** It comprises the living part of the environment, which includes the association of a number of interrelated populations belonging to different species in a common environment. The populations are that of animal community, plant community and microbial community. Biotic community is distinguished into autotrophs, heterotrophs and saprotrophs.

Figure 9.2: Grassland Ecosystem Showing Component Parts



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/ecosystem-components.php

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Autotrophs (Gr: auto-self, trophos-feeder) are also called producers, convertors or transducers. These are photosynthetic plants, generally chlorophyll bearing, which synthesize high-energy complex organic compounds (food) from inorganic raw materials with the help of sunlight, and the process is referred as photosynthesis. Autotrophs form the basis of any biotic system. In terrestrial ecosystems, the autotrophs are mainly the rooted plants. In aquatic ecosystems, floating plants called phytoplankton and shallow water rooted plants called macrophytes are the dominant producers. Heterotrophs (Gr: heteros - other; trophs - feeder) are called consumers, which are generally animals feeding on other organisms. Consumer's also referred as phagotrophs (phago - to ingest or swallow) or macroconsumers are mainly herbivores and carnivores.

Herbivores are referred as First order consumers or primary consumers, as they feed directly on plants.

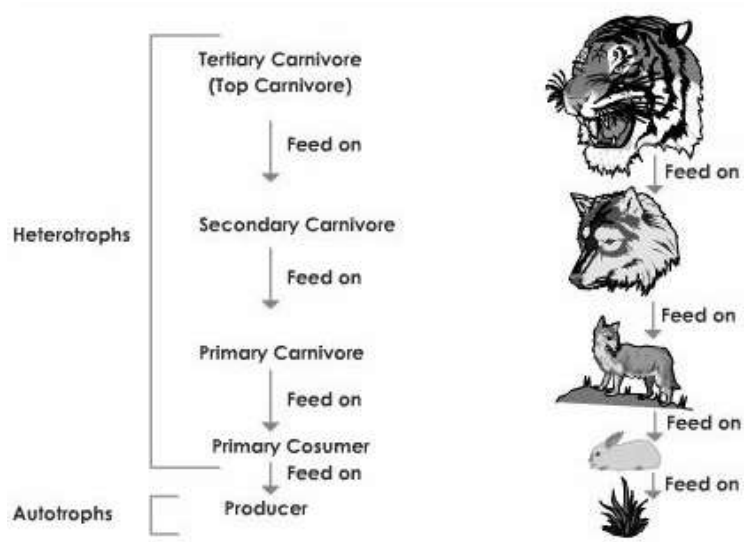
Example: Terrestrial ecosystem consumers like cattle, deer, rabbit, grass hopper, etc.

Aquatic ecosystem consumers like protozoans, crustaceans, etc. Carnivores are animals, which feed or prey upon other animals.

- Primary carnivores or Second order consumers include the animals which feed on the herbivorous animals. For example, fox, frog, predatory birds, smaller fishes, snakes, etc.
- Secondary carnivores or Third order consumers include the animals, which feed on the primary carnivores. For example, wolf, peacock, owl, etc. Secondary carnivores are preyed upon by some larger carnivores.
- Tertiary carnivores or Quaternary consumers include the animals, which feed on the secondary carnivores. For example, lion, tiger, etc.

These are not eaten by any other animals. The larger carnivores, which cannot be preyed upon further are called top carnivores.

Figure 9.3: Diagram of Carnivores



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/ecosystem-components.php

Saprotrophs (Gr: sapros - rotten; trophos - feeder) are also called decomposers or reducers. They break down the complex organic compounds of dead matter (of plants and animals). Decomposers

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do not ingest their food. Instead they secrete digestive enzymes into the dead and decaying plant and animal remains to digest the organic material. Enzymes act upon the complex organic compounds of the dead matter. Decomposers absorb a part of the decomposition products for their own nourishment. The remaining substances are added as minerals to the substratum (mineralisation). Released minerals are reused (utilised) as nutrients by the plants (producers).

9.1.3 Structure of Ecosystem

The characteristic structure of an ecosystem is obtained by the systematic physical organisation of the abiotic and biotic components of that particular ecosystem. The two main structural features of any ecosystem are its 'species composition' and 'stratification'. An ecosystem can be represented by depicting the producers-consumers relationship in the given ecosystem. This is also called the 'Trophic structure' of an ecosystem, wherein each animal population forms the various trophic levels. The producers (green plants) always form the first trophic level. Herbivores, which feed on producers, are at the second trophic level followed by secondary consumers, tertiary consumers and so on.

Did u know? Trophic structure of an ecosystem can be described in terms of its total amount of nutrients or the amount of living material. The amount of nutrients in the soil at any given time is referred as 'standing state' whereas the amount of living material is referred as 'standing crop'.

The structure of an ecosystem includes the living community (biotic components like plants, animals), their diversity, life history and distribution, etc. The living beings include:

1. Producers
2. Consumers and
3. Decomposers

These are stated as follows:

1. ***Producers***: Producers are those living beings which convert solar energy into chemical energy inside the body with the help of inorganic substances like water and carbon dioxide and organic substances such as enzymes. These producers are also called autotrophs which include green plants like trees, grass, herbs, shrubs, tiny green organisms living in water (phytoplanktons), etc. With the help of chlorophyll (a green pigment present in producers), solar energy or light, carbon dioxide from the atmosphere and the water and minerals from outside, the producers are able to produce food and maintain themselves.
2. ***Consumers***: Consumers are chiefly animals including humans. Consumers who eat plants or their parts or products are called herbivores and when they eat animals, they are called carnivores. The carnivores eat herbivores and other carnivores. Consumers are also referred to as heterotrophs.
3. ***Decomposers***: Decomposers are those living beings like bacteria or fungi which depend upon dead organic matter for their food. They break down complex organic matters found in dead animals and plants into simpler substances and release them for the producers.

9.1.4 Functions of Ecosystem

The functional attributes of an ecosystem helps to keep its component parts running together. An ecosystem is the basic functional unit that includes organisms and the physical environment, which are interacting and influencing each other and having relationship of interdependence.

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The parts of ecosystem are not separable from the whole functionally and thus analysis and functions of each part needs to be studied in detail. A pond or a particular forest or any other component of ecosystem can be considered as a functional unit and its functioning becomes the function of the ecosystem. It is important to point out that an ecosystem is a dynamic concept. It is capable of self maintenance and self-regulation and thus remains in a state of equilibrium.

Caution Human intervention can disrupt this equilibrium and the changes, then occurring in such an ecosystem are unnatural and threatening to life. Overuse of resources of ecosystem or exploitation of services provided by the ecosystem or any of its components for the purpose of higher production is commonly observed. Such overuse of ecosystem for production would not be sustainable.

The ecosystem as a dynamic concept is exemplified by the following functions or ecological services.

1. We observe a cyclical functioning of an ecosystem as we see various elements get circulated in the environment. Elements like oxygen, hydrogen and carbon dioxide are moving in and out of organisms and constitute nutrient cycle.
2. Food chain is another aspect of functioning ecosystem.
3. Every ecosystem has a carrying capacity. It can support population and communities to a limited extent. Ecosystem provides the needs of such a population but if the population becomes too large, ecosystem becomes overloaded and affects the health of the population.
4. Ecosystem provides services on which the organisms depend, and this dependence is based on complex conditions. Some of these conditions become a limiting factor. For example, if the ecosystem were not able to provide enough water or suitable temperature, it would affect the development of the organisms.
5. Various ecosystems serve as habitat for organisms in which they live and move about. The habitats are air, water and land, also called aerial, aquatic and terrestrial respectively. Each habitat has an important role in controlling the environment and maintaining the balance on the earth. Understanding, therefore, of these habitats is important in comprehending various functions of ecosystem.

The numerical strength and biomass of organisms affect the functioning of ecosystem. In ecosystems, the biotic communities usually contain a few common species represented by a large number of individuals or by a large biomass and a comparatively large number of individual species occurring in small numbers. Under stress conditions, the number of rare species is usually reduced, and only a few species may survive and their frequency of occurrence may be very high. As a rule, the total number of species in any ecosystem is reduced under conditions of extreme stress, as found in arctic, antarctic and desert region and so on. A system is considered stable in the ecological sense if its structure and functions remain more or less the same from year to year. A system with high species diversity and low dominance is less productive but stable. On the other hand, a system with a community with low species diversity and high dominance is more productive but unstable.

Task What is necessary for ecosystem sustainability?

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Caselet

Remote Sensing of Aquatic Marine Ecosystems

How do you monitor the health of an ocean? To help answer this question a team of Australian and Indian researchers held a workshop on remote sensing of aquatic marine ecosystems. The Australian Team Leader, Dr Arnold Dekker, explains that researchers use satellite-based earth observation of coasts and oceans to monitor ocean colour, which arises from changes in algae, suspended and dissolved organic material. "The effects of climate change and the pressures of human population growth are having significant impacts on oceans. Ocean colour helps us understand the interactions between aquatic ecosystems, climatic factors and human impacts."

Understanding these interactions can better inform policies for protecting coastal reefs and ecosystems from potentially harmful disturbances caused by human activity and environmental stresses. Attendees at the workshop were involved in identifying future strategies for monitoring ocean health. "These indicators might allow us to assess the amount of phytoplankton photosynthesizing in a particular area of the ocean, or to describe conditions associated with algal blooms. Such observations might enable scientists to answer questions such as: Are there links between agricultural practice and phytoplankton activity? How might we begin to predict algal blooms? How do human activities lead to changes in ocean processes?" Using high spatial resolution satellites, estimates can be made of bathymetry (depth of the water column), presence and - in some cases the health - of seagrasses and coral reefs. This can assist, for example, in the detection of coral bleaching. Coral bleaching is a response to stress induced by environmental triggers such as changes to temperature. Identifying areas at risk of, or experiencing, coral bleaching could allow measures to be implemented to protect coastal zones, such as the Great Barrier Reef, from coral destruction.

Source: http://www.innovation.gov.au/Science/InternationalCollaboration/aisrf/Documents/Ocean_Colour_Case_Study.pdf

Self Assessment

State whether the following statements are true or false:

1. Ecosystem is result of an active interaction between living and non-living components.
2. There are conceptual restrictions on how large or small a space or an area must be to host an ecosystem, or on the minimum numbers species or individual organisms to be present.
3. An ecosystem may be as large as a drop of pond water and as large as an ocean.

9.2 Energy Flow on Ecosystem

Work or any activity requires energy. Energy is required to maintain the functions of living organisms and this energy ultimately comes from the Sun (Solar energy). Solar energy enables the process of food formation in the plants which are the producers. This process of formation of food is called photosynthesis. In fact, the solar energy in this process is transformed into chemical energy inside the plants (producers). When the producers are eaten by the consumers, the stored energy of the producers is converted into heat energy when the consumers do work or carry out any other activity inside or outside their body. The stored energy is called potential energy and when energy is used for carrying out any work or any other activity, it is called kinetic energy.

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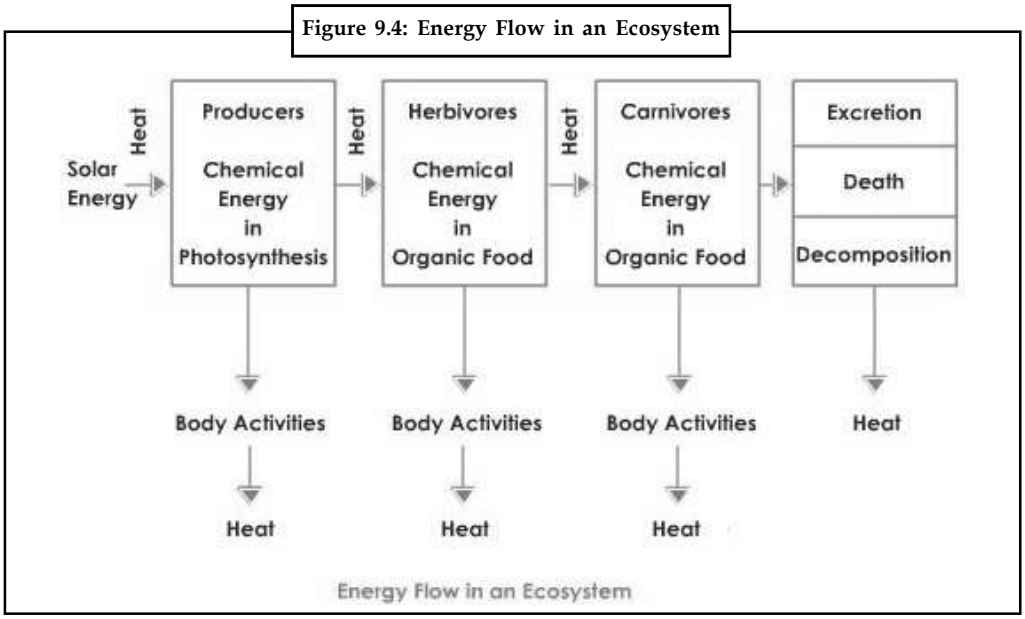
Energy transformation in ecosystems is explained in relation to the laws of thermodynamics. The first law of thermodynamics is the Law of Conservation of Energy, according to which energy may be transformed from one form to another. Energy is neither created, nor destroyed, it is transformed from one form to another and the decrease or increase occurs in the internal energy of the system itself.

In order to understand the energy flow in an ecosystem, the first step is to understand the dynamics of solar energy in relation to producers. All the solar energy reaching the earth's atmosphere is not available to producers. It depends upon the geographical distribution of producers, i.e., latitude of the hemisphere. Solar energy received at higher latitude is much more than that received at lower latitude.

Did u know? Energy flows through an ecosystem in a linear, one-way direction. In all ecosystems, energy enters the system as sunlight (radiant energy). Producers (photosynthetic organisms) trap and use about 0.02% of the sun's energy in photosynthesis.

Solar energy is used in the process of food production (photosynthesis). The carbon dioxide released by animals and human is consumed by plants and oxygen released during photosynthesis is consumed by animals. Energy flow in an ecosystem can thus be summed up as under. Solar energy enters the plants and is transformed into usable energy (by photosynthesis) for plant's growth and is stored in chemical form in plants. The plants are producers. When the plants are eaten by primary consumers that are called herbivores, the energy stored in the plants enters their body. When the herbivores are eaten by carnivores (animals), energy gets transformed into their body. These carnivores use energy for work and growth; some of the energy is lost through respiration. This transfer process continues along the entire food chain.

Figure 9.4: Energy Flow in an Ecosystem



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/energy-flow.php

Energy is the capacity to do work. Solar energy is transformed into chemical energy by the process of photosynthesis, and is stored in plant tissue and then transformed into mechanical and heat forms during metabolic activities. The energy, in the biological world, flows from the sun to plants and then to all heterotrophic organisms such as microorganisms, animals and man. Energy flow is the key function in an ecosystem and it is unidirectional. The study of energy transfer at different trophic level is known as 'Bioenergetics'.

Notes

Caution The energy flow in the ecosystem is unidirectional.

Sun is the main source of energy. The amount of energy received differs in amount as it depends upon the slope, cloud, latitude and pollutants present in the atmosphere. The energy received in the Varanasi of India is three times more than the energy received in the Britain. Some part of the energy is used by the producers. The rest is dissipated. The efficiency to conserve energy is around 1 percent in the grasslands and savannah. It is also similar in the mixed forests. It is higher in the modern crops and sugarcane field. It ranges from the 5 to 10 percent. The autotrophs are also known as the producers. They make the food by the process of photosynthesis from the inorganic materials. They not only make their food but also for the other organisms. They absorb the energy from sun and convert into the chemical energy. They release oxygen. The organic compounds release energy during respiration.

The organic compounds which are formed play an important role in the building of bodies and help in the release of energy which helps to overcome the entropy. The energy is dissipated as a heat. There are herbivorous which feed on the plants. They are not able to eat the whole of plant. There is a non usage of food energy which passes into the decomposers. The phytoplankton in the aquatic food chain is mainly eaten by the herbivore. The herbivores act on the ingested food which gets aggregated. It releases the energy later on and helps in the respiration. The energy lost in this case is not much and the remaining is used to overcome the entropy. The fraction of assimilated food is used for the body building. The primary carnivore feeds on the herbivore and is fed by the secondary carnivore. In the food chain when the food is broken energy is released. The small part of energy is utilized and so the rest of energy is dissipated. The energy transfer from one trophic level to the other decreases in the amount.

Self Assessment

Fill in the blanks:

4. ..... enables the process of food formation in the plants which are the producers.
5. Energy transformation in ecosystems is explained in relation to the laws of .....
6. The phytoplankton in the aquatic food chain is mainly eaten by the .....

9.3 Food Chain

"Food chain is a series of groups of organisms called trophic levels, in which, there is repeated eating and eaten by so as to transfer food energy". Food Chain is the sequence of populations of an ecosystem which allows food and energy to go through it in a specified direction. Those on the lower end of chain become food for the ones who are on upper end. The one who is at top of the food chain is not consumed by any. We also call the food chain as a predator food chain.

The concept of the food chain is an important ecological concept. The transfer of food energy initially from plants through a series of organisms where eating and being eaten occurs is referred to as the food chain. Each member of a food chain feeds on the one below. Human beings occupy a position at or near the end of most food chains. For example, man eats big fish that eats little fish that eats plants or microorganisms.

The concept of a food chain is important for another reason besides understanding how energy gets transferred from one organism to another. Pollutants also are transferred in this process

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from one organism to another and become more concentrated as they progress through the food chain. Thus pesticides that wash off soil into water come to reside in fish, and as smaller fish are eaten by larger fish, these enter the latter. When humans eat larger fish, these pollutants reach human system producing harmful effects. DDT has been detected in the human system including mother's milk.

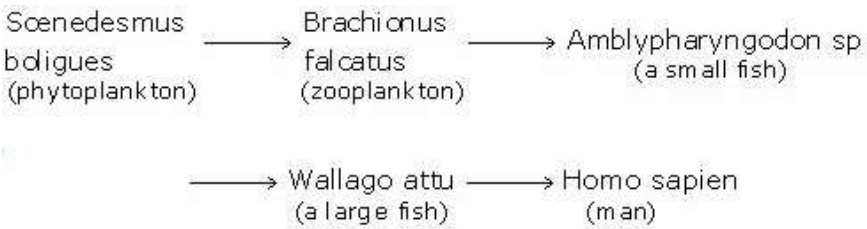
A food chain consists of producers, consumers and decomposers. Though decomposers are normally omitted but they also play a very vital role in food chain. We can divide consumers into various orders like the first, second, tertiary and the fourth order. The autotrophs also known as producers make food by the process of photosynthesis from inorganic materials. This food is not only consumed by them but also by many other organisms. They absorb energy from sun, convert it into chemical energy and then release oxygen which is used by other organisms as well. During respiration energy is released by transducers as they convert one form of energy to another. The organic compounds formed, help in building of bodies and releasing energy.

The herbivore animals include rabbit, mouse, deer and buffalo etc. Apart from these, few of these are also present in the aquatic areas and include the molluscs, crustaceans and protozoan. The primary carnivore includes snakes, frog, fish, jackal, birds and wild cat. Apart from these, we have few of the organisms called third order consumers (tertiary consumers) which feed on the primary carnivore. It includes tiger, lion, owl and fish. There are few carnivores which are not consumed by any other organism and thus they are at top of the food chain, example Lion. These are also known as secondary carnivores. They act as a food for the tertiary carnivore. There are certain carnivores which cannot become food for the other organism. They occur at the top of food chain. It includes the lion. The food chain ends at the herbivore animals. The food chains occur in the land as well as in the water. The pond is the most common place of their residence in water.

In the land the grass is eaten by the grasshopper. The grasshopper is eaten by the frog and the frog is eaten by the snake. Ultimately, the snake is eaten by the peacock. The vegetation is eaten by the insect. The insects eaten by the predator insect and the predator insect are eaten by the insectivorous bird. Ultimately, the insectivorous bird is eaten by the hawk. The vegetation is eaten by the rabbit. The rabbit is eaten by the fox and the fox is eaten by the wolf. Ultimately, the wolf is eaten by the tiger. In the aquatic areas the food chain consists of different organisms. The phytoplankton is eaten by the zooplankton. The zooplankton is eaten by the small crustaceans. The small crustaceans are eaten by the predator insects. The predator insects are eaten by the small fish. The small fish are eaten by the large fish. This is followed by the crocodile. In the other aquatic food chain, the phytoplankton is eaten by the zooplankton. The zooplankton is eaten by the small crustaceans. The small crustaceans are eaten by the predator insects. The predator insects are eaten by the small fish. The small fish are eaten by the large fish. This is followed by the kingfisher. The aquatic food chains are quite similar.

Example:

(a) ***Food chain observed in a river:***



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(b) ***Food chain observed in a pasture:***

Cynodon dactylon (a grass species) → Melanoplus differentialis (a grasshopper) → Bufo melanostictus (a toad) → Zamenis mucosus (a rat snake)

The transfer of food energy from plant sources through a series of organisms forms a 'food chain'.

The base of the food chain is always formed by a plant (producer/autotroph), which is grazed on by a herbivore, which is predated over by a carnivore, which may be eaten by another carnivore.

A food chain, can therefore, be represented as,

Producer (plant) → Herbivore → $Carnivore_1$ → $Carnivore_2$

Self Assessment

State whether the following statements are true or false:

7. A food chain consists of producers, consumers and decomposers.
8. The food chains occur only in the water.
9. The aquatic food chains are quite similar.

9.4 Food Webs

A food web of an ecosystem shows how different food chains link together, since most animals eat more than one food type and are in turn food for more than one consumer. The food web is defined as a collection of food chains which are interconnected at multiple trophic levels. They form many feeding connections in the different organisms of biotic community. It increases the stability of ecosystem. It provides other source of food and allows the endangered species to grow. The food web is modified by the taste and food habits of organisms. The availability of food and other factors are very important for its survival. In the Sunderban forests, the tiger eats the fishes and crabs when their taste of food is not present. There are few organisms which are present at more than one trophic levels.

Example: The human beings are herbivorous at one trophic level and are carnivorous at the other trophic level. There are certain varieties of cats which feed on mice as well as on the birds. These are known as wild cats. There are wolves which feed on fox along with the deer.

The concept of food web looks more ecological than the concept of food chain. The rabbit cannot kill by starvation if his preferred plant is reduced in the quantity. It can feed on the other plants. They can recover from loss by the preferred ones. The foxes, wild dogs and wild rabbits prey on the rabbits. As the number of rabbits decreases they act on the other preys which include the mice and shrews. In this span of time rabbit increase their number. There are different types of food chains in the food web. It may be predator or parasitic or saprophytic food chain. The predator food chain consists of the plants and move towards the animals. The parasitic food

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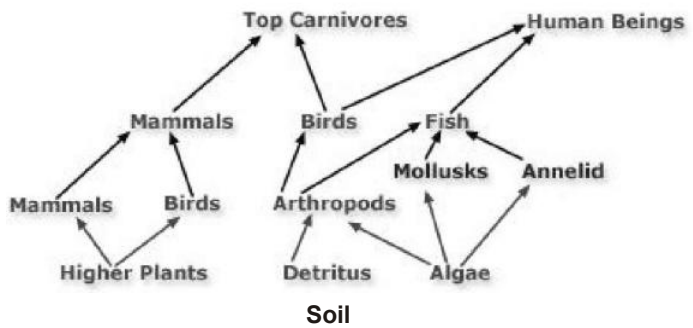
chain consists of the organisms which differ in their size. The saprophytic food chain consists of the microorganisms and dead animals.

In nature, food chain relationships are not isolated. They are very complex, as one organism may form the food source of many organisms. Thus, instead of a simple linear food chain, there is a web like structure formed by these interlinked food chains. Such interconnected matrix of food chains is called 'food web'. Food web can be defined as, "a network of food chains which are interconnected at various trophic levels, so as to form a number of feeding connections amongst different organisms of a biotic community". Food webs are indispensable in ecosystems as they allow an organism to obtain its food from more than one type of organism of the lower trophic level.

Figure 9.5: Network of Food Chain

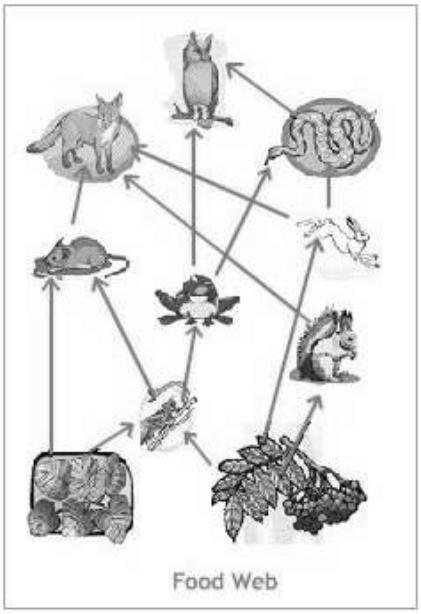


Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/food-web.php

Generally, a food web operates according to taste and food preferences of the organism, yet availability of food source and other compulsions are equally important.

Example: Tigers normally do not eat fish or crabs, but Sunderbans they are forced to feed on them in the absence of their natural prey.

Figure 9.6: Diagram of Food Web



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/food-web.php

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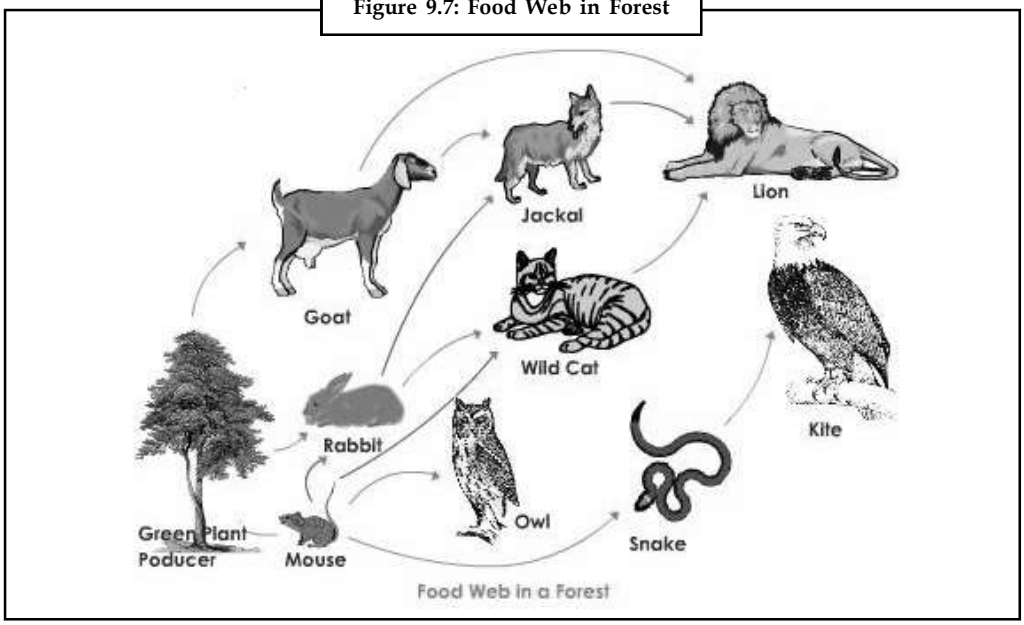
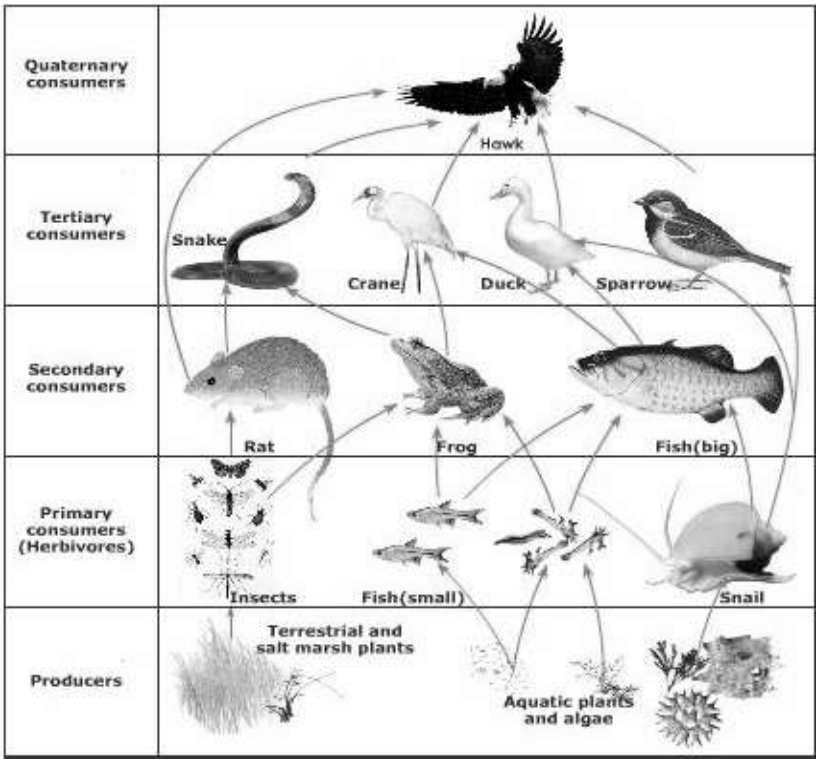
Example: Food Web in Forest is shown in Figure 9.7

Figure 9.7: Food Web in Forest



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/food-web.php

Figure 9.8: A Food Web in Terrestrial and Aquatic Ecosystem



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/food-web.php

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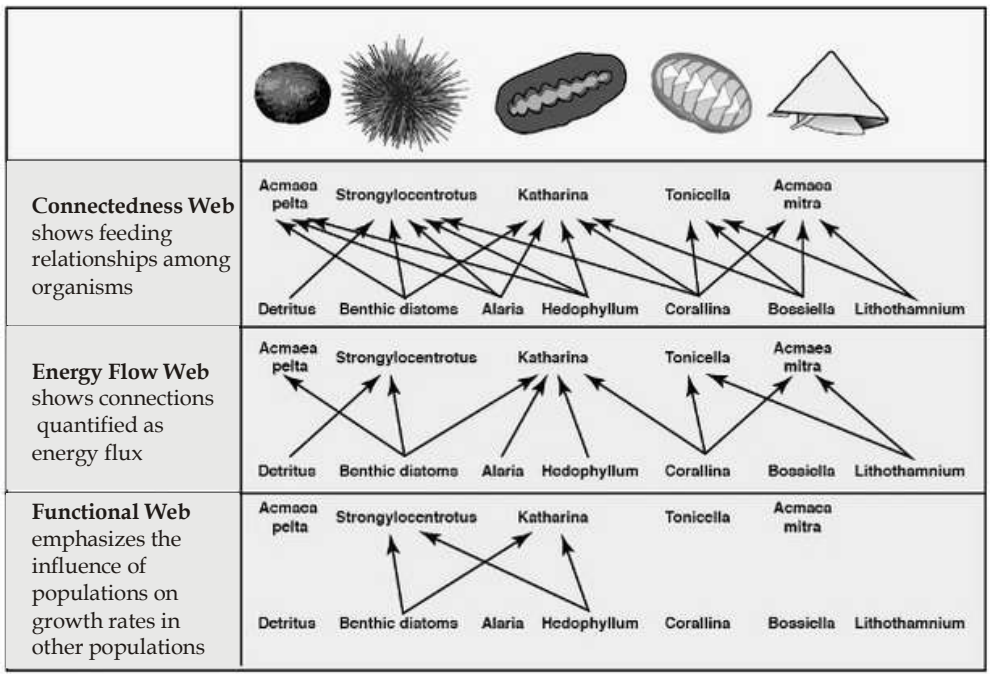
Food web is an important ecological concept. Basically, food web represents feeding relationships within a community. It also implies the transfer of food energy from its source in plants through herbivores to carnivores. Normally, food webs consist of a number of food chains meshed together. Each food chain is a descriptive diagram including a series of arrows, each pointing from one species to another, representing the flow of food energy from one feeding group of organisms to another.

Food webs describe the relationships — links or connections — among species in an ecosystem, but the relationships vary in their importance to energy flow and dynamics of species populations. Some trophic relationships are more important than others in dictating how energy flows through ecosystems. Some connections are more influential on species population change. Based on different ways in which species influence one another, Robert Paine proposed three types of food webs based on the species of a rocky intertidal zone on the coast of Washington (Figure 9.9). Connectedness webs (or topological food webs) emphasize feeding relationships among species, portrayed as links in a food web. Energy flow webs quantify energy flow from one species to another. Thickness of an arrow reflects the strength of the relationship.

Did u know? Functional webs (or interaction food webs) represent the importance of each species in maintaining the integrity of a community and reflect influence on the growth rate of other species' populations.

As shown in Figure 9.9, limpets Acmaea pelta and A. mitra in the community consume considerable food energy (energy flow web), but removal of these consumers has no detectable influence on the abundance of their resources (functional web). The most effective control was exerted by sea urchin Stronglocentrotus and the chiton Katharina.

Figure 9.9: Three types of food web diagrams based on species of a rocky intertidal zone



Source: http://www.nature.com/scitable/knowledge/library/food-web-concept-and-applications-84077181

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Self Assessment

Fill in the blanks:

10. The ..... is defined as a collection of food chains which are interconnected at multiple tropic levels.
11. The concept of food web looks more ..... than the concept of food chain.
12. Each food chain is a descriptive diagram including a series of arrows, each pointing from one species to another, representing the flow of ..... from one feeding group of organisms to another.

9.5 Ecological Pyramid

An ecological pyramid is an illustration of the reduction in energy as you move through each feeding (trophic) level in an ecosystem. The base of the pyramid is large since the ecosystem's energy factories (the producers) are converting solar energy into chemical energy via photosynthesis. A food chain can also depict a reduction in energy at each feeding level if the arrows, drawn between the different levels, continue to be reduced in size. Charles Elton developed the concept of ecological pyramid. After his name these pyramids are also called as Eltonian pyramids. It is a graphical representation or pyramid shaped diagram which depicts the number of organisms, biomass and productivity at each trophic level. Ecological pyramids begin with the producers at the bottom and proceed through the different trophic level.

9.5.1. Types of Ecological Pyramid

Succeeding levels in the pyramid represent the dependence of the organisms at a given level on the organisms at lower level. The ecological pyramids are of three types: (i) Pyramid of energy (ii) Pyramid of Biomass and (iii) Pyramid of numbers.

1. Pyramid of Energy

"Pyramid of energy is a graphic representation of the amount of energy trapped per unit time and area in different trophic level of a food chain with producers forming the base and the top carnivores at the tip".

The energy of the sun (solar energy) is perpetual source of energy. It is captured by primary producers, plants. The captured energy is used to prepare food in plants and some of the captured energy is lost in respiration and in other physiological processes of primary producers. When these plants are eaten by consumers like grasshopper (primary consumers), energy gets transferred in this process and some energy is spent for animal activities. Thus the net energy at this level is less than what we started with at first level of producer because partly it has been used in producing biomass and partly it has been lost in various activities of the organism.

The biomass of producer provides energy to the grasshopper for growth and living of the latter. When the grasshopper is eaten by frog (secondary consumers), again the energy is acquired and retained by the frog for its living and some of it get lost in carrying out various activities of frog. This process is repeated when frog is eaten by snake and snake, in turn, by hawk. The important point to be noted is that some quantity of energy is retained and the reminder is lost. The lost energy is returned to the atmosphere. Thus pyramid of energy is formed and it is vertical pyramid because less energy is transferred from each tropic level than being given to it.

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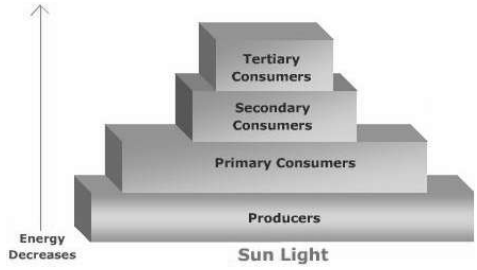
Figure 9.10: Representation of Pyramid of Energy



Source: http://www.tutorvista.com/content/biology/biology-iv/ecosystem/energy-pyramid.php

Pyramid of energy is always upright. It is so because at each transfer about 80 - 90% of the energy available at lower trophic level is used up to overcome its entropy and to perform metabolic activities. Only 10% of the energy is available to next trophic level.

The energy pyramids give the best picture of the overall nature of the ecosystem. Here there will be gradual decrease in the availability of energy from the autotrophs higher trophic levels. In other words, there is decrease in energy flow from autotrophs on/at successive trophic levels. In the course of energy flow from one organism to the other, is considerable loss of energy in the form of heat. More energy is available in the autotrophs in the primary consumers. The least amount of available energy will be in the tertiary consumer. Therefore, shorter the food chain, greater is the amount of energy available at the top.

1. The energy pyramid always upright and erect.
2. It shows the rate of energy flows at different trophic levels.
3. It shows that energy is maximum at producer level and minimum at the carnivores' level.
4. At every successive trophic level there is a loss of energy in the form of heat, respiration etc.

Notes The pyramid of numbers and pyramid of biomass have their limitations because they provide information only on the quantity of organic matter available at a particular time but not on the productivity and turnover time.

2. Pyramid of Biomass

"Pyramid of biomass is the graphic representation of biomass present per unit area of different trophic levels, with producers at the base and top carnivores at the tip". The total amount of living or organic matter in an ecosystem at any time is called '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 high up the pyramid. They are comparatively more fundamental, as they, instead of the geometric factor, show j the quantitative relationships of the standing crops. Here there will be gradual decrease in the biomass from the autotrophs to the higher trophic levels. This may be illustrated by studying the trophic levels in a pond.

Notes

The biomass in autotrophs like algae, green flagellates, green plants etc. is the maximum. The biomass is considerably less in the next trophic level occupied by secondary consumers like small fishes. The least amount of biomass is present in the last trophic level.

1. This pyramid shows the total biomass at each trophic level in a food chain.
2. Pyramid in erect.
3. It indicates a decrease in the biomass at each trophic level from the base to apex of pyramid.

Example: Total biomass than herbivores, which is again more than carnivorous.

There are two types of biomass pyramids: upright and inverted.

1. An upright pyramid is one where the combined weight of producers is larger than the combined weight of consumers.

Example: An example is a forest ecosystem.

2. An inverted pyramid is one where the combined weight of producers is smaller than the combined weight of consumers.

Example: An example is an aquatic ecosystem.

3. Pyramid of Number

"Pyramid of numbers is the graphic representation of number of individuals per unit area of various trophic levels stepwise with producers forming the base and top carnivores the tip".

They show the relationship between producers, herbivores and carnivores at successive trophic levels in terms of their number. Here there will be a gradual decrease in the number of individuals from the lower to the higher trophic levels. This may be studied by taking the example of trophic levels in grassland.

The grasses occupy the lowest trophic level and they are abundantly present in the grassland ecosystem. The deers occupy the second level; their number is less than compared to the grasses.

The wolves, which feed upon the deers, are far less in number when compared to the number of deers. The lions, which occupy the next trophic level, feed upon wolves, and the number of individuals in the last trophic level is greatly reduced.

In the parasitic food chain, the pyramid of numbers is founds to be inverted. Here, a single plant or tree might support varieties of herbivore. These herbivores like birds in turn, support varieties of parasites like lice, bugs that outnumber the herbivores.

Subsequently each parasite might support a number of hyperparasites like bacteria and fungi, which will outnumber the parasites. Thus from the producer level onwards, towards the consumers, in the parasitic food chain there is a gradual increase in the number of organisms, instead of the usual decrease.

As a result of this, the pyramid becomes inverted in the parasitic food chain. There is a gradual increase in the numbers of individuals from autotrophs to the higher trophic levels.

1. It shows the number of organism at different levels.
2. The pyramid is erect.
3. The smaller animals are preyed upon larger animals and smaller animals increase faster in number of organism at each stage of food chain, makes a triangular figure that is known as pyramid of number.

Notes

Task If "ecosystem" (no hyphen) is defined as "a system formed by the interaction of a community of organisms within their environment," should "ecosystem" (hyphenated) be used to describe a system formed by the interaction of a community of *non-biological* (say, electronic) elements within their environment? Or does it matter?

Self Assessment

State whether the following statements are true or false:

13. The ecological pyramids are of six types.
14. The energy of the sun (solar energy) is perpetual source of energy.
15. The biomass in autotrophs like algae, green flagellates, green plants etc. is the minimum.

Case Study

The Ecosystem Behind Innovation

In 1998, Michelin launched the PAX System, which would allow drivers with a punctured tyre to continue for 125 miles at up to 55mph before having to change it. The run-flat tyre would eliminate the danger of blowouts, the frustration of roadside tyre changes and the inconvenience of waiting for tow trucks – without sacrificing performance or comfort (the bane of earlier run-flat approaches). Industry analyst JD Power & Associates forecast that more than 80 per cent of cars would be fitted with run-flat tyres by 2010.

The Challenge

As well as the tyre itself, the PAX System depended on a host of other innovations to deliver its value, including a revolutionary wheel hub that would clamp the tyre rather than rely on air pressure to keep it in place; an inner support ring that would sit between the tyre and the wheel; and a pressure monitoring system. Also, because the PAX System was integrated into the car, it needed to be incorporated into vehicles at the design stage. Finally, the repair process would require garages to install dedicated new equipment to unclamp and reclamp the tyre and wheel.

The Strategy

Michelin was aware of these challenges from the outset, and devoted extensive attention and resources to bringing partners on board. Automakers saw an opportunity to differentiate on safety and design, including by finding new uses for the space formerly taken by the spare tyre. Garages would enjoy higher margins on repairs. And in an unprecedented move for this ultra-competitive industry, Michelin offered licences for the PAX System technology. Some rivals, acknowledging the PAX System's superiority, dropped their own run-flat efforts and adopted Michelin's as an industry standard.

What happened?

Acura, Audi, Nissan, Renault and other carmakers experimented with the PAX System as optional equipment on new models. Success seemed assured when Honda announced that from 2005 the PAX System would be standard equipment on the Odyssey, the best-selling minivan in the US.

Contd....

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However, despite enthusiasm among the carmakers, garages were slow to install repair equipment. For drivers, this meant their PAX tyres could not be repaired – only replaced, which was a far more costly proposition. In the US, several class action lawsuits were filed accusing Michelin and others of failure to disclose the paucity of repair facilities to car buyers. In 2007 Michelin ended further development of PAX. Michelin says it is sold "more than 200,000" PAX System assemblies. If JD Powers' forecast had been borne out, 80 per cent of 2010 car production would have meant sales of 46m in that year alone.

The lesson

The failure of PAX was caused by misunderstanding how it would affect Michelin's "ecosystem" of automotive relationships – rather than any misunderstanding of customer needs, inadequate technology or losing out to competitors. Unlike earlier tyre innovations, the success of PAX hinged on garage buy-in. But garage incentives to install the special repair equipment depended on the number of cars with PAX installed, which introduced a new interaction in the ecosystem. Even if PAX became a standard on new cars, it would be many years before they would account for a meaningful percentage of repairs – and therefore years before buying the equipment would be attractive for garages. Any company making the transition from standalone products to an integrated solution is signing on for a reconfiguration of this sort: new links, new actors and new roles. Success requires an assessment of interdependence among all partners, and clear strategies to manage them. It is no longer enough to manage your innovation: now you must manage your innovation ecosystem.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.ft.com/intl/cms/s/0/b438457a-7ca8-11e1 9d8f00144feab49a.html #axzz2NuQt2ZCB

9.6 Summary

- An ecosystem consists of the biological community that occurs in some locale, and the physical and chemical factors that make up its non-living or abiotic environment.
- Ecosystem is where community of plants, animals and their environment function as a whole, and relationship between organism and environment thrives blissfully.
- An ecosystem may be natural (like forest, lake, ocean, etc.) or man-made (such as an aquarium, a crop field, etc.), temporary (like a rainfed pond) or permanent (like a lake, forest, etc), aquatic (such as pond, ocean etc) or terrestrial (like grassland, forest, etc).
- An ecosystem may be as small as a drop of pond water and as large as an ocean.
- Herbivores are referred as First order consumers or primary consumers, as they feed directly on plants.
- The structure of an ecosystem includes the living community (biotic components like plants, animals), their diversity, life history and distribution, etc.
- An ecosystem is the basic functional unit that includes organisms and the physical environment, which are interacting and influencing each other and having relationship of interdependence.

Notes

- The numerical strength and biomass of organisms affect the functioning of ecosystem.
- Solar energy is used in the process of food production (photosynthesis).
- Food Chain is the sequence of populations of an ecosystem which allows food and energy to go through it in a specified direction.
- A food web of an ecosystem shows how different food chains link together, since most animals eat more than one food type and are in turn food for more than one consumer.
- An ecological pyramid is an illustration of the reduction in energy as you move through each feeding (trophic) level in an ecosystem.

9.7 Keywords

Autotrophs: An organism that is able to form nutritional organic substances from simple inorganic substances such as carbon dioxide.

Biomass: Biomass is biological material derived from living, or recently living organisms.

Carnivores: A carnivore is an animal that gets food from killing and eating other animals.

Decomposers: Decomposers and scavengers break down dead plants and animals. They also break down the waste (poop) of other organisms.

Ecological Pyramid: An ecological pyramid is an illustration of the reduction in energy as you move through each feeding (trophic) level in an ecosystem.

Ecosystem: Ecological system or ecosystem is an open space built by physical and biological components of an environment.

Food chain: Food chain is a series of groups of organisms called trophic levels, in which, there is repeated eating and eaten by so as to transfer food energy.

Food Webs: The food web is defined as a collection of food chains which are interconnected at multiple trophic levels.

Herbivorous: A herbivore is an organism anatomically and physiologically adapted to plant material, for example foliage, as the main component of its diet.

Law of Conservation of Energy: The law of conservation of energy is that energy cannot be created or destroyed, but it can be transferred or transformed from one form to another (including transformation into or from mass, as matter).

Quaternary consumers: The Quaternary consumer is the predator that eats the Tertiary consumer.

Saprotrophs: An organism that lives on or in non-living organic matter, secreting digestive enzymes into it and absorbs the products of digestion

Stratification: Stratification describes the way in which different groups of people are placed within society.

9.8 Review Questions

1. What do you understand by Ecosystem?
2. Highlight the components of Ecosystem.
3. Define Herbivores.

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4. What do you understand by Autotrophs?
5. Explain the structure of Ecosystem.
6. Throw some light on the functions of Ecosystem.
7. "Energy transformation in ecosystems is explained in relation to the laws of thermodynamics." Elucidate.
8. Write brief note on energy flow in ecosystem.
9. Define Food chain with the help of example.
10. Discuss food web of an ecosystem.
11. What do you understand by Ecological Pyramid?
12. Distinguish between pyramid of energy and pyramid of number.

Answers: Self Assessment

1.	True	2.	False
3.	False	4.	Solar energy
5.	Thermodynamics	6.	Herbivore
7.	True	8.	False
9.	True	10.	Food Web
11.	Ecological	12.	Food Energy
13.	False	14.	True
15.	False		

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Unit 10: Environmental Pollution

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Objectives

After studying this unit, you should be able to:

- Discuss the meaning of Environment Pollution
- Explain the Meaning, Causes, Effects and Control Measures of Air Pollution
- Describe the Meaning, Causes, Effects and Control Measures of Water Pollution
- Understand the Meaning, Causes, Effects and Control Measures of Soil Pollution
- Discuss the Meaning, Causes, Effects and Control Measures of Marine Pollution
- Understand the Meaning, Causes, Effects and Control Measures of Noise Pollution

Introduction

In the previous unit, we dealt with the meaning, structure, functions, and energy flow of Ecosystem along with the food chain, food webs and Ecological Pyramid. Environmental Pollution is a major global concern of the day. In India too we are facing lot of environmental problems. Globally speaking environmental pollution problem is much bigger than we think it is, even in many our cities there are problems with dirty air, or sound pollution from traffic and different other disturbing noises. The most severe environmental pollution is happening in developing countries of the third world because not only to they lack any form of sustainable management but they also lack even the basic sanitation so you can imagine how bad the environmental condition in these countries is. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the meaning of Environmental Pollution and discuss the meaning causes, effects and controlling measures of various types of pollution that is Air, Water, Soil, Marine and Noise.

10.1 Meaning of Environmental Pollution

The most appropriate definition of environmental pollution would be the introduction of different harmful pollutants into certain environment that makes this environment unhealthy to live in. The most common pollutants are usually chemicals, garbage, and waste water. Environmental pollution is happening in many parts of the world, especially in form of air and water pollution. The best example for air pollution is some of China's cities, including capital Beijing, and the best example for water pollution is India with its Ganges river pollution problem.

Environmental pollution is the build-up and concentration of toxic levels of chemicals in the air, water, and land, which reduces the ability of the affected area to support life. Pollutants may be gaseous–ozone and carbon monoxide.

Example: Liquid discharge from industrial plants and sewage systems; or solid-landfills and junkyards.

According to Environment Protection Act (1986), Environment includes water, air, land and their inter relationship with human beings, other living creatures, plants and microorganisms. Pollution refers to the presence of substances in air, water and land, whether they result from human activity or occur naturally which have adverse effects on human and on environment. Air pollution is thus the state of environment in which the outer atmosphere gets contaminated with gases and other materials in concentration which are harmful to man and environment. The contamination of air occurs because the contaminants cannot be absorbed by natural environmental cycles.

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The atmosphere is being polluted by the discharge of emissions originating from industrial plants, domestic sources, mobile vehicles and thermal power plants. Both in the developed and developing countries, the urban areas in particular, are exposed to such levels of atmospheric pollution that cause serious hazard to public health and hygiene. Presence of sulphur oxides, nitrogen oxides, carbon monoxide, hydro carbons and toxic particulate substances in atmosphere have caused harmful influence on man and other living beings.

Pollution depicts the substances (pollutants) which are released into the environment because of anthropogenic (human) activities that can be either deliberate or accidental. The reference point for pollution is the ambient quality of the environment which means environment in its natural state. Human activities, whether industrial production or others like sewage, result in the change in the ambient quality of the latter. In the production process, certain substances (wastes) are recycled or produced in the form of emissions/effluents and they impact the environment leading to damage to humans and ecosystem.

Notes It may be worthwhile to note that there are natural sources of pollution too. These are substances released from volcano eruptions or forest fires. But these natural pollutants don't stay long in the atmosphere since they can be recycled in the biological or chemical cycles. Hence, they pose only a short-term problem and that too localised.

Pollution of the environment is causing great damage to ecosystem that depends upon the health of this environment. Air and water pollution can cause death of many organisms in given ecosystem, including humans. Water pollution according to some estimates cause 14.000 deaths each day in the world, most of them in India. This is really no surprise when you look at the data that says that 700 million Indians do not even have access to a proper toilet, whether alone clean water. Many developed countries have introduced certain laws to not only regulate various types of pollution but also the laws to mitigate the adverse effects of pollution. Pollution levels need to be controlled all the time if we want to keep our environment safe and healthy. Without proper pollution control environment soon becomes unhealthy. Preventing introduction of pollutants into some environment is the best way to protect environment from pollution. To do so it is important to develop ecological conscience of nearby communities, and effective waste management in form of recycling.

The environmental imbalance gives rise to various environmental problems. Some of the environmental problems are pollution, soil erosion leading to floods, salt deserts and sea recedes, desertification, landslides, change of river directions, extinction of species, and vulnerable ecosystem in place of more complex and stable ecosystems, depletion of natural resources, waste accumulation, deforestation, thinning of ozone layer and global warming. The environmental problems are visualized in terms of pollution, growth in population, development, industrialization, unplanned urbanization etc. Rapid migration and increase in population in the urban areas has also lead to traffic congestion, water shortages, solid waste, and air, water and noise pollution are common noticeable problems in almost all the urban areas since last few years.

Caution As a result of over-population, rapid industrializations, and other human activities like agriculture and deforestation etc., earth became loaded with diverse pollutants that were released as by-products.

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Pollutants are generally grouped under two classes:

(a) ***Biodegradable pollutants:*** Biodegradable pollutants are broken down by the activity of microorganisms and enter into the biogeochemical cycles.

Example: Such pollutants are domestic waste products, urine and faecal matter, sewage, agricultural residue, paper, wood and cloth etc.

(b) ***Non-Biodegradable pollutants:*** Non-biodegradable pollutants are stronger chemical bondage, do not break down into simpler and harmless products.

Example: These include various insecticides and other pesticides, mercury, lead, arsenic, aluminium, plastics, radioactive waste etc.

The Air (Prevention and Control of Pollution) Act, 1981, defines "Air Pollutant" and in reference to them defines air pollution. "Air Pollutant" means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment. Air pollution means the presence in the atmosphere of any air pollutant. In this connection, definition of "Emission" is also relevant. "Emission" means any solid, liquid or gaseous substance coming out of any chimney, duct or any other outlet. There are 'standards' and legislation that exist for emissions. The company manager must be familiar with these. They should also ensure that emissions stay within legal limits.

Did u know? Approximately 95 per cent of earth's air occurs in the lower levels, the troposphere. In natural state this air contains 78% nitrogen, 21% oxygen, 0.4% carbon dioxide plus small amounts of other gases and water vapours. Rest (5%) of the planet air occurs in the upper levels, the stratosphere, together with gases like ozone.

Air pollutants can be primary or secondary. Primary pollutants are carbon dioxide, nitrogen oxides, sulphur dioxide, carbon monoxide (all formed from the combustion of fossil fuels), CFC and particulate matter. Secondary pollutants are acid rain and ozone. Sulphur dioxide and nitrogen dioxide combine with water in the atmosphere and react with sunlight forming acid droplets. These acid droplets constitute Acid Rain.

Caselet

Air Pollution in Madras City

The history of Madras began with the history of the British in India. In 1639, twenty five years before the British reached Bombay and 50 years before they arrived in Calcutta, the Rajah of Chandragiri gave Francis Day a lease to open a trading post for the British East India Company on the site of Madras, then known as Madraspatnam. The following year, work began on Fort St. George that was finished in 1653. From this strong hold, Britain held Madras until India achieved Independence with the exception of a two year period beginning in 1746, when Dupleix captured it for France.

Madras, also known as Chennai, the gracious capital city of Tamil Nadu is the fourth largest metropolis in India. Located on a 17 km stretch of the Coromandel coast, the city is trisected by the rivers: Cooum, Adyar and the Buckingham Canal. Chennai is a city that is growing, expanding and changing every year.

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Popularly regarded as the 'Gateway to the South', Chennai represents a culture that is distinctly different from that of northern India. Music, dance and all other art forms of the South are cherished and nurtured in this city which, though industrialised, continues to be traditional and conventional in many ways.

Chennai is a city where the traditional and the modern mix in everyday life everywhere. From traditional vegetarian fare to fast foods, from nine-yard saris to the latest in fashion, from ancient temple architecture to modern high rise - with Indo-Saracenic and Victorian as stops along the way - from classical music and dance to discos throbbing to heady beats, Chennai has them all and many more vivid contrasts that are a constant surprise. And perhaps the most striking of them all is that there is a modern metropolis with beaches, parks and even sanctuaries in the heart of the City. Chennai offers a wealth of Nature and a rich historic past to visitors in the ambience of a city with every modern facility.

IT appears to be a strange paradox, a precarious balance of the extremes. On the one side, Chennai has the distinction of ushering in the era of corporate healthcare in the country. On the other side, the metro continues to be besieged by a multitude of diseases. The city may have state-of-the-art medical technology but it is also host to insanitary conditions, pollution and deteriorating air and water quality.

The ambient air quality of Chennai has deteriorated with an increase in the number of vehicles and industrial pollution. A recent study by the State Pollution Control Board (PCB) found that the levels of suspended particulate matter (SPM) ranged from 274 to a mind-boggling 1,470 micrograms/cubic metre (micro g/m^3) at several areas, which was much higher than the WHO prescribed limit of 200 pg/M3. The level of carbon - monoxide ranged from 12 to 70 parts per million (ppm) as against the permitted 35 ppm. The study also showed that emissions from nearly 50 per cent of the vehicles in the city exceeded the permitted levels and the pollution load in the atmosphere increased by 3.5 per cent annually. A joint exercise in 1994 by the Automobile Association of South India (AASI), the Anna University and the PCB, showed that 73 per cent of the 1,746 vehicles tested randomly, exceeded the emission standards. From less than 200,000 vehicles in 1981-82, the vehicle population in Chennai has risen to 889,000, with 250 vehicles being added everyday. Nearly 75 per cent of the vehicles are two wheelers, a majority of them being two-stroke. Dr. Krishna said the SPM level was high in most of the areas surveyed by the CPR Foundation, ranging from 163.15 to 1,835 pg/M^3. The situation on working days was worse than that on holidays.

Due to air pollution, tuberculosis continues to be a major problem though there has not been a steep rise in the incidence in the last five years. Dr. K. Jagannath, of the Institute of Thoracic Medicine, said a study conducted four years ago found 25 per cent of children living in slums to be suffering from primary complex (the early stages of TB). Dr. C. N. Deivanayagam, Superintendent of the TB sanatorium in Tambaram (a suburb), said the outpatient (OP) attendance at the hospital had doubled in the last five years and the bed occupancy rate had increased from 76.16 to 178.6 per cent. The number of outpatients had more than doubled from 143,135 in 1995 to 300,376 in 1995.

The number of asthma cases has also increased substantially, according to Dr. Deivanayagam. Most of the cases were reported from north Madras which is dotted by several polluting industries. Non-seasonal asthma is also prevalent, with complaints of sneezing and sinusitis becoming common. There is a slight increase in the fatalities due to acute asthma, according to Dr. Jagannath. He also finds a perceptible increase in the incidence of respiratory diseases.

Source: http://www.ess.co.at/GAIA/CASES/IND/MAD/MADpollution.html

Notes

Self Assessment

State whether the following statements are true or false:

1. The contamination of air occurs because the contaminants can be absorbed by natural environmental cycles.
2. Pollution of the environment is causing great damage to ecosystem that depends upon the health of this environment.
3. The environmental imbalance gives rise to various environmental problems.

10.2 Air Pollution: Meaning, Causes, Effects and Control Measures

The Meaning, Causes, Effects and Control Measures of Air Pollution are discussed below:

10.2.1 Meaning of Air Pollution

Air pollution is the contamination of the air by the discharge of harmful substances. Air pollution may be described as contamination of the atmosphere by gaseous, liquid or solid wastes or by-products that can endanger human health and welfare of plants and animals, attack materials, reduce visibility, or produce undesirable odours. As some pollutants are released by natural sources like volcanoes, coniferous forests, and hot springs, the effect of this pollution is very small when compared to that caused by emissions from industrial sources, power and heat generation, waste disposal, and the operation of internal-combustion engines. Fuel combustion is the largest contributor to human caused air pollutant emissions, with stationary and mobile sources responsible for approximately equal amounts. The air pollution problem is both outdoors and indoors. Indoor air pollution first came to our attention in the 1980's, while outdoor pollution has been around for a much longer time. The major pollutants which contribute to the indoor air pollution include **radon, volatile organic compounds, formaldehyde, biological contaminants, and combustion by-products such as carbon dioxide, sulphur dioxide, hydrocarbons, nitrogen dioxides, and particulates.** The major pollutants which contribute to outdoor air pollution are **sulphur dioxide, carbon dioxide, carbon monoxide, nitrogen oxides, ozone, total suspended particulate matter, lead, carbon dioxide, and toxic pollutants.**

Air is mainly a mixture of various gases such as oxygen, carbon dioxide, nitrogen. These are present in a particular ratio. Whenever there is any imbalance in the ratio of these gases, air pollution is caused. The sources of air pollution can be grouped as under:

(i) Natural; such as, forest fires, ash from smoking volcanoes, dust storm and decay of organic matters.

(ii) Man-made due to population explosion, deforestation, urbanization and industrializations.

Certain activities of human beings release several pollutants in air, such as carbon monoxide (CO), sulphur dioxide (SO_2), hydrocarbons (HC), oxides of nitrogen (NOx), lead, arsenic, asbestos, radioactive matter, and dust. The major threat comes from burning of fossil fuels, such as coal and petroleum products. Thermal power plants, automobiles and industries are major sources of air pollution as well. Due to progress in atomic energy sector, there has been an increase in radioactivity in the atmosphere. Mining activity adds to air pollution in the form of particulate matter. Progress in agriculture due to use of fertilizers and pesticides has also contributed towards air pollution. Indiscriminate cutting of trees and clearing of forests has led to increase in the amount of carbon dioxide in atmosphere. Global warming is a consequence of green house effect caused by increased level of carbon dioxide (CO_2). Ozone (O_3) depletion has resulted in UV radiation striking our earth.

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Caution Air pollution is a problem at local or national level but sometime it may emanate in one country and may engulf the neighbouring countries.

It seems that earliest effort at air pollution control was made by the WHO (World Health Organisation) Conference in 1957-58. It is known as "Clean Air Conference". Later a symposium was held on Epidemiology of Air Pollution at the regional office of WHO for Europe in 1966. The 1972 Stockholm Conference was the first major effort to discuss control of pollution including air pollution.

In 1974 some of the major industrial countries of the world (19 European countries, Australia, Canada and Japan) convened a meeting for the control of air pollution. In this meeting two basic principles were evolved:

(i) Polluter must pay for pollution, and

(ii) Trans-frontier air pollution should be controlled.

The principle that 'polluter must pay for pollution' laid down that the industry where pollution originates must pay for its control. The second concept says that no single state should be taken into account as a unit of protection against air pollution but the aim should be the welfare and preservation of health, not only of people of one state but of people throughout the world. And protection should be of total environment for the good of mankind and other living beings of the planet.

10.2.2 Causes of Air Pollution

There are several main causes of air pollution; the vast majority of them can be attributed to man. Air pollution is the introduction into the atmosphere of chemicals, particulates, and biological matter that cause harm to humans, other living organisms, or cause damage to the natural environment. Stratospheric ozone depletion (contributed to air pollution) has long been recognized as a threat to human health as well as to the Earth's ecosystems. The Earth is capable of cleaning itself of a certain level of pollution, but man-made pollutant have become too numerous for the Earth's natural mechanisms to remove. We are seeing the results of this overload in the form of acid rain, smog, and the variety of health problems that can be contributed to our environment.

One of the main causes of air pollution is manufacturing. This source of pollution spews particulate matter and chemicals into the atmosphere. The exhaust from a factory includes, sulphur oxides, nitrogen oxides, carbon monoxide and dioxide, as well as volatile organic compounds and particulates. There is not an area of the Earth's atmosphere or an ecosystem that has not been altered by the long term effects of the pollution created by manufacturing. Strides have been made to filter the material coming from manufacturing plants, but it may take the Earth millennia to completely recover from the damage already done.

As the list of causes of air pollution goes this next offender is number one. The burning of fossil fuels is a part of the everyday life of every human on the planet. We burn fossil fuels in our cars, fossil fuel is burned to extract fossil fuel from the Earth, and fossil fuel is used to process fossil fuel into its individual components. Every step of the way releases sulphur and nitrogen oxides, carbon monoxide, heavy metals, and particulates into the air. Each step in the process increases the number of asthma cases in the world, raises a person's chance of having cancer, and increases the chance that your child will be born with congenital defects.

Notes

The causes and damages of pollutants are shown in Table 10.1:

Table 10.1: Causes and Damages of Pollutants

Pollutant	Source	Human Damage
Nitrogen dioxide (NO_2)	Produced when fuel is burned in vehicles, heating systems, etc.	It stimulates the mucous membrane of eyes and noses; causes chronic diseases such as respiratory disease, asthma, and heart disease; reduces the capacity of the lungs.
Ozone (O_3)	Produced by the photochemical reaction of nitrogen oxides. Office photocopier, laser printer, etc.	It irritates eyes, stimulates noses, and stifles heart; causes eye problems; increases the obstruction of the airway; reduces the capacity of the lungs; causes dyspnea in the worst cases.
Volatile organic compounds (VOCs)	Produced from paints, pigments, and vehicles.	The small amount in the air may cause a serious cancer.
Formaldehyde (HCHO)	Produced from adhesives for veneer boards and other wood products.	When exposed to it for a long time, it may cause emotional disorder, memory loss, or concentration problem. It may stimulate eyes, noses, and respiratory organs chronically.
Ammonia (NH_3)	Produced when organic matter is spoiled or from agricultural chemical, plating, refrigerator, decolourant, and nylon factory.	It may stimulate eyes, the airway, or respiratory organs and cause pulmonary oedema.
Sulphur dioxide (SO_2)	Discharged from thermoelectric power plant, refinery, and steel mill, or sulphur fuel is burned.	It may cause bronchial troubles, asthma, vesicular emphysema, or pneumonia.

Source: http://eng.me.go.kr/content.do?method=moveContent&menuCode=res_kid_cle_pol_causes

Human activities that result in air pollution include:

1. ***Emissions from Industries and Manufacturing Activities:*** Have you seen a manufacturing company before? You will notice that there are long tubes (called chimneys) erected high into the air, with lots of smoke and fumes coming out of it. Waste incinerators, manufacturing industries and power plants emit high levels of carbon monoxide, organic compounds, and chemicals into the air. This happens almost everywhere that people live. Petroleum refineries also release lots of hydrocarbons into the air.

2. ***Burning Fossil Fuels:*** After the industrial age, transportation has become a key part of our lives. Cars and heavy duty trucks, trains, shipping vessels and airplanes, all burn lots of fossil fuels to work. Emissions from automobile engines contain both primary and secondary pollutants. This is a major cause of pollution, and one that is very difficult to manage. This is because humans rely heavily on vehicles and engines for transporting

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people, good and services. Fumes from car exhausts contain dangerous gases such as carbon monoxide, oxides of nitrogen, hydrocarbons and particulates. On their own, they cause great harm to people who breathe them. Additionally, they react with environmental gases to create further toxic gases.

3. ***Household and Farming Chemicals:*** Crop dusting, fumigating homes, household cleaning products or painting supplies, over the counter insect/pest killers, fertilizer dust emit harmful chemicals into the air and cause pollution. In many case, when we use these chemicals at home or offices with no or little ventilation, we may fall ill if we breathe them.

10.2.3 Effects of Air Pollution

A variety of air pollutants have known or suspected harmful effects on human health and the environment. In most areas of Europe, these pollutants are principally the products of combustion from space heating, power generation or from motor vehicle traffic. Pollutants from these sources may not only prove a problem in the immediate vicinity of these sources but can travel long distances. Like photochemical pollutants, sulphur oxides contribute to the incidence of respiratory diseases. Acid rain, a form of precipitation that contains high levels of sulphuric or nitric acids, can contaminate drinking water and vegetation, damage aquatic life, and erode buildings. When a weather condition known as a temperature inversion prevents dispersal of smog, inhabitants of the area, especially children and the elderly and chronically ill, is warned to stay indoors and avoid physical stress. The dramatic and debilitating effects of severe air pollution episodes in cities throughout the world—such as the London smog of 1952 that resulted in 4,000 deaths—have alerted governments to the necessity for crisis procedures. Even everyday levels of air pollution may insidiously affect health and behaviour. Indoor air pollution is a problem in developed countries, where efficient insulation keeps pollutants inside the structure. In less developed nations, the lack of running water and indoor sanitation can encourage respiratory infections.

Example: Carbon monoxide, by driving oxygen out of the bloodstream, causes apathy, fatigue, headache, disorientation, and decreased muscular coordination and visual acuity.

Air pollution may possibly harm populations in ways so subtle or slow that they have not yet been detected. For that reason research is now under way to assess the long-term effects of chronic exposure to low levels of air pollution—what most people experience—as well as to determine how air pollutants interact with one another in the body and with physical factors such as nutrition, stress, alcohol, cigarette smoking, and common medicines. Another subject of investigation is the relation of air pollution to cancer, birth defects, and genetic mutations. A relatively recently discovered result of air pollution are seasonal "holes" in the ozone layer in the atmosphere above Antarctica and the Arctic, coupled with growing evidence of global ozone depletion. This can increase the amount of ultraviolet radiation reaching the earth, where it damages crops and plants and can lead to skin cancer and cataracts. This depletion has been caused largely by the emission of chlorofluorocarbons (CFCs) from refrigerators, air conditioners, and aerosols. The Montreal Protocol of 1987 required that developed nations signing the accord not exceed 1986 CFC levels. Several more meetings were held from 1990 to 1997 to adopt agreements to accelerate the phasing out of ozone-depleting substances.

Air pollution is responsible for major health effects. Every year, the health of countless people is ruined or endangered by air pollution. Many different chemicals in the air affect the human body in negative ways. Just how sick people will get depends on what chemicals they are exposed to, in what concentrations, and for how long. Studies have estimated that the number of people killed annually in the US alone could be over 50,000. Older people are highly vulnerable

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to diseases induced by air pollution. Those with heart or lung disorders are under additional risk. Children and infants are also at serious risk.

Because people are exposed to so many potentially dangerous pollutants, it is often hard to know exactly which pollutants are responsible for causing sickness. Also, because a mixture of different pollutants can intensify sickness, it is often difficult to isolate those pollutants that are at fault. Many diseases could be caused by air pollution without their becoming apparent for a long time. Diseases such as bronchitis, lung cancer, and heart disease may all eventually appear in people exposed to air pollution. Air pollutants such as ozone, nitrogen oxides, and sulphur dioxide also have harmful effects on natural ecosystems. They can kill plants and trees by destroying their leaves, and can kill animals, especially fish in highly polluted rivers.

Here, we will sum up and briefly explain the main environmental effects of air pollution:

1. Acid Deposition

Acid deposition is not merely characterized as acid rain; it can also be snow and fog or gas and dust. Acid deposition mainly forms during fossil fuel combustion. When emissions of sulphur dioxide and nitrogen oxides come in contact with water, they will become sulphuric acid and nitric acid. When acidifying agents, such as sulphur dioxide, nitrogen oxides and ammonia, end up in plants, surface water and soils, this has a number of consequences:

- Availability of nutrients and metal spores is likely to decrease.
- When acidity is high more metals will dissolve in water. This can cause surface water to become polluted, which has serious health effects on aquatic plants and animals.

Example: High aluminium (Al) concentrations can complicate nutrients uptake by plants. This makes aluminium one of the prior causes of forest decay. Mercury can be dispersed by transport through surface water, causing it to accumulate in fish. Mercury can bio magnify up the food chain, to be taken up by humans eventually.

- Buildings and monuments may be damaged through erosion. Sulphur dioxide breaks down limestone by reacting with calcium carbonate, causing limestone to absorb water during rainfall. Limestone will than fragment.

2. Eutrophication

Eutrophication is caused by an increase in plant nutrients in water. The higher availability of nutrients causes certain water plants, such as algae and duckweed, to grow so extensively. This blocks sunlight supplies to water. The plants also use all available oxygen supplies, which will not be renewed because heterotrophic plants and bacteria need light to perform photosynthesis. Eutrophication causes ecosystem disruption. Nitrogen pollutants such as nitrogen oxides and ammonia contribute to this problem.

3. Smog

Smog is a combination of the words smoke and fog. We can distinguish two separate types of smog, summer smog and winter smog. Photochemical smog, or summer smog, mainly consists of ozone. It is a brown, oxidising fog. The causes of photochemical smog are nitrogen oxides and VOC, which stem from traffic and industries. Ozone is formed according to the following chemical reactions:

$$NO_2 + UV \rightarrow NO + O$$

$$O + O_2 \rightarrow O_3$$

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The reverse reaction is:

$$NO + O_3 \rightarrow NO_2 + O_2$$

The best circumstances for the creation of high ozone concentrations are summer temperatures, direct sunlight and standing air layer, which enable dilution of contaminants. Humans cannot adapt to smog. Health effects of smog greatly depend upon the concentrations of ozone and other photochemical oxidants. These contaminants cause eye and respiratory irritations. Plants are extremely vulnerable to ozone. Even in low concentrations it can cause serious damage. Winter smog is also referred to as acid smog; it mainly consists of foggy elements. Winter smog is found in areas where vertical dispersion of air pollutants is not possible. Usually temperatures decrease during the day in high air layers. Heated air layers near the earths' surface rise, causing the air pollutants to be dispersed vertically, and to be diluted. In winter ground temperatures are sometimes lower than those of the upper atmospheric layers, causing the air to stay near the ground, so that pollutants will not spread. This causes winter smog. Winter smog can form when temperatures are low and sulphur dioxide concentrations increase consequential to central heater emissions from houses. The cold outside air will cause moist to condensate into fog. Aerosols in air play a part in this process, because they serve as condensation cores for water vapour. Humidity aids the transfer of sulphur dioxide to sulphuric acid, causing the smog to be acid. Acid smog causes breathing problems and eye irritations.

4. Ozone Loss

Ozone is created everywhere in the atmosphere through chemical reactions under the influence of UV-light. Ozone is decomposed under the influence of visible light and UV-A light. During ozone decomposition an oxygen-poor molecule is released, which aids the breakdown of ozone. There are a number of compounds that catalyse ozone decomposition. Examples are hydroxide (OH), nitrogen oxides, chlorine (Cl) and bromine (Br). Chlorine mainly aids the decomposition of ozone when it is a part of CFC-bonds (Chloro-Fluoro-Carbohydrates). These compounds are not lost during the chemical reaction, causing them to decompose ozone multiple times. The decomposition and production of ozone is a natural process. However, human activities have caused large concentrations of ozone-decomposing chemicals to enter the atmosphere, causing the natural balance to be disrupted.

Ozone is very important for all life on earth, because it absorbs harmful UV-B radiation from the sun. The highest concentrations of ozone are located in the atmospheric layer between twenty and forty kilometres above the earth. When the ozone concentrations in this layer decrease, UV-B radiation may reach the earth. This radiation damages DNA and causes skin cancer. The radiation can also damage the human immune system, causing humans to become more susceptible to infections. UV-B radiation also causes cataract and nearsightedness. The radiation can decrease growth and photosynthesis activity in a number of plants. Primary crops, such as rice, corn and sunflower are very susceptible to this. Trees are also susceptible to the radiation. UV-B radiation can affect aquatic life up to twenty metres under the water surface. It is damaging to species, such as plankton, fish larvae, shrimps, crabs and seaweeds. Phytoplankton forms the basis of the aquatic food chain. When radiation causes phytoplankton to decrease in number it will affect entire ecosystems.

10.2.4 Measures to Control Air Pollution

Air pollution control helps to keep the environment clean. In order to reduce the amount of air pollution that is allowed to escape into the environment, various pollution control measures must

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be taken by individuals and industries alike. While there are different types of air pollution control available, understanding the main differences between these methods can be confusing. The best methods for air pollution control often depend on the individual or industry using them.

Activated carbon is one of the most popular forms of air pollution control. This type of control involves the use of a pollution filter, carbon, to reduce the amount of pollutants that are allowed to escape into the air. When in use, these filters absorb pollutants helping to cleanse the air of any possible toxins.

Biofiltration is another effective type of air pollution control. It uses microorganisms, often bacteria and fungi, to dissolve pollutants. Industries that employ biofiltration systems include food and waste plants, pharmaceutical companies, and wastewater management facilities. While this method of air pollution control works rather well, a large space is required in order to operate a biofiltration system. Many industries do not have this amount of available space, so this method is often disregarded.

Since car engine emissions are responsible for a large portion of air pollution, various measures must be taken in order to reduce these emissions. Often, catalytic oxidizers are placed inside of car exhaust systems. These oxidizers help to reduce the amount of emissions that a car creates. Oxidizers do not completely reduce air pollution caused by automobiles, however.

Hydrocarbons produced by vehicles are still allowed to escape into the environment, even with the installation of a catalytic oxidizer. This poses a large problem, since hydrocarbons are highly damaging to the environment. Scientists are currently working on a way to reduce vehicle emissions completely, though a practical version this type of air pollution control is not yet available.

Even though the aforementioned air pollution control methods are effective, each country around the world has a different set of pollution standards set in place. Within the United States, the Environmental Protection Agency (EPA) monitors emissions control. Europe has another set of emissions standards, while China and India have entirely different standards.

In order to reduce global air pollution, many environmental experts believe that all countries across the world should have the same emissions standards. This way, air pollution can be managed on a global level. Presently, a worldwide emissions standard has not been established, though many are hopeful that this will change within the near future.

Task How does air pollution spread and how can we handle this?

Self Assessment

Fill in the blanks:

4. ..... is mainly a mixture of various gases such as oxygen, carbon dioxide, nitrogen.

5. It seems that earliest effort at air pollution control was made by the ..... Conference in 1957-58.

6. The Montreal Protocol of 1987 required that developed nations signing the accord not exceed 1986 ..... levels.

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10.3 Water Pollution: Causes, Effects and Control Measures

The Meaning, Causes, Effects and Control Measures of Water Pollution are discussed below:

10.3.1 Meaning of Water Pollution

Water pollution, in simple terms, can be defined as the contamination of the water bodies when pollutants are released into the water without thorough treatment and removal of harmful components. It not only affects the environment and human well-being, but also disrupts the balance of the ecosystem. Here are some of the major effects of water defilement on man and the environment.

When toxic substances enter lakes, streams, rivers, oceans, and other water bodies, they get dissolved or lie suspended in water or get deposited on the bed. This results in the pollution of water whereby the quality of the water deteriorates, affecting aquatic ecosystems. Pollutants can also seep down and affect the groundwater deposits. Water pollution has many sources. The most polluting of them are the city sewage and industrial waste discharged into the rivers. The facilities to treat waste water are not adequate in any city in India. Presently, only about 10% of the waste water generated is treated; the rest is discharged as it is into our water bodies. Due to this, pollutants enter groundwater, rivers, and other water bodies. Such water, which ultimately ends up in our households, is often highly contaminated and carries disease-causing microbes. Agricultural run-off, or the water from the fields that drains into rivers, is another major water pollutant as it contains fertilizers and pesticides. Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. The sources of water pollution are categorized as being a point source or a non-source point of pollution. Point sources of pollution occur when the polluting substance is emitted directly into the waterway.

Example: A pipe spewing toxic chemicals directly into a river is an example.

A non-point source occurs when there is runoff of pollutants into a waterway, for instance when fertilizer from a field is carried into a stream by surface runoff.

Various types of Water Pollution are as follows:

1. ***Toxic Substance:*** A toxic substance is a chemical pollutant that is not a naturally occurring substance in aquatic ecosystems. The greatest contributors to toxic pollution are herbicides, pesticides and industrial compounds.
2. ***Organic Substance:*** Organic pollution occurs when an excess of organic matter, such as manure or sewage, enters the water. When organic matter increases in a pond, the number of decomposers will increase. These decomposers grow rapidly and use a great deal of oxygen during their growth. This leads to a depletion of oxygen as the decomposition process occurs. A lack of oxygen can kill aquatic organisms. As the aquatic organisms die, they are broken down by decomposers which lead to further depletion of the oxygen levels.

Notes A type of organic pollution can occur when inorganic pollutants such as nitrogen and phosphates accumulate in aquatic ecosystems. High levels of these nutrients cause an overgrowth of plants and algae. As the plants and algae die, they become organic material in the water. The enormous decay of this plant matter, in turn, lowers the oxygen level. The process of rapid plant growth followed by increased activity by decomposers and a depletion of the oxygen level is called eutrophication.

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3. ***Thermal Pollution:*** Thermal pollution can occur when water is used as a coolant near a power or industrial plant and then is returned to the aquatic environment at a higher temperature than it was originally. Thermal pollution can lead to a decrease in the dissolved oxygen level in the water while also increasing the biological demand of aquatic organisms for oxygen.
4. ***Ecological Pollution:*** Ecological pollution takes place when chemical pollution, organic pollution or thermal pollution is caused by nature rather than by human activity.

Example:

1. Ecological pollution would be an increased rate of siltation of a waterway after a landslide which would increase the amount of sediments in runoff water.
2. When a large animal, such as a deer, drowns in a flood and a large amount of organic material is added to the water as a result.
3. Major geological events such as a volcano eruption might also be sources of ecological pollution.

Specific Sources of Water Pollution are as follows:

1. Farming

- Farms often use large amounts of herbicides and pesticides, both of which are toxic pollutants. These substances are particularly dangerous to life in rivers, streams and lakes, where toxic substances can build up over a period of time.
- Farms also frequently use large amounts of chemical fertilizers that are washed into the waterways and damage the water supply and the life within it. Fertilizers can increase the amounts of nitrates and phosphates in the water, which can lead to the process of eutrophication.
- Allowing livestock to graze near water sources often results in organic waste products being washed into the waterways. This sudden introduction of organic material increases the amount of nitrogen in the water, and can also lead to eutrophication.
- Four hundred million tons of soil is carried by the Mississippi River to the Gulf of Mexico each year. A great deal of this siltation is due to runoff from the exposed soil of agricultural fields. Excessive amounts of sediment in waterways can block sunlight, preventing aquatic plants from photosynthesizing, and can suffocate fish by clogging their gills.

2. Business

- Clearing of land can lead to erosion of soil into the river.
- Waste and sewage generated by industry can get into the water supply, introducing large organic pollutants into the ecosystem.
- Many industrial and power plants use rivers, streams and lakes to dispose of waste heat. The resulting hot water can cause thermal pollution. Thermal pollution can have a disastrous effect on life in an aquatic ecosystem as temperature increases decrease the amount of oxygen in the water, thereby reducing the number of animals that can survive there.
- Water can become contaminated with toxic or radioactive materials from industry, mine sites and abandoned hazardous waste sites.

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- Acid precipitation is caused when the burning of fossil fuels emits sulphur dioxide into the atmosphere. The sulphur dioxide reacts with the water in the atmosphere, creating rainfall which contains sulphuric acid. As acid precipitation falls into lakes, streams and ponds it can lower the overall pH of the waterway, killing vital plant life, thereby affecting the whole food chain. It can also leach heavy metals from the soil into the water, killing fish and other aquatic organisms. Because of this, air pollution is potentially one of the most threatening forms of pollution to aquatic ecosystems.

3. Homes

- Sewage generated by houses or runoff from septic tanks into nearby waterways, introduce organic pollutants that can cause eutrophication.
- Fertilizers, herbicides and pesticides used for lawn care can runoff and contaminate the waterway. As with agricultural fertilizers, home fertilizers can lead to the eutrophication of lakes and rivers.
- Improper disposal of hazardous chemicals down the drain introduce toxic materials into to the ecosystem, contaminating the water supplies in a way that can harm aquatic organisms.
- Leaks of oil and antifreeze from a car on a driveway can be washed off by the rain into nearby waterways, polluting it.

10.3.2 Causes of Water Pollution

The **causes of water pollution** vary and may be both natural and anthropogenic. However, the most common causes of water pollution are the anthropogenic ones including:

- ***Agriculture runoff:*** carrying fertilizers, pesticides/insecticides/herbicides and other pollutants into water bodies such as lakes, rivers, ponds). The usual effect of this type of pollution consists in algae growing in affected water bodies. This is a sign of increased nitrates and phosphates in water that could be harmful for human health.
- ***Storm water runoff:*** carrying various oils, petroleum products and other contaminants from urban and rural areas (ditches). These usually form sheens on the water surface.
- ***Leaking sewer lines:*** may add trihalomethanes (such as chloroform) as well as other contaminants into groundwater ending up contaminating surface water, too. Discharges of chlorinated solvents from Dry Cleaners to sewer lines are also a recognized source of water pollution with these persistent and harmful solvents.
- ***Mining activities:*** Mining activities involve crushing the rock that usually contains many trace metals and sulphides. The left material may easily generate sulphuric acid in the presence of precipitation water. Please, read more at Mining Sites.
- ***Foundries:*** have direct emissions of metals (including Hg, Pb, Mn, Fe, Cr and other metals) and other particulate matter into the air. Please, read more at Foundry.
- ***Industrial discharges*** – may add significant pollution to water bodies, but are usually regulated today. Please, read more at Industrial Sites.
- ***Accidental leaks and spills*** – Associated with handling and storage of chemicals may happen anytime and, although they are usually contained soon after they occur, the risk of polluting surface and groundwater exist. An example are ship accidents such as Exxon Valdez disaster which spilled large amounts of petroleum products into the ocean;

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- ***Intended/illegal discharges of waste*** – While such occurrences are less common today, they may still happen due to the high cost of proper waste disposal; illegal waste discharges into water bodies were recorded all over the world;
- ***Burning of fossil fuels*** – The emitted ash particles usually contain toxic metals (such as As or Pb). Burning will also add a series of oxides including carbon dioxide to air and respectively water bodies.
- ***Construction activities*** – introduce a series of contaminants into the ground that may eventually end up in groundwater. Please, read more at Construction Sites.
- ***Plastic materials/wastes in contact with water*** – may degrade slowly releasing harmful compounds for both human health and ecosystem.
- ***Disposal of personal care products and household chemicals*** (including detergents and various cleaning solutions) – This is a serious problem since the releases to water are unpredictable and hard if not impossible to control. It is up to each of us to minimize this contribution to water pollution by controlling our consumption and disposal of such products as well as trying to recycle as much as we can!
- ***Improper disposal of car batteries and other batteries*** – may add metals.
- ***Leaking landfills*** – may pollute the groundwater below the landfill with a large variety of contaminants (whatever is stored by the landfill).
- ***Animal wastes*** – contribute to the biological pollution of water streams.

Lack of awareness of humans is the primary cause of water pollution. Also dumping of garbage, oil spills, dumping of nuclear waste and passing waste in water sources are causes of water pollution.

10.3.3 Effects of Water Pollution

Water pollution has been a cause of concern for decades. With urbanization, it has increased to such enormous levels that it now poses a threat to the existence of aquatic life and human health. The effects of water pollution are varied and depend on what chemicals are dumped and in what locations. Water pollution has number of effects. The effects could be classified as:

1. Effects on Ecosystem

The effects of water pollution on ecosystem are as follows:

(i) Besides inorganic nutrient input, with the inflow of waste water, decomposition of organic wastes, plant nutrients such as nitrates and phosphates takes place. This promotes the growth of oxygen consuming algae (algal bloom), especially the blue-green algae. The growth of oxygen consuming algae, which deoxygenates water killing fish and other animals, is referred to as eutrophication.

(ii) Addition of oxygen not sufficient to support life.

(iii) Addition of non-degradable broad-spectrum pesticides, which cause mass destruction of agnatic life.

(iv) Addition of oil destroys life by reducing oxygen and catching fine, destroying ecosystem.

Biological oxygen demand or BOD stands for the amount of oxygen regained by the microorganisms of polluted water to complete the decomposition of organic matter present in the water. The term is usually used to know the amount of oxygen consumed. Higher in the

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amount of oxygen consumed, higher is the degree of organic pollutants. BOD is expressed in milligrams of O_2 per litre of water. A weak organic waste has a BOD less then 1500 mg/litre, a strong one has higher than this. A survey of the river Yamuna recorded BOD of 2000 at Delhi, 9000 at Mathura and 12,000 at Agra.

- Shifts in biodiversity of animals and plants in polluted ecosystem.
- Imbalance in host - parasite relations in the ecosystem and changes in food - webs and food chains.
- Imbalances in microbial population and effects due to such imbalances.
- Depositions of deleterious chemicals in soil leading to loss of soil fertility.

2. Effects on Animal Health

The effects of water pollution on animal health are as follows:

(i) Large scale death of aquatic and terrestrial animals

(ii) Reduced reproduction rate

(iii) Increased incidence of diseases

(iv) Imbalances created in secondary food chains

(v) Accumulation of bio-accumulative and non-biodegradable pollutants in animal bodies.

Did u know? Some organochlorine pesticides (like DDT, BHC, Endrin) are known for bioaccumulative and biomagnifiable characters.

3. Effects on Human Health

The effects of water pollution on human health are as follows:

(i) Increased incidence of tumours, ulcers due to nitrate pollution

(ii) Increased incidence of skin disorders due to contact with pollutants

(iii) Increased incidence of constipation, diarrhoea and infections to intestine

(iv) Dangerous effects on growing foetus in pregnant women

(v) Concentration of pollutants due to bio-accumulative pesticides through secondary and tertiary food chain in case of non-vegetarians.

(vi) Still births, abortions and birth of deformed children.

(vii) 'Blue baby' disease caused by methane globulinemia - which results in asphyxia (reduced O_2 supply).

(viii) Reduced activity of immune system.

(ix) Loss of memory power and reduced mental sharpness.

(x) Water borne diseases like jaundice, hepatitis, gastroenteritis will be more prevalent due to water pollution.

(xi) Reduced bone development and muscular development.

(xii) Reduced male fertility.

(xiii) Shifts in physiological cycles of human body.

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10.3.4 Measures to Control Water Pollution

With increasing urbanisation and expanding agricultural and industrial production, water pollution problems have progressively become more serious and necessitated the adoption of suitable control measures for ameliorating pollution. For a given body of water, the desired level of quality is usually specified in terms of parameters such as dissolved oxygen concentration, nutrient levels etc. The intended beneficial uses of the water resource are generally the basis on which the required quality criteria are formulated. Sources of pollution should then be regulated so as to achieve and maintain the minimum required water quality. This is usually accomplished through effluent discharge standards which specify the compliance requirements for the disposal of effluents in the environment.

Approaches to controlling sources of water pollution may be grouped into three broad categories:

1. Minimisation of Pollutant Generation

Reduction of the quantity of waste or pollutants generated by an activity is obviously the most desirable approach to pollution control. Since it conserves resources that would otherwise be wasted, and at the same eliminates the cost of removing pollutant after they are produced, it is the cheapest and most effective alternative. For non-point pollution sources, this is perhaps the only practicable method of pollution control. Yet, this approach has not been exploited by society to its fullest extent.

As a general rule, a resource becomes a waste when it can no longer be economically utilised or recovered. It is then disposed of in the environment in the cheapest manner possible. Availability of economical technology for resource processing and usage has been a main determinant of when the resource is discarded as waste.

In the past, decisions concerning resource usage or waste disposal have been governed largely by immediate economic considerations and have not always considered the effects of these actions on the quality of the environment. As accountability for environmental damage gains increased recognition, fostered by a growing desire within society for sustainable development and a cleaner environment, more attention and effort will undoubtedly be devoted to reducing resources going to waste and causing pollution.

Minimising soil erosion by improved agricultural practices (e.g. by minimising surface runoff and leaving crop residues in the ground), more efficient use of nutrients (e.g., though the use of slow release fertilisers) and the development and use of biological pest control techniques in preference to the use of non-biodegradable toxic chemicals are some of the measures for minimising water pollution from agriculture.

Considerable potential also exists in many industries to reduce waste generation. Development and use of non-polluting technology to modify or replace existing manufacturing processes, and recycling or recovering materials that would otherwise be wasted are two approaches which not only reduce pollutant generation, but can sometimes even result in a saving for the industry by minimising or eliminating the need for waste treatment for pollutant removal.

In other cases, it may be more practical to segregate strong and weak waste streams to facilitate materials or energy recovery. Good house keeping practices, such as for example minimising spillage and materials wastage, can also lead to waste reduction and savings in production cost.

2. Wastewater Treatments at Source

In nature, a variety of different mechanisms operate to degrade and transform waste materials into stable, harmless end products such as carbon dioxide. This cleansing ability is often referred

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to as the "self-purification" or "assimilative" capacity. When the quantities of wastes to be disposed of are large, however, the natural purification processes become overloaded and can no longer assimilate the wastes without adversely affecting environmental quality. Man-made treatment systems are then needed to reduce pollutant loads to acceptable levels for discharge. For the most part, these purification systems make use of the same mechanisms as in the natural environment to bringing about waste stabilisation.

The multitude of different wastewater treatment technologies can be classified as physical, chemical and biological processes, depending on the nature of the purification mechanism employed. The character of the pollutants and the form (suspended or dissolved) in which they are present usually determine the most suitable process for their removal. For example, gross suspended solids and floatable materials such as oil and fat are readily removed by physical processes such as sedimentation or flotation respectively.

Biological Methods are effective and economical when the waste water contains mostly biodegradable pollutants such as organic matter. A key advantage of biological processes is that the microorganisms involved in waste stabilisation are themselves produced in the process.

For Dilute Wastes - including general domestic wastewaters, "aerobic" biological processes (activated sludge, oxidation ponds and aerobic biofilter) are usually favoured since they are capable of producing an effluent with very low residual pollutant concentrations. These processes, however, require oxygen, in proportion to the pollutant load present. Oxygen is supplied through aeration, which is a significant cost component.

For Strong Wastes, "anaerobic" biological treatment in enclosed vessels is generally preferred as they proceed in the absence of oxygen, and in addition produce a useful, energy-rich by-product in the form of methane. The effluent from anaerobic processes, however, contains higher levels of residual organic materials and may require further polishing treatment (often in aerobic processes).

Chemical Treatment is used when the pollutant of interest is non- biodegradable and is not amenable to removal by simple physical means (e.g. when it occurs in dissolved form). Heavy metals are typically removed by chemical precipitation, while toxic substances such as cyanide may be chemically oxidised. An important disadvantage of chemical treatment methods is that they generally require dosing with a chemical which can prove to be quite expensive. In addition, disposal of the chemical sludge produced in these processes may also pose some problems.

Did u know? When a community based treatment system is impractical, it is still possible to provide a degree of treatment prior to discharging sewage into the environment. A popular method used for individual homes and small groups of residences is the SEPTIC TANK. It consists of a simple baffled tank which traps most of the solids in the waste water and also affords some decomposition of soluble organic matter. The effluent is disposed of into the ground through a system of leach drains. As solids progressively accumulate in the tank, it is necessary to periodically desludge the system, typically every 3 to 7 years.

As deep sewering in built-up areas is very expensive, other more efficient alternatives to the septic tank are also desirable for on-site use. In recent years, a number of new systems, which are essentially miniature versions of the biological processes used for large-scale plants have become available.

3. In-situ Pollution Control

Waste minimisation and treatment help prevent pollution from occurring and should be the principal approaches to water quality maintenance. Occasionally, however, when a water body

is already adversely affected, it will be necessary to consider action aimed at helping the ecosystem recover from the impact of pollution. Methods to facilitate this are collectively grouped under in-situ control techniques.

Aeration of lakes and reservoirs, especially when they are thermally stratified (in summer), has been used to prevent anaerobic conditions from occurring. Forced circulation of water in stratified lakes is an alternative method. Dredging nutrient rich superficial sediments from highly eutrophic lakes, while very expensive, have sometimes helped reduce occurrence of severe algal blooms. Addition of aluminium or iron salts to assist the precipitation of phosphorus has also been practiced in some lakes to control dissolved phosphorus levels in the water.

Task Where does water pollution come from? Critically analyse how we detect water pollution.

Self Assessment

State whether the following statements are true or false:

7. Water pollution has only one source.
8. An organic substance is a chemical pollutant that is not a naturally occurring substance in aquatic ecosystems.
9. Clearing of land can lead to erosion of soil into the river.

10.4 Soil Pollution: Causes, Effects and Control Measures

The meaning, causes, effects and control measures of soil pollution are discussed below:

10.4.1 Meaning of Soil Pollution

Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health. Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost topsoil. The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food. Soil pollution mainly is a result of penetration of harmful pesticides and insecticides, which on one hand serve whatever their main purpose is, but on the other hand bring about deterioration in the soil quality, thus making it contaminated and unfit for use later. Insecticides and pesticides are not to be blamed alone for soil pollution, but there are many other leading causes of soil pollution too.

The soil pollution is referred to as the presence of materials in the soil which are harmful to the living beings when they cross their threshold concentration levels. In this case the factors or substances which affect the soil are not static. It can be positive or negative. In the negative soil pollution there occur an overuse of soil and erosion. The erosion occurs by water and air. The water erosion occurs by the high speed rivers which remove the top layer of soil. It occurs near the hills. The floods are very common in our country. They occur mainly due to the decrease in forest cover area. It leads to overgrazing. It may also occur due to the high speed winds which brings the particles of sand from dry areas. Nearly half of the land has become desert. Thar Desert of Rajasthan was a fertile land around thousand years back.

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Example: The sand of Gujarat coast made the Thar Desert of Rajasthan into desert along with the overgrazing and felling of timber. It converts the land into a desert at the rate of 9 kilometer per year. The fertile land is also being affected by the roads, houses, unplanned development of houses, garbage, empty bottles, furniture and ash. These materials are dumped in an open area outside the town and they not only affect the land on which they are dumped but also the nearby land. It is also referred as the third pollution or landscape pollution. The best way to deal with this problem is to bury the waste in low lying areas. The garbage is burnt and is changed to the compost and the rubbish is recycled.

10.4.2 Causes of Soil Pollution

Soil pollution is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage links, application of pesticides, and percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage. A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the soil or which disturbs the biological balance of the organisms in the soil. Pollution in soil has adverse effect on plant growth. Soil pollution is a result of many activities and experiments done by mankind which end up contaminating the soil. Here are some of the leading soil pollution causes:

- Industrial wastes such as harmful gases and chemicals, agricultural pesticides, fertilizers and insecticides are the most common causes of soil pollution.
- Ignorance towards soil management and related systems.
- Unfavourable and harmful irrigation practices.
- Improper septic system and management and maintenance of the same.
- Leakages from sanitary sewage.
- Acid rains, when fumes released from industries get mixed with rains.
- Fuel leakages from automobiles, that gets washed away due to rain and seep into the nearby soil.
- Unhealthy waste management techniques, which are characterized by release of sewage into the large dumping grounds and nearby streams or rivers.

The intensity of all these causes on a local or regional level might appear very small and you may argue that soil is not harmed by above activities if done on a small scale. However, thinking globally, it is not your region or my place that will be the only sufferer of soil pollution. In fact, it is the entire planet and mankind that will encounter serious problems, as these practices are evident almost everywhere in the world.

10.4.3 Effects of Soil Pollution

The effects of pollution on soil are quite alarming and can cause huge disturbances in the ecological balance and health of living creatures on earth. Some of the most serious soil pollution effects are:

Decrease in soil fertility and therefore decrease in the soil yield. Soil contamination is the consequence of the introduction of various noxious materials or xenobiotic (man-made) chemicals that are present in concentrations at unacceptable levels.

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1. Contaminated Soil Poses Health Risks

Direct contact with soil that contains contaminates, inhalation of fumes or vapours from the pollutants, or ingestion of contaminated water from soil runoff may have an adverse impact on humans, animals, fowl, fish and other living organisms. Soil used to grow food for human consumption presents the biggest concern; however, soil found in school yards, parks and other locations where children may be in direct contact with polluted soil demands reclamation. Heavy metals such as arsenic, lead and chromium in soil present increased incidents of cancer, birth defects and leukaemia. There is a growing trend in home gardening to use only organic methods to avoid the dangers of noxious pesticides, toxic herbicides and commercial fertilizers that may contaminate soil.

2. Soil Pollutants Unbalance the Ecosystem

Soil contamination is often the result of leaching from landfills, the rupture of underground storage tanks, acidic precipitates, radioactive fallout, fuel dumping, direct discharge of chemicals or the percolation of polluted surface water to subsurface strata. Polluted soil produces meagre, stunted crops that may contain health endangering materials. The effects of tainted soil on agriculture is demonstrated in reduced soil fertility, reduced crop yields, reduced atmospheric nitrogen fixation, erosion and unbalance in soil flora and fauna.

3. Tainted Soil Destroys Animal Life

Contaminated soil may lead to the loss of domestic cattle, sheep and other animal food sources, as well as wildlife. Polluted, infertile soil increases the cost of crop production and can diminish wild vegetation that provides shelter and habitat to birds and small animals. When humans consume animals raised on feeds from polluted soil, health risks arise.

10.4.4 Measures to Control Soil Pollution

Since fertilizers and pesticides are useful in increasing crop production and protection from harmful organisms, their use cannot be discontinued. Though at present it has not caused higher concentration of unwanted materials in the soils of the country but if the existing rate of contamination continues, the day will come when our most valuable resource, that is, soil will be polluted.

Caution It will lead to the loss of soil fertility and crop failure. Therefore, the question arises as to how to use these toxic chemicals, so that their use may be fruitful but may not adversely affect soil fertility and the related environment.

The following measures may be suggested to control soil pollution:

1. Development of pesticides should be encouraged, which may save crops from pests and rodents but should not contaminate soil with toxic chemicals.
2. Pesticides and fertilizers should be applied on croplands only in recommended dose, prescribed by Indian Standard Institution experts. It will help in reducing the level of water and soil pollution caused through these chemicals.
3. There should be sufficient duration between the harvesting of crops and time of last spray of pesticides. This will help in reducing contamination of pesticides, directly to the crop. It will also cause less contamination of chloride and other chemicals to the soil.

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4. There must be arrangement for educating farmers regarding the proper use of pesticides and fertilizers. Only those fertilizers could be used for growing crops, which are deficient in soils.
5. After every two or three years soils percentage should be analyzed, so that it can be observed that what is the percentage of nutrients in the soils? This will help in maintaining the required amount of nutrient in the soils.
6. Waste water from industries should not be used for irrigation without eliminating toxic chemicals from the effluent. This will also reduce the concentration of unwanted substances in the soil.
7. Garbage should not be disposed of on cultivated land without covering it with the soils.
8. Soil conservation practices should also be adopted so as to avoid loss of valuable nutrients through soil erosion.

In addition to this, government should encourage research programmers examining the effects of pesticides and fertilizers on soils and human beings. This will help in devising suitable measures to control soil pollution and restore its fertility.

Self Assessment

Fill in the blanks:

10. ..... soils are necessary for agriculture to supply the world with sufficient food.
11. Soil pollution is caused by the presence of man-made chemicals or other alteration in the ..... environment.
12. ..... practices should also be adopted so as to avoid loss of valuable nutrients through soil erosion.

10.5 Marine Pollution: Causes, Effects and Control Measures

The Meaning, Causes, Effects and Control Measures of Marine Pollution are discussed below:

10.5.1 Meaning of Marine Pollution

Marine pollution refers to ocean contamination, especially with man-made waste or by-products. This is considered to be a severe problem by many environmentalists, since it can have detrimental and lasting effects on the global marine ecosystem. There are several types of marine pollution, each of which has the potential to harm the delicate balance of life. A number of sources can generate marine pollution. Sources that directly dump waste into the water are known as point sources. Non-point source pollution is harder to recognize, and therefore harder to regulate. This occurs when pollution comes from several hard-to-pinpoint sources, such as the debris blown into the ocean by gusts of wind. Marine debris usually includes plastic litter discarded by humans, either intentionally or accidentally. This marine pollution can be harmful to marine life, such as fish or dolphins. Animals can become tangled up in things like old fishnets or plastic six pack holders, or they can suffocate if they get trapped in a plastic bag. If the debris resembles an animal's food, it could also be ingested, and most likely, the animal will not be able to digest it.

Garbage and other marine debris sometimes end up covering the coastlines of islands in the middle of ocean gyres, which are large circulating ocean currents.

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Example: Hawaii is in the middle of the North Pacific Gyre. Because of the massive amount of debris found here, it is often referred to as the Great Pacific Garbage Patch.

One major source of marine debris is containers that fall off ships, the contents of which end up on shores all over the world. Ships and other ocean vessels are main contributors to marine pollution. Oil spills can harm marine life and often take months or even years to clean up. These vessels can also introduce non-native species of animals, plants, and microorganisms to new habitats when they dump their ballast waters. This can lead to an unbalanced ecosystem as these new species prey on and compete with the native species in the area.

Ships, large boats, and submarines are also a major source of noise pollution in the oceans and seas. Since sound travels farther in water than it does in air, noises like sonar can travel for miles. This can cause problems in animals that rely on noise to communicate with each other or find prey. Toxins, such as chemicals, certain metals, and radioactive waste, are another form of marine pollution. These poisonous substances often have harmful effects on marine life and can accumulate in their bodies. Mercury, which is a waste product of certain types of power plants, accumulates in fish. Albacore tuna and swordfish with high levels of mercury are considered unsafe to eat, especially for nursing mothers, pregnant woman, and children.

Chemical nutrients, like nitrogen and phosphorus used in fertilizers, accidentally released into the ocean also contribute to marine pollution. These often make it into bodies of water because of agricultural runoff. Excess amounts of these types of nutrients can cause excessive algae growth. This process, known as eutrophication, can often lead to less oxygen in the water. The amount of oxygen in the water also decreases as the water gets warmer. This can happen when water that is used as a coolant by industrial manufacturers and power plants is dumped into rivers and oceans. Since the warmer water contains less oxygen, some species find it harder to survive and may die off. This type of marine pollution is called thermal pollution.

Acidification of the world's oceans is another concern of many environmentalists. The ocean naturally absorbs carbon dioxide, and since the amount of carbon dioxide in the atmosphere is increasing, the amount that the ocean is absorbing is also increasing. The result is a lower pH level in the oceans, which can disrupt the delicate marine ecosystem. Many researchers believe more acidic waters can make it harder for some shellfish to form their shells. Disappearing coral reefs are also blamed on ocean acidification.

India has a long coastline of more than 7500 km. Its resources are spread over in the Indian Ocean, Arabian Sea, and Bay of Bengal. The exclusive economic zone (EEZ) of the country has an area of 2.02 million sq km comprising 0.86 million sq km on the west coast, 0.56 million sq km on the east coast and 0.6 million sq km around the Andaman and Nicobar islands. The east coast supports agriculture and aquaculture while a number of industries are supported on the west coast. Tourism has emerged as a major economic activity in coastal states of Goa, Kerala and Orissa.

Mangrove cover in India has been estimated at approximately 315,000 ha confined mainly along the east (Orissa and West Bengal) coast and Andaman and Nicobar islands. The Sunderbans in West Bengal have one of the largest mangrove forests in the world. The mangrove flora of India is comprised of 50 exclusive species. 67% of the mangroves and associated plant species are endangered, while 97% of the plant species are threatened. Indiscriminate cutting, reclamation for agriculture and urbanization, fuel demand and overgrazing by domestic cattle have severely degraded mangroves in India. The threat to mangroves in recent years comes mainly from, aquaculture and urban settlements. Sand dunes which support diverse flora are categorized as ecologically sensitive areas under the Coastal Regulation Zone (CRZ) notification of 1991.

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Coral reefs are found in the Palk Bay, Gulf of Mannar, Gulf of Kutch, central west-coast of India, Lakshadweep and Andaman and Nicobar islands. They are very rich in fauna and flora.

Fisheries in the Indian marine environment are a major economic consideration. The annual export of fisheries is 0.4 million tones (mt). Marine fishery exports in 2000 were 421,075 mt. The Indian marine production increased from 0.534 mt in 1950-51 to 2.576 mt in 1992-93.

However, the growth of Indian marine fisheries has become sluggish in recent years and reached a plateau at around 2.8 mt by 1995-96. While the inland sector contributed increasingly (6.2% annually since 1980-81) to the growth of fish production in India the growth in marine food production decreased to 2.5% during 1990-99 from 3.73% during 1980-90. About 1 million people in 3651 villages of India situated along the coast are employed in marine capture fisheries. Indian fishery also supports several ancillary activities such as boat building and processing plants.

The coastal and offshore environment of India support rich biodiversity including bacteria and algae. They are important component of food chain.

Economic activities such as offshore drilling, aquaculture, port activities all have impact on the coastal ecosystem. For the protection, preservation and management of coastal waters and maritime zones, the Central Government has formulated exclusive jurisdiction. The state governments too, have jurisdiction over the development of fishery and other living resources in the territorial waters adjoining the states.

The core issues with reference to the marine environment relate to the preserving of ecologically sensitive areas, developing and increasing the marine living resources, ensuring effective monitoring and enforcement with respect to fishing activities, improving the living standards of coastal communities, and addressing issues of critical uncertainty and climate change. To achieve these objectives following programme areas have been identified under the framework of Agenda 21.

1. Sustainable use and conservation of marine living resources: Sustainable use of marine living resources is of great concern. Marine living resources provide food and livelihood to coastal communities. Adequate knowledge, use of new technology and good regulatory measures are necessary to manage and conserve these resources. Agenda 21 aims at developing and increasing the potential of marine living resources to meet human nutritional needs, maintaining and restoring populations of marine species at levels that can produce the maximum sustainable yield, promoting the development and uses of selective fishing gear and practices that minimise waste in the catch of target species and minimise by-catch of non-target species. It also urges governments to ensure effective monitoring and enforcement with respect to fishing activities, protecting and restoring endangered marine species, preserving habitats and other ecologically sensitive areas and promoting scientific research with respect to marine living resources in the high seas. It emphasizes the need to take into account traditional knowledge and interests of local communities, small-scale artisanal fisheries and indigenous people in development and management programmes.

2. The marine and coastal environment is vulnerable to the uncertainties of climate change. These changes may cause significant damage to the coast and inhabitants of nearby areas. In order to reduce uncertainties, it is necessary to collect data systematically on various marine environmental parameters.

3. It is important to integrate relevant sectoral activities addressing the environment and development in marine and coastal areas at the national, sub regional, regional and global levels, promote effective information exchange and institutional linkages between bilateral and multilateral national, regional, sub-regional and interregional institutions dealing

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with environment and development in marine and coastal areas; promote within the United Nations systems, regular intergovernmental review and consideration of environment and development issues.

4. Small island developing states and islands supporting small communities are vital issues. They are ecologically fragile and vulnerable. They are rich in biodiversity as they shelter some unique species of flora and fauna.

10.5.2 Causes of Marine Pollution

Pollution of the world's oceans is quickly becoming a major problem on Earth. We know very little about the effect that pollution has on the oceans, but we continue to dispose off chemicals, sewage and garbage into it at an unprecedented rate. Most people likely do not even know what types of pollutants reach the oceans. There may be billions of people unconcerned about ocean pollution and hence this problem. Truly, the fish catch from the sea will tend to bio concentrate the pollutants to finally reach the humans.

1. Toxic Ocean Pollutants

Toxic pollutants in the ocean ecosystem have massive impacts on the plants and animals. Heavy metal poisoning (such as lead and mercury) from industrial effluents accumulate in the tissues of top predators such as whales and sharks (so do not hesitate to support ban of hunting whales and sharks but to the dislike of many others). Many a times such poisoning causes birth defects and damages nervous system. Dioxins from the pulp and paper bleaching process can cause genetic chromosomal problems in marine animals and may even cause cancer in humans. PCBs (polychlorinated biphenyls) typically cause reproduction problems in most marine organisms. PCBs usually come from older electrical equipment.

Poly-aromatic hydrocarbons (PAHs) are another source of marine toxic pollution and typically come from oil pollution and burning wood and coal. These PAHs are responsible for causing genetic chromosomal aberrations in many marine animals. Lastly, low-level radiation poisoning is also possible in the ocean environment. Though scientists know very little about how radiation affects marine organisms, it cannot be a good thing anyway. Some marine species such as a population of Beluga whales living in the St. Lawrence River area in Eastern Canada are in serious trouble because of marine toxic pollution. These Beluga whales are the victims of ocean pollution ranging from PCBs to heavy metals as well as other pollutants. However, toxic pollution is only the tip of the iceberg in terms of total ocean pollution.

The toxic pollution varies from PAHs heavy metal pollution from industrial effluent and fallout, PCB pollution and even possible low level radiation. No matter what we humans do, there is potential for serious pollution of the oceans.

2. Marine Garbage

Marine garbage disposal is another major form of ocean pollution. The world's oceans are a virtual dumping ground for trash. Sometimes the garbage includes junked out fishing nets, plastics, general household garbage and even like bulbs. In one case, an island 300 miles from the nearest inhabited island (and 3000+ miles from the nearest continent) had 950 pieces of garbage ranging from plastics to tin cans. Garbage in the oceans is a serious issue as fish entangle themselves in fishing nets and animals sometimes eat trash products and die. There are numerous examples of dolphins, sharks and whales entangling themselves in fishing nets and dying from oxygen starvation. It is possible to clean garbage from the oceans if humanity quits using it as a garbage dump. Marine garbage can often enter into animal gut; plastic pop tab rings accidentally strangle animals and so forth. Controlling this form of pollution is important to maintain a

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healthy ocean ecosystem. Even simple plastic bags can have large pollutive impacts within the ocean. In one case, a deceased sperm whale was found to have a party balloon blocking its digestive system. The whale died from inability to process its food and died of starvation. Plastics can also have negative impacts to boats if they accidentally plug water intake lines.

3. Sewage Disposal in Ocean

Sewage is yet another major source of marine pollution. Typically, the problem with sewage is that it causes massive nutrient loading in the ocean ecosystem. Nutrient loading triggers algal blooms in the water leading to the loss of dissolved oxygen. After the depletion of oxygen levels, many organisms in the ocean die from being unable to breathe properly. Other problems associated with sewage include parasites/bacteria that force closure of public coastal beaches and poisoning of shellfish fisheries. For the most part, cities in the developed world have sewage treatment facilities but many of the cities in poorer areas have little to no sewage treatment. As the world population continues to increase, sewage pollution will be on the rise.

What we often do not realize is that the waste water out of washing our clothes, faces, dishes and cattle, is ultimately headed to the sea. This includes everything from our homes (toilets, washing machines, bathtubs, dishwashers and so forth), industrial effluents and even chemicals such as paints and fertilizers that we dispose of down the drains. Eventually, all of this sewage pollution adds up and we land in serious problems due to lack of oxygen for organisms and poisoned water.

4. Non-Point Pollutants

The last major source of ocean pollutant is non-point. Non-point pollution can come from amazingly varying sources, viz., runoff from farmland (fertilizers, manure), industrial runoff (heavy metals, phosphorous), urban runoff (oils, salts, various chemicals) and atmospheric fallout of airborne pollution. Obviously, it is the hardest to control. Point pollution, in contrast, is pollution from a direct source like a factory outfall pipe. The enrichment of water by nutrients, especially compounds of nitrogen and phosphorus, causes an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms and the quality of the water (Eutrophication). Input of nutrients like nitrogen and phosphorus to the sea is a natural prerequisite for life, not an environmental problem. It becomes a problem only when the input increases to such levels that the original properties or functions of the ecosystem change. Then, it becomes too much of a good thing. When this manifests in marine waters or a lake, it is referred to as eutrophication - a concept covering a series of events in the aquatic environment. Input of too large amounts of nutrients, followed by other events and effects is ominous and results in higher levels of nutrients in the water. Physical, chemical and biological changes that follow tend to reflect in the fauna and flora, oxygen conditions change and other changes in the water mass, in the sediments and on the surface of the bottoms.

Example: **Pollution of coastal waters: Kerala under microscope**

The coastal waters of the maritime states are under the constant threat of pollution from a number of sources. The relatively long shoreline of India (6000 Km) is no exception either. More so is the case of Kerala. Compared to the rest of the union, profile of Kerala's coastal waters may be better; still a lot remains to be achieved. The tropicality of the region and consequent intense rain fall in the hinterland, along with the physiography has immensely contributed to the quality of coastal waters.

The agrarian nature of land use itself has become a bane to the coastal water bodies of the state in the midland as well as in the lagoons in coastal land. Fertilizer residue originating

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from the tea, cardamom, and rubber plantations of the highland and midland are finally headed to the coastal water of the ocean. But, the brunt is borne by the waters in the lagoons, ponds and other inland water bodies. The intracoastal water way is no exception either. Obviously, the fertilizer residue leads to the eutrophication of the coastal waters, and adds to the reservoir of the chemicals that already exists in the sea. Luckily, the amphibious plant species that characterise the fresh water bodies and lead to their eutrophication, do not survive in the marine environment. However, if not checked, we may reach a situation like in the mouth of Mississippi River, where a 60 mile wide algal belt has reportedly come to stay. The sheer size of the coastal waters is an insurance against the pollutants, like the fertilizer residues, yet could not influence the sea water chemistry to any great extent.

Industrial pollution is not as bad as it used to be in the developed world as new techniques and better waste and effluent treatment are put in place. New laws and regulations make it difficult for people to dump their trash into the oceans though inevitably some dumping will always occur. One idea is to promote community beach-cleaning events where in everybody volunteers in to pick trash off the beaches. By cleaning up the trash on beaches, we lessen the potential chances of accidental animal kills and afford better and cleaner looks for beaches.

Reduction of sewage is possible through the installation of better sewage treatment facilities and by adoption of volume reduction technologies for the world's cities. Developed countries like Canada and the United States as well as Western Europe should assist the poorer countries in installing sewage treatment facilities. Reducing harmful sewage discharge would be a major start in helping to clean the oceans of pollution. Many areas of the world have reduced non-point pollution through proper recycling facilities for used oil and paint products.

Did u know? In the past, people simply dumped used oils and paints into the sewer system where they would do serious damage to the water. Pollution will still occur but with effort and determination it is possible to reduce its impact on the oceans.

10.5.3 Effects of Marine Pollution

The effects of Marine Pollution are as follows:

1. 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.
2. 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.
3. 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.
4. Carbon dioxide is hazardous for marine life including coral reefs and free-swimming algae.
5. 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.

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6. Dumping of industrial wastes such as pesticides, especially DDT can accumulate in the fatty tissue of animals. This could lead to the failure in the reproductive system of mammals and birds.
7. Decomposition of organic matter causes a drop in dissolved oxygen, particularly in calm weather and sheltered bays. This can cause the death of marine plants and animals, and may lead to changes in biodiversity (see Enviro Facts "Biodiversity").
8. Ships often paint their hulls with antifouling substances, e.g. tributyl-tin or TBT, to prevent growth of marine organisms. These substances leach into water and, in high traffic areas such as harbours and marinas, can affect animal life. There is a world wide trend towards limiting the use of TBT containing paints.
9. Pathogenic microorganisms cause gastric and ear-nose- throat infections, hepatitis, and even cholera and typhoid. Filter feeding animals (e.g. mussels, clams, oysters) concentrate pathogens in their gut, so eating shellfish from polluted waters is a health risk.
10. Another toxic "Dioxins" generated from the bleaching process of pulp and paper can cause genetic chromosomal problems in marine animals and may even cause cancer in humans.

10.5.4 Measures to Control Marine Pollution

India's rapid population, economic and industrial growth has created pressures on the coastal resources. Some coastal stretches in India are highly polluted with municipal waste from urbanization and tourism, waste generated from industry, chemical agents from fertilisers and pesticides and silt from degraded catchments. Untreated sewage and other non-industrial wastes account for more pollution than industrial effluents. Mining of sand from the seabed results in an increase in turbidity in the coastal water, which affects ecosystem and primary productivity of fauna and flora by limiting the availability of light. Aquaculture activity in some parts of India has also placed considerable pressure on coastal resources. Construction of breakwater, which forms port development, alters the sediment transport mechanisms in the coastal areas, thereby causing erosion.

A number of rules and laws regulate activities on the Indian coast. India has regulatory agencies such as the Central Pollution Control Board (CPCB) at the central level and State Pollution Control Boards (SPCB) at the state levels, constituted under Water (Prevention and Control of Pollution) Act, 1974. The Aquaculture Authority of India has been constituted and guidelines on sustainable aquaculture development for regulating coastal aquaculture have also been developed. National Contingency Plan has been formulated to combat oil spills in the EEZ of India with the Coastal Guard as the nodal agency.

The disposal of ship-based wastes is regulated by the Merchant Shipping Act, 1958. Standards for discharging effluents are prescribed in the Environmental Protection Act, 1986 which is an umbrella act providing for the protection and improvement of the environment including coastal and marine areas. The effluents/discharges from various resources have to meet these standards before being discharged into marine waters.

The Coastal Zone Regulation Notification was issued in 1991 in India, under the EPA,1986. The notification aims at protecting and improving the quality of the coastal environment. The notification declares the limits of the Coastal Zone and classifies it into four categories for the purpose of regulation. CRZ I includes areas which are ecologically sensitive areas of outstanding natural beauty, historical heritage or rich genetic diversity. CRZ II includes the areas that have already been developed upto or close to the shoreline. Areas that are relatively undisturbed are classified under CRZ III. CRZ IV includes the coastal stretches in the Andaman and Nicobar, Lakshadweep and other small islands except those designated as CRZ I, II and III.

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The notification lays down certain prohibitions and also exceptions to prohibitions. Prohibited activities include setting up new industries (except those which are directly related to the water front or which directly need foreshore facilities) and expansion of existing industries including fish processing units, manufacture, handling, storage or disposal of hazardous wastes and substances, discharge of untreated wastes and substances, discharge of untreated wastes and effluents and dumping of municipal wastes as landfills or otherwise. Withdrawal of groundwater within 200 metres of the High Tide Line (HTL) is prohibited with some exceptions.

In most of these areas, an area of 200 metres from the HTL has been declared a no development zone. Several restrictions have been imposed for carrying out development in the area between 200 to 500 metres from the HTL. These measures have been adopted to protect fragile ecosystems which exist in the area and are vital for sustaining the ecological balance. Mangroves and coral reefs have been declared ecologically sensitive areas, (CRZ I) regular monitoring using satellite imagery which is in progress. A state-wise Mangrove Committee has been formed for effective management of the mangrove ecosystem. Mining of corals and coral sands has been banned. The CRZ notification also offers protection to coastal communities such as traditional fishermen.

The Recycled Plastics Manufacture and Usage Rules, 1999; Municipal Solid Wastes (Management and Handling) Rules, 2000; Ozone Depleting Substances (Regulation) Rules, 2000; the Prevention and Control of Pollution (Uniform Consent Procedure) Rules, 1999, are some of the rules framed under EPA, 1986, with an aim to providing environmental protection and are relevant to the coastal environment.

Since 1982, the CPCB has been carrying out a rapid inventory annually to assess the pollution status of coastal waters of India. This programme known as the Coastal Pollution Control Series (COPOCS) comprises among other things, (a) Identification of the uses of coastal water at different stretches and the best use among them; class designation of the sector or a portion thereof, and (b) Identification of land-based pollutants and polluting activities and those that require immediate control.

The Coastal Ocean Monitoring and Prediction systems (COMAPS) programme was launched in 1991, by the Department of Ocean Development (DOD) for monitoring the health of India's coastal waters. The programme monitors the effect of anthropogenic activities on the marine environment periodically and assesses the impact on the marine flora and fauna in the coastal waters of India. Studies related to the waste assimilation capacity of coastal waters have been undertaken from 1997-98 onwards.

Efforts have been made to set up sewage treatment plants in all coastal states. Treated effluents are being discharged into deeper waters through pipelines. The Government is also preparing an action plan for treatment of domestic wastes. Legislation has helped in the treatment of industrial wastes. In India, the Water (Prevention and Control of Pollution) Act includes tidal waters, unlike some other countries. The Act is applicable upto 5 km into the sea. Though the discharge of effluents from small scale industries is still a problem, efforts are being made to set up common treatment plants. This will help in minimising the load that is discharged to the sea.

Oil Spills

Tankers and off-shore oil wells are major source of marinal pollution and death of sea life. On account of ship wrecks good deal of oil spills into the Ocean. In January 1969, there was a blow out from an oil well in the Santa Barbara Channel in South California, USA causing a heavy oil spill into the sea, it covered miles of Ocean surface and smeared beaches with 2 inches layer of crude oil. The accident was huge health hazard to the living resources of the sea, human health and coastal amenities since the oil leak continued for more than a year. In March, 1978, 230,000 tonnes of oil in shipment through the English channel spilled from the tanker, Amoco Cardiz off Brittany, France. The ship ran around into rocks a bare 3 kilometres from Brittany's north-west coast. The wreck of tanker Exxon Valdez in 1989 spilled 10 million gallons of crude oil in Alaska, USA. In Persian Gulf War, Iraq released million of tonnes of oil causing worst of oil spills.

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Oil which is discharged on ocean surface forms into slick and floats over ocean surface and if it get absorbed on solid particles it sinks. The floating and suspended oil is absorbed by tiny organisms. Since these organisms are part of the food chain, the other higher forms of marine life feed upon them and successively pass the oil pollutants onto still higher organisms. Consequently, the concentrations reach higher levels in marine mammals, birds and man. Food chain is adversely affected.

Off-shore drilling, wrecked oil tankers and other wrecked ships, also cause marine pollution.

Thus the two major sources of marine pollution are (a) oil spill on the surface of oceans, and (b) waste disposal into the oceans from industrial and other sources mentioned above.

Control of Oil Pollution

The oceans are divided into two portions; that portion over which nations claim their sovereignty, and other portion over which all nations enjoy freedom of seas. This does not mean that on the sovereign portions of oceans, the State claiming sovereignty is free to damage it. Similarly, on the free seas, nations are not free to do everything. Marine pollution is a global problem and no nation can claim freedom to pollute. The developed nations have made seas as their dumping yard of all waste. And lately developing states too have joined in this pollution.

Several techniques have been used to reduce the effect of oil spill on the surface of oceans. These are:

- Burning of oil;
- Leaving the oil deposits in place and making them innocuous by coating them with various material;
- Emulsifying the oil and leaving its dispersal by the tides and wave;
- By hosing it down with water.

The United States had evolved a system of rubber bladders which can remove large quantities of oil from wrecked tankers. Another technique is the mechanical removal of oil from the beaches and elsewhere from the surface of the ocean. It is labour intensive and costly.

Self Assessment

State whether the following statements are true or false:

13. Marine pollution refers to ocean contamination.
14. Ships, large boats, and submarines are also a major source of noise pollution in the oceans and seas.
15. India has a long coastline of more than 9800 km.

10.6 Noise Pollution: Causes, Effects and Control Measures

The Meaning, Causes, Effects and Control Measures of Noise Pollution are discussed below:

10.6.1 Meaning of Noise Pollution

Modern life has given rise to a new form of pollution. The word noise is derived from the Latin 'nausea' meaning disgust. Noise is usually defined as undesired sounds producing an auditory sensation considered being annoying.

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Noise is the unwanted sound, usually of high intensity and it causes irritation and discomfort. Sources of noise are many, but it is always higher in urban and industrial areas than the rural one. Industries expose their workers to high noise load for long period of work every day.

Road traffic particularly during peak hours is another noise pollution source to travellers as well as to the shopkeepers and residents of the concerned area. Uses of loudspeakers on almost all kinds of occasions like festivals and elections, worship, and during advertisements are common almost all the year round.

Noise is defined physically as a complex sound with little or no periodicity and psychologically as a sound under sired by the recipient. Its definition can be more appropriately stated as - "Noise is unwanted sound or sounds of a duration, intensity, or other quality that cause some kind of physiological or psychological harm to humans or other living things."

1. 28 million people in India have hearing loss and noise is one of the leading causes of hearing loss, especially in young people.
2. Noise negatively affects learning and behaviour.
3. Studies show that children's learning is negatively affected by noise in the classroom.

Noise pollution affects the health physiologically, psychologically and in behaviour sense; with excessive noise, human beings become more irritable. It is estimated that noisy conditions result in lower efficiency and increased errors by the workers. Decibel is a ratio expressed on a logarithmic scale. This logarithmic scale takes care of wide range of sound power, intensity and pressure. The decibel (dB) scale begins from zero, which represents the faintest sound, which is audible to a normal ear.

Decibel (dB) is used in environmental noise pollution as a measure of sound power level, sound intensity level and sound pressure level. 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 Bel, the inventor of the telephone. Noise is unwanted, unpleasant sound. We cannot live without sound, yet too much of sound is unwanted. The unit for measuring sound is decibel (dB). Sound of 20 dB is whisper; 60 dB is normal conversation, 100 dB is conversation in running train; 120 dB is thunder and 140 dB is the level when sound becomes unbearable and irritating. Noise inside many factories exceeds 100 dB; aeroplane creates noise of 150 dB. This is what constitutes Noise Pollution. Attitude and annoyance threshold are determining factors to determine whether a sound is a noise. Degree of annoyance may not necessarily be related to the intensity of sound and personal attitude is an important influencing factor. A loud music may be liked or even considered melodious by a person whereas very feeble sound may be noise for another person. Noise pollution in such cases becomes subjective.

The effects, therefore, are psychological and physiological. Psychological effects may lead to tension and speech interference. Physiological effects lead to deafness. If a person is exposed to noise level about 100 dB continuously, as in workshops or exposure to jet aircraft, hearing defects become detectable. Also, the medical experts are of the opinion that fire crackers and continuous explosives lead to stomach ulcers and respiratory disorders. Further, noise becomes nuisance when one is either under meditation or enjoyment recreation.

The noise pollution can be defined simply as unwanted sound." Any type sound will be treated as unwanted due to the following facts.

- Annoying/unpleasant
- Loud
- Distracting/Intrusive

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Noise pollution definition can be given in one other way too.

Noise is actually a Latin word which gives the meaning seasickness. More commonly it can be stated as the sensation of annoyance, disgust or discomfort.

It is not very easy to define the noise pollution definition. Essentially noise pollution is the kind of pollution that is caused by several different audio sources that is causing the feel of irritation, distraction to our living environment. This not pollution is not only disturbing the environment but it also produces harm to our mankind.

10.6.2 Causes of Noise Pollution

The sources of noise are more in urban and industrial areas than in rural areas. The sources in general may be stationary or mobile.

1. Stationary Sources

Use of loudspeakers on various occasions like festivals, elections, worships in temples, mosques 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.

2. Mobile Sources

Road traffic, railway traffic, air traffic, navigation, etc. the sources of noise can be classified in following categories:

1. Transportation/Traffic noise
2. Industrial noise
3. Noise from construction work
4. Neighbourhood noise

These are stated as follows:

1. ***Transportation/Traffic Noise:*** The main threat of noise comes from transport. A survey in Delhi, Mumbai and Kolkata showed that daytime noises varied from 60 dB (A) in busy localities. In some heavy traffic areas, the average noise level reached up to 90 dB (A) even at nights.

   (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 one of the major causes of noise. The other factors on which traffic noise depends are traffic density and a number of operating factors/ conditions/type of vehicle. Heavy diesel engine vehicles are the noisiest vehicles on roads. It can be observed that sports car and motor cycles are notorious noise producers.

   (b) *Aircraft Noise:* Aircraft noise differs from road traffic noise in the sense that it is not continuous but intermittent. Noise is at a maximum during take-off and landing. Major cities around the world have banned or reduced flights at night and also prescribed noise limits.

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(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 normal ambient noise level near rail tracks went up by 10-20 dB (A) during train movement.

2. ***Industrial Noise:*** In industries, noise is the by-product of energy conversion. The compressors, generators, furnaces, looms, grinding mills, release valves and exhaust fans are the most offending noise sources.

   The common noise level in most units is 80-120 dB (A), which is really hazardous. Studies showed that 1.3 per cent of industrial workers suffer from tinnitus for noise exposure levels up to 80 dB.

3. ***Noise from Construction Work:*** 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.

4. ***Neighbourhood Noise:*** It includes a variety of noise sources which disturb and annoy general public. The most I prominent is the indiscriminate use of loudspeakers in public functions, entertainments, festivals, I elections etc. The other sources include vacuum cleaners, TV, radio sets and washing machines I etc.

During the festivals especially Diwali, fireworks push up the noise level up to 80-100 I dB(A) during evening hours, against the normal level of 50 dB(A).

10.6.3 Effects of Noise Pollution

Noise has always been with the human civilization but it was never so obvious, so intense, so varied and as pervasive as it is seen in the last of this century. Noise pollution makes men more irritable. The effect of noise pollution is multifaceted and inter related. The effects of Noise Pollution on Human Being, Animal and property are as follows:

1. ***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. In India it is suggested that reducing industrial booths could improve the quality of their work. Thus human efficiency is related with noise.

2. ***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.

3. ***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

4. ***Abortion is caused:*** There should be cool and calm atmosphere during the pregnancy. Unpleasant sounds make a lady of irrigative nature. Sudden Noise causes abortion in females.

5. ***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.

Notes

6. ***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 and 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.

7. ***Effect on Vegetation Poor quality of Crops:*** 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.

8. ***Effect on Animal:*** Noise pollution damages the nervous system of animal. Animal looses the control of its mind. They become dangerous.

9. ***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.

10.6.4 Measures to Control Noise Pollution

There are many methods which help to control the noise pollution. The source of noise must be reduced. The path of transmission of sound must be stopped and the receiver of noise must be safe guarded. The amount of traffic must be reduced near the residential homes, educational institutes and hospitals. The machinery must be redesigned and the vehicles must be properly maintained. The acoustical furnishing must be done so that the sound can be absorbed. The voice must not be passed directly to the receiver and must be diverted upwards instead of downwards as in case of ear splitting jet exhaust noise. The industries must be built away from the residential areas and the legal laws must be established and observed to protect the humans from noise pollution. A general awareness programme to educate the people must be done. It is basically a public nuisance which affects the human beings in almost all aspects.

Follow the below given steps for controlling and preventing noise pollution:

1. Control of Noise pollution at Source.
2. Noise producing industries, railway stations, aerodrome, etc. should be located far away from the residential areas.
3. We should play various music systems such as stereos, television, etc. at low volume.
4. We should not use loud speakers during night. Even during time they should be used at low volumes.
5. Various machines should be well maintained so that they produce less sound.
6. It is observed that certain persons blow horns of their vehicles unnecessarily, or remove silencers of the exhaust pipes of vehicles. Such practices produce lot of noise and should be avoided.
7. Laws should be framed so that the persons producing unnecessary noise are punished.

Noise pollution can be controlled by reducing noise at source. Making a change in design and operation of machines, vibration control, by using sound absorbing materials, can reduce noise pollution. It can also be reduced by prescribing noise limits for vehicular traffic and planning industrial establishments, amusement areas, residential colonies and hospitals to make them noise proof. Control of Noise Pollution by obstructing the path of Noise:

1. By constructing soundproof buildings, the menace of sound pollution can be minimized.

Notes

2. Plants also help in controlling noise pollution because they absorb high frequency sound waves. Thus, planting trees along the roads help in controlling noise pollution.

Self Assessment

State whether the following statements are true or false:

16. Noise positively affects learning and behaviour.
17. Noise is the unwanted sound.
18. Physiological effects lead to tension and speech interference.

Case Study

Water Pollution (Pesticide Pollution in India)

One of the most terrifying effects of pesticide contamination of groundwater came to light when pesticide residues were found in bottled water. Between July and December 2002, the Pollution Monitoring Laboratory of the New Delhi-based Centre for Science and Environment (CSE) analyzed 17 brands of bottled water; both packaged drinking water and packaged natural mineral water, commonly sold in areas that fall within the national capital region of Delhi. Pesticide residues of organochlorine and organophosphorus pesticides, which are most commonly used in India, were found in all the samples. Among the organochlorines, gamma-hexachlorocyclohexane (lindane) and DDT were prevalent, while among organophosphorus pesticides, Malathion and Chlorpyrifos were the most common. All these were present above the permissible limits specified by the European Economic Community (EEC), which is the norm, used all over Europe.

One may wonder as to how these pesticide residues get into bottled water that is manufactured by several big companies. This can be traced to several facts. There is no regulation that the bottled water industry must be located in 'clean' zones. Currently, the manufacturing plants of most brands are situated in the dirtiest industrial estates or in the midst of agricultural fields. Most companies use bore-wells to pump out water from the ground from depths varying from 24-152 m below the ground. The raw water samples collected from the plants also revealed the presence of pesticide residues. This clearly indicated that the sources of pesticide residues in the polluted groundwater are used to manufacture the bottled water. This is despite the fact that all bottled water plants use a range of purification methods. Thus, the fault obviously lies in the treatment methods used. These plants use membrane technology, where the water is filtered using membranes with ultra-small pores to remove fine suspended solids and all bacteria and protozoa and even viruses. While nanofiltration can remove insecticides and herbicides, it is expensive and thus rarely used. Most industries also use an activated charcoal adsorption process, which is effective in removing organic pesticides but not heavy metals. To remove pesticides, the plants use reverse osmosis and granular activated charcoal methods. So even though the manufacturers claim to use these processes, the presence of pesticide residues points to the fact that either the manufacturers do not use the treatment process effectively or only treat a part of the raw water. The low concentrations of pesticide residues in bottled water do not cause acute or immediate effects. However, repeated exposure even to extremely miniscule amounts can result in chronic effects like cancer, liver and kidney damage, disorders of the nervous system, damage to the immune system and birth defects.

Contd....

Notes

Similarly, six months after CSE reported pesticide residues in bottled water it also found these pesticides in popular cold drink brands sold across the country. This is because the main ingredient in a cold drink or a carbonated non-alcoholic beverage is water and there are no standards specified for water to be used in these beverages in India. There were no standards for bottled water in India till September 29, 2000, when the Union Ministry of Health and Family Welfare issued a notification amending the Prevention of Food Adulteration Rules, 1954. The BIS (Bureau of Indian Standards) certification mark became mandatory for bottled water from March 29, 2001. However, the parameters for pesticide residues remained ambiguous. Following the report published by CSE in Down to Earth, a series of Committees were established and eventually on 18th July 2003, amendments were made in the Prevention of Food Adulteration Rules stating that pesticide residues considered individually should not exceed 0.0001 mg/l and that the total pesticide residues should not be more than 0.0005 mg/l and that the analysis shall be conducted by using internationally established test methods meeting the residue limits specified herein. This notification came into force from January 1, 2004.

River Pollution in India

Almost all the rivers in India are polluted. The causes of pollution may also be more or less similar. This is a case study of the River Damodar as reported in Down to Earth. The 563-km long Damodar River originates near Chandwa village in the Chhotanagpur hills in Bihar's Palamau district. It flows through one of the richest mineral belts in the world before draining into the Hooghly, about 50 km south of Kolkata. Indian industry depends heavily on this region as 60% of the coal consumed in our country comes from the Chhotanagpur belt. Coal-based industries of all types dot the area because of locational advantages and the easy availability of water and power. In addition, various industries such as steel, cement, fertilizer and explosive plants are also located here. The River Damodar is polluted with minerals, mine rejects and toxic effluents. Both its water and its sand are infested by coal dust and waste from these industries. There are seven thermal power plants in the Damodar valley. The states of Bihar and West Bengal depend almost entirely on this area for their power requirements. These power plants not only consume a lot of water but also dump ash in the valley.

Mining

As underground mines cannot keep pace with the rising demand, 60% of the coal extracted from the area comes from open-cast mines, which are responsible for serious land degradation. The disposal of rock and soil extracted along with the coal only adds to the problem.

Industries

The industries in the area do not have proper effluent treatment plants. Among the big coal-based industries, the washeries account for the bulk of the pollution in terms of the total suspended solids (TSS), oil and grease. About 20% of the coal handled goes out in the form of slurry, which is deposited in the ponds outside. After the slurry settles, coalfine (the sediment) is collected manually. Due to inadequate retrieval methods very often the water discharges into the river from the pond carries high amounts of fine coal particles and oil, thus polluting the river. The other major coal-based polluters are the coke oven plants that heat coal to temperatures as high as 1100°C in the absence of oxygen to prepare it for use in blast furnaces and foundries. The volatile components in the coal are removed, leaving hot, non-volatile coke in the oven, which is washed with huge quantities of water. This water that contains oil and suspended particles is then discharged into the river.

Notes

Fly-ash from the Thermal Power Plants

Only one of the thermal power plants has an electrostatic precipitator to collect the fly-ash, while the other just make do with mechanical dust collectors. As most of these plants are located on the banks of the river, the fly-ash eventually finds its way into the river. The bottom-ash from the boilers is mixed with water to form slurry, which is then drained into ash ponds. Most of the ponds are full and in several cases the drainage pipes are choked. The slurry is, therefore, directly discharged into the river.

Effects

The river and its tributaries are the largest source of drinking water for the huge population that lives in the valley. On April 2, 1990, about 200,000 litres of furnace oil spilled into the river from the Bokaro Steel Plant. This oil travelled 150 km downstream to Durgapur. For a week after the incident, five million people drank contaminated water in which the oil levels were 40 to 80 times higher than the permissible value of 0.03 mg/l. The Damodar Action Plan, an end-of-the pipe pollution treatment scheme, seeks to tackle effluents. One viable option could be to switch to less polluting industries and cleaner technology. This would need strong Government initiative and also a mass movement by people.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.environmentandpeople.org/WaterPollutionCasestudy.html

10.7 Summary

- Pollution is the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the ecosystem i.e. physical systems or living organisms.
- Pollution can take the form of chemical substances, or energy, such as noise, heat, or light energy. Pollutants, the elements of pollution, can be foreign substances or energies, or naturally occurring; when naturally occurring, they are considered contaminants when they exceed natural levels.
- Pollution is often classed as point source or non-point source pollution.
- Pollution of the environment is causing great damage to ecosystem that depends upon the health of this environment.
- Environmental pollution is defined as the undesirable change in physical, chemical and biological characteristics of our air, land and water.
- The Air (Prevention and Control of Pollution) Act, 1981, defines "Air Pollutant" and in reference to them defines air pollution.
- Air is mainly a mixture of various gases such as oxygen, carbon dioxide, nitrogen.
- Air pollution is the introduction into the atmosphere of chemicals, particulates, and biological matter that cause harm to humans, other living organisms, or cause damage to the natural environment.
- Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water.

Notes

- The **causes of water pollution** vary and may be both natural and anthropogenic.
- With increasing urbanisation and expanding agricultural and industrial production, water pollution problems have progressively become more serious and necessitated the adoption of suitable control measures for ameliorating pollution.
- Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.
- Marine pollution refers to ocean contamination, especially with man-made waste or byproducts.
- Carbon dioxide is hazardous for marine life including coral reefs and free-swimming algae.
- Noise is the unwanted sound, usually of high intensity and it causes irritation and discomfort.
- The effect of noise pollution is multifaceted & inter related.

10.8 Keywords

Air Pollution: Air pollution is the introduction into the atmosphere of chemicals, particulates, or biological materials that cause discomfort, disease, or death to humans, damage other living organisms such as food crops, or damage the natural environment or built environment.

Biodegradable Pollutants: Biodegradable pollutants are broken down by the activity of microorganisms and enter into the biogeochemical cycles. Non- Biodegradable pollutants - Non-biodegradable pollutants are stronger chemical bondage, do not break down into simpler and harmless products.

Climate Change: Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years.

Ecosystem: A biological community of interacting organisms and their physical environment.

Eutrophication: Eutrophication is caused by an increase in plant nutrients in water. The higher availability of nutrients causes certain water plants, such as algae and duckweed, to grow so extensively.

Fossil Fuels: A natural fuel such as coal or gas, formed in the geological past from the remains of living organisms.

Marine Pollution: It refers to ocean contamination, especially with man-made waste or byproducts.

Noise: Noise is unwanted sound or sounds of duration, intensity, or other quality that cause some kind of physiological or psychological harm to humans or other living things.

Oil Spills: An oil spill is a release of a liquid petroleum hydrocarbon into the environment due to human activity, and is a form of pollution.

Ozone: Ozone is created everywhere in the atmosphere through chemical reactions under the influence of UV-light.

Pollution: The presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects.

Smog: It is a combination of the words smoke and fog.

Notes

Soil Pollution: It is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.

Thermal Pollution: Thermal pollution can occur when water is used as a coolant near a power or industrial plant and then is returned to the aquatic environment at a higher temperature than it was originally.

Toxic Substance: A toxic substance is a chemical pollutant that is not a naturally occurring substance in aquatic ecosystems.

Water Pollution: It can be defined as the contamination of the water bodies when pollutants are released into the water without thorough treatment and removal of harmful components. Water pollution is any chemical, physical or biological change in the quality of water that has a harmful effect on any living thing that drinks or uses or lives (in) it.

10.9 Review Questions

1. Define Environmental Pollution. Explain with the help of example.
2. What are the causes of Air Pollution?
3. Highlight the effects of Air Pollution.
4. Discuss the measures to control Air Pollution.
5. Explain the various types of Water Pollution.
6. Describe the specific sources of Water Pollution.
7. Highlight the effects of water pollution on ecosystem.
8. Discuss the causes of Soil Pollution.
9. What measures you may be suggested to control soil pollution?
10. Write brief note on Marine Pollution.
11. Throw some light on the causes of Marine Pollution.
12. Discuss the effects of Marine Pollution.
13. Define Oil Spills.
14. How can oil pollution be controlled?
15. What are the causes of Noise Pollution?

Answers: Self Assessment

1.	False	2.	True
3.	True	4.	Air
5.	WHO	6.	CFC
7.	False	8.	False
9.	True	10.	Productive
11.	Natural Soil	12.	Soil conservation
13.	True	14.	True

Notes

15. False
16. False
17. True
18. False

10.10 Further Readings

Books

Allaby, Michael, (2002), *Basics of Environmental Science,* Routledge

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Kaushik, Anubha, (2006), *Perspectives in Environmental Studies,* New Age International

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Online links

http://agritech.tnau.ac.in/environment/envi_pollution_introduction.html

http://depssa.ignou.ac.in/wiki/index.php/Environmental_Pollution

http://meridian.aag.org/sustainable/gallery/projects/gathambo.pdf

http://pollutionarticles.blogspot.in/2009/11/environmental-pollution-definition-and.html

http://saferenvironment.wordpress.com/2009/09/01/environmental-pollution-problems-and-control-measures-%E2%80%93-overview/

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Unit 11: New Sources of Pollution

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Objectives

After studying this unit, you should be able to:

- Discuss the overview of Thermal Pollution
- Explain the Nuclear Pollution
- Describe the Role of Individual in Prevention of Pollution

Introduction

In the previous unit, we dealt with the meaning of Environmental Pollution and discuss the causes, effects and controlling measures of various types of pollution that is Air, Water, Soil, Marine and Noise. Thermal pollution by power plants arises mainly from the approximately 65 percent of the thermal energy generated which is rejected to the cooling medium via the turbine condenser. This can be rejected into a river, lake, or the sea, or to the atmosphere via cooling towers. The amount of heat rejected for a turbine of a given output is not much different for nuclear plants compared to fossil fuelled ones. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the overview of Thermal and Nuclear Pollution along with the role of Individual in Prevention of Pollution.

Notes

11.1 Thermal Pollution

Thermal pollution is the act of altering the temperature of a natural water body, which may be a river, lake or ocean environment. This condition chiefly arises from the waste heat generated by an industrial process such as certain power generation plants. The concept is most frequently discussed in the context of elevating natural water temperature, but may also be caused by the release of cooler water from the base of reservoirs into warmer rivers. Elevated river temperatures can also arise from deforestation or urbanization that can reduce stream shading. Thermal pollution is one parameter of the broader subject of water pollution. There can be significant environmental consequences of thermal pollution with respect to surface receiving waters such as rivers and lakes; in particular, decrease in biodiversity and creation of an environment hospitable to alien aquatic species may occur.

Notes Regulation of thermal pollution has been more elusive than for other forms of water pollution, although straightforward mitigation measures are available, especially in the case of elevated temperature discharges.

In India, there are about 75 thermal power stations. Main sources of air pollution from various units of thermal power stations are sulphur dioxide, nitrogen oxides, carbon monoxide hydrocarbon, fluorine, fly ash, etc. These pollutants affect the ecosystem in general and plants in particular. Many of the trees due to high level of air pollution stop bearing fruits. Plants not blossom and even if they do the flowers are very small and rickety. Air pollution has ahead led to the disappearance of much of vegetation including trees. 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 caused by either dumping hot water from factories and power plants or removing trees and vegetation that shade streams, permitting sunlight to raise the temperature of these waters.

Caution Like other forms of water pollution, thermal pollution is widespread, affecting many lakes and vast numbers of streams and rivers in the United States and other parts of the world.

11.1.1 Major Sources

The major sources of thermal pollution are electric power plants and industrial factories. In most electric power plants, heat is produced when coal, oil, or natural gas is burned or nuclear fuels undergo fission to release huge amounts of energy. This heat turns water to steam, which in turn spins turbines to produce electricity. After doing its work, the spent steam must be cooled and condensed back into water. To condense the steam, cool water is brought into the plant and circulated next to the hot steam. In this process, the water used for cooling warms 5 to 10 Celsius degrees (9 to 18 Fahrenheit degrees), after which it may be dumped back into the lake, river, or ocean from which it came. Similarly, factories contribute to thermal pollution when they dump water used to cool their machinery.

Notes

The second type of thermal pollution is much more widespread. Streams and small lakes are naturally kept cool by trees and other tall plants that block sunlight. People often remove this shading vegetation in order to harvest the wood in the trees, to make room for crops, or to construct buildings, roads, and other structures. Left unshaded, the water warms by as much as 10 Celsius degrees (18 Fahrenheit degrees). In a similar manner, grazing sheep and cattle can strip stream sides of low vegetation, including young trees. Even the removal of vegetation far away from a stream or lake can contribute to thermal pollution by speeding up the erosion of soil into the water, making it muddy. Muddy water absorbs more energy from the sun than clear water does, resulting in further heating. Finally, water running off of artificial surfaces, such as streets, parking lots, and roofs, is warmer than water running off vegetated land and, thus, contributes to thermal pollution.

In the industrial area, petroleum refineries, pulp/paper mills, chemical plants, steel mills and smelters are the big contributors to thermal heat pollution. Natural causes include geothermal and volcanic activity, either under the oceans and seas or from above ground lava flow.

Did u know? Lightening strikes can also introduce massive amounts of heat, and the natural progress of warmer currents into colder biomes occurs.

The effects of thermal pollution include damage to larvae and eggs of fish in rivers where there is a limited tolerance for temperature change. The other effects are on the biodiversity of aquatic biomes due to killing off of some species that are not resistant to temperature change, which disrupts the balance of the food and light chains for plants, fish, bacteria, and microscopic life forms.

Example: Fish and macro-invertebrates are most susceptible to temperature changes, as they have the most limited tolerance for sudden excessive heat and cold.

Heat affects the metabolic rate and enzymatic activity of aquatic animals, leading to more eating, which can upset the balance in food availability. Dissolved oxygen and other chemical changes to the structure of the water are another effect of heat thermal pollution. The heat tends to decrease the amount of dissolved oxygen in the water. Another effect is that living entities attempt to migrate when their environment is untenable. The increased migration of life forms to areas that had a perfect balance can create a fight for limited resources, once the population increases.

11.1.2 Impacts

All plant and animal species that live in water are adapted to temperatures within a certain range. When water in an area warms more than they can tolerate, species that cannot move, such as rooted plants and shellfish, will die. Species that can move, such as fish, will leave the area in search of cooler conditions, and they will die if they can not find them. Typically, other species, often less desirable, will move into the area to fill the vacancy.

In general, cold waters are better habitat for plants and animals than warm ones because cold waters contain more dissolved oxygen. Many freshwater fish species that are valued for sport and food, especially trout and salmon, do poorly in warm water. Some organisms do thrive in warm water, often with undesirable effects. Algae and other plants grow more rapidly in warm water than in cold, but they also die more rapidly; the bacteria that decompose their dead tissue use up oxygen, further reducing the amount available for animals. The dead and decaying algae make the water look, taste, and smell unpleasant.

Notes

Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers. This affects fish (particularly their eggs and larvae), macro invertebrates and river productivity. This has become an increasing and the most current pollution, owing to the increasing call of globalization everywhere. Heat produced from industries is a major contribution to the pollution, much to the operation of the heavy industries which produces high amount of heat energy.

11.1.3 Causes of Thermal Pollution

Thermal pollution is basically the form of water pollution that refers to degradation of water quality by any process that changes ambient water temperature. The main cause of thermal pollution is our industry, or to be more precise power plants that use water as a coolant. After this water has been used as coolant it is returned to its natural environment at a higher temperature. This change in water temperature decreases the amount of oxygen in the water which can lead to many negative ecological effects. Less oxygen in the water can harm fish population, for instance it can increase the metabolic rate of fish and other aquatic animals so they eat lot more food in a shorter time than if their environment were not changed. This can lead to imbalance in food chain resulting in significant damage to many aquatic ecosystems.

Warmer water temperatures can also lead to reproduction problems for many aquatic animals, and can cause huge bacteria and plant growth. It can even lead to algae bloom resulting in even less oxygen in the water. Industry doesn't always return water at higher temperatures, sometimes the water can return to its natural environment at lower temperatures. Colder water can have even more serious consequences to fish population than warmer water, as it can completely disrupt their reproduction ability. There have been several cases around the globe where colder water created total extinction of native fish species which lead to the drastic changes in these ecosystems.

Example: In United States power plants currently account for more than three quarters of total thermal pollution. The thermal pollution levels are still relatively high in United States despite the controlling measures like the implementation of cooling ponds and cooling towers in some power plants. This is because many power plants in United States use less efficient cooling solutions like once-through cooling (OTC).

Urban runoff can also become the source of thermal pollution especially in smaller streams once storm water passes over hot parking lots and roads and enters the water body. Thermal pollution still doesn't get much of public attention. In most cases it is being scarcely mentioned when discussing the general water pollution issue.

11.1.4 Control of Thermal Pollution

There are several means of reducing impacts of warm water terminal discharges, including use of cooling ponds, cooling towers and also productive use of the heated water for a secondary industrial process or space heating. In the case of cold water discharge from reservoir bottoms, the mitigation is not as straightforward, and can often be very expensive. Since there are seasonal variations in the degree of vertical thermal stratification, the timing of water releases can sometimes be conducted to minimize cold water different in the discharge, provided these releases are consistent with needs for flood control or power generation. In the summer, for example, there may be extremes in formation of cold water layers at the reservoir bottom; such times would be adverse for cold water release impacts downstream.

Notes

1. Industrial Wastewater

Thermal pollution from industrial sources is generated mostly by power plants, petroleum refineries, pulp and paper mills, chemical plants, steel mills and smelters. Heated water from these sources may be controlled with:

- cooling ponds, man-made bodies of water designed for cooling by evaporation, convection, and radiation
- cooling towers, which transfer waste heat to the atmosphere through evaporation and/or heat transfer
- cogeneration, a process where waste heat is recycled for domestic and/or industrial heating purposes.

Some facilities use once-through cooling (OTC) systems which do not reduce temperature as effectively as the above systems.

Example: The Potrero Generating Station in San Francisco, which uses OTC, discharges water to San Francisco Bay approximately 10° C (20° F) above the ambient bay temperature.

2. Urban runoff

During warm weather, urban runoff can have significant thermal impacts on small streams, as storm water passes over hot parking lots, roads and sidewalks. Storm water management facilities that absorb runoff or direct it into groundwater, such as bio-retention systems and infiltration basins, can reduce these thermal effects. Retention basins tend to be less effective at reducing temperature, as the water may be heated by the sun before being discharged to a receiving stream.

Thus, in order to prevent thermal pollution due to devegetation, the prescription is simple: do not devegetate. Landowners can leave strips of trees and vegetation along streams and shorelines. Grazing livestock can be kept away from streamsides by fencing. All efforts to control erosion also have the effect of keeping water clearer and, thus, cooler.

As a practical matter, however, thermal pollution from devegetation is quite hard to control because it is caused by the cumulative effect of many peoples' actions, most of which are individually minor. Regulations focus on a few of the most important threats. Grazing management plans, for instance, are intended to counter thermal pollution and other problems on lands owned by the federal government. In the United States, regulations governing logging on both public and private lands supposedly protect streamsides, though enforcement is often lax. Elsewhere, streamside protection is largely up to private landowners, encouraged and aided by such advisory organizations as the federal Natural Resources Conservation Service and cooperative Resource Conservation Districts.

Task Critically examine how factories prevent thermal pollution.

Notes

Caselet

Korba - National Thermal Power Corporation

Korba is situated between 22°30' N latitude and 82° 46' E longitude in Korba district of Chhattisgarh. Apart from National Thermal Power Corporation (major source of air pollution other sources of pollution at Korba are Bharat Aluminium Company Ltd. (BALCO) Captive Power Plant, Chhattisgarh.

Electricity Board Thermal Power Plant (C.G. east and west). In addition to these, there are a number of coal mines in the area. Burning of coal in the power station and for other industrial activities leads to the increase of SO_2, NO_2, CO_2 particulates in the form of fly ash and other industrial pollutants significant quantities of fly ash emanate from the four chimneys of NTPC and are carried by air currents to the residential surroundings.

In addition to the pollutants emitted in the gaseous form, solid and liquid pollutants are also coming out from the thermal power stations and drain out through the river Hasdeo.

It has been observed that under acute pollution, defoliation takes place, which is reflected from the physiological observations on plants. Even many plants are at the verge of extinction. Plants in the east and south direction are highly affected.

There is a considerable reduction in number of species at the nearest point of the industrial establishment. Maximum reduction is in the south and east direction (54.7 and 50.6 per cent respectively).

With the increase of the distance from the central point there is an increase in the number of species. The ground vegetations, which are growing outside the zone of acute pollution

But these species are rarely found at the nearest point of the industrial establishment particularly in the east and south directions. It may be noted that due to the height of stack (180m), the emission spread to a large distance (10 to 12 km) and downwind play a vital role in spreading the emission. The upwind has little effect as compared to the downwind. The direction of winds is from northwest to southeast and as a result the effect is high in the east and south directions.

Ground vegetation (herbs and grasses) and shrubs seem to be more sensitive to pollution induced changes as compared to trees, the herbs and grasses being more effected as evidenced from their density (field observation).

Higher sensitivity of the herbs and shrubs can be explained by the fact that they are very small and the pollutants are distributed equally in the entire plant body exposed. Also, the plant surface is tender and holds and absorbs the pollutants without much resistance. Further, surface soils are being altered (unpublished data) due to the impact of pollution and thus, hamper the establishment of shallow rooted ground covers.

At Korba, the leaves with different injury symptoms indicate that some of the pollutants are present beyond the permissible limit as suggested by United States Environment Protection Agency and World Health Organization. Dust fall (19.1 t/km2/mo A AM, maximum recorded 40.45 t/km2/ mo), suspended particulate matter (60/mg/m3 AGM, max 1464), sulphurd dioxide (52.23mg/m3 AAM, max. 151.9) and nitrogen dioxide (37.77mg/m3 AAM, max. 109.65) exceed air quality standard.

Throughout the year although in the rainy season their concentrations are comparatively lower. These may be causing some metabolic disruption in the plants and the symptoms like necrosis, chlorosis, tipburn, etc., are apparent. Sulphur dioxide is a widely recognized

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phytotoxicant. Symptoms of morphological injury such as chlorosis, necrosis, bronzing and/or premature leaf fall usually appear when plants are exposed to SO.

But in this study the relationship between basal area of the trees and the distance from the power plant is poor because of the fact that trees around the thermal power plant were established before the power plant came into existence. However, the effect of pollutants is well reflected from the extent of damage to leaves.

Phytotoxic effects of air pollution may be classified into visible and subtle effects. Visible effects are marked by necrotic and chlorotic patches and/or yellowing of leaves resulting from physiological disturbance of plant cells whereas subtle or invisible effects lead to decreased yields and lower quality of plant products. Reduction in annual diameter grown in the polluted area has been documented

Depending upon the extending of damage, the plants growing near thermal power plants can be grouped into three categories, viz., highly tolerant, moderately tolerant and sensitive to emission. Herbal species are the most susceptible while already established woody species are able to cope up with the pollution although they show some visible injuries under stress.

These trees may provide a natural sink for air pollutants/thermal power emissions and may be planted on large scale. The selection of species for green belt around industrial areas is the most urge for mitigating dust pollution and other industrial pollution.

Source:http://www.preservearticles.com/2012011320622/short-essay-on-thermal-pollution-case-study.html

Self Assessment

State whether the following statements are true or false:

1. In India, there are about 25 thermal power stations.
2. Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence.
3. Like other forms of water pollution, thermal pollution is not widespread.
4. The major sources of thermal pollution are electric power plants and industrial factories.
5. During cold weather, urban runoff can have significant thermal impacts on small streams, as storm water passes over hot parking lots, roads and sidewalks.

11.2 Nuclear Pollution

Power starving world took shelter under the umbrella of nuclear plants. The idea sprang from the energy released by atom bombs. It is very difficult to have a nuclear war. Prof. Warner revealed in Madurai Kamraj University that even a limited nuclear war would instantly kill 1000 million people. 3000 million would die of starvation. The smoke would cover sun bringing temperature to 15 to 20 degrees. Ozone layer would be depleted. The radioactive clouds would travel all over the world and the world would be full of disabled persons. A little bigger warfare would finish the world. All problems would be over.

The people became wiser. They channeled the atomic power into energy through atomic plants little knowing that the radiation from these plants would be as hazardous—even more—as that from ultraviolet rays of the sun. Man cannot gain immunity from it. The plants are good only till they do not let radioactive fumes come out. It may come at intervals affecting animal world including man, and poison food too.

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The developed countries started the plants, as they wanted more energy for their luxurious and wanton life. As soon as they realized the hazards of these plants they propagated the usefulness of the plants in developing countries. Being misled by the West many third world countries purchased the plants from the former. The West started dismantling their own—but only after the serious leakage at Chernobyl in Ukraine in 1986. 1,35,000 persons had to be moved to safer places within two and a half hours. Soviet academicians laid responsibility on incompetence and irresponsibility. But Arthur Purcell reminded the world that it was "another example of technology's limit in serving humanity."

Besides the death of a large number of people the radioactive particles spread to Germany and polluted the atmosphere in Poland, Austria and France. Thousands of tonnes of milk and vegetables had to be destroyed. Radio activated cattle too were killed and their meat destroyed. The seriousness of the nuclear plant pollution can be estimated from the fact that since 1957 more than 4000 accidents have taken place.

To recapitulate a few-Ural Mountains in Russia in 1957-58, UK in 1957, USA in 1961, Luceans Vad in Switzerland in 1969, Russia in 1974, USA again in 1975 and 1979, Tsuruga in Japan in 1981, Buenos Aires in Argentina in 1983, Oklahoma in USA in 1986, Three mile Island in USA in 1979 continuing up to 1987. Another study reported other 151 accidents in 14 countries between 1971 and 1984. A private body in USA reported 3000 accidents in Nuclear Power Projects in the USA in 1985 and 2,300 in 1984 besides 750 emergency shut downs in 1984.

It looks rather strange that even after so many accidents polluting the world atmosphere there are still near about 450 nuclear plants supplying electricity to 26 countries. France tops the list with 70% dependence on nuclear power. USA comes next from the bottom with 18%. The former USSR had 41 plants for its 11% nuclear power generation.

Dr. David Lilienthal who initiated the first Atomic Power Station in the world is again the first to question "the moral right to promote and sell such a complicated immature and fundamentally unsafe nuclear system". One of the problems of the NPPs is that there is radioactive waste that remains pollutant.

According to Dr. Dhirendra Plutonium 239 remains active for 24,300 years and PU 242 for 3,79,000 years. Who can manage this waste for such a long period covering so many millenniums? 3000 tonnes of radioactive waste of Indian Rare Earths in Kerala was dumped into the Arabian Sea in the 60s it has also contaminated Periyar river. It has resulted in the death of 20,000 people with cancer in Kerala—twice the national average.

In India there have been accidents and leakage at Tarapur exposing 3,000 workers. Madras Atomic Power Station at Kalpakkam and CANDV the NPP of Rajasthan also faced the same problem. There were lapses of safety at Narora, Kakrapar, Kaiga and Nagarjunsagar plants too. Sugatha Kumari the well-known Malayalam poetess and many other luminaries formed a group that came to the conclusion that "The radiation hazard was intrinsic to and inseparable from atomic power generation, as irrespective of their design and construction all reactors were liable to routinely release radioactivity and harmful radio-nuclides." Even after this warning the clout of Indian nuclear scientists has been making efforts to have more nuclear plants.

It is good that the movement against this most hazardous pollutant is gaining grounds in the USA and some European countries. About 600 orders for atomic reactors were cancelled. Some of the states in the USA have banned commissioning of existing plants too. In India there is no organization to investigate. The affected workers are dismissed and new ones are appointed.

Huge energy will be released by Nuclear Fission. This nuclear fission can be used for two purposes – one for atom bombs, and another for nuclear energy, i.e. electricity.

America had throng first nuclear bomb on Hiroshima and Nagasaki in Japan during the Second World War. Too much disaster was created by the atom bombs fallen on Hiroshima and Nagasaki.

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Japan surrendered itself to America immediately. As a result, the Second World War was stopped. Since then America, soviet Russia, France, England, China, etc., countries have accumulated several thousands of nuclear bombs. There are several other countries accumulated the atom bombs, including India, Israel, Pakistan, Iran, North Korea etc. Now the formula of atom bombs is not in secret. Every some groups of terrorists also know this formula.

The effects of each nuclear bomb, if it is put into use, shall create huge disaster and danger to the human beings and environment. What happened in Hiroshima and Nagasaki, was witnessed by the world.

In 1968, the first review conference of the Non-Proliferation Treaty (NPT) was concluded by majority of the States. It aimed to prevent nuclear bombs. As NPT has shown discrimination between the Nuclear States, i.e. America, China, Soviet Russia, France, England and other courtiers, India did not sign on it.

Let us hope that some non-government organization in India too would force the government to put an end to these most hazardous pollutant projects, and to have energy give importance to the plants based on sea waves, wind and sun rays that are non-pollutant.

11.2.1 Nuclear Hazards

Release of radioactive substances into air, water, or earth as a result of human activity, either by accident or by intention is referred to as nuclear waste. The sources of such wastes are:

1. Nuclear weapon testing;
2. The nuclear fuel or materials being used in nuclear power plants or nuclear bombs; and
3. Accidental release of nuclear material from nuclear power plants.

A small amount of radiation due to radioactive material release can have serious consequences and since nuclear wastes remain active for long time, radioactive pollution is a serious environmental concern even though natural sources of radioactivity far exceed artificial ones.

Radioactive wastes spread over a broad area very rapidly and may not fully show its effects upon humans and organisms for decades. So when the radioactive leak is detected, many of the individuals affected by the leak might have died already.

Three types of fallout result from nuclear explosion or testing or release:

1. Local fallout which is quite intense but short-lived;
2. Fallout in the lower atmosphere which is deposited at a later time and covers a larger area; and
3. Fallout, which releases particles into the upper atmosphere, may continue for years after an explosion and attain a worldwide distribution.

The two best-known examples illustrating the effect of fallout are the bombing of Hiroshima and Nagasaki, Japan in 1945 and the Chernobyl Nuclear Power Station disaster in 1986. Within five years of the bombing of Japan by America, 225,000 people died as a result of long-term exposure to radiation from the bomb.

11.2.2 Nuclear Waste Management

Radioactive waste is the hazardous waste material. Such waste can be categorized as low or high level waste. Low-level radioactive waste usually contains a small amount of radioactivity dispersed in a large volume of material. Such materials are produced in a great variety of industrial, medical and research procedures. A common practice is to store these materials in

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sealed containers and when their level of radioactivity is very low, they can be disposed by burial or by other traditional solid waste disposal systems. The assumption is that the level of radiation released by these wastes is now too low to cause any harmful environmental effects. This assumption has been challenged by some scientists who suggest that safer methods of disposal for such wastes need to be developed.

High-level radioactive wastes consist of materials that contain large amount of radioactivity whose intensity is very high even for hundreds or thousands of years. They pose a difficult disposal problem. The primary sources of high level wastes are nuclear power plants and development of nuclear weapons.

Notes A number of methods for the storage of high-level wastes have been suggested. Various countries have developed a variety of methods for storing high-level nuclear wastes. In Canada, such wastes have been stored in water filled pools for more than 25 years. France, which has one of the world's largest nuclear power establishments, has constructed a large underground vault for preserving its wastes. In the United States, Congress passed the Nuclear Waste Policy Act in 1982, emphasizing for the construction of a high-level waste repository in the early twenty-first century.

11.2.3 Cold War

There was a stringent cold war between America and Soviet Russia upto 1992. The cold war between super powers had caused too much threat to the globe as each of these countries accumulated more and more nuclear weapons. There was a breath-stopping tension between these two groups. It was feared that if the third world war happens, no human being or tree shall survive. The reason is that in the future war; the traditional weapon would not be used. The nuclear weapons accumulated at States upto 1990s have the capacity to smash the entire world for fifteen times. The testing of nuclear weapons also threatened the ozone layer. However due to the splitting of Soviet Russia into 15 small countries and destruction of the Soviet Power, now America remains as the only super power in the world. Hence cold war ended. There were several agreements between America and Soviet Russia to reduce the number of nuclear weapons.

However, cold war was ended between America and Russia, now there are several other countries possess the atom bombs and their technology, i.e. India, Pakistan, Israel, North Korea, Iran etc. Now the threat of nuclear bombs is more than previous, as there is a chance of getting this technology by the terrorist.

Nuclear Plants

Now, besides the nuclear bombs, the world also fears about nuclear plant sand their bad affects on the people and environment. If a nuclear plant fails and bursts, it could create more and more pollution, deaths in its country and also its surrounding countries.

Nuclear Disaster

The electricity produced by the nuclear plants costs cheap. Hence several countries established nuclear thermal plants. In the early 1990s, 17 percent of the world electricity was produced from about 420 nuclear reactors in 25 countries. France has 73% of its electricity generated by nuclear reactors. Belgium generates 66% of its electricity by nuclear plants, Britain (20%), whole Europe (30%), Canada (20%), USA (20%), Korea (20%), Taiwan (49%), etc. The reason is that nuclear fuels contain much more energy than conventional and traditional fuels.

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Stockholm Declaration made it clear the principle of "Sustainable Development". The economic development should not cause environmental pollution. We cannot cut our throats with golden knife. The Chernobyl nuclear plant leakage cased shock and fear throughout the world.

Self Assessment

Fill in the blanks:

6. The smoke would cover sun bringing temperature to ..... degrees.
7. Release of radioactive substances into air, water, or earth as a result of human activity, either by accident or by intention is referred to as ..... pollutants.
8. ..... wastes spread over a broad area very rapidly and may not fully show its effects upon humans and organisms for decades.
9. There were several agreements between America and Soviet Russia to reduce the number of .....
10. There was a stringent ..... between America and Soviet Russia upto 1992.

11.3 Role of Individual in Prevention of Pollution

Environmental pollution cannot be completely prevented and removed, but the proper implementation and especially the individual participation are the important aspects which should be given due importance and stress. The individual participation is useful in law making processes and restraining the pollution activities and thereby the public participation plays a major role in the effective environmental management. The concept of pollution prevention centres on the idea of eliminating the creation of pollutants. In some cases that means not creating waste; another perspective is to limit energy consumption, thus reducing the amount of pollution caused in the creation of most common forms of energy. Although industry, commerce and institutions create the majority of pollutants, individuals can address pollution prevention and improve environmental health on a personal-sized scale.

1. Decrease Waste

Reducing waste is a crucial step in preventing pollution. Landfills and incinerators release carbon dioxide, methane and other greenhouse gases that contribute to local and global air pollution. Choosing products with recyclable packaging or less packaging reduces waste. Check with your local recycling site to learn which plastics and other recyclables are accepted. Avoid purchasing products that cannot be recycled locally. Compost food wastes to reduce landfill space and pollution.

2. Reduce Toxins

Mercury, a bio-accumulating toxin that affects the brain and neurological health, can be found in electrical switches, fluorescent bulbs, thermometers, thermostats and older batteries. Bioaccumulation is a process in which mercury, or any other persistent pollutant, accumulates in fatty tissues of animals and plants and increases in concentration as the food chain progresses. To prevent mercury pollution, choose mercury-free products, like digital thermometers, or use products that contain little mercury. Check with local waste management services about the best method for disposing of mercury-containing products. Degreasers, pesticide formulations, cleaning products and paints often contain ethoxylates and nonylphenol. These chemical

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compounds pollute groundwater and are toxic to fish and other aquatic organisms. Choosing products free of these chemicals helps prevent pollution.

3. Use More Efficient Transportation

Selecting a fuel-efficient vehicle is an essential step for pollution prevention. One year of using fuel-efficient vehicles reduces greenhouse gas emissions by one ton, according to the Canadian Institute for Environmental Law and Policy. Maintaining your vehicle is also essential to preventing pollution. Low tire pressure and a poorly tuned engine increase fuel consumption and emissions by 50 percent. Carpooling, public transportation, walking and biking are ways to reduce pollutants, prevent wear and tear on your vehicle, and save money.

4. Reduce Energy Consumption

Unplugging electronics when they are not in use and turning off unnecessary lights are examples of reducing energy consumption. Energy conservation does not require significant sacrifices. Purchasing energy-efficient and water-efficient appliances, electronics and plumbing devices reduces not only energy consumption but also your electric and water bills. The EPA partners with environmental organizations and industrial companies to select energy- and water-efficient products labeled with the Energy Star or WaterSense logos.

5. Vote Green

Support amendments, initiatives and laws that prevent pollution. Vote to encourage green infrastructure and low-impact development, improve waste reduction, decrease air pollution emissions and groundwater pollution, and limit pesticide use. Look for opportunities to support alternative energy sources. Local electric companies may offer wind or solar power alternatives.

Self Assessment

State whether the following statements are true or false:

11. Increasing waste is a crucial step in preventing pollution.
12. Avoid purchasing products that cannot be recycled locally.
13. Selecting a fuel-efficient vehicle is an essential step for pollution prevention.
14. Energy conservation requires significant sacrifices.
15. Low tire pressure and a poorly tuned engine increase fuel consumption and emissions by 50 percent.

Case Study

Bhopal Tragedy

It was the night of Dec. 2, 1984 when the gas containing methyl isocynate (MIC) and hydrogen cyanide leaked from the Union Carbide plant in Bhopal (India). It was the world's worst chemical accident. More than ten thousand people died as a result of breathing the gases. The aftermath of the leak is still there; people are dying today because they were exposed to the toxic gases which did not kill them at that time but crippled

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them. More than fifty thousand suffered some sort of health damage. There were many spontaneous abortions and stillbirths. An estimated sixty thousand people sued Union Carbide for compensation for 10 billion US dollars. Union Carbide settled for 470 million dollars in 1991 and left India. The workers of the Union Carbide plant at Bhopal say that disaster was a case of negligence at the plant because before the disaster occurred, there were problems with pipelines that developed breaches due to corrosion; also many instruments did not function properly. Not only the maintenance was poor, the plant was not well designed for safety. The poisonous MIC released from the plant was carried by prevailing winds to the south and east of city. These areas are highly congested where most of people are poor, working as labourers at the Union Carbide plant and other nearby factories. Since the leak was in the night the gas went undetected by the affected people who remained asleep and thus had a maximum exposure. Many died in their sleep, others ran to safer places, but died in following days and weeks. The Government of India organised relief measures and medical treatment. It was found that medical treatment was ineffective because doctors were not familiar with the toxicity information of MIC. As the news of the disaster spread all over the world, Union Carbide India Ltd. came forward and accepted responsibility for the accident. The parent company of Union Carbide India Ltd. is Union Carbide Inc. U.S.A. It refused to accept the legal responsibility for the Union Carbide India Ltd. The question of compensation and settlement of other issues became a controversy. Ultimately, Government of India decided to file the suit in United States Courts. The United States Courts refused to hear the case and it was then transferred to Indian Courts. Warren Anderson, the then Chairman of Union Carbide refused to appear in Indian Court. Recently, in the District Court in Bhopal, a case was filed to change the charges against Anderson from culpable homicide to rash negligence. The court rejected the case. It is worth mentioning that families of those who were killed by gas leak were paid a compensation of US $1250 per person whereas in case of Exxon Valdez Oil spill in Alaska, USA the sea otter (aquatic mammals) were kept alive by feeding them with fresh lobsters costing thousands of dollars per day. India and USA have an Extradition Treaty and any criminal can be brought to justice in either courts. This has not happened in case of Anderson. Warren Anderson ignored the summons from Bhopal Court to appear, the reason being that he could not be traced. Greenpeace recently announced that it has succeeded in locating Anderson in Long Island, New York. Meanwhile, there have been protests both from within India and by international NGOs for the cause of Bhopal victims. There have been hunger strikes by the victims recently at New Delhi Rallies of protestors organised before the Parliament demanded extradition of Warren Anderson to India to face trial. Union Carbide was recently acquired by Dow Chemicals. While Dow Chemicals has taken over the assets and liabilities of Union Carbide everywhere, they have refused to accept the liability of Bhopal. Recently, the gas victims sent brooms to the head office of Dow Chemicals telling them that they have a great deal of mess to clean up in Bhopal. It is reported too that the victims of Bhopal tragedy, who attended Johannesburg Earth Summit, handed over a broom to the President of Dow Chemicals who also attended the Summit.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: *Environmental Management*, N K Uberoi, Excel Books, New Delhi

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11.4 Summary

- Thermal pollution is the act of altering the temperature of a natural water body, which may be a river, lake or ocean environment.
- In India, there are about 75 thermal power stations.
- Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence.
- Thermal pollution is caused by either dumping hot water from factories and power plants or removing trees and vegetation that shade streams, permitting sunlight to raise the temperature of these waters.
- Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers.
- Thermal pollution is basically the form of water pollution that refers to degradation of water quality by any process that changes ambient water temperature.
- Thermal pollution from industrial sources is generated mostly by power plants, petroleum refineries, pulp and paper mills, chemical plants, steel mills and smelters.
- During warm weather, urban runoff can have significant thermal impacts on small streams, as storm water passes over hot parking lots, roads and sidewalks.
- Release of radioactive substances into air, water, or earth as a result of human activity, either by accident or by intention is referred to as nuclear waste.
- A small amount of radiation due to radioactive material release can have serious consequences and since nuclear wastes remain active for long time, radioactive pollution is a serious environmental concern even though natural sources of radioactivity far exceed artificial ones.
- Radioactive waste is the hazardous waste material. Such waste can be categorized as low or high level waste.
- Environmental pollution cannot be completely prevented and removed, but the proper implementation and especially the individual participation are the important aspects which should be given due importance and stress.

11.5 Keywords

Bioretention systems: A bioretention system consists of a soil bed planted with suitable non-invasive (preferably native) vegetation.

Degradation: Degradation is the lowering of a riverbed over a period of time. Learn more about its causes and impact.

Habitat: Habitat is a place where species get what they need to survive: food, water, cover, and a place to raise young.

Nuclear Hazards: Risk or danger to human health or the environment posed by radiation emanating from the atomic nuclei of a given substance, or the possibility of an uncontrolled explosion originating from a fusion or fission reaction of atomic nuclei.

Nuclear Pollution: Radioactive waste is a waste product containing radioactive material.

Radioactive: Emitting or relating to the emission of ionizing radiation or particles.

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Species: The term species can be defined as a group of individual organisms that are capable of interbreeding to produce fertile offspring in nature.

Thermal Pollution: It is the act of altering the temperature of a natural water body, which may be a river, lake or ocean environment.

Toxins: A toxin is a poison that is produced by bacterial pathogens and that damage cells.

Urban Runoff: Urban runoff is surface runoff of rainwater created by urbanization.

Vegetation: The term vegetation is used in ecology to describe the overall characteristics of plant cover in an area.

11.6 Review Questions

1. Define Thermal pollution.
2. Highlight the Major Sources of Thermal Pollution.
3. Discuss the Impacts of Thermal Pollution.
4. What are the causes of Thermal Pollution?
5. How can thermal pollution be controlled?
6. Describe Nuclear Hazards.
7. Write brief note on Cold War.
8. Explain Nuclear Waste Management.
9. Throw some light on Nuclear Disaster with the help of example.
10. Elucidate the role of individual in prevention of pollution.

Answers: Self Assessment

1.	False	2.	True
3.	False	4.	True
5.	False	6.	15 to 20
7.	Nuclear Waste	8.	Radioactive
9.	Nuclear Weapons	10.	Cold War
11.	False	12.	True
13.	True	14.	False
15.	True		

11.7 Further Readings

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Unit 12: Disaster Management

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Objectives

After studying this unit, you should be able to:

- Discuss the Meaning of Disaster Management
- Explain the Phases of Disaster Management
- Describe the Disaster Management in case of Floods, Earthquake, Cyclone and Landslides
- Understand the Disaster Preparedness Measures

Introduction

In the previous unit, we dealt with the overview of Thermal and Nuclear Pollution along with the role of Individual in Prevention of Pollution. The increasing occurrence of natural and human-caused disasters, including armed conflicts, is causing extensive loss of life, damage to property, and harm to the environment. Natural disasters like floods, earthquakes, hurricanes, landslides, volcanic eruptions and drought also cause tremendous devastation. There is an increase in the frequency of these disasters and the damage caused by them. Libraries and archival collections are not unaffected by their devastating impact. The countries are gradually shifting from disaster response to a more proactive approach to disaster management. A proactive stance to reduce the toll of disasters in the region requires a more comprehensive approach that

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encompasses both pre-disaster risk reduction and post-disaster recovery. And this is evident in case of documentary and cultural heritage also. India is one of the most disaster prone countries of the world. It has had some of the world's most severe droughts, famines, cyclones, earthquakes, chemical disasters, mid-air head-on air collisions, rail accidents, and road accidents. India is also one of the most terrorist prone countries. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the meaning and phases of Disaster Management along with the Disaster Management in case of Floods, Earthquake, Cyclone and Landslides.

12.1 Meaning of Disaster Management

Disaster (from Greek, meaning "bad star") is a natural or man-made event, which brings sudden great misfortune and disruption in normal life including that of the power supply. It negatively affects life, property, livelihood or industry often resulting in permanent changes to human societies, ecosystems and environment. Disasters manifest as hazards exacerbating vulnerable conditions and exceeding individuals and communities means to survive and thrive.

The term disaster may be defined as any occurrence that threatens human safety and/ or causes damage to library facilities and materials. Disasters can be natural or man-made depending on their origin. Disasters related to extreme weather events (floods, cyclones, tornadoes, blizzards, droughts) occur regularly. Disasters cannot be predicted and there is little that can be done to prevent these disasters as most of the disasters occur suddenly and perhaps unexpectedly. Disasters can be minor or major, and range from roof and plumbing leaks which can be repaired by in-house personnel; to broken water mains, power disruptions which require large effort and money for repairs; to major catastrophes, such as earthquakes, floods, tornadoes etc. in which all the organization's operations are disrupted, all utilities are out of order, and destruction occurs on a massive scale. These disasters include fires, floods, earthquakes, hurricanes, tornadoes, and workplace violence. Any of these disasters, large or small, natural or man-made, has the potential to harm the library's collections, the building, the library employees, and the library users. In addition to potential damage, the disaster may disrupt the services that the library offers to its users. As Henson has put it "A library disaster is a threat that might cause harm to the library collection, building, staff, or users, or it is an unscheduled disruption of normal library services". Having a disaster response plan in place before a disaster strikes can help the library minimise the impact of a disaster and restore collections and services in an optimum time.

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. Disaster management is a process or strategy that is implemented before, during or after any type of catastrophic event takes place. This process can be initiated whenever anything threatens to disrupt normal operations or puts people's lives at risk. Governments at all levels as well as many businesses create their own disaster plans that make it possible to overcome various catastrophes and return to functioning normally as quickly as possible.

12.1.1 Four Key Elements

Not all catastrophes can be prevented, but many types can be avoided, and the effects of others can be mitigated. Four Key Elements of Disaster Management are as follows:

1. ***Potential Disasters:*** One of the keys to disaster management is defining the types of catastrophes that could possibly disrupt the day-to-day operation of a business, city, region or country. Among the many types of events that might occur are natural disasters such as floods, hurricanes, tornadoes and earthquakes as well as those such as fires, bombings, mass failures of public utilities and the rapid spread of disease. Identifying those potential

disasters makes it possible to create contingency plans, assemble supplies and create procedures that can be initiated if and when a particular disaster happens. A truly comprehensive disaster management plan encompasses a wide range of possibilities that can easily be adapted if one disaster causes other types of disasters to occur.

2. ***Preparation and Reaction:*** Governments and businesses need to continue functioning during emergency situations, so disaster management plans are often multilayered to account for as many potential scenarios as possible. A typical disaster plan for a local or regional government is likely to address such matters as evacuating people from the affected region, arranging temporary housing, distributing food and providing medical care. It also is not unusual for a plan to work toward containing, neutralizing or eliminating the cause or causes of the disaster if at all possible.

3. ***Communication Networks:*** Disaster management also often addresses the issue of communication. Many disasters can cause communication networks to fail, so a competent plan will include the quick setup of alternative communication capabilities that do not rely on the switches, towers and hubs that are usually part of telephone and cellular communication networks. By making use of short-wave transmissions that are supported by satellite technology, for example, communication can continue to flow from the area affected by the disaster.

4. ***Disaster Kits:*** As part of the crisis management component of a disaster plan, it is not unusual for some type of disaster kits to be created. The kits might include food and clothing for people who have been affected. Kits might also include first aid supplies and basic medication that could help treat headaches, fevers and other minor ailments. In some cases, the kits might include items such as sleeping bags or other necessities that will help displaced people cope after the disaster.

Notes Crisis management is an essential concept in any form of business and usually refers to two practices. One part of this is planning ahead to anticipate various types of crises and determining how a company would address them. The other is the actual handling of crises when they occur and in their aftermath so that a company continues on its way with minimal loss in profitability and having retained, if needed, its reputation.

Improving Plans

Creating an effective disaster management plan is often easier said than done. As many cities, countries and organizations have learned, emergency plans that had been thought to be comprehensive have turned out to be partially effective at best. This has caused many companies and government agencies to revisit all aspects of their plans and run computer simulations to identify their weaknesses and refine them so they can be carried out with more speed and efficiency.

12.1.2 Types of Disasters

There is no country that is immune from disaster, though vulnerability to disaster varies. There are four main types of disaster:

1. ***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.

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Example: Recent disasters due to natural calamities

A deadly Earthquake struck Gujarat in January 26, 2001. The earthquake flattened hundreds of towns and villages in Gujarat. More than 20,000 people were killed, 166,000 injured and 1.1 million homes destroyed. The damage to historic buildings, and sites of cultural heritage significance was both severe, and widespread. Many libraries and their collections were damaged in the devastating earthquake.

2. ***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.

3. ***Complex emergencies:*** These emergencies involve a breakdown of authority, looting and attacks on strategic installations. Complex emergencies include conflict situations and war.

4. ***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. Local, regional, national and (where necessary) international organisations are all involved in mounting a humanitarian response to disasters. Each will have a prepared disaster management plan. These plans cover prevention, preparedness, relief and recovery.

12.2 Disaster Management Plan

Disaster management encompasses all such activities that enable various agencies to plan for, quickly respond to and to recover from unexpected events and situations. Disaster Management Plan in the power sector is a tool to provide necessary guidelines to organisations engaged in the generation, transmission and distribution of electrical power for ensuring safety of people, protection of environment, protection of installations and restoration of power supply. It is intended to establish policies, procedures and organisational structure for response to emergencies that are of a magnitude to cause a significant disruption of the functioning of all or a portion of the power distribution area. The first step in planning for disaster management involves assessing which areas are prone to which kinds of natural or man-made disasters. The objectives of the Disaster Management Plan should be to:

- improve the state of preparedness to meet any contingency;
- reduce the response time in organizing assistance;
- identify major resources (human, material and equipment) needed to make the plan operational; and
- make optimum use of the combined resources

The Disaster Management Plan should spell out the roles and responsibilities of departments, teams units and personnel during emergency situations. It should address several specific types

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of emergencies on an individual basis, providing guidelines for the stabilization and recovery from the incident. These include emergency instructions and references in a concise format for the individuals designated to manage the resources. It should encompass the preparation, response and recovery of utility personnel and resources for emergency situations.

Notes Based on data collected the world over, natural calamities like earthquakes, cyclones, floods, etc., have been studied extensively. It has become possible to predict their intensities with certain degree of confidence so that structures/equipment/machinery, etc., can be designed to withstand the effect of these forces. Seismic loads as well as wind loads have been measured in the country by various organizations like Indian Meteorological Department, Geological Survey of India etc. As regards floods, the Central Water Commission is involved in the measurement of discharge data of major rivers.

It should facilitate interagency coordination between responding agencies. The main thrust of the plan should be to make the utility employees familiar with the various kinds of emergencies and disasters which can affect the power sector and the action plan to tackle them. The basic emergency procedures are designed to protect lives and property through effective use of the available resources both of the utility and the community. Since an emergency may be sudden and without warning, these procedures should be designed to be flexible in order to accommodate contingencies of various types and magnitudes.

Caselet

Endangered India way behind Japan in Disaster Management in Case of Earthquake

Japan on Friday experienced an earthquake measuring 8.9 on the Richter scale. Though India does not face a threat of a quake of this magnitude, but the possibility of an earthquake measuring over 6 on the scale looms over several parts of the country. Though there have been over thousand deaths in the country, Japan has always understood the threat posed by earthquakes and made attempts to tackle it, while India has not even been able to gauge the threat posed by it.

Quake threat looms over India

As much as 65 per cent of the area in India falls under zone three with respect to the earthquake threat. The whole of the country has been divided into four seismic zones (2, 3, 4 and 5) on the basis of their sensitivities to earthquakes. Zone 5 comprises areas that are prone to earthquake that measure around 9 on the Richter scale. Similarly, zone 4 consists of areas expecting earthquake measuring 8-9 on Richter scale and zone 3 has areas prone to that up to 6 to 8. As many as 169 districts in 17 states have been declared to be earthquake sensitive. National capital Delhi falls in zone 4. The situation is so grave in the capital that in case of an earthquake, over one lakh houses in east Delhi, near River Yamuna, can get buried. According to professor T K Datta, the moisture in the soil of the capital has increased, hence it has lost much of its strength.

In 2006, use of anti-earthquake techniques was made compulsory for houses being constructed in Delhi, but has always been ignored. And the situation remains the same for other cities as well. Almost 80 per cent of the Delhi population resides in slums and irregular colonies, which have been constructed without the recommendations of any engineer. Therefore, the houses are not constructed in accordance with the norms to tackle

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earthquake situations. Professor S Mukherjee points that in several localities in Delhi and Kolkata, over two lakh people reside every square kilometre. And because of this, there may be heavy casualties in case of an earthquake.

Japan, the worst affected

On an average, Japan receives minor tremors every five minutes. As much as 20 per cent of the 6 richter scale earthquakes throughout the world occur in Japan itself. A number of volcanic eruptions keep happening under the sea in the pacific basin near the country. Located in the 'Ring of Fire' zone, Japan has a detailed history of earthquakes and tsunamis. To tackle the situation, citizens of the country **are made to undergo training and repeated practices.**

Japan always prepared to tackle disaster

The mechanism in Japan to give alerts on tsunami is quite advanced. Japan tops the list of the countries throughout the world with respect to the study on earthquake and its impact. Any construction in the country is done in accordance with the studies done. The system is such that nuclear reactors shut by themselves in case of earthquakes. Japan has spent billions of dollars to conduct studies into tsunami and earthquakes and in developing measures and techniques to lessen their impact. Through six regional centres, the country has 180 seismic centres and 80 underwater sensors, which send the warning signals. The meteorological department and the news channels in the country have developed a system wherein alerts begin flashing on the television screen ahead of tsunami or earthquakes. In addition to this, local officials are also informed about any such alerts through satellites. People are also warned through loudspeakers and sirens. Proper rescue measures are also in place to tackle any emergency situation. Japan spends as much as dollar two crore on the warning mechanism. A law ensures that the buildings are constructed in accordance with earthquake-resisting norms. In India, on the contrary, mere committees have been constituted at national and state levels to tackle emergency situations. However, a few private players have also been made a part of it.

Experts believe that disaster management in India is not adequate at all. And they have also been proved right on several occasions. There is no mechanism to get prior warning about any such happening and the weather forecasts also go wrong often. There is no system to give earthquake alerts as well. And this is not all. The relief mechanism for disasters like tsunami and earthquakes is also in similar condition. Over 18,000 lives were lost in India on December 26, 2004 due to tsunami. More than three lakh people had died that year in the Asia-Pacific region because of tsunami, of which over two lakh victims were from Indonesia itself. As part of the measures taken in India, a tsunami warning centre has been established in Hyderabad, which claims that it can issue a tsunami alert within 10 minutes of an earthquake. The centre has been established at a whopping cost of ₹ 125 crore at the National Centre for Ocean Information Services and has issued 25-30 quake alerts in the last three years.

Inadequate infrastructure mars relief measures in India

More lives are lost in India in case of any disaster also because of the lack of basic infrastructure. Not even a single hospital bed is available for every thousand people in the country. The ratio in India is 0.7:1000 in India while it is 8.2:1000 in Japan. Besides, on an average, only one doctor is there for every 1,722 patients in India, while in Japan there are 2.1 doctors for per thousand people. Scarcity of funds is another major problem that plagues the system in India. As per the GDP, India ranks 11 among other countries of the world. The current growth rate of the country is 8.2 per cent. Whereas, Japan was till sometime back the biggest (now third) economy of the world.

Source: http://daily.bhaskar.com/article/WOR-FTR-earthquakes-endangered-india-way-behind-japan-1931095.html

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Self Assessment

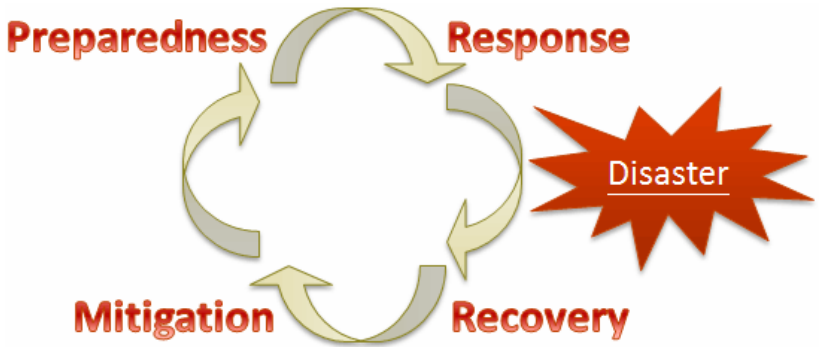
State whether the following statements are true or false:

1. Disasters related to extreme weather events.
2. There are two essential parts to disaster management.
3. Disaster management also often addresses the issue of communication.
4. Complex emergencies involve a sudden onset of a contagious disease that affects health but also disrupts services and businesses, bringing economic and social costs.

12.3 Phases of Disaster Management

The so-called "Disaster Management" is a continuous, dynamic process of management planning in order to reduce the uncertainty and possibility of danger. In terms of management, types of disasters, how to prevent, time of occurrence, response plan, recovery plan, policy review and so on all belong to the field of disaster management. The process of disaster can be divided into four stages which are shown in Figure 12.1: mitigation, preparedness, response and recovery. Each stage are closely linked together, a stage not ready will influence the next stage. In fact, prevention is better than cure, so among these years Disaster Management gradually focusing on mitigation, because mitigation is the most fundamental and long-termed disaster management measures.

Figure 12.1: Four Stages of Disaster Management



Source: http://246eng.swcb.gov.tw/Learning/DisasterManagement/Status/1-FourStages.aspx

The four stages of Disaster Management which is shown in Figure 12.1 are discussed below:

First Phase – Emergency Response

A life-saving phase, its aim is to ensure that an effective response - rescue efforts, fire fighting, emergency medical assistance and an evacuation procedure - is in place when a disaster has taken place.

Second Phase – Recovery

This phase involves rehabilitation and disaster-resilient reconstruction efforts as well as appropriate land use planning, industrial rehabilitation planning and livelihood support.

Third Phase – Prevention/Mitigation

This phase focuses on efforts to prevent or mitigate damage when a disaster strikes. Among the activities related to this phase are the utilisation of seismic resistant technology for rebuilding

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or retrofitting, the construction of dikes, replanting of mangroves, forestation and the construction and operation of meteorological observation systems to help prevent and mitigate damage in the event of an earthquake, flood, landslide or storm.

Final Phase – Preparedness/Readiness

As it is important for any country to be prepared in the event of a disaster, this phase is crucial as it places the importance of hazard maps, food and material stockpiling as well as the preparation of emergency kits, all vital factors that help to minimise the impact of a disaster.

The risk of disasters and its adverse impact can be reduced effectively if balanced attention is placed on all phases of the disaster management cycle.

Self Assessment

Fill in the blanks:

5. The ..... is a continuous, dynamic process of management planning in order to reduce the uncertainty and possibility of danger.
6. The ..... phase involves rehabilitation and disaster-resilient reconstruction efforts as well as appropriate land use planning, industrial rehabilitation planning and livelihood support.
7. The risk of disasters and its adverse impact can be reduced effectively if balanced attention is placed on all phases of the .....
8. ..... phase focuses on efforts to prevent or mitigate damage when a disaster strikes.

12.4 Disaster Management in Case of Floods, Earthquake, Cyclone and Landslides

Disasters in the power sector can occur due to natural calamities as well as human acts.

12.4.1 Disaster Management in Case of Floods

Floods caused by overflowing rivers result from heavy rains or from the melting of winter snow, or from both. Floods in rivers differ from flash floods in their extent and duration. Flash floods are of short duration in small streams, while floods in rivers take place in river systems whose tributaries may drain large geographic areas and encompass many independent river basins. Floods on large river systems may continue for periods ranging from a few hours to many days. Flood flows in large river systems are influenced primarily by variations in the intensity, amount, and distribution of precipitation. The condition of the ground - amount of soil moisture, seasonal variations in vegetation, depth of snow cover, and imperviousness due to urbanization - directly affects runoff. Silting, soil conditions, absorption capacity of the watershed, and the capacity of streams to carry runoff have an effect on the extent of the flooding.

Caution As far as flood management is concerned, no town is planned on an area which is not well drained. Towns are always located on places that are well protected. Also, towns must have access to water resources. But if a town is close to its water source which, at the same time, is its drainage basin, it becomes flood-prone.

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Floods are the most common and widespread of all natural disasters. India is one of the highly flood prone countries in the world. Around 40 million hectares of land in India is prone to floods as per National Flood Commission report. Floods cause damage to houses, industries, public utilities and property resulting in huge economic losses, apart from loss of lives. Though it is not possible to control the flood disaster totally, by adopting suitable structural and non-structural measures the flood damages can be minimised. For planning any flood management measure latest, reliable, accurate and timely information is required. In this context satellite remote sensing plays an important role.

Violent floods and storms that cause wind or water-related damage are typical natural disasters for libraries and information centres. The floods that may result from such events can be devastating. Besides natural occurrences such as hurricanes, tornadoes, and floods, water damage can come from malfunctioning plumbing, sprinkler, and air-conditioning systems. Floods, rain, sprinkler pipe breaks and other disasters can leave paper records, microfilm and other library materials soaked with water. Once water has entered the collection areas, a danger of a mold problem arises, especially if the humidity is high.

Notes India's first Prime Minister Jawaharlal Nehru believed that dams to produce power, irrigation and control flooding would be the "temples" of a modern, secular state. Since his day, 400 large dams have been built in India, along with thousands smaller levees as well as 16,000 km of river embankments, but the area affected by floods has expanded from 2 million hectares to 9 million due to deforestation, poor urban drainage and other factors.

Evacuation is a preemptive move to protect life and property, where as rescue is a post-disaster phenomenon of helping people to move from areas that have been hit by disaster to a safer place. However, the situation of evacuation and rescue comes along with numerous unanswered queries in mind. Very often, due to lack of information or in haste, living during evacuation and rescue becomes difficult and painful. However, during such the situations, following precautionary norms should be kept in mind.

Impact of Floods

Floods are natural hazards that are not, in and of themselves, disasters, but they can transform a vulnerable situation into a disaster. The vulnerability of a human settlement is determined by its exposure to flooding. The primary effects are power failure, electrocution and short circuit due to water logging in flooded areas as well as around the substation grids. In Table 12.1, we summarise the impact of natural calamities on power utilities.

Table 12.1: Impact of Natural Calamities on Power Distribution Utilities and Their Roles

Calamity	Primary impact	Secondary impact
Earthquake	Structural collapse and collisions; Injury and death.	Landslides; Fires; Tsunamis; Floods; Power failure.

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Cyclone / Storm	Destruction of human settlements; Death and injuries by drowning, Structural collapses; Flying objects.	Mudslides; Power failure.
Flood	Drowning Inundated farmlands; Washing away of irrigation systems; Change in the course of rivers or streams.	Mudslides; Epidemics; Power failure; Short circuits; Electrocution.

Source: http://www.egyankosh.ac.in/bitstream/123456789/1581/1/Block%209.pdf

Preparing for a Flood

Here are some basic steps to take to prepare for the flood:

- Contact the local geologist or town planning department or meteorology department to find out if your home is located in a flash-flood-prone area or landslide-prone area.
- Learn about your community's emergency plans, warning signals, evacuation routes, and locations of emergency shelters.
- Plan and practice a flood evacuation route with your family. Ask an out-of-state relative or friend to be the "family contact" in case your family is separated during a flood. Make sure everyone in your family knows the name, address, and phone number of this contact person.
- Post emergency phone numbers at every phone.
- Inform local authorities about any special needs, i.e., elderly or bedridden people, or anyone with a disability.
- Identify potential home hazards and know how to secure or protect them before the flood strikes. Be prepared to turn off electrical power when there is standing water, fallen power lines etc. Turn off gas and water supplies before you evacuate. Secure structurally unstable building materials.
- Buy a fire extinguisher and make sure your family knows where it is and how to use it.
- Buy and install sump pumps with back-up power.
- Have a licensed electrician to raise electric components (switches, sockets, circuit breakers and wiring) at least 12" above your home's projected flood elevation.
- For drains, toilets, and other sewer connections, install backflow valves or plugs to prevent floodwaters from entering.
- Anchor fuel tanks which can contaminate your basement if torn free. An unanchored tank outside can be swept downstream and damage other houses.

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Did u know? ***Devastating floods affect millions in India 2005:*** Operation Blessing teams are responding with emergency disaster relief after heavy monsoon rains prompted severe flooding in western India. More than 1,000 people have already perished after weeks of incessant rainfall. The city of Mumbai, formerly known as Bombay, was deluged with 37 inches of rain in 24 hours — the most any Indian city has ever received in one day. Officials estimate 25 million people have been impacted by the widespread flooding. OBI relief workers navigated treacherous roads to reach the hardest hit areas in the state of Gujarat, where up to 10,000 different villages have been inundated by floodwaters. Food distribution efforts began immediately, and OBI medical teams soon arrived to care for the sick and injured. More than 6,000 flood victims have received meals from Operation Blessing, while OBI doctors have treated 9,870 people in need. OBI relief efforts are also underway in Uttar Pradesh and Yavatmal, Maharastra, where more than 3,000 people have received medical care and 350 families were given temporary housing materials. Additionally, Operation Blessing is supplying community assistance through providing temporary shelters, burying animals and other debris removal and distributing supplies at one local prison that was impacted by the flooding.

As damage assessment persists, concerns are growing over the threat of water-borne diseases as well. Indian authorities have distributed medicine to many survivors, but thousands remain stranded in amid huge lakes of standing water. Train services, telecommunications and electricity supplies have been disrupted throughout the region by driving rains, floodwaters and resulting landslides. Estimated losses from the floods have been placed at $2.3 billion.

12.4.2 Disaster Management in Case of Earthquake

Earthquake is one of the most destructive natural hazards. They may occur at any time of the year, day or night, with sudden impact and little warning. They can destroy buildings and infrastructure in seconds, killing or injuring the inhabitants. Earthquakes not only destroy the entire habitation but may destabilize the government, economy and social structure of the country. Earthquakes are one of the most dangerous and destructive forms of natural hazards. They Strike suddenly with Little Warning. They may occur at any time of day or on any day of the year. Earthquake is a natural catastrophe that may effect the collections in a library or museum. During an earthquake walls, ceilings, and shelves may collapse causing structural damage. The library buildings may be destroyed and the collections buried underneath covered in debris and mud. The damage to archival collections due to earthquake could be irreplaceable.

India has had a long history of earthquake occurrences. About 65% of the total area of the country is vulnerable to seismic damage of buildings in varying degrees. The most vulnerable areas, according to the present seismic zone map of India, are located in the Himalayan and sub-Himalayan regions, Kutch and the Andaman and Nicobar Islands. Depending on varying degrees of seism city, the entire country can be divided into the following seismic regions:

- ***Kashmir and Western Himalayas*** - Covers the states of Jammu and Kashmir, Himachal Pradesh and sub-mountainous areas of Punjab.
- ***Central Himalayas*** - Includes the mountain and sub-mountain regions of Uttar Pradesh and the sub-mountainous parts of Punjab.
- ***North-east India*** - Comprises the whole of Indian territory to the east of North Bengal.

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- ***Indo-Gangetic basin and Rajasthan*** - This region comprises of Rajasthan, plains of Punjab, Haryana, Uttar Pradesh and West Bengal.
- Cambay and Rann of Kutch.
- Peninsular India, including the islands of Lakshwadeep.
- The Andaman and Nicobar Islands.

Impact of Earthquakes

Earthquakes can devastate an entire city or a region of hundreds of square kilometres. A large earthquake gives rise to a series of violent motions in the ground, which set in motion the structures (e.g., buildings, roads, towers, bridges, transmission lines, etc.) on the earth's surface. Each type of structure responds differently, depending on the type of materials it is made up of. Buildings collapse like packs of cards. They get reduced to piles of rubble in seconds, killing and injuring their inhabitants. Since the power distribution network spreads over the entire area with conductors running on metallic structures, it is most prone to the effects of the earthquake. Moreover, sensitive equipment gets activated when shaken by an earthquake and immediately interrupts power supply from the power grid. Fire is another concern immediately following an earthquake because of severed electrical lines.

Pre-disaster Preventive Measures

For better understanding of all the possibilities of earthquake risk reduction, it is important to classify them in terms of the role that each one of them could play. Therefore, in the pre-earthquake phase, preparedness, mitigation and prevention are concepts to work on. Post-disaster, immediate rescue and relief measures including temporary sheltering soon after an earthquake until about 3 months later and reconstruction and rehabilitation measures for a period of about six months to three years need to follow. To encapsulate, the most effective measures of risk reduction are pre-disaster mitigation, preparedness and preventive measures to reduce vulnerability and expeditious, effective rescue and relief actions immediately after the occurrence of the earthquake. Depending upon the calamity and its consequences, strategies can also be divided into long term (five to fifteen years), medium term (one to five years) and short term (to be taken up immediately in high risk areas). Since it has been realized that earthquakes don't kill people but faulty constructed buildings do, the task of reducing vulnerability of structures and buildings will be the key to earthquake risk reduction. Also, pre-disaster preparedness through a post-earthquake response plan, including training of the concerned personnel in various roles, is considered essential for immediate and effective response after an earthquake occurrence.

Long-term Measures

- Re-framing buildings' codes, guidelines, manuals and byelaws and their strict implementation. Tougher legislation for highly seismic areas.
- Incorporating earthquake resistant features in all buildings at high-risk areas.
- Making all public utilities like water supply systems, communication networks, electricity lines etc. earthquake-proof. Creating alternative arrangements to reduce damages to infrastructure facilities.
- Constructing earthquake-resistant community buildings and buildings (used to gather large groups during or after an earthquake) like schools, dharamshalas, hospitals, prayer halls, etc., especially in seismic zones of moderate to higher intensities.

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- Supporting R&D in various aspects of disaster mitigation, preparedness and prevention and post-disaster management.
- Evolving educational curricula in architecture and engineering institutions and technical training in polytechnics and schools to include disaster related topics.

Medium-term Measures

- Retrofitting of weak structures in highly seismic zones.
- Preparation of disaster related literature in local languages with dos and don'ts for construction.
- Getting communities involved in the process of disaster mitigation through education and awareness.
- Networking of local NGOs working in the area of disaster management.

Task Identify conditions that permit earthquakes to be destructive to human settlements. List the primary and secondary effects of earthquakes.

12.4.3 Disaster Management in Case of Cyclone

Cyclones are among the most awesome events that nature can produce. They pose a major threat to lives and property in many parts of the world. Every year these sudden, unpredictable, violent storms bring widespread devastation to coastlines and islands lying in their erratic paths. A windstorm's destructive work is done by the high wind, flood-producing rains and associated storm surges. Cyclones are among the most awesome events that nature can produce, and pose a major threat to lives and property in many parts of the world. A cyclone's destructive work is done by the high wind, flood-producing rains, and associated storm surges. The cyclonic storm dominates the ocean surface and lower atmosphere over tens of thousands of square kilometres. Devastating floods from extremely heavy rainfall often accompany tropical cyclones.

Example: On November 12, 1977, a cyclone that originated in the Bay of Bengal developed winds of 90-110 kilometres per hour (60-70 miles per hour) and struck the central coast of Tamil Nadu State in southern India. Hardest hit by the resulting floods were the areas of West Tanjore, Dindigul, Vedasandur and Chidambaram. Of particular concern was the Vedasandur Dam area, which had recently been transformed by irrigation from an arid, sheep-raising land to a three-crop-per year area. The floods destroyed much of the irrigation system. The number of casualties in Tamil Nadu was limited, apparently by the fact that people had heeded early warnings and moved to higher ground.

Cyclones are born in the hot, humid late-summer environment of the tropics as the sun warms the oceans, evaporation and conduction transfer heat to the atmosphere so rapidly that air and water temperatures seldom differ by more than 1 degree F. The water vapour generated by such evaporation is the fuel that drives a tropical storm, because as the vapour condenses into clouds and precipitation it pumps enormous amounts of heat into the cyclone. The fuel supply is controlled by the evaporation rate—which explains why cyclones cannot develop when the ocean temperature is below about 24 degrees Centigrade (76 degrees F).

To develop and mature into a tropical storm, storm seedlings must overcome many obstacles. In fact only about nine of the more than 1000 seedlings tracked each year in the Atlantic will evolve into gale-force tropical storms or full-fledged cyclones the sole difference between harmless

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thunderstorms and a dangerous cyclone is the rotation that organizes weather systems. This spin, which meteorologists call vorticity, is ever-present in temperate latitudes, where the Coriolis Effect of the earth's rotation is pronounced. But in the tropics the weak Coriolis Effect must be augmented by the wind itself. (The Coriolis Effect is the force caused by the earth's rotation that deflects a moving body to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.)

When two wind currents move side by side, the faster current tends to curl around the slower one. If the faster current is on the right (viewed from upwind), the curl is to the left, yielding positive vorticity in the Northern Hemisphere because it adds to the counter clockwise Coriolis Effect; a right-hand curl creates negative vorticity. A curving wind also possesses vorticity—positive for a left-hand turn, negative for a right turn. When positive vorticity becomes strong enough to spin a storm seedling, it starts a chain reaction. The thunderstorms, not revitalized by a steady influx of warm, moist air, organize around a deepening low-pressure centre, called a tropical depression. This dramatically increases the likelihood of cyclone formation; fully 70 percent of these depressions develop into cyclones.

Tropical cyclones are known around the world by various names: hurricanes in the Atlantic and Caribbean, typhoons in the West Pacific, baguios in the Philippines, cordonazos in Mexico, Taino in Haiti. A tropical cyclone is essentially a rotating storm in the tropical oceans. It is conventionally defined as a circular storm with rotating wind speeds in excess of 64 knots (32 meters per second). The life span of a tropical cyclone is, on average, about six to nine days until it enters land or recurves into temperate latitudes, but this may vary from a few hours to as much as three to four weeks. Tropical cyclones form in the oceans between 5 to 30 degrees north and south of the equator. They are found in all oceans of the world, with the probable exception of the South Atlantic and the South Pacific east of 140 deg. W longitudes. No two tropical cyclones follow the same track; some recurve, some do not; some loop; some slow to a standstill and some will accelerate. The movement of a tropical cyclone is generally 12 knots or less. It is important to be aware of the regional names so that, for example, what is described as a severe cyclone in the Bay of Bengal will be understood as essentially the same phenomenon as that which is called a hurricane when it occurs in the north Atlantic.

Impact of Cyclones

Cyclones can lead to tremendous loss of life, property and infrastructure, particularly, in the vulnerable human settlements. Their vulnerability is determined by the exposure to the storms, the degree to which the houses and other structures can be damaged, and the likelihood that secondary effects could occur. Safety is also compromised by the damage to or destruction of public installations and facilities, such as water and electrical plants, hospitals, and police stations. The impact of cyclones on the power utility is immediate interruption of supply from the power grid due to network disruption by cyclonic winds. Fire is another concern immediately following a cyclone because of severed electrical lines.

12.4.4 Disaster Management in Case of Landslides

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

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

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

- Slope-Magnitude, length and Direction
- Soil thickness
- Relative relief
- Land use
- Drainage-pattern and density
- Landslide affected population

Causes of Landslides

Landslides can be caused by the following:

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

A Checklist of Causes of Landslides Ground Causes

Following are the ground causes for checklist of Landslides:

1. Weak, sensitivity, or weathered materials
2. Adverse ground structure (joints, fissures etc.)
3. Physical property variation (permeability, plasticity, etc.)

Morphological Causes

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

Physical Causes

- Prolonged precipitation
- Rapid draw- down

Notes

- Earthquake
- Volcanic eruption
- Thawing
- Shrink and swell
- Artesian pressure

Man-made Causes

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

An overall evaluation of the pattern and nature of landslide occurrences in the Kerala part of Western Ghats and its corresponding eastern flank falling within Tamil Nadu reveals the following main features:

1. Almost all mass movements occur during monsoons (SW and NE monsoon) in the western flank of Western Ghats and during occasional cyclonic events in the eastern flank indicating that main triggering mechanism is the over-saturation of overburden caused by heavy rains
2. There seems to be a relation between intensity of rainfall and slope failures.
3. Majority of the catastrophic mass movements is confined to the overburden without affecting the underlying bedrock.
4. Improper land use practices such as heavy tilling, agricultural practices and settlement patterns have contributed to creep and withdrawal of toe support in many cases.
5. A common factor noticed in most of these vulnerable slopes deforestation in the recent past, cultivation of seasonal crops and increase in settlements.
6. In all the vulnerable slopes terracing/contour bounding is adopted mainly to prevent soil erosion and to enhance percolation during dry season for cultivation of cash crops as well as seasonal crops invariably.
7. In all these cases, natural drainage lines on slopes are blocked or modified without adequate provision for surface drainage of excess storm water during high intensity rains prevalent in the area.
8. In all the vulnerable slopes terracing/contour bounding is adopted mainly to prevent soil erosion and to enhance percolation during dry season for cultivation of cash crops as well as seasonal crops. Invariably, in all these cases, natural drainage lines on slopes are blocked or modified without adequate provision for surface drainage of excess storm water during high intensity rains prevalent in the area.

Notes

Self Assessment

State whether the following statements are true or false:

9. Flood flows in large river systems are influenced primarily by variations in the intensity, amount, and distribution of precipitation.
10. Around 80 million hectares of land in India is prone to floods as per National Flood Commission report.
11. Earthquakes can devastate an entire city or a region of hundreds of square kilometres.
12. Cyclones are among the most awesome events that nature can produce.

12.5 Disaster Preparedness Measures

A trigger mechanism must be established by the utility to initiate the action for mitigation of disaster, as soon as information is received about any calamity which is likely to occur or has occurred. An illustrative check list of who has to do what should be prepared by each organisation for each of its sections, in case of emergency. The rescue operation for any disaster has to start right from the warning received from the Intelligence, meteorological organisations or any other State/Central agency. The rescue operation should concentrate on life safety as the prime objective followed by attending to the injured and stopping the disaster from spreading further. Utilities should undertake the following general disaster preparedness measures:

- developing a disaster preparedness plan to sequence the activities and responsibilities of each department;
- training for first aid and trauma and maintaining stocks of medical supplies;
- establishing emergency communication systems as well as messages to the public regarding matters of health, safety, and security;
- reviewing the location of critical facilities such as hospitals, important buildings, communications installations, and other structures;
- formation of teams for search and rescue operations and teams for disaster assessment; and
- preparing plans and equipment for alternative electric supply as necessary.

The role of the utilities also includes creating public awareness, preparedness planning, economic mitigation, search and rescue activities, establishing the distribution network of relief, disaster assessment, structural surveys and bringing the power distribution to normal service level. **The focus should be on education and planning of the utility personnel. Conducting Public Awareness Programmes on a regular basis is equally important**. The people living in the surroundings can play a vital role in the event of a disaster. Utilities should make the general public aware about potential hazards likely to occur in project area. Emphasis may be laid on the following aspects:

- Fixing permanent notice boards at all suitable places in the area displaying information related to assisting agencies, important telephone numbers, etc.
- Taking help from local youth organisations, voluntary organisations, educational institutions for spreading awareness about the safely measures and rescue operations in the event of a disaster.

Notes

In addition, some specific measures need to be taken for earthquakes, cyclones and floods. These are described below:

Earthquake-preparedness activities:

- Identification of safe sites where people living in areas threatened by landslides in secondary tremors could be relocated.
- Reviewing and upgrading the structural soundness of facilities that are essential for the operation of disaster response, such as grids, buildings, communications installations, etc.
- Preparing plans for clearing streets on a priority basis to provide emergency access.

Additional activities for cyclone and flood-preparedness:

- Developing early warning and evacuation procedures for people under threat.
- Dewatering pump and barrier walls in cable trenches to prevent the water from entering the substation.

Disaster planning is becoming an important part of the overall management plan for a library or archive. For effectiveness disaster planning must be integrated into the routine operating procedures of the institution. Survey of an institution's collections and creation of an inventory for disaster planning enables better access to the collections for researchers and staff. The disaster plan should address all types of emergencies and disasters that the institution is likely to face. It should include plans for both immediate response and long-term salvage and recovery efforts. An effective disaster plan is characterised by comprehensiveness, simplicity, and flexibility. Last but not the least the plan must be easy to follow. In situation of a crisis people often have trouble thinking clearly, so the plan must have concise, easy to follow instructions in a clear and simple language and style. Adequate training is also essential for the success of plan.

Response to Disaster

In case of crisis the first response should be contacting the Library's Security office. Library's security staff will then contact Public Safety if required. Meanwhile they should take the required steps to limit potential damage. These steps involve making sure that the library users and staff members are not in danger, and locating and eliminating the source of the problem. In case of minor fire, fire extinguishers should be used to put out fire. In case of water damage, efforts should be made to cut off the water supply to the effected area. This should be followed by efforts to remove the materials out of danger. However, any clean up or salvage work should not be undertaken till the situation is stable and a proper damage assessment has been made. Once the situation is brought under control, the members of the disaster maintenance team should then make an assessment of the overall damage caused. Types of materials have been damaged, the nature of damage, the extent of damage - all these factors should be considered while making damage assessment. On the basis of the assessment made by the disaster management team important decisions, as whether to withdraw, replace, or attempt salvage of damaged materials, should be taken. Materials that are to be withdrawn should be set aside and not discarded immediately. Water-damaged materials can usually be salvaged, but the process is expensive, labour intensive, and time-consuming. However, in case of severe fire, damage is generally irreversible and salvage is not possible. In the event of major disasters, salvage should be done according to the set salvage priorities. However, if the extent of damage is small all damaged items can receive treatment.

Task List the activities that utilities must undertake in preparing to handle the natural disasters most likely to occur in your area.

Self Assessment

Notes

Fill in the blanks:

13. The rescue operation for any disaster has to start right from the ..... received from the Intelligence.
14. The rescue operation should concentrate on ..... as the prime objective.
15. ..... is becoming an important part of the overall management plan for a library or archive.
16. ..... should makes the general public aware about potential hazards likely to occur in project area.

Case Study

Disaster Management in Flash Floods in Leh (Ladakh)

In the midnight of August 6, 2010, Leh in Ladakh region of North India received a heavy downpour. The cloud burst occurred all of a sudden that caught everyone unawares. Within a short span of about 2 h, it recorded a rainfall of 14 inches. There were flash floods, and the Indus River and its tributaries and waterways were overflowing. As many as 234 people were killed, 800 were injured, and many went missing, perhaps washed away with the gorging rivers and waterways. There was vast destruction all around. Over 1000 houses collapsed. Men, women, and children were buried under the debris. The local communication networks and transport services were severely affected. The main telephone exchange and mobile network system (BSNL) which was the lifeline in the far-flung parts of the region was completely destroyed. Leh airport was flooded and the runway was covered with debris, making it non-functional. Road transport was badly disrupted as roads were washed away and blocked with debris at many places. The civil, medical and health facilities were also severely affected, as the lone district civil hospital was flooded and filled with debris.

Three core disaster management strategies were adopted to manage the crisis. These strategies included: (i) Response, rescue, and relief operations; (ii) Mass casualty management; and (iii) Rehabilitation.

Response, Rescue and Relief Operations

The initial response was carried out immediately by the Government of India. The rescue and relief work was led by the Indian Army, along with the State Government of Jammu and Kashmir, Central Reserve Police Force (CRPF), and Indo-Tibetan Border Police (ITBP). The Indian Army activated the disaster management system immediately, which is always kept in full preparedness as per the standard army protocols and procedures.

There were just two hospitals in the area: the government civil hospital (SNM Hospital) and Army Hospital. During the flash floods, the government civil hospital was flooded and rendered dysfunctional. Although the National Disaster Management Act was in place, with the government civil hospital being under strain, the applicability of the act was hampered. The Army Hospital quickly responded through rescue and relief operations and mass casualty management. By dawn, massive search operations were started with the help of civil authorities and local people. The patients admitted in the civil hospital were evacuated to the Army Hospital, Leh in army helicopters.

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The runway of Leh airport was cleared up within a few hours after the disaster so that speedy inflow of supplies could be carried out along with the evacuation of the casualties requiring tertiary level healthcare to the Army Command Hospital in Chandigarh. The work to make the roads operational was started soon after the disaster. The army engineers had started rebuilding the collapsed bridges by the second day. Though the main mobile network was dysfunctional, the other mobile network (Airtel) still worked with limited connectivity in the far-flung areas of the mountains. The army communication system was the main and the only channel of communication for managing and coordinating the rescue and relief operations.

Mass Casualty Management

All casualties were taken to the Army Hospital, Leh. Severely injured people were evacuated from distant locations by helicopters, directly landing on the helipad of the Army Hospital. In order to reinforce the medical staff, nurses were flown in from the Super Specialty Army Hospital (Research and Referral), New Delhi, to handle the flow of casualties by the third day following the disaster. National Disaster Cell kept medical teams ready in Chandigarh in case they were required. The mortuary of the government civil hospital was still functional where all the dead bodies were taken, while the injured were handled by Army Hospital, Leh.

Army Hospital, Leh converted its auditorium into a crisis expansion ward. The injured started coming in around 0200 hrs on August 6, 2010. They were given first aid and were provided with dry clothes. A majority of the patients had multiple injuries. Those who sustained fractures were evacuated to Army Command Hospital, Chandigarh, by the Army's helicopters, after first aid. Healthcare staff from the government civil hospital joined the Army Hospital, Leh to assist them. In the meanwhile, medical equipment and drugs were transferred from the flooded and damaged government civil hospital to one of the nearby buildings where they could receive the casualties.

Rehabilitation

1. ***Shelter and Relief:*** Due to flash floods, several houses were destroyed. The families were transferred to tents provided by the Indian Army and government and non-government agencies. The need for permanent shelter for these people emerged as a major task. The Prime Minister of India announced ₹ 100,000 as an ex-gratia to the next of kin of each of those killed, and relief to the injured. Another ₹ 100,000 each would be paid to the next of kin of the deceased from the Chief Minister's Relief Fund of the State Government.

2. ***Supply of Essential Items:*** The Army maintains an inventory of essential medicines and supplies in readiness as a part of routing emergency preparedness. The essential non-food items were airlifted to the affected areas. These included blankets, tents, gum boots, and clothes. Gloves and masks were provided for the persons who were working to clear the debris from the roads and near the affected buildings.

3. ***Water, Sanitation and Hygiene:*** Public Health is seriously threatened in disasters, especially due to lack of water supply and sanitation. People having lost their homes and living in temporary shelters (tents) puts a great strain on water and sanitation facilities. The pumping station was washed away, thus disrupting water supply in the Leh Township. A large number of toilets became non-functional as they were filled with silt, as houses were built at the foothills of the Himalayan Mountains. Temporary arrangements of deep trench latrines were made while the army engineers made field flush latrines for use by the troops.

Contd....

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Water was stagnant and there was the risk of contamination by mud or dead bodies buried in the debris, thus making the quality of drinking water questionable. Therefore, water purification units were installed and established. The National Disaster Response Force (NDRF) airlifted a water storage system (Emergency Rescue Unit), which could provide 11,000 L of pure water. Further, super-chlorination was done at all the water points in the army establishments. To deal with fly menace in the entire area, anti-fly measures were taken up actively and intensely.

4. ***Food and Nutrition:*** There was an impending high risk of food shortage and crisis of hunger and malnutrition. The majority of food supply came from the plains and low-lying areas in North India through the major transport routes Leh–Srinagar and Leh–Manali national highways. These routes are non-functional for most part of the winter. The local agricultural and vegetable cultivation has always been scanty due to extreme cold weather. The food supplies took a further setback due to the unpredicted heavy downpour. Food storage facilities were also flooded and washed away. Government agencies, nongovernmental organizations, and the Indian Army immediately established food supply and distribution system in the affected areas from their food stores and airlifting food supplies from other parts of the country.

5. ***Health:*** There was a high risk of water-borne diseases following the disaster. Many human bodies were washed away and suspected to have contaminated water bodies. There was an increased fly menace. There was an urgent need to prevent disease transmission due to contaminated drinking water sources and flies. There was also a need to rehabilitate people who suffered from crush injuries sustained during the disaster. The public health facilities, especially, the primary health centres and sub-health centres were not adequately equipped and were poorly connected by roads to the main city of Leh. Due to difficult accessibility, it took many hours to move casualties from the far-flung areas, worsening the crisis and rescue and relief operations. The population would have a higher risk of mental health problems like post-traumatic stress disorder, deprivation, and depression. Therefore, relief and rehabilitation would include increased awareness of the symptoms of post-traumatic stress disorder and its alleviation through education on developing coping mechanisms.

6. ***Economic Impact:*** Although it would be too early to estimate the impact on economy, the economy of the region would be severely affected due to the disaster. The scanty local vegetable and grain cultivation was destroyed by the heavy rains. Many houses were destroyed where people had invested all their savings. Tourism was the main source of income for the local people in the region. The summer season is the peak tourist season in Ladakh and that is when the natural disaster took place. A large number of people came from within India and other countries for trekking in the region. Because of the disaster, tourism was adversely affected. The disaster would have a long-term economic impact as it would take a long time to rebuild the infrastructure and also to build the confidence of the tourists.

   The floods put an immense pressure and an economic burden on the local people and would also influence their health-seeking behaviour and health expenditure.

7. ***Political Context:*** The disaster became a security threat. The area has a high strategic importance, being at the line of control with China and Pakistan. The Indian Army is present in the region to defend the country's borders. The civil administration is with the Leh Autonomous Hill Development Council (LAHDC) under the state government of Jammu and Kashmir.

Contd....

Notes

It is impossible to anticipate natural disasters such as flash floods. However, disaster preparedness plans and protocols in the civil administration and public health systems could be very helpful in rescue and relief and in reducing casualties and adverse impact on the human life and socio-economic conditions. However, the health systems in India lack such disaster preparedness plans and training. In the present case, presence of the Indian Army that has standard disaster management plans and protocols for planning, training, and regular drills of the army personnel, logistics and supply, transport, and communication made it possible to immediately mount search, rescue, and relief operations and mass casualty management. Not only the disaster management plans were in readiness, but continuous and regular training and drills of the army personnel in rescue and relief operations, and logistics and communication, could effectively facilitate the disaster management operations.

Effective communication was crucial for effective coordination of rescue and relief operations. The Army's communication system served as an alternative communication channel as the public communication and mobile network was destroyed, and that enabled effective coordination of the disaster operations.

Emergency medical services and healthcare within few hours of the disaster was critical to minimize deaths and disabilities. Preparedness of the Army personnel, especially the medical corps, readiness of inventory of essential medicines and medical supplies, logistics and supply chain, and evacuation of patients as a part of disaster management protocols effectively launched the search, rescue, and relief operations and mass casualty reduction. Continuous and regular training and drills of army personnel, health professionals, and the community in emergency rescue and relief operations are important measures. Emergency drill is a usual practice in the army, which maintains the competence levels of the army personnel. Similar training and drill in civil administration and public health systems in emergency protocols for rescue, relief, mass casualty management, and communication would prove very useful in effective disaster management to save lives and restore health of the people

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3483513/

12.6 Summary

- The term disaster may be defined as any occurrence that threatens human safety and/ or causes damage to library facilities and materials. Disasters can be natural or man-made depending on their origin.
- '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.
- One of the keys to disaster management is defining the types of catastrophes that could possibly disrupt the day-to-day operation of a business, city, region or country.
- Disaster management also often addresses the issue of communication.

Notes

- As part of the crisis management component of a disaster plan, it is not unusual for some type of disaster kits to be created.
- Any disaster can interrupt essential services, such as the provision of health care, electricity, water, sewage/garbage removal, transportation and communications.
- Disaster Management Plan in the power sector is a tool to provide necessary guidelines to organisations engaged in the generation, transmission and distribution of electrical power for ensuring safety of people, protection of environment, protection of installations and restoration of power supply.
- In terms of management, types of disasters, how to prevent, time of occurrence, response plan, recovery plan, policy review and so on all belong to the field of disaster management.
- Floods caused by overflowing rivers result from heavy rains or from the melting of winter snow, or from both.
- Floods are natural hazards that are not, in and of themselves, disasters, but they can transform a vulnerable situation into a disaster.
- Earthquakes can devastate an entire city or a region of hundreds of square kilometres.
- A cyclone's destructive work is done by the high wind, flood-producing rains, and associated storm surges.
- Landslides are simply defined as the mass movement of rock, debris or earth down a slope and have come to include a broad range of motions whereby falling, sliding and flowing under the influence of gravity dislodges earth material.
- A trigger mechanism must be established by the utility to initiate the action for mitigation of disaster, as soon as information is received about any calamity which is likely to occur or has occurred.

12.7 Keywords

Complex Emergencies: These emergencies involve a breakdown of authority, looting and attacks on strategic installations.

Cyclone: Cyclones are huge revolving storms caused by winds blowing around a central area of low atmospheric pressure.

Disaster: It is a natural or man-made event, which brings sudden great misfortune and disruption in normal life including that of the power supply.

Disaster Management: It is a process or strategy that is implemented before, during or after any type of catastrophic event takes place.

Disaster Plan: Systematic procedures that clearly detail what needs to be done, how, when, and by whom before and after the time an anticipated disastrous event occurs.

Earthquake: An Earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rocks beneath the earth surface.

Environmental Emergencies: These emergencies include technological or industrial accidents, usually involving hazardous material, and occur where these materials are produced, used or transported.

Notes

Floods: Floods are caused by overflowing rivers result from heavy rains or from the melting of winter snow, or from both.

Landslides: Landslides are simply defined as the mass movement of rock, debris or earth down a slope and have come to include a broad range of motions whereby falling, sliding and flowing under the influence of gravity dislodges earth material.

Mitigation: Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters.

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.

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.

12.8 Review Questions

1. Define Disaster Management.
2. What are the key elements of Disaster Management?
3. Highlight the types of Disasters.
4. Elucidate the objectives of the Disaster Management Plan.
5. Throw some light on the phases of Disaster Management.
6. Explain Disaster Management in case of Floods.
7. Discuss Disaster Management in case of Earthquake.
8. Describe Disaster Management in case of Cyclone.
9. Highlight Disaster Management in case of Landslides.
10. What are the utilities be undertaken in disaster preparedness measures?

Answers: Self Assessment

1.	True	2.	False
3.	True	4.	False
5.	Disaster Management	6.	Recovery
7.	Disaster Management Cycle	8.	Prevention/Mitigation
9.	True	10.	False
11.	True	12.	True
13.	Warning	14.	Life Safety
15.	Disaster Planning	16.	Utilities

12.9 Further Readings

Notes

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Notes

Unit 13: Environmental and Social Issues

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Objectives

After studying this unit, you should be able to:

- Discuss the Unsustainable to Sustainable Development
- Explain the Energy related Problems of Urban People
- Describe the Rain Water Harvesting (RWH)
- Understand the Climate Change and Global Warming
- Discuss the Acid Rain and Ozone Layer Depletion
- Explain the Rain Water Harvesting

Notes

Introduction

In the previous unit, we dealt with the meaning and phases of Disaster Management along with the Disaster Management in case of Floods, Earthquake, Cyclone and Landslides. India has been opposing the inclusion of social and environmental issues in any multilateral and bilateral trade talks — be it FTAs or under the aegis of the World Trade Organization (WTO), as there are other international fora to deal with non-trade matters. India is the largest contributor to world population growth, adding about 17 million people every year to an already huge population of over one billion. Although more than two-thirds of India's population still lives in the rural areas, it has experienced rapid urbanization over the last two decades. India has attained food sufficiency in spite of its growing population. It has also created a large base of skilled scientific and technical human resources with a diversified industrial base. However, the benefits of this impressive growth have been substantially offset by environmental degradation. Even though India has a rich tradition of environment conservation, large scale environment degradation has resulted from population pressures, industrialization and the indiscriminate use of forest areas for fuel, power generation and irrigation purposes. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the Unsustainable to Sustainable Development, Energy related Problems of Urban People and meaning of Rain Water Harvesting, Climate Change, Global warming, Acid Rain and Ozone Layer Depletion along with the Rain Water Harvesting.

13.1 For Unsustainable to Sustainable Development

Until two decades ago the world looked at economic status alone as a measure of human development. Thus countries that were economically well developed and where people were relatively richer were called advanced nations while the rest where poverty was widespread and were economically backward were called developing countries. Most countries of North America and Europe which had become industrialized at an earlier stage have become economically more advanced. They not only exploited their own natural resources rapidly but also used the natural resources of developing countries to grow even larger economies. Thus the way development progressed, the rich countries got richer while the poor nations got poorer. However, even the developed world has begun to realise that their lives were being seriously affected by the environmental consequences of development based on economic growth alone. This form of development did not add to the quality of life as the environmental conditions had begun to deteriorate.

By the 1970s, most development specialists began to appreciate the fact that economic growth alone could not bring about a better way of life for people unless environmental conditions were improved. Development strategies in which only economic considerations were used, had begun to suffer from serious environmental problems due to air and water pollution, waste management, deforestation and a variety of other ill effects that seriously affected peoples' well being and health. There were also serious equity issues between the "haves and the have nots" in society, at the global and national levels. The disparity in the lifestyles between the rich and the poor was made worse by these unsustainable development strategies.

Many decades ago, Mahatma Gandhi envisioned a reformed village community based on sound environmental management. He stressed on the need for sanitation based on recycling human and animal manure and well-ventilated cottages built of recyclable material. He envisioned roads as being clean and free of dust. His main objective was to use village made goods instead of industrial products. All these principals are now considered part of sound long-term development. Gandhiji had designed a sustainable lifestyle for himself when these concepts were not a part of general thinking. A growing realization of the development strategy that Mahatma Gandhi had suggested many decades earlier is now accepted by experts on development across the world. This is based on his concept that the world could support people's needs but

Notes

not their greed. It has become obvious that the quality of human life has worsened as economies grew. The world now appears to be at a crossroad. It has taken the path of short term economic growth and now suffers the consequences of environmental degradation at the cost of loss of 'quality of human life'.

Notes The earth cannot supply the amount of resources used and wasted by the economically well off sectors of society as well as that required for day to day sustenance of the ever growing population in less developed countries. Society must thus change its unsustainable development strategy to a new form where development will not destroy the environment. This form of sustainable development can only be brought about if each individual practices a sustainable lifestyle based on caring for the earth.

It was also realized that these were not simple issues. Indira Gandhi said in the Stockholm Conference in 1972 that poverty was the greatest polluter. This meant that while the super rich nations had serious environmental problems, the under-developed in Asia, Africa and South America had a different set of environmental problems linked to poverty. Developing countries were suffering the consequences of a rapidly expanding human population with all its effects on the over utilization of natural resources. Thus increasingly the world began to see the need for a more equitable use of earth resources. The control over natural resources and the wealth that it produces also begins to create tensions between people that can eventually lead to both strife within a country and wars between nations. This is also a major cause for the loss of quality of life. How then could a new form of development be brought about that could solve the growing discontent in the world? It has become obvious that development must begin to change from aiming at short term economic gains to a long term sustainable growth that would not only support the well being and quality of life of all people living in the world today but that of future generations as well.

The current strategies of economic development are using up resources of the world so rapidly that our future generations, the young people of the world, would have serious environmental problems, much worse than those that we are facing at present. Thus current development strategies have come to be considered unsustainable for the world's long-term development. The newer concept of development has come to be known as "Sustainable Development". The nations of the world came to clearly understand these issues at the Rio Conference in 1992. Several documents were created for the United Nations Conference on Environment and Development (UNCED), which brought out the fact that environment and development were closely connected and that there was a need to 'care for the Earth'.

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It also looks at the equity between countries and continents, races and classes, gender and ages. It includes social development and economic opportunity on one hand and the requirements of environment on the other. It is based on improving the quality of life for all, especially the poor and deprived within the carrying capacity of the supporting ecosystems. It is a process which leads to a better quality of life while reducing the impact on the environment. Its strength is that it acknowledges the interdependence of human needs and environmental requirements.

Caution To ensure sustainable development, any activity that is expected to bring about economic growth must also consider its environmental impacts so that it is more consistent with long term growth and development.

Notes

Large dams, major highways, mining, industry, etc. can seriously damage ecosystems that support the ecological health of a region. Forests are essential for maintaining renewable resources, reducing carbon dioxide levels and maintaining oxygen levels in the earth's atmosphere. Their loss impairs future human development. Loss of forests depletes biodiversity which has to be preserved to maintain life on earth. Major heavy industries if not planned carefully lead to environmental degradation due to air and water pollution and generate enormous quantities of waste that lead to long term environmental hazards. Toxic and Nuclear wastes can become serious economic problems as getting rid of them is extremely costly. Thus the economic benefits of a project must be weighed against the possible environmental costs before a project is permitted.

We as citizens of our Nation, and increasingly as citizens of one common future at the global level, must constantly monitor the pattern of development. If we see that a development project or an industry is leading to serious environmental problems, it is our duty to bring this to the attention of authorities such as the local administration, the Forest Department or the Pollution Control Board, to look into the issue. Further if new development projects are being planned in and around the place where we live it is our duty to see that this is brought about in accordance with environmental safeguards. While we all need to think globally, we need to act locally. We have to see to it that we change development from its present mandate of rapid economic growth without a thought for future ecological integrity, to a more sustainable ecologically appropriate strategy.

If new projects of a large size are to be passed Government has made it compulsory to publish the summary report of the Environmental Impact Assessment (EIA) and conduct a 'Public Hearing'. It is essential that all of us as responsible citizens read evaluate and respond to such public hearings held in our area and make comments on the possible impacts of the project. In many situations there are proponents of the project who only look at their own rapid economic gains. It is for citizens as concerned individuals and groups to counter these vested interests so that our environment is not degraded further. Life has to be made more liveable for all. We cannot support the economic growth of one sector of society while we permit environmental degradation to destroy the lives of the less fortunate.

Caselet

Mewar, Rajasthan

The Mewar region of Rajasthan has a rich legacy of traditional water harvesting systems to share the available water for cultivation. There are various types of rainwater harvesting systems.

Medhbandi: This is a stone embankment built on a hill slope to help create a level field for cultivation. It controls erosion and conserves moisture.

Naada/bandha: These are stone check dams across streams or gullies that are constructed to capture runoff on a stretch of fertile land that is submerged in water during the monsoon. The land not only becomes more fertile after trapping silt, but also retains substantial quantities of water in the soil. These dams are constructed in phases over several years. The height is slowly increased up to the right height of the check dam which determines the size of the naada.

Hembar: These are small temporary dams constructed with stones, twigs and mud over a seasonal stream when water flows in it is reduced to a point that it cannot be taken directly to the fields for irrigation.

Contd....

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Chak: Chak is a big plot of land, usually a charnot or village pasture land, enclosed by a stone boundary wall called kot. Tree plantations, seeding of grass for fodder, contour bunds with trenches and loose stone check dams are developed in the chak. The chak is used for fodder and fuel wood. It reduces soil erosion and enhances recharge of ground water.

Talab: The Mewar region is well-known for its built reservoirs (talabs). Udaipur City is famous for its large number of talabs, and is called the lake city. A small reservoir of less than five bighas is called talai, a medium sized lake is called bandh or talab and a bigger lake is called sagar or samand.

Saza kuva: This is an open dug well which has several owners. In Mewari language, saza means partner. This is an important method for irrigation in the Aravalli hills. About 70,000 wells in the Udaipur District provide water for 80% of the area under irrigation and provide water for their owners. These are considered common property resources.

Source: http://www.ugc.ac.in/oldpdf/modelcurriculum/Chapter6.pdf

Self Assessment

State whether the following statements are true or false:

1. Indira Gandhi said in the Stockholm Conference in 1982 that poverty was the greatest polluter.
2. Developed countries were suffering the consequences of a rapidly expanding human population with all its effects on the over utilization of natural resources.
3. Forests are essential for maintaining renewable resources, reducing carbon dioxide levels and maintaining oxygen levels in the earth's atmosphere.

13.2 Energy related Problems of Urban People

Energy is an essential need of a man. In urban areas the need of energy is increasing by leaps and bounds. Take the case of mega-urban dwelling places. Vehicles both petrol and diesel engine driven are seen flowing like floods. These vehicles run with the basic input called oil which is one form of energy what about the other sources of energy-renewable and non-renewable being used by urban population. The worldwide demand for energy will be more than double by the year 2020. Moreover, countries use energy in an uneven mariner in the world.

Some countries use more energy whiles many less. In developed countries the amount of energy used is much more compared to underdeveloped developing countries. Industrialised developed countries use energy for these purposes: (i) residential and commercial, (ii) industrial and (iii) transportation. In less-developed countries, most of the energy is used by individuals. Canada and United States use about twice as much energy as someone in France or Japan and over twenty-five times as much energy as a person in Africa. The consumption of energy in India is more than Africa because it is the second populous country in the world with population touching slightly more than 110 crores.

Urban centres use enormous quantities of energy. In the past, urban housing required relatively smaller amounts of energy than we use at present. Traditional housing in India required very little temperature adjustments as the materials used, such as wood and bricks handled temperature changes better than the current concrete, glass and steel of ultra modern buildings.

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Did u know? ***Embodied Energy:*** Materials like iron, glass, aluminium, steel, cement, marble and burnt bricks, which are used in urban housing, are very energy intensive. The process of extraction, refinement, fabrication and delivery are all energy consuming and add to pollution of earth, air and water. This energy consumed in the process is called embodied energy.

Until the 1950s many urban kitchens were based on fuelwood or charcoal. This was possible and practical when homes had chimneys and kitchens were isolated from the rest of the house. Smoke became a problem once this changed to apartment blocks. Kerosene thus became a popular urban fuel. This changed to electrical energy and increasingly to natural gas by the 1970s in most parts of urban India. Urban centres in hot climates need energy for cooling. The early systems of fans changed into air-conditioning, which consumes enormous quantities of energy. New buildings in our country have taken to using large areas covered by glass. While in cold climates this uses the green house effect to trap the warmth of the sun inside, in our hot climate this adds several degrees to the temperature inside. Thus it requires even more energy to run large central air conditioning units. High rise buildings in urban centres also depend on energy to operate lifts and an enormous number of lights.

Example: **Energy efficiency**

Urban residential and commercial facilities are responsible for approximately 35% of USA's greenhouse gas emissions. Buildings need to be made energy efficient and reduce carbon dioxide emissions, which cause 'heat islands' or pockets of high temperature over these urban areas.

Urban transport depends on energy mainly from fossil fuels. Most urban people use their own individual transport rather than public transport systems for a variety of reasons. Urban transport in different cities and even different parts of a city are either inefficient or overcrowded. Thus even middle income groups tend to use their own private vehicles. This means more and more vehicles on the road which leads to traffic congestion, waste of time for all the commuters, and a great load of particulate matter and carbon monoxide from the exhaust of vehicles. This causes a rise in the number of people having serious respiratory diseases. Thus there is a need to develop a more efficient public transport system and discourage the use of individual vehicles in all our urban areas. Each of us as an environmentally conscious individual must reduce our use of energy. An unnecessary light left on carelessly adds to energy use. Imagine the amount of energy wasted by thousands of careless people. If we learned to save electricity, we would begin to have a more sustainable lifestyle.

In India, about 70% commercial energy is being generated through coal-fired thermal plants. Coal consumption by thermal plants is rising every year. There are about 40 thermal plants both big and small scattered all over the country. The Korba-Super Thermal Power

Station is the largest. It has installed capacity of 2,100 MW Power from the project goes into the western grid comprising the states of Madhya Pradesh, Maharashtra, Gujarat and Goa. However, Bihar, West Bengal, Delhi, Gujarat and Haryana are some of the main producers of thermal power in India.

Before discussing the sources of energy those can be harnessed, let us have an idea of energy demand for residential, commercial, industrial and transportation sectors of both developed and developing countries of the world.

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Urban-Residential and Commercial Energy Demand

As already explained, the amount of energy required for residential and commercial use varies greatly throughout the world.

The economics of energy consumption describe that a country with high GNP (gross national product roughly national income) use less per capita energy for residential and commercial needs, than a less developed country like Africa and India. 30 per cent energy used in North America and 90 per cent used in India is for residential and commercial purposes.

Reason is very simple. North Americans use air conditioning, refrigeration, water heating and space heating. So 75 percent energy is used in these gadgets. In India, almost all of the energy used in home is for cooking due to scarcity and high cost of fuel. About half of the energy demand in Africa is for cooking because they use an open fire instead of stoves. Using more efficient stoves instead of open fires could reduce these energy requirements by 50 percent.

Summarily North America and India could reduce energy consumption in many ways.

Urban-Industrial Energy Demand of Sustainable Development

Considerable variation is found in the amount of energy used for industrial processes. About 30 per cent of energy is used by USA for industries. In the former Soviet Union large deposits of coal, oil and natural gas reserves were available.

On account of this reason steel is processed from ore because energy is readily available. Spain and Italy lack large deposits of fossil fuel necessary for the extraction of oil and natural gas.

So both Italy and Spain produce steel from scrap steel because it needs less energy/Producing 1 metric ton of steel from iron or in the former Soviet Union uses as much energy as producing a metric ton of steel from scrap in Spain or Italy.

Large capital investment is required to upgrade the process of industrial production, because updated and upgraded machinery and equipment reduce industrial energy consumption. Many countries of the world cannot afford to convert their existing processes due to financial and other constraints.

Take the case of India, a nation with few coal deposits, still uses the outdated open hearth furnace to produce steel. This process needs double the worldwide energy for producing a metric ton of steel on an average. India being an underdeveloped developing country if unable to change the process to modern methods has to continue to use energy expensive methods.

Urbanization is a global phenomenon in the developed countries of the world. It is now taking a steady stride in developing countries. The degree of urbanization has increased tremendously. It means that (A) the proportion has increased (B) the population density of towns has increased and (C) the percentage of growth of population has increased in countries like India. These three parameters which are related with volume, spatial spread and growth from the three indices of degree of urbanization is largely due to a steady migration of rural population from rural to urban areas.

The main reason for heavy concentration of urban population in large metropolitan cities is that they are the centres of major industrial and commercial activities. They offer much attraction for migration of people and these accounts for rapid increase in their population.

Factors contributing to urbanization are (A) Industrialization (B) Transportation (C) Socio-economic changes all of which have impact on environment and health. The management of urbanization involves an extremely range of problems and thus effecting all aspects of social life.

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The urbanization and proliferation of urban slums presents a challenge to public health. This situation has become a global concern and future of entire mankind is at stake due to phenomenal rise in population, rapid urbanization, degradation, of environment, ever increasing pollution and over exploitation of natural and non-renewable resources.

Urbanization has brought into associated problems related with the energy. Energy is an essential impact for urban development. Energy is produced from commercial sources like cow dung, fuel wood and agricultural wastes. Per capita consumption of commercial energy is sometimes used as an index of the consumption of economic advancement. India's per capita commercial energy however is very low. It is one eighth of the world average commercial energy accounts for a little over of the total energy used in the country, the rest coming from non-commercial sources.

Self Assessment

Fill in the blanks:

4. ..... is an essential need of a man.
5. In developed countries the amount of energy used is much more compared to ..... developing countries.
6. Urban transport depends on energy mainly from .....

13.3 Rain Water Harvesting (RWH)

As our world faces serious water shortages, every drop of water we can use efficiently becomes of great value. One method is to manage rain water in such a way that it is used at the source. If as much water as possible is collected and stored this can be used after the rainy season is over. In many parts of the world especially in very dry areas this has been traditionally practiced. However the stored water has to be kept pollution free and clean so that it can be used as drinking water. Stored water can grow algae and zooplankton (microscopic animals). This can be pathogenic and cause infections. Thus keeping the water uncontaminated is of great importance. Current technologies of rainwater harvesting require that all roof and terrace water passes down into a covered tank where it can be stored for use after the monsoon. This is most advantageous in arid areas where clean water is very scarce. However there are practical difficulties such as constructing large storage tanks which are expensive. Another way of using rooftop rainwater harvesting is to collect it so that it percolates into the ground to recharge wells instead of flowing over the ground into rivers. Thus by recharging ground water harvested from rooftops, the water table rises and the surrounding wells retain water throughout the year.

The rainwater harvesting is the simple collection or storing of water through scientific techniques from the areas where the rain falls. It involves utilization of rain water for the domestic or the agricultural purpose. The method of rain water harvesting has been into practice since ancient times. It is as far the best possible way to conserve water and awaken the society towards the importance of water. The method is simple and cost effective too. It is especially beneficial in the areas, which faces the scarcity of water.

People usually make complaints about the lack of water. During the monsoons lots of water goes waste into the gutters. And this is when Rain water Harvesting proves to be the most effective way to conserve water. We can collect the rain water into the tanks and prevent it from flowing into drains and being wasted. It is practiced on the large scale in the metropolitan cities. Rain water harvesting comprises of storage of water and water recharging through the technical process.

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13.3.1 Need for Rainwater Harvesting

Water is one of the most essential requirements for existence of living beings. Surface water and ground water are two major sources of water. Due to over population and higher usage levels of water in urban areas, water supply agencies are unable to cope up demand from surface sources like dams, reservoirs, rivers etc. This has led to digging of individual tube wells by house owners. Even water supply agencies have resorted to ground water sources by digging tube-wells in order to augment the water supply. Replenishment of ground water is drastically reduced due to paving of open areas. Indiscriminate exploitation of ground water results in lowering of water table rendering many bore-wells dry. To over come this situation bore wells are drilled to greater depths. This further lowers the water table and in some areas this leads to higher concentration of hazardous chemicals such as fluorides, nitrates and arsenic. In coastal areas like Chennai, over exploitation of ground water resulted in seawater intrusion; thereby rendering ground water bodies saline. In rural areas also, government policies on subsidized power supply for agricultural pumps and piped water supply through bore wells are resulting into decline in ground water table. The solution to all these problems is to replenish ground water bodies with rain water by man made means.

13.3.2 Components of Rain Water Harvesting (RWH)

The components of Rain Water Harvesting are as follows:

1. ***Catchment:*** Any surface or the paved areas can be treated as catchment. Even the footpaths and roads can act as the catchment, as these areas too receive the direct rainfall. Rooftops are the best among them because of the large coefficient of run off generated from them and there are less chances of contamination of water.

2. ***Conveyance:*** Conveyance system basically includes rain gutters and down pipes which collects the rain water from catchment to the storage tank. These rain gutters are usually built during the time of construction. They need to be designed appropriately as to avoid the loss of water during the conveyance process.

3. ***Storage:*** The most important part of the rain water harvesting is the storage system. The storage system is designed according to the amount of water that is to be stored. The design and site (location) of the storage or the recharge system should be properly chosen. The areas which receive the rainfall frequently, there a simple storage system could be constructed, to meet the daily water requirements. Otherwise the areas which receive the lesser rainfall, there the storage systems are quite essential. Rain barrels, underground or open slumps are mostly used to collect rain water. Make sure that the storage system is properly sealed and does not leak. Use Chlorine from time to time to keep the water clean.

4. ***Coarse mesh/leaf screen:*** To prevent the entry of leaves and other debris in the system, the coarse mesh should be provided at the mouth of inflow pipe for flat roofs. For slope in roofs where gutters are provided to collect and divert the rain water to downspout or conduits, the gutters should have a continuous leaf screen, made of ¼ inch wire mesh in a metal frame, installed along their entire length, and a screen or wire basket at the head of the downspout.

5. ***Gutter:*** Gutter is required to be used for collecting water from sloping roof and to divert it to downspout. These are the channels all around the edge of a sloping roof to collect and transport rain water to the storage tank. Gutters can be of semi-circular, rectangular or trapezoidal shape. Gutters must be properly sized, sloped and installed in order to maximize the quantity of harvested rain. Gutter can be made using any of the following materials:

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- Galvanized iron sheet
- Aluminium sheet
- Semi-circular gutters of PVC material which can be readily prepared by cutting these pipes into two equal semi-circular channels
- Bamboo or betel trunks cut vertically in half (for low cost housing projects)

The size of the gutter should be according to the flow during the highest intensity rain. The capacity of the gutters should be 10 to 15% higher. The gutters should be supported properly so that they do not sag or fall off when loaded with water. The connection of gutters and down spouts should be done very carefully to avoid any leakage of water and to maximize the yield. For jointing of gutters, the lead based materials should not be used, as it will affect the quality of water.

6. ***Down Spout/Conduit:*** The rain water collected on the roof top is transported down to storage facility through down spouts/conduits. Conduits can be of any material like PVC, GI or cast iron. The conduits should be free of lead and any other treatment which could contaminate the water.

7. ***Filter:*** If the collected water from roof top is to be used for human consumption directly, a filter unit is required to be installed in RWH system before storage tank. The filter is used to remove suspended pollutants from rain water collected over roof. The filter unit is basically a chamber filled with filtering media such as fibre, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank. The filter unit should be placed after first flush device but before storage tank. There are various types of filters which have been developed all over the country. The type and selection of filters is governed by the final use of harvested rain water and economy.

13.3.3 Benefits of Rainwater Harvesting

Rainwater harvesting first of all increases water security. It is the perfect solution to meet water requirements especially in the areas which do not have sufficient water resources. It helps in improving the quality of the ground water and increasing the level of the ground level. It also helps in improving the overall floral system. It reduces the loss of top layer of the soil. If we capture the water directly we need not to depend much on the water storage dams. It is the good solution to the increasing water crises. Rain water harvesting reduces the flooding on roads and further prevents it from contamination. And in the last it decreases the menace of floods on regional scale. Benefits of Artificial Recharge in Urban Areas are as follows:

- Improvement in infiltration and reduction in run-off.
- Improvement in groundwater levels and yields.
- Reduces strain on Special Village Panchayats/Municipal/Municipal Corporation water supply
- Improvement in groundwater quality
- Estimated quantity of additional recharge from 100 sq. m. roof top area is 55,000 litres.

Rainwater harvesting provides an independent water supply during regional water restrictions and in developed countries is often used to supplement the mains supply. Rain water harvesting provide water when there is a drought or in summer season. Rainwater harvesting systems are appealing as they are easy to understand, install and operate. They are effective in 'green droughts' as water is captured from rainfall where runoff is insufficient to flow into dam storages. The quality of captured rainwater is usually sufficient for most household needs, reducing the need

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for detergents because rainwater is soft. Financial benefits to the users include that rain is 'renewable' at acceptable volumes despite climate change forecasts, and rainwater harvesting systems generally have low running costs, providing water at the point of consumption.

Benefits of widespread rainwater harvesting to the regional reticulated supply system may include reduced treatment, pumping, operation and augmentation costs, reducing peak storm water and storm water processing costs, as well as reduced greenhouse gas emissions due to reduced dependence on pumping and potential augmentation through sources such as desalination.

13.3.4 Rain Water Harvesting Methods

There are three methods of harvesting rain water as given below:

(a) ***Storing rain water for direct use:*** In place where the rains occur throughout the year, rain water can be stored in tanks. However, at places where rains are for 2 to 3 months, huge volume of storage tanks would have to be provided. In such places, it will be more appropriate to use rain water to recharge ground water aquifers rather than to go for storage. If the strata are impermeable, then storing rain water in storage tanks for direct use is a better method. Similarly, if the ground water is saline/unfit for human consumption or ground water table is very deep, this method of rain water harvesting is preferable.

(b) ***Recharging ground water aquifers from roof top run off:*** Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows into the recharge well. The recharge well should preferably be shallower than the water table. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth. The various methods of recharging ground water aquifers from roof top runoff are discussed separately.

(c) ***Recharging ground water aquifers with runoff from ground areas:*** The rain water that is collected from the open areas may be diverted by drain pipes to a recharge dug well/bore well through filter tanks. The abandoned bore well/dug well can be used cost effectively for this purpose.

Self Assessment

State whether the following statements are true or false:

7. The rainwater harvesting is the simple collection or storing of water through scientific techniques from the areas where the rain falls.
8. Catchment system basically includes rain gutters and down pipes which collects the rain water from catchment to the storage tank.
9. Gutter is required to be used for collecting water from sloping roof and to divert it to downspout.

13.4 Climate Change and Global Warming

The one word or phrase that the entire world is talking about everyday is "Climate Change" or "Global Warming". It is widely reported in television medium and newspapers about the negative impacts of climate change. Many countries in the way of economic development have given least importance to the environment surrounding them thereby causing ecological imbalance which has resulted in the change of weather patterns over a period of time. Climate

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change also has the exact meaning. It is defined as the change in weather patterns over a period of time wherein the time can be in number of years to decades and million years. In general, climate change is described with respect to a particular region. Sometimes, it can be referred by taking the entire Earth into account. In a country like India which is fast growing into a global economy, climate change is a major talking point and issue to be dealt with. The causes for climate change include both natural and human influences.

13.4.1 Climate Change in India

In India, climate change has caused tremendous changes in the weather patterns across different parts of the country. Extended summers, unpredicted rainfall are all some of the effects of climate change. If climate change is not seriously considered, the consequences will be irreparable. Climate change will affect the environment, economy and social welfare of a particular region or country. Some of the research work going on regarding climate change and its impact in India has revealed shocking results. The annual monsoon season will lead to severe droughts and floods in various parts of India. As India depends on monsoon rains for agriculture, forestry and fisheries it has a strong influence for the water based ecosystems. One of the debatable topics in India is the concept of development and climate change. Does development take place at the cost of impacting the environment thereby aiding climate change? So, India is on the fast track of becoming a global economy and on the other hand industrialization and urbanization leads to more greenhouse gas emissions which in turn cause climate change mainly impacting the monsoon rains. The changing rainfall patterns over the recent years have caused difficulties to farmers who are not able to cultivate crops with the deficit rainfall.

It is a known fact that global temperature levels will rise anywhere between 2 – 5° over the next century. A 2001 report by the Intergovernmental Panel on Climate Change has issued statistics which show that temperatures in India will rise by 4° around 2080. Further, it states that the sea level would have risen by about 88 centimetres around the beginning of 21st century. Climate change will also cause health problems which mainly come from water related diseases. Some of the ways of reducing impact of climate change is by finding alternate energy sources for transport which has fewer emissions. Awareness about the impacts of climate change has to be passed on to the common man who is not aware of what the impacts of half a degree increase in temperature would be like. Changing climatic conditions can have the big effect on our life and our environment. In fact, it is the greatest environmental threat faced by planet earth.

Notes The change in weather conditions can be best observed through the extreme rise in temperature, melting of glaciers and sudden rise in sea level. These changes are causing serious problems to humans and other forms of life. Biologist and Environmentalists are constantly searching for the new solutions to combat these environmental changes.

1. Agriculture

Agriculture in India and entire world is mostly dependent on the persisting weather conditions. The alteration in Global warming has dramatically affected agriculture and its productivity. The increase in temperature has significantly led to a change in the agricultural zones and shift in the growing seasons. On the other hand the change in the rainfall pattern is the serious threat to the agriculture, which in turn affects the country's economy and food security. The delayed or inadequate monsoons also cause influence on the sale of the agriculture inputs such as fertilizers, agro-chemicals, tractors etc. Some of the areas in India receive more than normal rainfall while some of the areas receive almost no rainfall. The various studies show the overall loss in the

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crop production in the country in the last few years due to the anticipated rise in the temperature. It is expected that in the near future India is going to face the challenges that includes unwanted pressure from the growing population, and changing scenario of world trade in agriculture.

2. Biodiversity

The changes in the climatic conditions are already felt by the biodiversity and wildlife habitats across the world. Many plant and animal species are eventually becoming extinct as a result of the climatic changes. Some of the plant and animal species are unable to adapt to the changing climate. While some of the mammals have already reached the suitable places, appropriate for their survival. Green houses gases are the main reason for the climatic change which in turn posses the threat to the vast biodiversity. Further more the redistribution of life on the earth's surface is increasing at an alarming fast pace. The tremendous change in the climatic conditions can be best felt at mountains, where due to the excessive heat; trees have started growing on the much higher elevations. Another example that apt to explain the impact of climate change is in the great Rann of Kutch, where the population of Lesser Florican and Indian Ass is plummeting sharply. As the global warming causes the rise in the sea level, it is expected that the marshes and mudlands of the Kutch will be submerged. Climate change not only influences the animal behaviour but also slash the genetic diversity of the animals.

3. Coastal Areas

The changing climatic conditions are also the severe threat to the coastal areas, which has led to the increase in the sea level. This could result in flooding and can cause damage to the coastal infrastructure. This will displace the large section of population and force others to migrate. The worst hit coastal areas in India will be Maharashtra, Goa and Gujarat. As for the purpose of information these coastal regions provide human with wide variety of goods and services including food, recreational opportunities and transportation corridors. As well as support the great wealth of marine life and diverse habitats. So the treat to the coastal areas is the threat to the human population at large.

Did u know? ***Damage to coral reefs, Pacific:*** The severity of periodic warming due to El Nino in 1997 in the Pacific led to the most serious death in coral ever known. It is estimated that about 10% of the Earth's coral reefs were dead, another 30 % were seriously affected and another 30% were degraded. The Global Coral Reef Monitoring Network Townsville, Australia, has predicted that all the reefs could be dead by 2050.

Human societies will be seriously affected by extremes of climate such as droughts and floods. A changing climate would bring about changes in the frequency and/or intensity of these extremes. This is a major concern for human health. To a large extent, public health depends on safe drinking water, sufficient food, secure shelter, and good social conditions. All these factors are affected by climate change. Fresh water supplies may be seriously affected, reducing the availability of clean water for drinking and washing during drought as well as floods. Water can be contaminated and sewage systems may be damaged. The risk of spread of infectious diseases such as diarrhoeal diseases will increase. Food production will be seriously reduced in vulnerable regions directly and also indirectly through an increase in pests and plant or animal diseases. The local reduction in food production would lead to starvation and malnutrition with long-term health consequences, especially for children. Food and water shortages may lead to conflicts in vulnerable regions, with serious implications for public health. Climate change related impacts

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on human health could lead to displacement of a large number of people, creating environmental refugees and lead to further health issues. Changes in climate may affect the distribution of vector species (e.g. mosquitoes) which in turn will increase the spread of disease, such as malaria and filariasis, to new areas which lack a strong public health infrastructure. The seasonal transmission and distribution of many diseases that are transmitted by mosquitoes (dengue, yellow fever) and by ticks (Lyme disease, tickborne encephalitis) may spread due to climate change.

13.4.2 Causes of Climate Change in India

Causes of Climate Change in India are as follows:

Natural Causes

There are a number of natural factors responsible for climate change. Some of the more prominent ones are continental drift, volcanoes, ocean currents, the earth's tilt, and comets and meteorites.

1. ***Continental drift:*** The continents that we are familiar with today were formed when the landmass began gradually drifting apart, millions of years back. This drift also had an impact on the climate because it changed the physical features of the landmass, their position and the position of water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate. This drift of the continents continues even today; the Himalayan range is rising by about 1 mm (millimetre) every year because the Indian land mass is moving towards the Asian land mass, slowly but steadily.
2. ***Volcanoes:*** When a volcano erupts it throws out large volumes of sulphur dioxide (SO2), water vapour, dust, and ash into the atmosphere. Although the volcanic activity may last only a few days, yet the large volumes of gases and ash can influence climatic patterns for years. Millions of tonnes of sulphur dioxide gas can reach the upper levels of the atmosphere (called the stratosphere) from a major eruption. The gases and dust particles partially block the incoming rays of the sun, leading to cooling. Sulphur dioxide combines with water to form tiny droplets of sulphuric acid. These droplets are so small that many of them can stay aloft for several years. They are efficient reflectors of sunlight, and screen the ground from some of the energy that it would ordinarily receive from the sun. Winds in the upper levels of the atmosphere, called the stratosphere, carry the aerosols rapidly around the globe in either an easterly or westerly direction. Movement of aerosols north and south is always much slower. This should give you some idea of the ways by which cooling can be brought about for a few years after a major volcanic eruption.
3. ***The earth's tilt:*** The earth makes one full orbit around the sun each year. It is tilted at an angle of 23.5° to the perpendicular plane of its orbital path. For one half of the year when it is summer, the northern hemisphere tilts towards the sun. In the other half when it is winter, the earth is tilted away from the sun. If there was no tilt we would not have experienced seasons. Changes in the tilt of the earth can affect the severity of the seasons - more tilt means warmer summers and colder winters; less tilt means cooler summers and milder winters. The Earth's orbit is somewhat elliptical, which means that the distance between the earth and the Sun varies over the course of a year. We usually think of the earth's axis as being fixed, after all, it always seems to point toward Polaris (also known as the Pole Star and the North Star). Actually, it is not quite constant: the axis does move, at the rate of a little more than a half-degree each century. So Polaris has not

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always been, and will not always be, the star pointing to the North. When the pyramids were built, around 2500 BC, the pole was near the star Thuban (Alpha Draconis). This gradual change in the direction of the earth's axis, called precession is responsible for changes in the climate.

4. ***Ocean currents:*** The oceans are a major component of the climate system. They cover about 71% of the Earth and absorb about twice as much of the sun's radiation as the atmosphere or the land surface. Ocean currents move vast amounts of heat across the planet - roughly the same amount as the atmosphere does. But the oceans are surrounded by land masses, so heat transport through the water is through channels. Ocean currents have been known to change direction or slow down. Much of the heat that escapes from the oceans is in the form of water vapour, the most abundant greenhouse gas on Earth. Yet, water vapour also contributes to the formation of clouds, which shade the surface and have a net cooling effect.

Human Causes

The Industrial Revolution in the 19th century saw the large-scale use of fossil fuels for industrial activities. These industries created jobs and over the years, people moved from rural areas to the cities. This trend is continuing even today. More and more land that was covered with vegetation has been cleared to make way for houses. Natural resources are being used extensively for construction, industries, transport, and consumption. Consumerism (our increasing want for material things) has increased by leaps and bounds, creating mountains of waste. Also, our population has increased to an incredible extent. All this has contributed to a rise in greenhouse gases in the atmosphere. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles generate electricity for industries, households, etc. The energy sector is responsible for about ¾ of the carbon dioxide emissions, 1/5 of the methane emissions and a large quantity of nitrous oxide. It also produces nitrogen oxides (NOx) and carbon monoxide (CO) which is not greenhouse gases but do have an influence on the chemical cycles in the atmosphere that produce or destroy greenhouse gases.

Greenhouse Gases and their Sources

Carbon dioxide is undoubtedly, the most important greenhouse gas in the atmosphere. Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have all led to a rise in the emission of carbon dioxide. Methane is another important greenhouse gas in the atmosphere. About ¼ of all methane emissions are said to come from domesticated animals such as dairy cows, goats, pigs, buffaloes, camels, horses, and sheep. These animals produce methane during the cud-chewing process. Methane is also released from rice or paddy fields that are flooded during the sowing and maturing periods. When soil is covered with water it becomes anaerobic or lacking in oxygen. Under such conditions, methane-producing bacteria and other organisms decompose organic matter in the soil to form methane. Nearly 90% of the paddy-growing area in the world is found in Asia, as rice is the staple food there. China and India, between them, have 80-90% of the world's rice-growing areas. Methane is also emitted from landfills and other waste dumps. If the waste is put into an incinerator or burnt in the open, carbon dioxide is emitted. Methane is also emitted during the process of oil drilling, coal mining and also from leaking gas pipelines (due to accidents and poor maintenance of sites).

A large amount of nitrous oxide emission has been attributed to fertilizer application. This in turn depends on the type of fertilizer that is used, how and when it is used and the methods of tilling that are followed. Contributions are also made by leguminous plants, such as beans and pulses that add nitrogen to the soil.

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Did u know? The best way to stop the formation of acid rain is to reduce the emissions of sulphur dioxide and nitrogen oxides into the atmosphere. This can be achieved by using less energy from fossil fuels in power plants, vehicles and industry. Switching to cleaner burning fuels is also a way out, for instance, using natural gas which is cleaner than coal, using coal with lower sulphur content, and developing more efficient vehicles. If the pollutants have already been formed by burning fossil fuels, they can be prevented from entering the atmosphere by using scrubbers in smokestacks in industry. These spray a mixture of water and limestone into the polluting gases, recapturing the sulphur.

13.4.3 Global Warming

Global Warming is an increase in the average temperature of the earth's atmosphere, especially a sustained increase sufficient to cause climatic change. Global warming is the greatest challenge facing our planet. It is, in fact, the increase in the temperature of the earth's neon- surface air. It is one of the most current and widely discussed factors. It has far-reaching impact on biodiversity and climatic conditions of the planet. Several current trends clearly demonstrate that global warming is directly impacting on rising sea levels, the melting of ice caps and significant worldwide climate changes. In short, global warming represents a fundamental threat to all living things on earth.

Global average temperature rose significantly during the past century. The prevailing scientific view is that most of the temperature increases since mid-20th century has been caused by increases in atmospheric greenhouse gas concentrations produced by human activity. Most scientists agree that planet's temperature has risen 0.5 degree Celsius since 1900 and will continue to increase at an increasing rate. As a result, the world is getting warmer. The year 1990 was the hottest year in the last century.

Together with 1991, the years of 1983, 1987, 1988 and 1989 have been measured to be the warmest six years in the last hundred years. The year 1991 was the second warmest year of the past century. The consequences of the rise in temperature is being felt all over the globe the findings of scientific research done in this field reveal that the temperature of the earth is likely to rise from 1.4°C to 5.8°C within a period of 100 years.

Caution Global warming is accelerating faster than what climatologists had calculated a few years ago. In 1995, the Intergovernmental Panel on Climate Change predicts that global warming would rise temperatures by 3.5 to 10 degrees Centigrade during the 21st century, if the present trends continue. It is now believed that this could be much greater. This would lead to not only temperature changes but in the amount of rainfall. India may see great annual fluctuations in rainfall leading to floods and drought.

Unfortunately, the imbalance which we have created between our life and earth is already showing the signs disasters in the form of flood, cyclones, landslides, tsunami, drought, etc. If the imbalance continues to rise, one day this will pose a question mark on the existence of this planet. Carbon dioxide (CO_2) which is an important constituent of environment is causing a warming effect on the earth's surface.

It increases the evaporation of water into the atmosphere. Since water vapour itself is a greenhouse gas, this causes still more warming. The warming causes more water vapour to be evaporated. The CO_2 level is expected to rise in future due to ongoing burning of fossil fuels and land use change. The rate of rise will depend largely on uncertain economic, sociological, technological

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and natural developments. Other gases such as methane, CFCs, nitrous oxide, tropospheric ozone are also responsible for global warming. Increases in all these gases are due to explosive population growth, increased industrial expansion, technological advancement, deforestation and growing urbanisation, etc.

Trees play a significant role in the global carbon cycle. They are the largest land-based mechanism for removing carbon dioxide from the air. Deforestation is checking these positive processes. It is the second principle cause of atmospheric carbon dioxide. Deforestation is responsible for 25 per cent of all carbon emissions entering the atmosphere, by the burning and cutting of 34 million acres of trees each year. Everyday over 5500 acres of rainforest are destroyed. As a consequence of massive loss of forests, global CO, levels rise approximately 0.4 per cent each year, the levels not experienced on this planet for millions of years. As we know the forests are the great absorbers of CO.

There is a close relation between global warming and population growth. Today the large population on earth is using the technologies which are destructive for the earth. Approximately, 80 per cent of atmospheric CO_2 increases are due to man's use of fossil fuels either in the form of coal, gas or oil. A large portion of carbon emission is attributed to the burning of gasoline in internal-combustion engine of vehicles. Vehicles with poor gas mileage contribute the most to global warming. Besides, the sulphur group gas is the most harmful for this. Its contribution is 30 per cent in global warming. This gas is also emitted from the burning of fossil fuels. Increase in global temperatures will cause rise in sea level.

It will lead to melting of glaciers, changes in rainfall patterns, increased intensity and frequency of extreme weather. As per the latest survey report the rate of melting of glaciers has seen sharp increase in recent times. Even those glaciers are affected from global warming which have been considered permanent. The shrinking of glaciers is going to pose a major problem of drinking water.

The sea levels as a result of melting of glaciers have risen from 0.35 mm to 0.4 mm. Scientists have warned in their reports that most of the glaciers will disappear within a period of 15 to 25 years. It will create problems of drinking water and food grains in most of the North American countries. India is not unaffected from it. The Himalayan glaciers have shrunk about 30 per cent after 1970.

The rise in sea levels is a major cause of concern. A large number of cities located in coastal areas will submerge in the sea. Besides, many island countries will ultimately "lose their existence and will be washed away from the surface of the earth. The damage of rising sea levels is diverse. Buildings and roads close to the water could be flooded and they could suffer damage from hurricanes and tropical storms. Experts believe that global warming could increase the intensity of hurricanes by over 50 per cent. In addition, as the sea rises, beach erosion takes place, particularly on steep banks.

Wetlands are lost as the level rises. Rise in atmospheric temperature will lead to the outbreak of air borne and water-borne diseases. It would also contribute to the rise in death caused by heat. The problem of drought would be frequent. Consequently, malnutrition and starvation will pose serious challenge before humanity. Global warming is a great threat to the flora and fauna of the earth. A large number of species of them may become extinct.

The expanse of desert would increase. Low rainfall and rising temperature could add to the intensity and frequency of dusty storm. This in turn will immensely affect the quality of agricultural land, ultimately causing adverse effect on agricultural produce. It would have far-reaching socio-economic impact.

In Indian context, the impact of global warming is a matter of grave concern. As is well known, India is mainly an agricultural country and agriculture here is gamble of the monsoon,

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e.g. largely depending on rainfall. Though it is to affect the whole country, the worst likely impact would be on central and northern India which is high-yielding parts of the country. These are the regions which produce the largest agricultural yield. The rise in atmospheric temperature and fall in rain would naturally result in decline in crop production. Moreover, it would have great effect on biodiversity as well.

The growing concerns over global temperatures have led to the nations, states, corporations and individuals to draw out a plan of action to avert the situation. As a result the world's primary international agreement on combating global warming was reached in Kyoto in 1997 which came to be known as Kyoto Protocol. However, ten years have passed; the situation does not appear to be very changed. It seems that the member countries are not very serious about its devastating effects.

In addition, forestation can be of great help in this regard. Planting more trees and reducing timber cuts worldwide will help restore the imbalance. Secondly, we must follow on environmental policy of 'reduce, reuse, recycle', i.e. promoting the reuse of anything. Thirdly, the use of fuel-efficient vehicles should be promoted as these vehicles have lower emissions of harmful gases. Fourthly, every individual should be aware of the importance of the protecting environment. Besides, eco-friendly technologies must be promoted, and must be substituted with the technologies which cause great emission of global warming gases. Public awareness campaign can be of great help in this regard because unless each and every individual is aware only governments' effect cannot bring desired difference.

Self Assessment

Fill in the blanks:

10. ..... gases are the main reason for the climatic change which in turn posses the threat to the vast biodiversity.
11. The changing climatic conditions are also the severe threat to the ....., which has led to the increase in the sea level.
12. When a ..... erupts it throws out large volumes of sulphur dioxide (SO_2), water vapour, dust, and ash into the atmosphere.

13.5 Acid Rain and Ozone Layer Depletion

The standard practices of running the economy of the industrialized nations all over the world have caused catastrophic results to our environment such as Acid Rain and Ozone depletion.

13.5.1 Acid Rain

Acid rain is rain consisting of water droplets that are unusually acidic because of atmospheric pollution - most notably the excessive amounts of sulphur and nitrogen released by cars and industrial processes. Acid rain is also called acid deposition because this term includes other forms of acidic precipitation such as snow. Acidic deposition occurs in two ways: wet and dry. Wet deposition is any form of precipitation that removes acids from the atmosphere and deposits them on the Earth's surface. Dry deposition polluting particles and gases stick to the ground via dust and smoke in the absence of precipitation. This form of deposition is dangerous however because precipitation can eventually wash pollutants into streams, lakes, and rivers.

Acid rain affects many chemical and biological processes in regions where it is a concern, however, the chemistry behind its formation and how it interacts in nature is often overlooked.

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The most common natural example of acidity is a lemon. Soft drinks are also acidic. The acid is a base. Baking soda is just barely basic. Other bases, which are stronger, often be found in cleaning solutions. Bases will have a "slimy" feel, like soap. A neutral is neither acid nor base. Pure water, for example, is a neutral substance.

Acidity itself is determined based on the pH level of the water droplets. PH is the scale measuring the amount of acid in the water and liquid. The pH scale ranges from 0 to 14 with lower pH being more acidic while a high pH is alkaline; seven is neutral. Normal rain water is slightly acidic and has a pH range of 5.3-6.0. Acid deposition is anything below that scale. It is also important to note that the pH scale is logarithmic and each whole number on the scale represents a 10-fold change. Today, acid deposition is present in the north-eastern United States, south-eastern Canada, and much of Europe including portions of Sweden, Norway, and Germany. In addition, parts of South Asia, South Africa, Sri Lanka, and Southern India are all in danger of being impacted by acid deposition in the future.

It is important to understand why something is classified as being acidic, basic, or the pH scale is used to classify substances understanding this scale and what it means important for many reasons. In the case of acid rain, many natural environments can only see certain organisms in narrow pH ranges. Only knowing pH as a raw number loses much system's importance.

The pH values for any liquid can range from 0-14. A pH of 7 is directly in the middle represents neutral. If the pH number is higher, it is basic. If the pH is lower than 7 then acid. The measurement scale is logarithmic, not linear like a ruler.

Logarithmically, a change a pH of 6 to 5 is increasing acidity by 10 times, while a change from 6 to 4 represents acid increasing 100 times greater. The numbers in a logarithmic scale represent increases by factors of ten.

What is being counted is important. The "H" in pH refers to hydrogen. More specific) pH is a measure of hydrogen ions (protons) in a solution. Just like magnets, oppositely charged molecules attract. The excess hydrogen protons attract the negative charge that can be four the electrons of other atoms and molecules.

When water droplets in clouds dissolve pollutants, it can result in the formation of ex hydrogen protons, making the substance acidic. As this acid precipitation falls on an area introduces the H+ wherever it lands.

The additional H+ changes the pH of lakes, rivers, streams and affects the organisms they hold. Because all living organisms survive by chemical reactions, pH changes that are too big or too quickly are very serious.

Rainwater is naturally acidic, because carbon dioxide in the atmosphere combines with water molecules to form carbonic acid. Acidic precipitation or acid deposition occurs with sulphur dioxide and nitrogen oxides in the atmosphere react with oxygen in the air to form sulphuric acid (H_2SO_4) and nitric acid (HNO_3), which falls to the surface as rain, snow, or dust. To consider acid precipitation, the precipitation has to have a pH of 5.0 or lower.

Acid rain is the fall out of the degradation of environment in general and pollution atmosphere in particular. Sulphur in contact with rainwater causes acid rain, which is devastating for life.

Every year the terrestrial atmosphere is polluted by 200 million tons of carbon monoxide more than 50 million tons of hydrocarbons, 120 million tons of soot and 150 million tons of sulphur monoxide, which return back to earth in the form of acid rain.

Acid rain has created one of the worst problems, i.e., deforestation in Europe. India is not exception; highly industrialized areas have already begun to suffer from this phenomenon.

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Causes and History of Acid Rain

Acid deposition can occur via natural sources like volcanoes but it is mainly caused by the release of sulphur dioxide and nitrogen oxide during fossil fuel combustion. When these gases are discharged into the atmosphere they react with the water, oxygen, and other gases already present there to form sulphuric acid, ammonium nitrate, and nitric acid. These acids then disperse over large areas because of wind patterns and fall back to the ground as acid rain or other forms of precipitation.

The gases responsible for acid deposition are normally a by-product of electric power generation and the burning of coal. As such, it began entering the atmosphere in large amounts during the Industrial Revolution and was first discovered by a Scottish chemist, Robert Angus Smith, in 1852. In that year, he discovered the relationship between acid rain and atmospheric pollution in Manchester, England.

Effects of Acid Rain

As this acidic liquid flows into larger bodies of water, it is diluted but over time, acids can accrue and lower the overall pH of the body. Acid deposition also causes clay soils to release aluminium and magnesium further lowering the pH in some areas. If the pH of a lake drops below 4.8, its plants and animals risk death and it is estimated that around 50,000 lakes in the United States and Canada have a pH below normal (about 5.3 for water). Several hundred of these have a pH too low to support any aquatic life. Aside from aquatic bodies, acid deposition can significantly impact forests. As acid rain falls on trees, it can make them lose their leaves, damage their bark, and stunt their growth. By damaging these parts of the tree, it makes them vulnerable to disease, extreme weather, and insects. Acid falling on a forest's soil is also harmful because it disrupts soil nutrients, kills microorganisms in the soil, and can sometimes cause a calcium deficiency. Trees at high altitudes are also susceptible to problems induced by acidic cloud cover as the moisture in the clouds blankets them.

Damage to forests by acid rain is seen all over the world, but the most advanced cases are in Eastern Europe. It's estimated that in Germany and Poland, half of the forests are damaged, while 30% in Switzerland have been affected. Finally, acid deposition also has an impact on architecture and art because of its ability to corrode certain materials. As acid lands on buildings (especially those constructed with limestone) it reacts with minerals in the stones sometimes causing it to disintegrate and wash away. Acid deposition can also corrode modern buildings, cars, railroad tracks, airplanes, steel bridges, and pipes above and below ground.

13.5.2 Depletion of Ozone Layer

The Ozone layer is a thin layer in the atmosphere made up of oxygen atoms (03) that absorb harmful ultraviolet radiation (UV-B) from reaching the earth's surface. The ozone is being depleted by chemicals released into the atmosphere like chlorofluorocarbons (CFCs), carbon tetraflouride, methyl chloroforms, chlorofluoromethanes (aerosol repellents and as refrigerants). The problem is when CFC's reach the ozone layer, it is broken down by the UV-B rays and it is these free chlorine atoms that do the damage to the ozone. One free chlorine atom will destroy 100,000 ozone molecules before it dies off.

There are some natural means that effect ozone like volcano eruptions, and drastic changes in weather problems (El Nina and La Nina). What would happen if a hole was breached and UV-B rays were able to pass through? This has already happen. Scientists have discovered a hole over the Antarctic and some mid-altitude regions over Chile in South America. The Mapuche Nation lives under one of these holes in the ozone and they have seen an increased

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number of skin cancer and blindness among their people. They see a huge impact to the plants and animals in their surrounding environment.

Ozone layer present in stratosphere plays a protective role and filters the sun's damaging UV radiations. Thus, preventing them from reaching the earth surface and saving life. Concentration of ozone in the stratosphere is sufficient to remove more than 95% of radiant energy of UV-B range with wavelength between 290 and 320 nanometre. In fact, it is in this range that UV radiations are harmful to plants and animals.

A close look at the evolution of life shows that initially the atmosphere was devoid of oxygen but photosynthesis activities of blue green algae another anaerobic unicellular organism helped in building up oxygen level in atmosphere, which in turn helped in the formation of ozone layer in stratosphere and the deadly ultraviolet radiation of the sun was detained in the upper atmosphere. It is believed that before formation of ozone layer, organisms evolved in shallow water, because only visible light could penetrate here and not the dangerous ultraviolet light. However, after formation of ozone layer, the most complexly forms of life on earth have evolved.

The major cause of depletion of ozone layer or formation of holes are certain locations in ozone layer are Chlorofluorocarbons (CFCs) and halons, which are mostly used in air conditions, refrigerators, aerosol, electric and metal clearing, foam blowing and modern fire fighting. They serve as catalyst in destruction of ozone in stratosphere. In addition, oxides of nitrogen, released from the exhausts of large fleet of supersonic aircraft (SST) have also been held responsible for increasing the rate of ozone destruction.

As per estimates travelling time for CFCs and halons to reach the stratosphere, may rang from 20 to 40 years. Once they reach the stratosphere, the chlorine and bromine atoms present within these chemicals are released due to interaction with UV radiations. The chlorine and bromine atoms act as a catalyst to break down ozone into oxygen molecule and chlorine monoxide (ClO). ClO in turn interacts with another ozone molecule to give us two oxygen molecules. Thus, one atom of chlorine released by the action of UV radiations on CFCs break two molecules of ozone into three oxygen and again the same chlorine acts afresh on new ozone molecules.

The chlorine/bromine atoms remain active for 100 years and have capacity to break down several thousands of ozone molecules before the released chlorine gets converted into dilute hydrochloric acid and comes down as acid rain. It has been observed that this break down process becomes much more faster in presence of green house gases like CO_2, CH_4, etc.

The depletion of ozone layer has been found to be much more acute on Polar Regions, particularly Antarctica (South Pole) than in other parts of earth. This could be due to prevailing cold climatic conditions and other complex atmospheric parameters including air turbulence. The other reason put forward for acute depletion of ozone at polar region is the absent of Nitrous oxide in these areas. N_2O destroys chlorine monoxide and check ozone depletions, whereas, in polar regions, N_2O at subzero temperature freezes into droplets or clouds, the leaving ClO free to act on ozone molecules.

Mathematical models estimate that 16% reduction of ozone concentration at global scale would increase UV-B penetration to earth by 40% and 30% reduction in ozone would double the UV-B penetration. In general it has been estimated that intensity of UV radiations that reaches the earth's surface is expected to increase by 2% for every 1% decrease in ozone concentration.

UV-B radiation has potential to affect genetic material and photosynthetic chemicals because peak absorption spectra for DNA and photosynthetic chemicals (Plastoquinine and plastoquinol) lie in the range from 260 to less than 320nm. DNA disorders lead to mutation, genetic defects and cancer development. The most common consequence would increase in skin cancer cases, over other types of cancer or genetic disorder. Skin cancer could be fatal (melanoma) or chronic

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(on-melanoma). However, it is believed that chronic skin cancer cases would be much more prevalent than fatal ones. Estimates released by UNEP predict 26% rise in incidence of non-melanoma skin cancer worldwide, if overall ozone levels drop even by 10%.

Increased inflow of UV radiation will lower down the sea productivity thereby depleting the oxygen concentration of marine water, which will adversely affect the marine flora and fauna. The temperature of the earth surface would also increase resulting into melting of ice from high altitude and polar caps, which in turn would raise the level of sea resulting into many islands and low lying areas submerging into water. It will lower the food productivity, particularly in temperate region. And certainly the biodiversity of these regions would also get affected. It will in general, affect the health of living organisms and particularly there would be marked increases in eye and skin disease cases.

Efforts are being made at international level to decrease the thinning of ozone layer/widening of ozone holes. The Montreal Protocol is its result. Major reduction was achieved due to use of hydrocarbons as aerosol propellant and as blowing agent for flexible foams instead of CFCs and recycling of CFC refrigerants and increasing the use of HFCs (hydrofluoric carbons) by refrigeration and air-conditioning industry. HFCs are environment friendly as chlorine is not resent in them, which is the main culprit. Ammonia can also be used as alternative to CFCs as it has been used in refrigeration in the past, but there are some disadvantages in its use as refrigerant chemical.

US scientists have proposed that ozone loss could be arrested by injecting the alkenes, ethanes or propane into Antarctic atmosphere. The alkenes could rapidly react with chlorine atoms, making them ineffective. But the solution can have its own side effects not known yet. Therefore, the wisest move is the drastic reduction in use of chemicals responsible for ozone layer degradation and an earnest effort has been going on through Montreal Protocol to achieve it. However, the point to be booted is that till a complete phase-out is archived the world will continue to add ozone depleting substances to the atmosphere.

Self Assessment

State whether the following statements are true or false:

13. Acid rain is rain consisting of water droplets that are unusually acidic because of atmospheric pollution.
14. Acidity itself is determined based on the pH level of the water droplets.
15. The gases responsible for acid deposition are normally a by-product of electric power generation and the burning of coal.

13.6 Environment Protection Act, 1986

The Environment (Protection) Act, 1986 not only has important constitutional implications but also an international background. The spirit of the proclamation adopted by the United Nations Conference on Human Environment which took place in Stockholm in June 1972 was implemented by the Government of India by creating this Act. Government has the duty to protect the 'exhaustible natural resources from rash reckless spoliation'. This duty is also base on the Professor Joseph Sax's doctrine of public trust. Under this doctrine, Government, as the trustee for its citizen and unborn generation, has the enough competencies to control the polluter to prevent the natural resources or in much simpler term protect the environment. Indian Government is also aware of its responsibility. With being the signatory to UN Convention on Environment, 1972 and Constitutional provisions, legislations and administrative directions to protect the Environment, Indian Government has shown its seriousness about the environment.

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The government can protect the environment in the two ways - market based solution and direct regulation. Market based solution gives some incentive to the produce so that he can be influenced to reduce the level of pollution. Pollution tax, fine, reductions in other direct or in indirect tax are the good example of that. On the other hand, through the direct regulation, government can fix the amount of pollution, for example granting license. Both instruments are reflected in the Environment (Protection) Act, 1986, the Environment (Protection) Rules, 1986 and other laws. The one of the main aim of environment protection law is to prevention from pollution.

Although there were several existing laws that dealt directly or indirectly with environmental issues it was necessary to have a general legislation for environmental protection because the existing laws focused on very specific types of pollution, or specific categories of hazardous substances or were indirectly related to the environment through laws that control land use, protect our National Parks and Sanctuaries and our wildlife. However there were no overarching legislation and certain areas of environmental hazards were not covered. There were also gaps in areas that were potential environmental hazards and there were several inadequate linkages in handling matters of industrial and environmental safety. This was essentially related to the multiplicity of regulatory agencies. Thus there was a need for an authority which could assume the lead role for studying, planning and implementing long term requirements of environmental safety and give directions to, as well as coordinate a system of speedy and adequate response to emergency situations threatening the environment.

This Act was thus passed to protect the environment, as there was a growing concern over the deteriorating state of the environment. As impacts grew considerably environmental protection became a national priority in the 1970s. The decline in the environmental quality was evidenced by increasing pollution, loss of forest cover and an increasing threat to biodiversity. The presence of excessive concentrations of harmful chemicals in the atmosphere and aquatic ecosystems leads to the disruption of food chains and a loss of species. These are symptoms of a rapidly deteriorating environment. The growing risks of environmental accidents and threats to life support systems now loom threateningly over our civilisation. The decision taken at the conference in Stockholm strongly voiced these environmental concerns and several measures were made possible for environmental protection. While the need for a wider general legislation to protect our environment is now in place, it has become increasingly evident that our environmental situation continues to deteriorate. We need to implement this Act much more aggressively if our environment is to be protected. Public concern and support is crucial for implementing the EPA (Environment Protection Agency). This must be supported by an enlightened media, good administrators, highly aware policy makers, informed judiciary and trained technocrats who together can influence and prevent further degradation of our environment. Each of us has a responsibility to make this happen.

After the Bhopal Gas Tragedy the Government of India, felt the lacuna of environmental laws and in order to strengthen the environmental laws Government passed the umbrella legislation for environment, the Environment Protection Act 1986. This legislation indented to protect the entire environment, rather merely the water or the air. According to it 'environment includes water, air and land and the interrelationships which exists among and between water, air and land, and human beings, other living creatures, plants, microorganisms and property'. It also defines environmental pollution as the presence of any environmental pollutant in the environment. Another significance of this Act is that it.

The UN Conference on Human Environment and Development held at Stockholm and 'Stockholm Declaration on the Human Environment' 1972 has the significant impact on India Environment Law. It is considered as Magna Carta of Environmental law and it has same parallel significance as Universal Declaration on the Human Right, 1948. In this conference, twenty-six principles

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were laid down. After the Stockholm Conference, 1972, Government of India brought the 42nd amendment in the Constitution and incorporated Article 48A and Article 51A(g). Article 48A comes under the part IV 'Directive Principle of State Policy', and under this Article the states are under the 'active obligation' that it shall endeavour to protect and impose the environment. Whereas Article 51A(g) states the citizen has the duty to protect and improve the environment. Article 51A(g) is not law and, a fortiori, not supreme law.

The Act was promulgated to provide for the protection and improvement of environment and matters connected the results. The Act consists of 26 sections distributed among four chapters and extends to the whole of India.

The Act provides general powers to the Central Government to take all necessary measures for the purpose of:

(A) Protecting and improving the quality of the environment, and

(B) Preventing, controlling and abating environmental pollution.

Besides, other powers the Central Government shall have process for:

(i) Planning and execution of a nationwide programme for the prevention, control and abatement of environmental pollution.

(ii) Laying down standards for the quality of environment in its various aspects.

(iii) Laying down standards for emission or discharge of environmental pollutants from various sources whatsoever.

(iv) Restriction of areas in which industry, operations or processes shall not be carried out subject to contain safeguards.

(v) Laying down procedures and safeguards for prevention of accidents, which may cause environmental pollution.

(vi) Laying down procedures for handling of hazardous substances.

(vii) Examination of such manufacturing processes materials and substances as are likely to cause environmental pollution.

(viii) Carrying out and sponsoring investigations and research relating to problems of environmental pollution.

(ix) Collection and dissemination of information on environmental pollution.

(x) Preparation of manuals, codes or guides, relating to the prevention, control and abatement of environmental pollution.

Task Discuss the role of the common law in the protection of our environment. Is there a need for strict liability for pollution incidents within the common law?

Self Assessment

State whether the following statements are true or false:

16. The Environment (Protection) Act, 1986 only has important constitutional implications.

17. The government can protect the environment in the four ways.

18. The one of the main aim of environment protection law is to prevention from pollution.

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Case Study

Climate Change in Orissa

Orissa's fluctuating weather conditions suggest that it is reeling under climatic chaos. For more than a decade now, the state has experienced contrasting extreme weather conditions claiming many lives: from heat waves to cyclones, from droughts to floods. They have not only become more frequent, but have hit areas that were never considered vulnerable. As a result, Orissa's economy has been ripped apart. Agriculture, which is considered as the state's backbone has been worst hit due to such changes in the microclimate and natural calamities. A heat wave in 1998 killed around 1500 people in the state, mostly in coastal Orissa, a region otherwise known for its moderate temperature. The mean daily maximum and minimum temperature of the state is gradually increasing. The Titilagarh and Koraput belt comprising entire south and western Orissa has witnessed an exceptional rise in daily maximum and minimum temperature. Earlier western Orissa was a known calamity hotspot, but now the coastal areas are also experiencing heat waves. Bhubaneshwar now has a mean maximum temperature above 40°C which is comparable to Sambalpur located in the interior.

The frequency of cyclones has increased on the Orissa coast, the worst ever being the cyclones of 1999, when two cyclones hit the state in quick succession. The second one lasted three days and ravaged 14 coastal districts. Around 15 million people were affected. Two million tonnes of rice crop was lost and 17,000 square kilometre of agricultural land was devastated. Official estimates put the loss at ₹ 10,000 crore. Around 200,000 trees were uprooted in about 25,000 hectare (ha) of reserved forest. In the districts of Jagatsinghpur and Kendrapada, the forest cover has now been reduced by 50 per cent. The microclimate of the region has changed after this loss in vegetation. Temperature data of the coastal region in the last three years shows wide fluctuations and average temperatures have risen. Change in climate following the super cyclone possibly caused the state's mango and mahua trees to flower unusually early.

Floods have become an annual affair in Orissa. The worst ever flood in 2001 inundated 25 out of the 30 districts of the state. Areas with no history of floods such as districts in western Orissa were also submerged. Ironically, Orissa suffered one of its worst droughts in 2001. It affected the lives of 11 million people in more than two-thirds of the state's districts, engulfing earlier drought free districts like Sundergarh and Kendrapada. Since Orissa is placed at the head of the Bay of Bengal where weather changes are formed, even a slight change in the sea's behaviour can have an immediate impact on the coast. The Bay becomes the centre of low pressures causing heavy rains and cyclones in the sub-continent, especially in Orissa. Scientists are of the opinion that increasing temperature and rainfall, triggered by global warming and climate change may cause the climate to worsen in Orissa.

Apart from more frequent extreme weather events like floods and droughts, large-scale impact of climate change is also expected to cause an increase in sea level causing economic loss and disruption of life. In a case study of the Orissa and West Bengal region, an international body of scientists estimated that in the absence of protection, a one metre sea level rise will inundate an area of 170,000 ha predominantly prime agricultural land and displace 0.7 million people. An additional 4000 kilometres of dykes and sea walls will be required to protect the area.

With sea level rise, many coastal systems will experience increased levels of inundation and storm flooding, accelerated coastal erosion, seawater intrusion into fresh groundwater

Contd....

Notes

and encroachment of tidal waters into river systems. Big cities situated on coasts, flood plains and river deltas, supporting a large number of people and industries can expect increased flood damage causing loss of structures and property. Disappearing shorelines also mean loss of social amenities and infrastructure.

Coastal erosion will increase substantially, endangering natural protective features such as mangroves and barrier islands, and exacerbating flood risk. Consequently, many coastal communities dependent on these and fisheries will suffer. Deltas and low lying coastal areas will be inundated by sea level rise. Increased rainfall during the monsoons will increase the frequency of floods. Areas already prone to floods will suffer more. Both religious and resort-based coastal tourism will suffer.

It is important to note that all this climate chaos implies displacement of large numbers of people leading to rapid urbanization, straining resources and putting more pressure on civic amenities.

Agriculturally fertile coastal regions with paddy fields are vulnerable to inundation and salinisation. Orissa normally produces around five million tones of rice each year. The rice crop on the coast contributes about 40 per cent to the total rice grown in the state.

With rising temperatures, pest population will significantly increase because generally warmer and moist conditions are highly conducive to them. Higher temperatures also speed up the life cycle of both the mosquito and the disease organisms they harbour and make adult mosquitoes bite more often. The state accounts for 15-22 per cent of malaria cases in the country and 40-50 per cent malaria related deaths. At 20°C, mosquitoes take 26 days to breed. This period reduces to 13 days when the temperature rises to 25°C, which is also the average temperature of Orissa now. A possible increase in cyclone intensity of 10-20 per cent against a rise in sea surface temperature of 2 to 4°C is very likely to happen. Climate change has already intensified the Asian monsoon and increased river flows. Experts say Orissa should brace itself for more severe flooding in years to come because of deforestation, faulty flood control planning and global climate changes.

Disasters have a long-term impact, as people are forced to spend more of their earnings on basics like building homes and agriculture. The already stressed ecosystem is made even more fragile with each disaster. And the poor living on the margins of subsistence are forced into greater penury. With each disaster their capacity to rebuild is reduced.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://zeenews.india.com/myearth2011/orissa.aspx

13.7 Summary

- Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- By the 1970s most development specialists began to appreciate the fact that economic growth alone could not bring about a better way of life for people unless environmental conditions were improved.
- In urban areas the need of energy is increasing by leaps and bounds.

Notes

- Urban transport depends on energy mainly from fossil fuels.
- In India, about 70% commercial energy is being generated through coal-fired thermal plants.
- Large capital investment is required to upgrade the process of industrial production, because updated and upgraded machinery and equipment reduce industrial energy consumption.
- The rainwater harvesting is the simple collection or storing of water through scientific techniques from the areas where the rain falls.
- In India, climate change has caused tremendous changes in the weather patterns across different parts of the country.
- Global Warming is an increase in the average temperature of the earth's atmosphere, especially a sustained increase sufficient to cause climatic change.
- Acid rain is rain consisting of water droplets that are unusually acidic because of atmospheric pollution - most notably the excessive amounts of sulphur and nitrogen released by cars and industrial processes.
- The Ozone layer is a thin layer in the atmosphere made up of oxygen atoms (O_3) that absorb harmful ultraviolet radiation (UV-B) from reaching the earth's surface.
- The Environment (Protection) Act, 1986 not only has important constitutional implications but also an international background.

13.8 Keywords

Acid rain: It is rain consisting of water droplets that are unusually acidic because of atmospheric pollution - most notably the excessive amounts of sulphur and nitrogen released by cars and industrial processes.

Biodiversity: Biodiversity is the variety of species, their genetic make-up, and the natural communities in which they occur.

Catchment: A catchment is an area of land, bound by hills or mountains from all runoff water flows which to the same low point.

Climate Change: Climate change is a Significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years.

Energy: Energy is defined to the ability or the capacity to work from.

Global Warming: It is an increase in the average temperature of the earth's atmosphere, especially a sustained increase sufficient to cause climatic change.

Ozone Layer: The Ozone layer is a thin layer in the atmosphere made up of oxygen atoms (O_3) that absorb harmful ultraviolet radiation (UV-B) from reaching the earth's surface.

Rain Water Harvesting (RWH): Rainwater harvesting is the accumulation and deposition of rainwater for reuse before it reaches the aquifer.

Sustainable development: It is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Urbanization: Urbanization is the physical growth of urban areas as a result of rural migration and even suburban concentration into cities, particularly the very largest ones.

Notes

Volcanoes: The volcano is a mountain that opens downward to a pool of molten rock below the surface of the earth.

13.9 Review Questions

1. What do you understand by Sustainable development?
2. Do you think that energy is an essential need of a man? If yes, give reason.
3. Write brief note on Urban-Industrial Energy Demand of Sustainable Development.
4. Define Rain Water Harvesting (RWH).
5. Highlight the main components of Rainwater Harvesting.
6. Discuss the benefits of Rainwater Harvesting.
7. Describe the causes of Climate Change in India.
8. Write short note on Global Warming.
9. What are the effects of Acid rain?
10. Explain Depletion of Ozone Layer.
11. Discuss Environment (Protection) Act, 1986.

Answers: Self Assessment

1.	False	2.	False
3.	True	4.	Energy
5.	Underdeveloped	6.	Fossil Fuels
7.	True	8.	False
9.	True	10.	Green Houses
11.	Coastal Areas	12.	Volcano
13.	True	14.	False
15.	True	16.	True
17.	False	18.	True

13.10 Further Readings

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Notes

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Unit 14: Environment and Human Population

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Objectives

After studying this unit, you should be able to:

- Understand the Human Population and Environment
- Explain the Population Growth along with its variation among Nations
- Describe the Population Explosion in India

Notes

- Understand the Family Welfare Programmes in India
- Discuss the Effects of Environment on Human Health
- Explain the Human Rights
- Discuss the HIV – AIDS
- Understand the Women and Child Welfare
- Describe the Role of Information Technology in Environment and Health

Introduction

In the previous unit, we dealt with the Unsustainable to Sustainable Development, Energy related Problems of Urban People and meaning of Rain Water Harvesting, Climate Change, Global warming, Acid Rain and Ozone Layer Depletion along with the Rain Water Harvesting. As the world's population grows, improving living standards without destroying the Environment is a Global challenge. Most developing countries with rapid population growth face the urgent need to improve living standards. Countries in this situation generally have devoted less energy to addressing environmental issues than their wealthier neighbours, so these problems have intensified. Especially in the poorest countries, therefore, future population growth is likely to make environmental deterioration worse (although it does not automatically follow that countries with low population growth rates will have cleaner environments). However, the relationship between population and the environment is complex. Societies' environmental impacts take two major forms. First, we consume resources such as land, food, water, soils, and services from healthy ecosystems, such as water filtration through wetlands. Over-consumption uses up or severely depletes supplies of non-renewable resources, such as fossil fuels, and depletes renewable resources such as fisheries and forests if we use them up faster than they can replenish themselves. The purpose of this Unit is to enable the students to comprehend basic expressions. At the end of this unit you should be able to understand the Population Growth along with its variation among Nations, the Population Explosion in India, the Family Welfare Programmes, the Effects of Environment on Human Health, Human Rights, HIV – AIDS, ABOUT the Women and Child Welfare and the Role of Information Technology in Environment and Health.

14.1 Human Population and Environment: An Overview

Human population of the world has got doubled during the last 50 years. According to UN projections, population of the world will increase from present 6.1 billion to 10 billion or so in 2050 and according to another estimate, it may be more than 10 billion or it may be about 8 billion in 2050.

Especially, after the World War II, the population of the countries of the South (Africa, Latin America and Asia excepting South Asia) began to outpace that of the countries of the North (North America, Europe, USSR, and South Asia). Even with a modest increase in World's population, the developing countries have been struggling to cope with the growing number in terms of providing food, shelter, education, health services, employment and water. The effect of growing population on environment and its resources and on health and other social factors is a matter of great concern. The carrying capacity of the planet earth will be greatly stretched and exceeded if the present rate of population growth continues. The population in certain western countries has got stabilized. Population has not been stabilized in all the countries of the world. In many countries of the South, population is going to be doubled before it gets stabilized.

Notes

Those who study population dynamics have described the reasons for growing population as under. First, as the rates of birth and death are high, this leads to population growth to a small extent. Second, when mortality or death rate falls, and birth rates remain high, population growth increases. In the third situation, there is low birth rate as well as death rate; this results in stability of population. The third situation is ideal and it is under this situation that living standards become better. Fortunately, today we do not find any country where both birth and death rates are high. Countries either fall under second or third situation. There is optimism that the rate of population growth will slow down in the coming decades, though there would be increase in the absolute numbers annually.

As mentioned earlier, rising population growth would not be sustainable because demand for food, water and other essential requirements for life would not be able to match the supply. The results in case of rising birth rates would be a stress on natural resources and deterioration in environment. This in turn will lead to high death rates due to starvation or diseases or both. There would be a great stress on land and water tables resulting in lower productivity of food. Diseases or epidemics like AIDS (Acquired Immune Deficiency Syndrome) would also result in high death rate.

Our planet earth has been offering us natural resources. With the advent of industrial revolution in 19th century, rate of population growth started rising and then everything was changed - especially the exploitation of natural resources started at an increasing speed. The nature took billions of years to deposit non-living natural resources (coal, petroleum) and evolution took millions of years to provide living resources for us to use. This use as described in a book The Population Explosion' by Paul and Anne Erilich has to be like interest accrued on the deposit in a bank, the problem with us is that instead of living on interest we are utilizing the principal. Our deposits of coal and petroleum are being exploited for the last 100 years and according to modest projections, at the current rate of consumption, these resources will not last beyond the present century. The resources for which the nature has taken billions or millions of years will be used up in 200 years.

Example: In land, it is estimated that due to modern methods of agriculture for producing food for growing population, we are loosing tons of topsoil every year with the result that fertility of the soil is reduced and it no longer remains arable. Therefore, we can say that soil erosion, desertification and soil poisoning because of effluents from the industries are the result of increasing demands by the growing population.

Another impact of expanding population on environment is deforestation. Reducing forest cover to meet the demand of population has adverse effects on our life support system.

The depletion of fresh water resources is the most obvious example of high population impact on environment. China and India constitute world's one-third population. Both have water shortage and may face water famine. Water shortage not only affects human consumption, but also it affects both agricultural and industrial output.

The issue of rising demand for energy of expanding population has been dealt with elsewhere in this book. Growing population in developing countries means higher demand for energy, though it may not be of same magnitude as in developed ones. The import of oil of every country is rising and it will keep on rising due to population growth and higher living standards. Increase in energy demand due to over population and over consumption means faster rate of depletion of fossil fuels.

Relationship between food production and population growth is a well-known fact. Increase in demand for food due to rising population led to green revolution which created new problems like use of fertilizers and pesticides. The use of fertilizers have impact on soil and causes pollution.

Notes

The situation on food front is very peculiar. While expanding population in the developing countries causes food shortages, high consumption and wasting of food in developed countries present another dimension.

Finally it is not out of place to mention that increasing population in the developing countries has enormous implications for economic and political stability. Economic and political reasons in turn have implications for environmental protection.

Caselet

Protection of Right of Victims in Cases of Industrial hazards, Uttar Pradesh

The petitioner, Ms. Subhashini Ali, drew the attention of the Commission to the occurrence of a ghastly incident in the factory premises of Jyoti capsules on 4 January 1998 in Kanpur, in which 8 workers had lost their lives. The accident occurred due to an explosion caused by the leakage of an inflammable chemical, hexane. The petitioner alleged that the factory had resumed production without taking due care of safety conditions. The Special Rapporteur of the Commission investigated the case and stated that the accident was the result of criminal negligence by the factory owner in handling and storing explosive chemicals and that he had failed to maintain safe working conditions in the factory. A major contributory factor was supervisory lapse on the part of the Inspectorate of Factories. The Commission directed the Government of Uttar Pradesh to finalise criminal cases registered against the owner and also ordered that the factory should not be permitted to resume production without complying with all safety requirements. The Labour Department of the Government was directed to investigate the reasons for the supervisory lapse and to penalise the culprits. The District Magistrate, Kanpur was directed to ensure early payment of all financial benefits in case of death and injuries. The intervention of the Commission brought about the award of immediate relief of ₹ 5000 each to the victims apart from the compensation which was sanctioned to them by the State.

The Directive Principles contained in Art. 48A of the Constitution direct the State to endeavour to protect and improve the environment. Principle 13 of the UN Declaration on Environment and Development proclaims that States shall develop national laws regarding liability and compensation for the victims of pollution and other environmental damage. The Public Liability Insurance Act 1991 is in consonance with the spirit of principle 13 of the Rio Declaration, in as much as it aims at providing for public liability insurance for the purpose of providing immediate relief to persons affected by accident occurring while handling any hazardous substance or matters connected therewith or incidental thereto. Under the Act, any person handling any hazardous substance is required to take out insurance policies so that he is insured against liability to give relief in case of death or injury to a person, or damage to any property, arising from an accident occurring while handling any hazardous substance. This Act has been enacted subsequent to the Bhopal Gas leak disaster where MIC leaked from the plant of Union Carbide India Ltd. and caused the death of over 3000 persons and serious injuries to a large number of others.

It is important to mention here that in the case brought before the Commission by Ms. Subhashini Ali, negligence was involved on the part of the factory owner. In such cases, exemplary compensation and damages are to be awarded to the victims. The Supreme Court of India has modified the English rule of strict liability in M.C. Mehta vs. UOI and has laid down the concept of 'absolute liability' in the case of industrial hazards, even though there might not have been any negligence on the part of the enterprise owner.

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By providing additional relief and ordering the expeditious criminal trial of the culprits, the Commission has kept in mind the constitutional obligations of the State and also the UN Declaration on the Environment and Developments.

Source: http://www.environmentandpeople.org/HumanRightsCasestudy.html

Self Assessment

State whether the following statements are true or false:

1. Human population of the world has got doubled during the last 50 years.
2. Japan and India constitute world's one-third population.

14.2 Population Growth – Variation among Nations

Population of the world was 3.0 billions in 1960. From 1960 to 2000, population rose to 6.0 billion. Today, population-doubling time is 35 years or so. The first expansion of population occurred with the advent of agriculture. The second expansion of population occurred as a result of industrial revolutions which began in Europe. The rate of population growth has been different in developed and developing countries.

Africa: It has the fastest population growth. Between 1965 and 1995, its population increased from 311 million to 728 million i.e., an increase of more than 100%, whereas the increase between 1925 and 1950 was 40% only. The rate of population growth is still rising in Africa. The factors responsible for high population growth are high birth rate and falling death rate. Africa has a very large landmass which is capable of sustaining large population. But it is the development which is lacking.

Asia: It is heavily populated and has constituted more than half of the world's population. East Asia has the highest population. However, among the East Asian countries, China, which has world's largest population, is now showing drop in population growth from 14% in 1965 to 10% in 2000. Among East Asian countries, Eastern China, Japan and Korea are very densely populated. South Asia which includes India has added 600 million people in the 30 years (between 1965 and 1995). In Southeast Asia, Indonesia is the largest country and had a population of 200 million in 2000. Other countries of South East Asia are Vietnam and Singapore representing extremes; the latter is among the richest countries and had a population of 4 million in 2000. Vietnam had the population of 78 million in 2000 and is expected to grow to 105 million in 2025 whereas Singapore population is expected to grow to 5 million by 2025. Philippines and Thailand, part of South-east Asian region had a population of 75 and 62 million and projected figures are 107 and 77 in 2025 respectively.

Europe: From 1700 to 1900, Europe's population had been growing very fast (it included immigrants also). But after World War II (1945), Europe's population growth was the slowest and in many regions of Europe it is stable and is expected to decline. Eastern Europe especially had an annual growth of 0.1% in 1995. It is the only region in the world where population has declined. In Western Europe, birth and death rates are almost equal and if there is any increase in population, it may be due to migration only.

South America: It includes people of European descent and is thinly populated. The population was 332 million in 2000 and its annual growth rate has fallen from 2.8% to 1.8% during the last 30 years.

Brazil: Brazil is highly populated among South American countries and had a population of 166 million in 2000.

Notes

Central America: It had a population of 131 million in 2000. Mexico has the largest population in this region. It had a population of 96 million and is expected to have 130 million in 2025.

North America: It has shown a slow rate of population growth, its population increased from 214 million to 293 between 1965 and 1995. Its growth rate has fallen from 1.5% to 1.0% annually. The increase in its population is largely due to migrants. Unlike Europe, North America is thinly populated.

Oceania: The countries of Oceania are thinly populated. Australia and New Zealand are the major countries. They are thinly populated and their growth rate has fallen from 2.1% in 1965 to 1.4% in 1995. Here, too, only migration increases population.

The above data show that there are significant variations in the rate of growth and change in population in different parts of the world. The future projections are also revealing. For example, China today has more population than India but in 2050, India's population will be more than that of China. Not only there are variations in population growth between developed and developing countries but also there are significant variations among the developing countries. In nine African countries, population-doubling time is 20 years while in many countries of South America and Asia, doubling time is 40 years. And in many European countries, doubling time may be 100 years or more. The reasons for variations are economic, social, cultural and political.

How to Ease Pressure Caused by Population Explosion?

Expanding population of the world, especially of the developing countries means more pressure on natural resources. One method of reducing population and fertility is to adopt family welfare programmes. About 800 million couples in developing countries are of reproductive age. Of these, about 440 million currently use family planning methods; while at least another 100 million married women of reproductive age have need for family planning.

According to population projections, most likely 1.6 billion couples will be in the reproductive age group in 2020, nearly twice as many as at present. If there will be no change in the percentage of people using family planning in 2020, then there will be nearly 880 million needing family planning.

Over the past few decades, as fertility rates have fallen, world population growth has slowed down. Population is growing at an annual rate of 1.2% as estimated in 2000, compared with 2.1% in the 1960s. Nevertheless, the world's population is growing by almost 80 million per year - about one billion every 12 years. Even if fertility rates continue to fall as projected, the number of people will continue growing substantially.

According to UN Report, 2000, fertility has fallen to or below replacement level in 61 countries, 13 of them in the developing world. In 123 countries, fertility is still above replacement level. In most countries, couples still have at least three children. About 1.7 billion people live in 47 countries where fertility averages between three and five children per woman. Another 730 million people live in 44 countries in which a woman has five children or more in average.

Notes According to population reports of Population Reference Bureau (USA), family welfare programs have shown high improvement. Since the 1960s, family planning programs have played a key role in slowing down population growth. Between 20% and 50% of the fertility decline in developing countries has come as a direct result of family planning programs. This suggests that many women who want to control their own fertility have not been able to do so.

Notes

In developing countries, as contraceptive use has risen from 10% on average in the 1960s to over 50% today, the total fertility rate has fallen by half. In fact, the relationship between contraceptive prevalence and fertility level in a country is a positive and direct relationship. In countries where family planning prevalence is high, the fertility is low; where family planning prevalence is low, the fertility is high. Differences in average family size have a large impact within a few generations.

Example: Consider the impact over four generations if each woman has only two children instead of having three or five. If a woman has only two children, as in many developed countries today, and each of these children has two children each, and so do their children also, the woman will have only 8 great-grandchildren. If the women had three children and so did their children, she would have 27 great grandchildren. As these numbers indicate, unintended births can make a huge difference in future population size.

Self Assessment

Fill in the blanks:

3. Expanding population of the world, especially of the developing countries means more pressure on .....
4. Differences in average ..... have a large impact within a few generations.

14.3 Population Explosion in India

The term population explosion means rapid growth in population which affects the economic growth and progress of the per capita income of the people. The economy remains in Vicious circle of poverty. The consumption and nutrition standards of the people are low and they suffer from poor health and low productivity. Population explosion is the most serious problem facing our country today. With 16 per cent of the world's population, India is toady the second largest populations' country in the world. As on March 1.1991, when the last census was conducted, the country's population stood at 846.30 million, with 439.23 males and 407.07 females. The country's population is currently estimated at about 950 millions. The population growth has been extremely rapid in the last 50 years. The phenomenal growth is now more appropriately termed as "population explosion".

Population change = (Births + Immigration) – (Deaths + Emigration)

India, being a developing country, has had to face several economic and political challenges. One of the most important problems is the population explosion. According to Geography.com, "India's population hit 1 billion in May 2000, increasing the urgency for the country to moderate its population growth." Some of the reasons for this population explosion are poverty, better medical facilities, and immigration from the neighbouring countries of Bangladesh and Nepal. The population density of India in 1996 was about 287 persons per square kilometre (Encyclopaedia Britannica, Internet). Several solutions to decrease the rate of population increase have been tried by the government, some successful, some unsuccessful. Although the rate of increase has decreased, the rate has not reached the satisfactory level yet. The population in India continues to increase at an alarming rate. The effects of this population increase are evident in the increasing poverty, unemployment, air and water pollution, and shortage of food, health resources and educational resources.

Notes

14.3.1 Causes of the Rapid Growth of Population

India experiences a very high rate of growth of population. The following are some of the major factors, which are responsible for high rate of growth of population.

1. ***Universal marriage system:*** Marriage in India is universal. Everybody gets married. Marriage is considered not as a religious duty. The practice of early marriage system is a potent case of rapid growth of population in India. More than 80% of girls are married during the most fertile period of 15 to 20 years of age.
2. ***Polygamy:*** Some people in India prefer to have more than one wife. In the eyes of those people women are considered as commodities. They consider a matter of pride to own them. Behind such polygamy many factors are responsible some such rich people prefer this for their happiness. Those who did not have child from their first wife, preferred to have a second wife.
3. ***Preference for a male child:*** Every family in India prefers a male child. There are some religious rites which can be undertaken, only by the males. So even if a couple has a number of daughters to on reproducing children till a male child is born.
4. ***Widow marriage:*** Now widow marriage system is prevailing which helps in the growth of population.
5. ***Economic Causes:*** The economic causes for increase in population are as follows:
   (a) *Poverty:* About 60 percent of the populations are below the poverty line. Most of the people remain in rural area. They also think that more children mean more income. The children help their percents in wages and family vocation and support the family.
   (b) *Illiteracy:* It is the cause of high birth rate in India. The literacy rate- among the women is only 39.4 percent and male literacy is 63.9 percent. Illiteracy combined with poverty leads to ignorance, from belief in religious doctrines and superstitions. Due to illiteracy people do not know the use of contraceptives arid modern method to crab the population.

Inadequate Supply of Effective Birth Control Devices: The birth control devices are not sufficient and these are not available in a right time.

14.3.2 Causes of Decline in Death Rates

The main reasons for decline in death rates are as follows:

1. ***Control of famines and Epidemics:*** In the early parts of the 20th century, there were frequent occurrence of famines and epidemics that broke out. There is no development of transport and communication facilities. The epidemics like cholera, malaria, and influenza broken out and took a heavy two of human life. Epidemics life plague, cholera and small pox are not seen in India. Modern medicines and surgical operation system has reduced the death rate in India.
2. ***Availability of medical facilities and public services:*** A rapid decline death rate is the result of the availability of medical facilities and public health service. Provision of public drinking water and better drainage facilities have control epidemics. The opening of medical clinics, hospitals and public health centres in remote village of the country has provided medical facilities to the people.

Notes

3. ***Material and Child service:*** Specific care has been taken now for the health of the pregnant and nursing mothers and new born babies. Better arrangements have been made for delivery of the babies. As a result of these measures the death rate of pregnant women and new born babies has reduced a lot.

14.3.3 Effects of Population Explosion

The current rate of population growth in India is 1.58% and the total fertility rate is 3. Although the total fertility rate has decreased, due to the increase in the total number of women between the ages of 15 and 44 (reproductive ages), the total number of births has increased. This has lead to the current enormous population size of approximately 1 billion. This has greatly hampered the development of the Indian economy. The amount of resources that could have been available to one person a few years ago now need to be shared between two people, which are not sufficient for either of them. The population increase has lead to air and water pollution, unemployment, poverty, lack of educational resources, and even malnourished women and children.

1. Air Pollution

The technological development of India has lead not only to medical advancements, but also to an increase in the number of factories. That has lead to air and water pollution. More energy needs to be produced to power these factories. When fossil fuels - the world's major source of energy - are burnt, gases are added to the atmosphere. Many cities in India have crossed the limits of suspended particulate matter, sulphur dioxide, and other pollutants due to vehicular and industrial emissions. According to an article by the World Bank Organization, Delhi, the capital of India is one of the world's most polluted cities. In fact, in 1999, the average total suspended particulate (TSP) level in Delhi was 378 micrograms per cubic meter – approximately five times the World Health Organization's (WHO) annual average standard. Furthermore, TSP levels in Delhi exceeded the WHO 24-hour standard on 97 percent of all days on which readings were taken. As the population grows, more and more forests are cleared. The two most common reasons for deforestation are to make houses for increased number of people to live in, and to use wood as a fuel in the industries. As a result, the trees that help us in reducing the air pollution through the process of photosynthesis are not able to do so any more. According to an article published in the Times of India on March 25th, 2000, "…increasing air pollution level in the year 1999, caused 3,650 untimely deaths and about 1,545,003 persons had been reportedly suffering with air (polluted) borne diseases." Some of the diseases caused by air pollution are "respiratory diseases, asthma, chronic obstructive pulmonary disease, cardiovascular disease and cancer of the lung" (World Health Organization, Internet). Due to the tropical climate of India, air pollution also causes smog which may result in headaches, dizziness, breathing difficulties, or even mass illness due to carbon monoxide. This slow murder goes unnoticed because people die of diseases like cancer, asthma, and heart problems after long exposures to deadly air pollutants. Besides the untimely deaths of several thousands of people every year due to air pollution, the pollutants also have a deadly impact on our national heritage – the historical monuments that have made India proud for centuries.

Example: A classic example of the air pollution effect is the Taj Mahal in India. The sulphur dioxide in the air because of the pollution caused by the neighbouring industries mixes with atmospheric moisture and settles as sulphuric acid on the surface of the tomb, making the smooth white marble yellow and flaky, and forming a subtle fungus that experts have named "marble cancer". Trying to save the monument might mean closing down several industries in the neighbourhood. However, this means that several thousands of people would lose their jobs, resulting in eventual poverty. This again brings us to the same problem that is the root of all the problems – population increase.

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One of the major issues that have lately been bothering environmentalists all over the world is global warming. Like glass in a greenhouse, gases like carbon monoxide admit the sun's light but tend to reflect back downward the heat that is radiated from the ground below, trapping heat in the earth's atmosphere. This is called the greenhouse effect. However, due to the increase in pollution, especially due to carbon dioxide and chlorofluorocarbons, the ozone layer is getting depleted. This layer plays the major role in controlling the temperature of earth, saving it from the harmful effect of the ultraviolet radiation of the sun. However, with the depletion of the ozone layer on the rise, the temperature of the earth is increasing. This is global warming. As we know that India is mainly an agrarian country, temperature and climate plays an important role in the economy of the country. According to an article in Earth One news, global warming affects the main crops in India in 2 major ways:

Notes Researchers have estimated that only a 2O C increase in mean air temperatures will be enough to decrease the rice yield by 0.75 ton/hectare in high-yield areas like Punjab, Haryana and Uttar Pradesh. It is also estimated that a drastic increase in greenhouse gases like carbon dioxide may cause wheat production to fall as much as 68%.

Additionally, the changing climatic conditions have the potential to significantly increase tropical disturbances like cyclones and storms in coastal regions.

The effect on crops greatly hampers the economy of the country, especially for those farmers who solely depend on agriculture for their survival. For them, the loss of one crop would lead to a plunge into absolute poverty, and thus, the vicious cycle of poverty and population explosion continues. The effects of air pollution on the climatic conditions reveal that air pollution not only affects our environment, but it also greatly endangers the lives of everybody. This means that if the number of people increases the carrying capacity, the mere survival of human beings poses a threat to the lives of all human beings.

2. Water Pollution

Air pollution is not the only environmental damage being done by the increasing population. Nowadays water pollution is also one of the increasing problems due to the population explosion. Water is considered the essence of life. There is no life without water. One might think that 70% of the earth is covered with water, so, why worry about the water problem? In fact, three sides of the Indian subcontinent are surrounded by water. And there are several rivers, lakes, and other sources of water within the country as well. However the fact is that less than 3 percent of that water we see can be used for human consumption and industrial uses. Nearly 10 percent of the world's population faces chronic freshwater shortage. This figure may rise if the population growth is uncontrolled. As in the case of air pollution, the increasing population calls for increasing numbers of factories. These factories lead to various kinds of pollution, including water pollution. Also, India being an agrarian country, the water pollution also comes from pesticides used for agriculture. Some of the major types of pollutants are:

- Petroleum products required for automobiles, cooking, and other such human activities.
- Pesticides and herbicides used for agriculture by the Indian farmers.
- Heavy metals from industries, automobiles' exhausts and mines.
- Hazardous wastes.
- Excessive organic matter like fertilizers and other organic matter used by farmers.

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- Sediments caused by soil erosion produced by strip mines, agriculture and roads.
- Thermal pollution caused by deforestation.

Example: One of the classic examples of water pollution in India is the river Ganga. This river is considered sacred and incorruptible. People bathe in it for spiritual renewal and drink water from it. But people do not realize that along with washing off their sins in the river, they are also washing off their body wastes, leading to polluting the holy water of the river. Also, cremated and partially cremated bodies are dumped into the river. Although, dumping these bodies is a religious act in India among the Hindus, but at what cost? Thus, with the increasing population, the number of people dying is also increasing, and so is the pollution in the river Ganga. In addition, the nearby factories and human colonies dump sewage directly into the river. Recent studies show that there are more than 25,000 small-scale industries in just one of the states sharing the river and dispose off their waste in the river (Times of India, Internet). Also, according to the same article in the Times of India, just in Uttar Pradesh, one of the states sharing the river "sewage containing excrete of about 3 million people from 34 sewage pipes is being released into the Gomti in the eight-km stretch from Gaughat to Hanuman Setu in Lucknow." Currently the river is so polluted that some experts believe such water should not even be exposed in nature without being treated.

As we can observe, the increased population size is leading to increased pollution, which in turn is leading to a more hostile environment for human beings themselves.

3. Food Resources

Resources are always limited. And in a developing and highly populous country like India, resources are even scarcer. Population explosion results in the shortage of even the most basic resources like food. According to an article by World Bank Group, "…more than half of all children under the age of four are malnourished, 30 percent of newborns are significantly underweight, and 60 percent of women are anaemic." Resources are limited everywhere. Thus, unless we can develop a technology that would enable us to live on just one grain of wheat, the population increase remains a serious problem in India. India spends approximately $10 billion each year on malnutrition, and even then the government of India cannot provide the everyday nutritional requirements to everybody in India.

Example: If you walk on the street of Calcutta or Delhi, you would notice several children fighting with each other for a small piece of bread that they found in a dumpster. While this might be shocking to most people, this is a daily routine and the only way to survive for many people in India. Survival of the fittest finds its true meaning on the streets of the urban cities of India.

14.3.4 Remedial Measures to Check the Population

The government of India has been organizing several programs for limiting the population increase and has been spending millions of dollars on controlling the birth rate. Some of the programs have been successful, and the rate of increase has also reduced, but has still to reach the sustainable rate. The major factors affecting the population increase of India are the rapidly increasing birth rate and decreasing death rates. We can follow strict birth control measures like China to decrease the birth rate, but we cannot go and decrease our technological advancements to decrease the death rate. Thus, our main emphasis falls on decreasing the birth rate. Several government-funded agencies like the Family Planning Association of India spend hundreds of

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thousands of dollars on promoting family planning. These organizations aim to promote family planning as a basic human right and the norm of a two-child family on a voluntary basis, to achieve a balance between the population size and resources, to prepare young people for responsible attitudes in human sexuality, and to provide education and services to all. The family planning methods provided by the family planning program are vasectomy, tubectomy, IUD, conventional contraceptives (that is condoms, diaphragms, jelly/cream tubes, foam tables) and oral pills. In addition, induced abortion is available, free of charge, in institutions recognized by the government for this purpose. However, the success of the family planning program in India depends on several factors like literacy, religion and the region where the couple live.

Population explosion in India can be checked either increasing death rate or reducing birthrate increasing death is suicide method or this is not possible from the humanitarian point of view. So to check the population it is necessary to decrease the birth rate. The following measures may be suggested for lowering the high birth rate in India:

1. Postponement of universal marriage system and marriageable age.
2. Spread of education and emphasis on population Education curriculum in schools and colleges.
3. Improving the status of the women both educationally and economically independent.
4. Removal of poverty and economic disparities.
5. Development of Rural sector.
6. Industrial Development.

Population of India was growing at its peak during the 1960's at about 3% per year. Over the decades, the growth rate has fallen down to about 1.5%. The figure of 1.21 billion can certainly scare weak hearted people but the rate of growth has been falling and is expected to fall further in coming years. The average number of children per woman was six fifty years ago, now it is about 2.75. Therefore, all talks of "**population explosion**" or some "**population Bomb**" ticking in India are nothing but display of irrational fears following 200 year old Malthusian theory that poses growing population as a threat to earth's limited food supply.

Task The general perception is that "growth is good." Why isn't population growth good? What is the carrying capacity of our nation?

Self Assessment

State whether the following statements are true or false:

5. With 20 per cent of the world's population, India is toady the second largest populations' country in the world.
6. Marriage is considered as a religious duty.

14.4 Family Welfare Programmes in India

In order to control the rapid growth of population, the policy of family planning was adopted by the Govt. of India in 1952. India is the first country to adopt a deliberate policy measure to control the high birth rate. Though the programme initially was taken up in a modest way, it gathered momentum after the 1961 census. During the First Five Year Plan a sum of ₹ 65 Lakhs was earmarked for the purpose and the amount increased to ₹ 3 crore during the 2nd plan period.

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During 3rd plan emphasis was given on mass propaganda and motivation programme in order to make people conscious about the adverse effect of population growth ₹ 25 crore were allotted for the purpose during the 3rd plan period. Different methods of contraception were introduced to check the high birth rate and a pill factory was set up in India during 1966-69.

Did u know? A "Cafeteria Approach" meaning choose whatever method of contraception you like was introduced by the Health and Family welfare minister Prof. Chandrasekhar. A time bound target oriented approach was adopted to reduce the birth rate from 39 per thousand to 32 per thousand. Actually nothing remarkable could be achieved in this direction. By 1971, our population increased to 548 million.

In 1972, the Parliament passed the Medical Termination of Pregnancy Act legalizing abortion on demand. Mass vasectomy camps were started in the country. The Family Planning of Programme was widened to cover nutrition, maternity and child care. In 1976, the Govt. of India announced the National Population Policy. The objective was to reduce the fertility period of reproductive couples. The policy discouraged the child marriages and increased the minimum age of marriage to 18 for girls and 21 for boys. The family planning programme was started on a war-footing during the emergency period (1975-77). Compulsory sterilization was introduced and nearly 10 million people were sterilized. Financial initiatives were given to the people to be attracted for sterilization. However, the programme was virtually rejected by the people and its progress received a serious set-back during two years after 1976. The Janata Government in 1977 renamed the programme as Family Welfare Programme and put emphasis on the welfare of the family as a whole. The method of persuasion replaced the earlier method of compulsion in the filed of sterilization. The policy targeted to reduce the birth rate to 30 per thousand by 1979 and 25 per thousand by 1989. However, during the brief tenure of Janata Govt. the policy could not achieve much.

In India, as in many developing countries, the family planning programme is the most direct public policy measure initiated to reduce the population growth rate. Since the formal beginning of the programme in the early 1950s, it has gone through many structural, administrative and implementation strategy changes. All those changes will not be described here; instead focus will be on only critical areas of programme activity and their impact on achievements and their limitations. There is no doubt that the facilities and services made available for family planning have increased substantially over time. In the rural areas, at the beginning of April 1991 there were 130,978 sub-centres, 22,059 primary health centres, and 1,923 community health centres. The above statistics are just one of the indicators which show that the programme has certainly succeeded in establishing a very good infrastructure through which family planning facilities and services have increased over time. However, there are some doubts about the full utilization of these services and the quality of service standards being provided by these centres.

14.4.1 Evolution of Family Welfare (FW) Program (Programme)

"The Family Welfare Programme in India is recognised as a priority area, and is being implemented as a 100% centrally sponsored programme. As per Constitution of India, Family Planning is in the Concurrent list. The approach under the programme during the First and Second Five Year Plans was mainly "Clinical" under which facilities for provision of services were created. However, on the basis of data brought out by the 1961 census, clinical approach adopted in the first two plans was replaced by "Extension and Education Approach" which envisaged expansion of services facilities along with spread of message of small family norms.

At the outset it must be stated that 'family welfare' as a title is highly misleading because the entire effort of the concerned department is family planning, and that too mostly tubectomies.

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Other concerns of this department like child immunisation, antenatal care, abortions, deliveries, post-natal care etc. are only marginal ; occasional spurts of activity like universal immunisation using a mission approach did change things temporarily but as routine set in, it could not be sustained and has again been marginalised.

Caution One doesn't have to give the gory details of statistics to show how miserable health care in general and specifically for women and children is. It should suffice to mention that access to basic services like basic medical care; facilities for child birth, abortion services, contraceptive services, pregnancy care, immunisation etc. are just not there when clients visit the primary health centres or other provider units.

1. 4th Five Year Plan

In the IV Plan (1969-74), high priority was accorded to the programme and it was proposed to reduce birth rate from 35 per thousand to 32 per thousand by the end of plan. 16.5 million Couples, constituting about 16.5% of the couples in the reproductive age group, were protected against conception by the end of IVth Plan.

2. 5th Five Year Plan

The objective of the fifth Five Year Plan (1974-79) was to bring down the birth rate to 30 per thousand by the end of 1978-79. The programme was included as a priority sector programme during the Five Year Plan with increasing integration of family planning services with those of Health, Maternal and Child Health (MCH) and nutrition, so that the programme became more readily acceptable. The years 1975-76 and 1976-77 recorded a phenomenal increase in performance of sterilisation. However, in view of rigidity in enforcement of targets by field functionaries and an element of coercion in the implementation of the programme in 1976-77 in some areas, the programme received a set-back during 1977-78. As a result, the Government made it clear that there was no place for force or coercion or compulsion or for pressure of any sort under the programme and the programme had to be implemented as an integral part of "Family Welfare" relying solely on mass education and motivation. The name of the programme also was changed to Family Welfare from Family Planning. The change was not merely in nomenclature but essentially in the content of its objectives.

3. 6th Five Year Plan

In the Sixth Five Year Plan (1980-85), certain long-term demographic goals of reaching net reproduction rate of unity were envisaged. The implications of this were to achieve the following by the year 2000 AD.

1. Reduction of average size of family from 4.4 children in 1975 to 2.3 children.
2. Reduction of birth rate to 21 from the level of 33 in 1978 and death rate from 14 to 9 and Infant Mortality Rate (IMR) from 127 to below 60.
3. Increasing the couple protection level from 22% to 60%.

4. 7th Five Year Plan

The Family Welfare Programme during VII five year plan (1985-90) was continued on a purely voluntary basis with emphasis on promoting spacing methods, securing maximum community

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participation and promoting maternal and child health care. In order to provide facilities/ services nearer to the door steps of population, the following steps/initiatives were taken during the 7th Plan period.

1. It was envisaged to have one sub-centre for every 5000 population in plain areas and for 3000 population in hilly and tribal areas. At the end of 7th plan, i.e.31.3.1990, 1.30 lakhs sub-centres were established in the country.
2. The Post Partum programme was progressively extended to the sub-district level hospitals. At the end of 7th plan, 1012 sub-district level hospitals and 870 Health Posts were established in the country.
3. The Universal Immunization Programme started in 30 Districts in 1985-86 was extended to cover all the districts in the country by the end of the 6th Year plan.
4. A project for improving Primary Health Care in urban slums in the cities of Bombay and Madras was taken up with assistance from World Bank.
5. Area Development Projects were implemented in selected districts of 15 major States with assistance from various donor Agencies.

   The achievements of the Family Welfare Programme at the end of the VII plan were:

   (i) Reduction in crude birth rate from 41.7 (1951-61) to 30.2

   (ii) Reduction in total fertility rate from 5.97 (1950-55) to 3.8

   (iii) Reduction in infant mortality rate from 146 (1970-71) to 80

   (iv) Increase in Couple Protection Rate from 10.4% (1970-71) to 43.3% (31.3.1990).

   (v) Setting up of a large network of service delivery infrastructure, which was virtually non-existent at the inception of the programme.

   (vi) Over 118 million births were averted by the end of March, 1990.

The approach adopted during the Seventh Five Year Plan was continued during 1990-92. For effective community participation, Mahila Swasthya Sanghs at village level was constituted in 1990-91. MSS consists of 15 persons, 10 representing the varied social segments in the community and five functionaries involved in women's welfare activities at village level such as the Adult Education Instructor, Anganwari Worker, Primary School Teacher, Mahila Mukhya Sevika and the Dai. Auxiliary Nurse Midwife (ANM) is the Member-Convenor. A major new initiative undertaken during 1991-92 was the Child Survival and Safe Motherhood Project, an integration of Universal Immunization Programme with expanded/intensified MCH activities in high IMR States/Districts of the country.

5. 8th Five Year Plan

To impart new dynamism to the Family Welfare Programme, several new initiatives were introduced and ongoing schemes were revamped in the Eighth Plan (1992-97). The broad features of these initiatives are as under:

1. World Bank assisted Area Projects which seek to upgrade infrastructure and development of trained manpower have been continued during the 8th Five Year Plan. Two new Area Projects namely India Population Project (IPP)-VIII and IX have been initiated during the 8th Plan. The IPP-VIII project aims at improving health & family welfare services in the urban slums in the cities of Delhi, Calcutta, Hyderabad and Bangalore. IPP-IX will operate in the States of Rajasthan, Assam and Karnataka.

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2. An USAID assisted project named "Innovations in Family Planning Services" has been taken up in Uttar Pradesh with specific objective of reducing TFR from 5.4 to 4 and increasing CPR from 35% to 50% over the 10 years project period.

3. Recognising the fact that demographic and health profile of the country is not uniform, 90 districts which have CBR of over 39 per thousand (1991 census) were identified for differential programming. Enhanced allocation of financial resources, amounting to ₹ 50 lakhs per year per district, was made for upgradation of health infrastructure in these districts from 1992-93 to 1995-96. This amount is being used for providing well equipped Operation Theatres, Labour Room, a six-bedded observation ward and residential quarters for paramedical workers in 5 PHCs of each district per year. All the block level PHCs of these 90 districts have been covered.

4. Realising that Government effort alone in propagating and motivating the people for adaptation of small family norm would not be sufficient, greater stress has been laid on the involvement of NGOs to supplement and complement the Government efforts. Four new schemes for increasing the involvement of NGOs have been evolved by the Department of Family Welfare.

5. The Universal Immunisation Programme (UIP) was launched in 1985 to provide universal coverage of infants and pregnant women with immunisation against identified vaccine preventable diseases. From the year 1992-93, the UIP has been strengthened and expanded into the Child Survival and Safe Motherhood (CSSM) Project. It involves sustaining the high immunisation coverage level under UIP, and augmenting activities under Oral Rehydration Therapy, prophylaxis for control of blindness in children and control of acute respiratory infections. Under the Safe Motherhood component, training of traditional birth attendants, provision of aseptic delivery kits and strengthening of first referral units to deal with high risk and obstetric emergencies are being taken up.

The targets fixed for the 8th plan of a National level birth rate of 26 was achieved by all States except the States of Assam, Bihar, Haryana, Madhya Pradesh, Orissa, Rajasthan and Uttar Pradesh.

6. 9th Five Year Plan

Reduction in the population growth rate has been recognised as one of the priority objectives during the Ninth Plan period.

The objectives during the Ninth Plan are:

(i) to meet all the felt-needs for contraception

(ii) to reduce the infant and maternal morbidity and mortality so that there is a reduction in the desired level of fertility

The strategies during the Ninth Plan will be:

(i) to assess the needs for reproductive and child health at PHC level and undertake area-specific micro planning

(ii) To provide need-based, demand-driven, high quality, integrated reproductive and child health care

14.4.2 Objectives of Family Welfare Programmes

Temporary Assistance for Needy Families or TANF is the current legislation known as family welfare. TANF is a federally run program legislated in 1996 that replaced several other social welfare programs. According to the U.S. Department of Health and Human Services, the mission

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of TANF is to "help needy families achieve self-sufficiency." The federal government aims to achieve this goal by working towards several objectives.

1. ***Keeping Families Out of Shelters:*** TANF administers "block grants" to states to fund cash assistance programs. These programs are available to qualifying families in need. The aim of cash assistance is to help families pay their bills and housing costs and stay in their homes even in times of financial stress. This reduces the number of housing evictions for non-payment and ultimately reduces the number of homeless families.
2. ***Promoting Employment for Needy Parent:*** By promoting employment for needy parents, TANF aims to increase family self-sufficiency and reduce long-term dependence on cash assistance. TANF funds job preparedness programs for recipients and also requires work or volunteer activity in order to remain eligible for benefits. Working or volunteering parents are able to increase their job skills and prepare for full-time paid positions.
3. ***Preventing Pregnancy before Marriage:*** One of the objectives of TANF legislature is to reduce the number of children born out-of-wedlock. Studies show that single mothers are more likely to remain in poverty than other heads of households. The legislature promotes marriage before pregnancy as a way of decreasing the number of single mothers struggling with poverty and managing families on their own.
4. ***Encouraging the Stability of Two-Parent Families:*** Like promoting marriage before pregnancy, TANF aims to increase the number of families living in two-parent households. Of families living in poverty, families with two parents are shown to be more stable, able to access resources more easily and able to increase self-sufficiency at greater rates. By encouraging parents to remain a stable unit, the TANF program hopes to ensure better outcomes for children.

Task Is it possible to realize human rights when resources are limited? Do human rights depend on culture? Elucidate.

Self Assessment

Fill in the blanks:

7. In 1972, the parliament passed the ..... Act legalizing abortion on demand.
8. In the ..... Five Year Plan (1980-85), certain long-term demographic goals of reaching net reproduction rate of unity were envisaged.

14.5 Effects of Environment on Human Health

The environment affects our health in a variety of ways. The interaction between human health and the environment has been extensively studied and environmental risks have been proven to significantly impact human health, either directly by exposing people to harmful agents, or indirectly, by disrupting life-sustaining ecosystems. Although the exact contribution of environmental factors to the development of death and disease cannot be precisely determined, the World Health Organization (WHO) has estimated that thirteen million deaths annually are attributable to preventable environmental causes. The report also estimates that 24% of the global disease burden (healthy life years lost) and 23% of all deaths (premature mortality) are attributable to environmental factors, with the environmental burden of diseases being 15 times higher in developing countries than in developed countries, due to differences in exposure to environmental risks and access to health care.

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However, huge economic development and population growth result in continuing environmental degradation. Intensification of agriculture, industrialization and increasing energy use are the most severe driving forces of environmental health problems. For countries in the early stages of development the major environmental hazards to health are associated with widespread poverty and severe lack of public infrastructure, such as access to drinking water, sanitation, and lack of health care as well as emerging problems of industrial pollution. However, environmental health hazards are not limited to the developing world. Although at a lesser extend, environmental risks are also present in wealthier countries and are primarily attributed to urban air and water pollution. Occurrences of Asthma are rising dramatically throughout the developed countries, and environmental factors appear to be at least partly to blame.

Caution The Millennium Ecosystem Assessment synthesis report warns that the erosion of ecosystems could lead to an increase in existing diseases such as malaria and cholera, as well as a rising risk of new diseases emerging.

Climate change is also posing risks to human population health and well-being and thus is emerging as a serious concern worldwide. In 2000 climate change was estimated to be responsible for approximately 2.4% of worldwide diarrhoea and 6% of malaria. According to the IPCC third assessment report the world temperature is expected to further rise during the century, implying increased health threats for human populations, especially in low-income countries. Reviewing the US literature addressing health impacts of climate variability and change, conclude that climate change is expected to increase morbidity and mortality risks from climate-sensitive health outcomes such as extreme heat events, floods, droughts and fires. A spread in vector–borne diseases, like malaria, is also expected. A study in Mexico revealed that lower greenhouse gases emissions would result in avoidance of some 64,000 premature deaths over a twenty year period.

Despite vast improvements in health globally over the past several decades, environmental factors remain a major cause of sickness and death in many regions of the world. In the poorest regions, one in five children do not live to see their fifth birthday, largely because of environmentally related and preventable diseases. That number translates into 11 million childhood deaths each year, mostly due to illnesses such as diarrhoea and acute respiratory infections. Insect-borne diseases also exact a heavy toll; malaria alone claims 1 to 3 million lives a year, most of them children.

Environmental threats to health are by no means limited to developing countries. In the United States, some 80 million people are exposed to levels of air pollution that can impair health. In China, which has one of the world's fastest growing economies, 2 million people die each year from the effects of air and water pollution, according to one recent estimate. Nearly 100 countries, both developed and developing, still use leaded gasoline, unnecessarily exposing their citizens to a pollutant long known to cause permanent brain damage.

Environmental health problems vary dramatically from region to region, reflecting geography, climate, and perhaps most important, a country's level of economic development and policy choices. Many environmental health problems are associated with poverty and a lack of essential resources, chief among them sufficient and clean water, food, shelter, fuel, and air. Indeed, the World Health Organization has called poverty the world's biggest killer. These environmental problems, prominent at the household or community level, underlie the 17 million deaths each year from infectious diseases.

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Notes Other environmental threats to health are associated with development itself, when it is pursued without proper safeguards for the environment. Without question, economic growth and social development are critical for improving human health and well-being. Yet, if not well managed, economic growth can exact a major toll on environment and health. It is not a coincidence that some of the booming Asian economies also have some of the worst air pollution in the world.

In many developing countries today, populations are in double jeopardy, facing both the unfinished agenda of traditional environmental health problems, such as insufficient clean water and sanitation, as well as the emerging problems of industrial pollution. In these countries, both pesticides and faeces may contaminate drinking water; likewise, air pollution may stem both from the household burning of dirty fuels and the industrial use of fossil fuels.

New indexes developed for this report attempt to capture the geography of environmental threats to health. Portrayed in maps, these indexes highlight those countries where traditional risks are high and also vast areas such as India and China where traditional and modern risks coincide. In the more developed countries, the indexes show that many populations still face threats from avoidable hazards such as leaded gasoline. Although preliminary, these indexes suggest where policy interventions could improve both environmental quality and human health. Although useful for painting a picture in broad strokes, these indicators cannot capture serious disparities in risk that occur within countries.

Example: Although the United States overall faces low environmental risks to health, the prevalence of asthma is increasing among poor and minority populations, and environmental factors are believed to be contributing to that increase. Similarly, lead exposures are typically far higher among poor, inner-city children than other groups. This unequal burden of risk, closely tied to poverty, is described in detail in the text. Nor do country-level indicators reveal another inequity: the disproportionate share of global environmental threats created by the wealthiest countries, who consume more energy and resources per capita than do poorer countries. The wealthy countries, for instance, bear the greatest responsibility for releasing the greenhouse gases that threaten to change global climate, with myriad potential health effects.

This special section describes the complex links between the environment, development, and health. It explores the ways in which environmental factors, and particularly environmental change, can degrade health—either directly, by exposing people to harmful agents, or indirectly, by disrupting the ecosystems that sustain life. The section then examines how improved environmental management can reduce these risks and preserve both human health and environmental quality.

Why focus on the role of environment in health? Admittedly, environmental factors are by no means the only, or even the major, cause of ill health globally. Environmental factors predominate in poorer countries, for instance, but play a much smaller role in undermining health in the wealthier countries, where voluntary behaviours such as diet and smoking are larger determinants of health. In both settings, however, environmental factors deserve increased policy attention because they are avoidable causes of ill health.

Much has been done globally in the past few decades to improve health. Governments, communities, international agencies, donors, and nongovernmental groups have worked together to make widely available such life-saving interventions as vaccines and oral rehydration

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therapy. Many millions of dollars have been spent on medical research, although arguably not enough on tropical diseases that cause so much misery and claim so many lives throughout the developing world. These health-care strategies are essential and deserve increased support. However, supplementing these approaches with preventive strategies that intervene earlier in the disease process and stop harmful exposures from occurring in the first place would bring additional gains, often at relatively modest cost.

It has been attempt to illuminate these points of intervention by exploring the driving forces and trends that underlie many of today's environmental health problems. Three trends in particular stand out in terms of their profound impact on the physical environment and their enormous potential for influencing human health: the intensification of agriculture, industrialization, and rising energy use—in particular, fossil fuel consumption.

All of these trends play a vital role in economic development patterns worldwide, yet all can be a source of avoidable ill health as well.

Example: Agricultural intensification can expose workers and communities to toxic pesticides. Land clearing and irrigation projects can facilitate increases in vector-borne diseases such as malaria and schistosomiasis. Industrialization, which is so critical to economic growth, can also bring exposure to heavy metals and other toxic contaminants. Rising energy use is largely responsible for air pollution that blankets many of the world's cities and also has the potential to alter the Earth's climate.

It has then describes a range of environmental interventions—from simple and local to complex and international—that can mitigate these problems. Many of these problems are hard to address. Indeed, the question of how to expand access to water and sanitation has defied simple solution for decades. Yet, tackling fundamental problems will yield myriad benefits, not just in terms of health. The provision of water and sanitation and associated interventions, for instance, would not only reduce disease and improve human dignity but could also help combat poverty if the time formerly spent collecting water or caring for sick children could be devoted to education or income-generating activities.

Other interventions, too, promise multiple benefits beyond the health arena. Curbing fossil fuel consumption could save lives immediately by reducing levels of ambient air pollution. In addition, the same strategy could help avert long-term climate change and its predicted ecological, economic, and health costs. Similarly, adopting more environmentally benign forms of agriculture—approaches that use fewer agricultural chemicals and cause less ecological disruption—would help to reduce both acute and chronic health risks associated with exposure to harmful pesticides. At the same time, reducing the use of fertilizer and improving watershed management could lessen agriculture's toll on coastal waters—particularly the harmful algal blooms and fish kills that threaten not only ecosystem health but human health as well.

In addition to these large-scale changes, the report calls attention to situations in which the problems and solutions are relatively well understood. Removing lead from gasoline, for instance, could immediately reduce environmental threats to health. Similarly, the report illustrates the many benefits possible if concerns about environmental threats to health are incorporated into development planning at the outset. Experience has shown it is possible to anticipate and prevent some of the problems associated with development. Dams can be built so that they do not provide habitat for disease vectors. Factories can be sited so that they do not contaminate groundwater. But achieving such results requires coordination and communication among agencies that do not often interact, such as government ministries of health, agriculture,

economics, and the environment, and also international aid agencies. Making the environment a central component in public health strategies is essential to ensure health for everyone in the 21st Century.

Self Assessment

State whether the following statements are true or false:

9. Climate change is also posing risks to human population health and well-being and thus is emerging as a serious concern worldwide.
10. Dams can be built so that they provide habitat for disease vectors.

14.6 Human Rights

Human Rights are internationally agreed standards or rules regulating the conduct of states towards their own citizens and non-citizens.

Fifty years ago, idea of human rights was not much prevalent among people, though some of the governments in the West were caught up in legal and moral discussion and debate on this subject. Situation has changed today; human rights movement is spreading throughout the world. In 1948 United Nations adopted Universal Declaration of Human Rights and decided that Dec. 10 should be observed as Human Rights Day throughout the World.

It is not that idea of human rights became known fifty years ago; the concept of human dignity is old; it existed in major religions of the world since ancient times. The League of Nations after World War I asked the governments to ensure that their nationals are protected and there is respect of the rights of ethnic, linguistic and religious groups. It is only after World War II that human rights concept was given an institutional meaning and its meaning became broader in scope embracing moral, social and legal aspects. Everywhere, individuals want to be treated with dignity, want to voice their own opinions and worship when and where they want. Today, the language of human rights is almost universal in the sense that how a country treats people within its own borders including its own citizens. It is an issue of concern for all nations. But this does not mean that there is no variation in the extent and exercise of human rights among various cultures and political groups; different cultures may interpret certain rights in their own way. Many countries have agencies and commissions that deal with the problems concerning human rights. These problems refer to claims relating to discrimination of groups or sects, children, women for environment, food or life. The universal Declaration of Human Rights, mentioned above, has resulted in emergence of many Human Rights NGOs. The NGOs have been pushing hard for implementation of rights specifically if these are directed against torture, racial and gender discrimination and other such acts perpetuated by oppressive regimes.

14.6.1 Achievements of Human Rights Declaration

Even since the Declaration of Human Rights in 1948, UN has played a key role in implementation of human rights by various governments. UN has been playing an important role in developing human rights standards and devising mechanisms for monitoring the compliance of human rights and also censoring the governments or other agencies that violate the rights. The UN Conference on Human Rights and Development in 1993 was a milestone because it provided and fostered a forum in which society could raise concern about abuse of people or women. Even prior to 1993, many Human Rights Treaties were signed and ratified by various governments.

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Notes In fact, after 1948 Declaration, two organizations were formed namely International Convention on Economic, Social and Cultural Rights and the International Convention on Civil and Political Rights. The first deals with right to self-determination, work, education, food, health, housing, clothing, social security and the cultural life of the community. The second deals with the right or freedom to speech, freedom of thought and religion and to prohibit against torture or cruelty. These two organizations constitute International Bill of Human Rights of UN.

Human Rights in both the categories were later elaborated to include right of migrants, minorities, prisoners, refugees, healthy environment and development. Several conventions were set up dealing with rights in a subject wise manner. Some of these are given below:

1. Convention on the status of Refugees
2. Convention on Political Rights of Women
3. International Convention on the elimination of all forms of Racial Discrimination
4. Convention against Torture and other Cruel Inhuman and Degrading Treatments or Punishments.
5. Convention on the Rights of the Child.

In addition, there have been many declarations of UN General Assembly and also of many countries of regions of Africa, Asia and Latin America.

A Commission and a High Commissioner on Human Rights was established at UN. Human Rights movements initially were led by states with the support of individual groups. Later, NGOs and other agencies became the champions of the cause. In case of governments serving as the main agents of Human Rights movement, it was observed that this was more or less a political instrument for obtaining sanctions against another political ideology. For example, the civil rights movement of USA was a reminder to the then governments of communist countries led by Soviet Union that the democratic system of the west has a lead over authoritarian regimes in the matter of human rights.

At the time when the Human Rights Movement acquired a global character, Regional instruments that have been serving as forum for raising protests against violations also became active. For many aspects of Human Rights, the movements or activism started in the West and spread to other parts of world. But the some other aspects, like freedom against colonial rule, the movements started within the countries that include mostly the countries of South - (Asia, Africa, and Latin America). Also the movements for freedom and human rights in the countries of Eastern Europe and Soviet Union in 1980's are the examples of movements that originated outside West. In fact, in 1979 human rights movement was spreading to all regions of the world and to almost all areas of human concern and prior to that the rights to self determination led many third world countries to get freedom from colonial rule to become independent.

14.6.2 Human Right: Legal or Moral

Human rights have been identified and operate through commissions or committees in many countries. But unless, the governments of various countries ratify the standards laid down in different areas of human rights, they do not become legally binding instruments. They even don't become morally binding. Even after ratification, problem of implementation remains to be solved, despite pressures from NGOs. Some of the violations against human rights like

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genocide or crime against humanity can be brought to International Criminal Court, which is a forum for redressal of acts of violation.

Human Rights movements, their existence, ratification and implementation face a great challenge when the violation or abuse is done by the state (e.g., genocide, racial discrimination or religious persecution). The NGOs and other groups then find it difficult to get even right access to information regarding the violation. The international NGOs in association with local organizations have been taking up the cause of human rights; this has led to local organization becoming activist groups. For example, Greenpeace has fought many battle on rights to clean water, rehabilitation of indigenous people uprooted on account of clearing forests and such other matters. Their role in confronting the governments or Business Corporation continues to be a source of great inspiration for serving the cause of human rights.

14.6.3 Value Education

Education continues to be enmeshed in debates, especially about its aims and philosophy starting from Greek period. Aristotle, followed by Plato, was the chief among Greek philosophers who handed us good commentaries on education, its use for moral purpose, for value formations, for its rationalism, instrumentalism or existentialism. Equally, rather more significant are commentaries on Indian ancient education, both the theory and practice.

The Ancient System

Ancient Indian education is based on Indian theory of knowledge, thought and religion. Religion has not only shaped the civilization of ancient India and dominated every sphere of national life but also influenced and regulated India's social, economic and political life. Indian theory of knowledge was extensive, embracing the whole scheme of creation especially the central theme of life and death, and it is also defining material, moral and spiritual values of life. This is not the place to go into details of religion, tradition and knowledge. The Hindu believes and perceives that it is the individual that dies and not the whole or Absolute. The individual merges into Absolute. There is emphasis on the individual and individual's duty (dharma) to achieve expansion to the Absolute for self-fulfilment rather than to the outer world. The ancient Indian tradition is that education is not mere acquisition of objective knowledge but also its realization attained by withdrawing of mind from the world of matter.

Further, this system assumes that our universe is not limited to what is perceived by sense mechanism. Education then, is to open up other avenues of knowledge than merely what is perceived by five senses or brain. It is the mind that is trained to focus on the principles of knowledge rather than the contents of knowledge; its method therefore, is Yoga – a discipline that originated from Indian soil and constitutes the bedrock of our philosophy and culture.

Aims of Education

These ancient ideals of education, no longer practiced now, have been built up through ages, storing both conscious and unconscious experiences that an individual has passed through. These ideals have not become totally extinct; they exist in vestigial form and in a dormant form. In Western education too, there is a parallel philosophy in which improvement of self has an important place, though self is not used in metaphysical sense. Before proceeding further, we have to discuss the issues relating to aims of education because these are related to value education. While discussing the aims of education, TP. Nunn provides a useful commentary. He believes that 'attempt to state a universal aim of education' is largely misconceived since people's interpretation of whatever aim is proposed will differ according to their different ideals of life; what counts as the formation of character or a preparation for a living for A will be ridiculous or

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rankly offensive to B and so on. Nunn puts forward the alternative. Since ideas of life vary considerably between individuals it follows "that there can be no universal aim of education if that aim is to include assertion of any particular ideal of life; for there are as many ideals as there are persons. Instead, educational efforts seem to be limited to securing for every one the conditions under which his individuality is most completely developed". Another expert, John White says that to insist on development of individuality is to demand a universal aim. Therefore, there is confusion in Nunn's theory and this confusion has persisted into present generation. Whatever the confusion may be, individual development is our great concern. As educators, we have to be clear about what individual development is and how it is to be directed and for what purpose or end.

We must remember that the child or adolescent or even adult we are educating wants his/her good by this education. Even parents would like that the main part of education should be directed towards the good of the child and towards the well being of the child. Also, in education, they see a social mobility and an opportunity that would bring useful employment to a child after completion of education at school or college or wherever education takes place. That a child should develop into a good citizen may be an additional expectation but a job that would enable the child for making a living remains a primary aim these days. Teachers or educators are also equally concerned about the primary aim and lay more emphasis on how the students acquire good knowledge which would enable them to get good grades which in turn would provide further job prospects. All this indicates a student oriented consideration so far as the aims of education are concerned. The expectations of parents in Indian context lie within a spectrum, on one side of which is education that should enable persons to live, to meet their basic needs of food, shelter, clothing and health and on the other side of the spectrum, are expectations which should enable the persons not only to meet the basic needs but also to occupy a position of high status. There may be a section of people in this spectrum for whom the primary aim of education is acquisition of knowledge and skills and shaping of character. Knowledge, they argue can be used for good or bad purposes. It is, therefore, the aim of education to develop in children such dispositions so that they act morally and do not think of using knowledge for bad purposes.

It may be appropriate to discuss whether student-centred aim or the aim of producing good students is the only aim or there are other aims too and secondly, whether aims are the means to certain ends or these are ends in themselves. The other aims including above-mentioned aims are whether education should enlarge its scope to include societal aims. The societal aims are those which are good for the society, as for example, the society needs skilled manpower to maintain its economy; these are also called economic aims. The economic aims would mean that schooling or education would be particularly concerned to prepare children in terms of knowledge, skills and attitudes for producing a work force for maximum material production for economic progress. We may now pause and remember that economic aims must not conflict with student-centred aims discussed above.

Did u know? There is another objection to student-centred education, i.e., it is feared that the students may take no account of moral obligations. If educators promote child-centred aims, then children will think that this is all important; in this way, they may grow up without developing any understanding of moral duties.

One thing that parents, educators and society may like to see in children is that they develop habits like not telling lies or not to steal. They may also like them to have concern for others (as well as for themselves). They would like them to have an understanding about discrimination. Not to tell lies, not to steal or to have concern for others are the objectives that fall in the domain of morality and moral aims. The question is whether we can impose what we believe as moral

on children or students. It is here that we need to bring in the issue of general or liberal education and whether it includes moral education or not. Liberal education means to liberate the child from ignorance. In the days of Aristotle, it meant encompassing all knowledge and learning. But it's meaning and philosophy has been changing. Till the beginning of 20th century, liberal education was considered to be ordained only for leisurely, small and elitist class as contrasted to worker or artisan class.

We have defined liberal education in a general way to avoid involving ourselves into controversy. Despite differing views, there is a sufficient measure of consensus among the educationalists that a liberal education is that education which helps the pupil to become an informed person and a free rational chooser of what to believe and what to do. Also, the essential part is the involvement of pupil not only in instrumental means but also worthwhile intrinsic ends. When we say about free rational chooser, it implies involvement in reason and development of rational mind. The question is whether liberal education should be moral as well as rational. Greeks struggled with this question more than 2000 years ago. They also asked whether morals or virtues could be taught. Of course, it would have to be settled first as to what is meant by morals or virtues. More important thing is to decide whether teaching morals means the same thing as inculcating morality for a moral conduct. We know that teaching ethics, morals or moral philosophy like political science, economics or sociology can be possible. But moral conduct is a behavioural problem and this requires only practice, not a mere theory.

Children, parents or anyone else can say why one should be moralistic. This view may lead into lengthy discussion at the end of which we may have no answer to those who hold such a question. To proceed further, let us take it for granted that people have some concern for others and children ought to be brought up and educated with these values. Now, how can this be achieved? This brings us to the study of theories of education. According to progressive theory, education is the process of development and growth towards the fullest development of one's potentialities in other words; it is full flowering of instincts with which we are born. The other theory is that we are not concerned with instincts, what is important is that children should acquire certain kind of knowledge and understanding instead of depending upon instincts.

Notes John White mentions that "we are not born with mathematical knowledge or understanding, we are also not born with scientific knowledge; we have to deliberately acquire both of these knowledge and understanding". And among these is moral understanding. Thus the "central aim of education is to initiate pupils into all the varied forms of understanding". Let us take it for granted that moral understanding is developed, but where is the guarantee that this understanding would be used for virtuous ends. These can be used for one's own benefit only. Therefore, what is needed is that children should not only develop understanding but also should develop dispositions as well. Disposition means willingness or desire to do something and in case of value education, it means doing something virtuous. We come back to the question of self-interest. There may be people who may say that their self-interest is more important for them. They admit that they are egoistic also. Their experience tells them that they cannot be altruistic. There are also people who may have some concern for others and donate few hundred rupees to war victims; they may not give lakhs; but donating a few hundreds does not hurt their pockets. This is a situation where you have served other's interests, at the same time, not putting demand on your self-interest. Then there are people who believe in the concern of others at one's own cost, i.e., one should care for others and should not care for one's own well-being and, children should be brought up in this way, they may even be indoctrinated to this belief. This may lead some to become puritans. All these types are found in any society. We have come to live with this kind of polarization, which comes from original dichotomy between self-interest and morality.

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What is possible is that one can enlarge his horizon to integrate personal preferences and moral conflicts in such a way that moral demands made on him are minimum. And another way is to make plans in such a way those minimum occasions will arise for such conflicts.

There is much work still to be done in the area of value education, both conceptual and empirical. Concepts have to be worked out carefully and activities have to be planned which may lead to the development of desire characteristics.

Self Assessment

Fill in the blanks:

11. ..... are internationally agreed standards or rules regulating the conduct of states towards their own citizens and non-citizens.
12. Even since the Declaration of Human Rights in 1948, ... has played a key role in implementation of human rights by various governments.

14.7 HIV – AIDS

AIDS has become the most devastating disease humankind has ever faced. Twenty years after finding out the first clinical evidence of acquired immuno-deficiency syndrome (AIDS), it was reported, more than 60 million people have been infected with the virus. HIV/AIDS is now the leading cause of death in sub-Saharan Africa. Worldwide, it is the fourth biggest killer.

Most infants get infected during childbirth or breastfeeding are likely to develop AIDS and die before they are five years old. At the end of 2001, it was estimated that nearly 36.1 million people globally were living with HIV (Human Immuno-Deficiency Virus). In India, this estimate is 3.97 million, placing it second only to South Africa.

In most parts of the developing world, majority of new infections occur in young adults especially in young women. About one-third of those currently living with HIV/AIDS are aged 15 to 24. Most of them do not know that they carry the virus. Millions of others know nothing or a little about HIV to protect themselves against it.

In June 2001, the UN General Assembly adopted a Declaration of Commitment to halt the spread of AIDS by 2015, to identify factors that made individuals vulnerable by 2003 and to ensure implementation of national strategies by 2005. Globally the most vulnerable to this epidemic are those who have unequal access to social and economic rights.

WHO plays a crucial role in providing supports to national programmes for AIDS control and prevention. It calls for urgent action and solidarity in the prevention of HIV and provision of care and support at family and community level.

Most people infected with AIDS are within the age group of 15 to 49 years. Adolescents form the largest segment that indulge in unsafe sex and must be recognized as key target for practicing healthy behaviour. Unsafe and unprotected sexual activity accounts for 85 to 90 per cent of HIV transmission. The most likely carriers of HIV/AIDS are men. This constitutes a large chunk of the mobile population, which consists of migrant workers, truck drivers and labourers. Marginalized street children form another large chunk. Women trapped by prostitution, those who are unable to resist sexual dominance and those subjected to multiple partners are the other most likely carriers of AIDS infection.

AIDS victims live miserable lives and die lonely deaths. All prevention essentially begins at home but does not stop there. Education, communication through mass media, community

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involvement, treatment of reproductive tract infections, safer sex and use of condoms and regular testing are the ways in which HIV infections can be controlled.

Africa needs a special mention as far as HIV epidemic is concerned. More than 6000 people die due to AIDS every day in Africa and this member is likely to be doubled during the next decade (2000-2010). The highest infection rate is in Botswana where 36% of adults are carrying HIV positive, according to UN and WHO reports. Life expectancy has fallen down due to AIDS in many African countries. Since AIDS affects young population, these countries are loosing productive work force.

In Zimbabwe, half of health care budget is used for treating AIDS patients. The economy of these countries is being affected adversely due to this epidemic. Some countries of Africa are taking strong measures to control the spread of AIDS. In Uganda, for example, number of new infections has been dropped out and its infection rate is coming down because of preventive measures.

In India, outbreak of AIDS was observed in the late 1980s particularly in Manipur and now in many states of India. Initially HIV attacked specific group of people like (i) homosexuals (having sex with the members of the same sex) (ii) sex workers and (iii) drug users who are using common needles for injecting drugs.

Thailand and Cambodia are the two countries where occurrence of HIV and sexually transmitted diseases (STD) was high but now preventive measures undertaken by them have lowered the incidence. This has become possible by extensive use of condoms. Condoms use has increased from 30% to 90% between 1990 and 1997. Occurrence of STD has declined upto more than 90% in 1990s. In both the countries, it was possible to have success in preventive measures due to political will and increased budge provisions. Increasing public awareness through the help of NGOs and media has been another contributory factor.

Besides, preventive measures like use of condoms, clean needles and use of right information through media, contribution of social, cultural and economic factors cannot be ignored. One important lesson from cases which have had success stories of prevention of HIV is that educating community that is at great risk is a very crucial factor. The education and information regarding various aspects of HIV should also be focused in dealing with problems attached to the disease and discrimination against those having HIV and AIDS.

Despite the crucial role of family welfare services on the future development programmes and the future of socio-economic conditions, family planning services are not accessible to all those who need them. There are, however, some countries (Saudi Arabia, Argentina) where government policies do not permit access to family planning services specially contraceptives. There are also reports which show that in many countries husbands do not extend cooperation for adoption of family planning.

Information and education are key elements in adopting family welfare programme. In countries like Thailand, people of every age group are given education on the importance of family planning programmes. The teachers use population-related examples in teaching various subjects. This has led to reduction in population growth in Thailand from 3.0% in 1960 to 1.0% in 2000. Iran is another example where change in population policies of the Government in late 1980s led to reduction in population growth rate from 4% to 1% in 2001. This was possible by providing large sum of money in budget, opening family welfare centres in small areas and by performing sermons by religious leaders who advise people that it is their duty to have fewer children. This can be a model for other developing countries.

In order to constrain population explosion, it is desirable that all those who need family planning services must have an access to them. The United Nations estimated that the world needs 17 billion US dollars a year for family welfare programmes which is equivalent to one-week military expenditure.

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Self Assessment

State whether the following statements are true or false:

13. About one-third of those currently living with HIV/AIDS are aged 15 to 24.
14. WHO plays a crucial role in providing supports to national programmes for AIDS control and prevention.

14.8 Women and Child Welfare

According to WHO reports, women live longer than men. Therefore, quality of life is very important for them to maintain physical, social and mental well-being. Improvement in health care of females during childhood, adolescent, pregnancy, middle and old age is very important.

There has been an unprecedented economic and social gain during the last 50 years or so. In both the developed and the developing countries and particularly in the latter, there has been increase in GDP (Gross Domestic Product) and exports, these being the indicators of economic progress. Food production has been increased and living standards are becoming better. Life expectancy has increased from 45 to 65 years between 1950 and 2000. Infant mortality rates have declined and many diseases have been controlled due to immunization. Still much more needs have to be done. In case of women, health and well-being is closely linked with their status in the society; discrimination against women affects their status and then the progress and development of the nations. In many parts of the world, there is discrimination against women; female babies are unwanted in many cultures and societies.

Caution Many societies do not permit some rights to girls as the boys have and there is also a big gap in the status among women living in rural and urban areas. But situation has been changing during the last three decades or so. There is now an increased participation of women in economic, social and political life. This has resulted in change in the life style of family especially in urban areas. Women empowerment became the buzzword and the public and media started paying more attention to the role of women both in the society and family life.

Among various health problems, women of age group 15 to 20 and those who give birth to babies need special attention. More than 10% of babies worldwide are born to this age group. These are high-risk births and problematic both for the health of the mother and child. Infant morality for babies born in this age group is much higher than for the women in the age group of 21 to 30. Unless there is increase in educational and economic status of young women, these babies born to women of age group 15 to 20 would remain at high risk in terms of health.

WHO in a report examined the differences between men and women regarding access to health care and rights. According to this report, the factors that affect health and status of women are not only biological but also social, cultural, environmental and political. This means that women have to play vital roles beyond being wives and mothers. The report also examines the roles and responsibilities of men in removing the inequalities between men and women.

It may be noted that according to census record of 1991, ratio of women to men has decreased with every ten years. In 1981, it was 972 females to 1000 males and in 1991, it was 927 to 1000.

In 1992, India ratified the UN Convention on the Rights of Child (1989). The basic principles of this convention are:

1. ***Equality and non-discrimination:*** According to this principle, the parties who have ratified the convention shall respect and ensue the rights set forth in the convention to each child

without discrimination irrespective of child's parents or guardians, race, colour, sex, language, religion, political or ethnic, social, birth or other status.

2. In all actions concerning children, whether undertaken by the government or private social welfare institutions, the best interest of child shall be given primary consideration.

3. The right of every child to survival and development must be protected. This implies that rights of women have to start with girl child.

Statistics in India shows that among deprived and disadvantaged children who are denied their right to education, girls outnumber boys. This can be attributed to inequality within family and society, child labour, early marriage and adolescent pregnancies. The older girl child is kept at home and does not go to school because she is made to look after the younger brothers and sisters so that mother can go out to earn livelihood. Even when they are enrolled in school, the girls are expected to undertake heavy domestic work at an early age and are expected to perform both educational and domestic responsibilities.

14.8.1 Child Development

Child development not only includes physical health of a child but also whole development that includes mental, emotional and educational aspects. Right from the first year of their life, the infants need care to develop a sense of security and trust. The child's development in early years of life has a life-long impact, therefore early nutrition, immunization, schooling and other social aspects are very important. The best child development should include strengthening the health of mothers to take care of the infants especially unto 4 years of age. This would reduce infant morality. By improving their health, mothers would take care of children born with low birth weight. Studies have shown that physical and mental development of any child is related to early childcare. Since poverty continues to be the major constraint in child development programme, intervention of governments and political forces are required for achieving the goals of healthy child development practices.

There have been significant improvements in infant's health, during the last 50 years. World's infant mortality rate has fallen from 210 to 178 per 1000 babies born between 1950 and 1995. (There are regional differences, no doubt.) This became possible because of early nutrition and prevention of infectious diseases, better hygienic conditions and water supply. Childhood diseases are on decline; small pox is eliminated. However, infant mortality is still high largely due to malnutrition, measles, respiratory diseases and diarrhoea; other major causes are tetanus and AIDS.

Immunization, improved nutrition, better sanitation and water supply can prevent infant mortality further. There is no doubt that efforts are being made by developing countries to follow these preventive steps. Immunization alone has produced dramatic improvements. Epidemic of polio occurred in many countries in 1950s and earlier, but now anti-polio vaccine (drops) has resulted in disappearance of polio in developed countries. Same is the case with measles. Mass immunization has resulted in elimination of measles in developed countries. In developing countries, measles is yet to be eliminated because of financial constraints. Tetanus and diphtheria are common childhood diseases but they are preventable by immunization.

Notes The findings of WHO and UNICEF indicate that childhood deaths are mainly caused by (i) diarrhoea (ii) pneumonia (iii) measles (iv) malaria and (v) malnutrition. Therefore, an integrated approach is required for proper child development.

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Low birth-weight is another important factor to be considered in child development. The factors responsible for low birth-weight are poor nutrition of mother during pregnancy or short interval pregnancies. Low birth-weight children are at high risk of death during the first week of birth. Breast-feeding is one of the most effective methods in early development of child. In many developed countries, breast-feeding now is on increase. Iodine deficiency is another matter of concern for child development. The deficiency of Iodine can cause brain damage and mental retardation. About 15% of world's population suffers from diseases caused by iodine deficiency. Iodine supplement in salt can help this.

Rheumatic fever is another disease of childhood. It can lead to rheumatic heart disease. There is not much decline in the occurrence of this disease in the developing countries.

14.8.2 Effect of Social, Economic and Cultural Changes on Child Development

Many diseases of childhood are being controlled by the efforts of international agencies and various governments. Yet it must be remembered that a healthy growth and development of a child is influenced by social, economic and cultural factors irrespective of the countries' economic differences. Child or women abuse is a common phenomenon seen in all the countries and this has a serious impact on child development. Abuse may be physical, social, sexual or emotional. Childhood labour, poverty, neglect by parents (because they have to work long hours outside home for earning livelihood) are the few aspects of social and cultural deprivation. In the process of urbanization, many poor migrate from villages to towns and big cities for employment. In big towns and cities, there is a lack of proper facilities for housing, health and education to meet the requirements of migrant families and their children. As a result, slums emerge and slum children remain deprived. Poor living conditions and inadequate care during childhood result in violent behaviour when these children become adolescent and adults. They develop their own value system that may be different from the society at large. It is, therefore, very appropriate and important to have an understanding of the broader aspects of society that relate to child development.

Self Assessment

Fill in the blanks:

15. ..... not only includes physical health of a child but also whole development that includes mental, emotional and educational aspects.
16. Immunization, improved nutrition, better sanitation and water supply can prevent .....

14.9 Role of Information Technology in Environment and Health

We are in midst of IT (Information Technology) revolution. Recent development in information and communication technology has opened up new ways of producing data, analysis of data and their dissemination. It has now become possible to share the information and knowledge of world's databank store in respect of environment and health both in developing and developed world. Rapidly developing information systems, internet, satellite broadcasting and telecommunication network through fibre optics are changing the ways in which world communicates in matters relating to many human activities including health and environment protection. We are now building information societies in which citizens can participate in decision making process and strengthen the community links. Communication through internet in contrast to any other telecommunication advances has revolutionized the information flow.

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Environmental information system (ENVIS) of the Ministry of Environment and Forests, Government of India is engaged in collation, storage, retrieval and dissemination of data through its networks to all concerned centres. The network partners of ENVIS are developing their database and homepages. ENVIS network and its partners process and respond to queries, both at national and international levels. The major queries relate to air and water pollution, human settlement, wetlands etc. ENVIS updates the website of the Ministry of Environment and Forests periodically. Many documents like annual reports notifications, guidelines for environmental clearance, forestry projects, environmental acts and regulations can be accessed easily through websites.

The Sustainable Development Networking Programme (SDNP) provides information on various environmental issues. This website can be browsed in the URL: http://sndp.delhi.nic.in. Various services being provided by SNDP include information on Sustainable Development issues obtained from many national and international journals, important conferences and workshops. Large numbers of ENVIS nodes are being set up in State Governments Departments, State Pollution Control Boards, Universities and other institutions to develop nationwide web enabled network on environmental information.

According to a Report of Ministry of Environment and Forests, the following thrust areas have been identified for setting up ENVIS nodes throughout the country:

1. Municipal Waste Management
2. Environmental Biotechnology
3. Conservation of Ecological Heritage and sacred sites in India
4. Coastal Regulation Zone Management
5. Environmental Audit
6. Renewable Energy Resources
7. Environmental Economics
8. Environmental Law
9. Medicinal Plants
10. Marine Ecosystem
11. Bamboo Conservation
12. Micro organisms and Environmental Management
13. Eco-labelling and Eco-friendly products
14. Environmental problems in tea gardens
15. Desert Ecosystem
16. Biomedical Wastes Management
17. Island Ecosystem
18. Wetland Ecosystem
19. Natural Disaster Management
20. Coastal Management
21. Global Environmental problems like Global Warming and Ozone Depletion.

Notes

ENVIS also functions as National Focal Point and Regional Service Centre for South-Asian countries for INFOTERRA network, a Global Information Network of United Nations Environmental Programme providing information on various environmental issues.

ENVIS also keeps liaison with various national information systems like NISSAT (National Information System on Science and Technology) for exchange of environmental information. Information Revolution has helped the various stakeholders to address the issues of Environmental concern in a systematic and quick way. Development of database on various subject areas has enabled to retrieve knowledge and information instantly for public, free of cost. Database on Environmental Impact Assessment; various aspects of Energy and Environment; Western Ghats Ecology; NGOs and media (data located at WWF-India) pesticides and toxic chemicals; desertification; environmental education; Biodiversity; Panchayati Raj and Environment; eco-tourism and many other areas are available.

Information and Communication technology has opened up new way of producing, analyzing and disseminating data on health too. The information on rapid changes on drug development, safety and treatment needs to be reliable and update. This has now become possible with the help of information technology.

WHO has built comprehensive data bank on health and disease. The internet surfers can find out huge information by connecting to WHO site on World Wide Web. Abstracts of journals and even complete texts are available through this medium. WHO has also produced CD-ROMs that contain data on libraries, publications and catalogues. There is also facility of e-mail for sharing information and exchanging ideas with WHO. Dissemination of information through electronic media has now become a means of communication, between doctors and doctors and between doctors and patients. And globally it has become possible to monitor the disease through sophisticated record system developed by health agencies.

Self Assessment

State whether the following statements are true or false:

17. WHO has not built comprehensive data bank on health and disease.
18. The Sustainable Development Networking Programme (SDNP) provides information on various environmental issues.

Case Study

Challenges Facing India "From Family Planning to Reproductive Health"

More than 45 years ago, India became the first country in the developing world to initiate a state-sponsored family planning program with the goal of lowering fertility and slowing the population growth rate. Since the program's inception, fertility levels have declined throughout the country, at varying paces in different regions; overall, the total fertility rate decreased from 6.4–; 6.6 lifetime births per woman in the early 1970s to 3.4 births per woman in the mid-1990s. Since the 1960s, however, the Indian population has continued to grow by approximately 2% annually and has more than doubled in size, from 439 million in 1961 to an estimated 930 million in 1996. The population is expected to grow beyond 1.5 billion before it stabilizes.

Despite the decline in fertility, the reproductive health situation in India remains poor: Although the rate of infant mortality declined from more than 200 infant deaths per 1,000

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live births in the 1960s to approximately 74 per 1,000 live births in the 1990s, maternal mortality ratios (550 deaths per 100,000 live births) remain among the highest in the world. Moreover, two-thirds of Indian women go through pregnancy and childbirth without seeing a trained birth attendant, and obstetric and gynecological disorders are widely prevalent and remain largely untreated and silently borne. The AIDS pandemic has added another dimension to the poor reproductive health scenario; it is expected that by 2005, some one million Indians with AIDS will require medical attention. Finally, while contraceptive prevalence increased from barely 10% in 1971 to 46% in the mid-1990s, contraceptive choice and quality of care within the Indian program remain problematic.

Since its inception in 1951, the National Family Planning Program has been dominated by demographic goals. The government introduced method-specific family planning targets in the mid-1960s, wherein state targets were set by the central government and then pursued at the local level. The program focused primarily on sterilization, largely obviating client choice and limiting availability to a narrow range of services. The program subsequently evolved into the Family Welfare Program, which currently administers family planning and maternal and child health services through various primary and community health centres and district and subdistrict hospitals.

In April 1996, the Indian government decided to abolish method-specific family planning targets throughout the country. In October 1997, India reoriented the national program and radically shifted its approach to more broadly address health and family limitation needs. The new approach involves a more comprehensive set of reproductive and child health services and a focus on client choice, service quality, gender issues and under-served groups, including adolescents, postmenopausal women and men. The objective of this article is to trace the roots of this change in orientation, document the program's achievements to date and examine the challenges that remain at the policy level, at the implementation level and in the overall socioeconomic environment in establishing a program that truly meets clients' health needs.

In 1992, the Indian government published its eighth five-year plan, and with candor listed several factors that had contributed to the poor realization of its family welfare goals. According to this report, the family planning program, which had been conceived and implemented by the Ministry of Health and Family Welfare, had suffered from centralized planning and target-setting that allowed for little innovation or flexibility. That same year, the government launched the Child Survival and Safe Motherhood Program to enhance the health of women and children and further reduce maternal and child mortality. The Family Welfare Program, however, continued to emphasize family planning services, and the child survival components of the new program—especially the expansion of child immunization services—were implemented earlier than the safe motherhood components. Therefore, the overall national program still offered little to improve the quality or availability of reproductive health services for women. In addition, monitoring of the national family planning program entailed only routine reporting of target goals, making it difficult to identify problems in service delivery and therefore impossible to take corrective action. Responsibility for achieving method-specific contraceptive targets was passed to successively lower administrative units. Failure by local health workers to achieve the targets often led to serious consequences, such as reprimands from supervisors, withdrawal of annual salary increments and job transfers to undesirable posts. As a result, providers often over-reported the use of reversible contraceptives or coerced couples into accepting sterilization in order to meet program expectations. In short, the program as implemented was insensitive to the needs of clients and discouraged community involvement.

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The government report acknowledged other problems as well: Both initial and on-the-job training of service providers had been poor; information and education efforts had been ineffective, presenting family planning as a means to contain population growth rather than as a way to improve a family's economic and social status by limiting births; the infrastructure for extension services in some of the more populous regions was lacking; the program had few resources for new initiatives or for strengthening health care services; and the government program allowed for little active involvement of the community. As awareness of the existing program's weaknesses was growing, evidence emerged that data from assessments of the program did not correspond with data from population-based surveys: Contraceptive use rates calculated from program statistics were inconsistent with observed fertility levels, and official program-based protection rates were significantly higher than survey-based contraceptive prevalence rates.

Since the mid-1970s, when the Indian government vigorously promoted sterilization as a means of population control, various stakeholders have voiced concern about the national family planning program. Some women's organizations, for example, have viewed the government's approach as a violation of human rights. Additionally, the poor quality of care offered by contraceptive providers has been considered indicative of the government's lack of respect for women's health. Some groups have protested against the government's conducting clinical trials of hormonal contraceptives, claiming that proper ethical procedures were not followed. These protests received some media attention but little notice from official quarters.

After the release in 1985 of the 1985-1990 five-year plan, however, the government itself recognized and publicly acknowledged the inherent constraints in state-administered social-sector programs in general, and the limited impact of the family welfare program on birth rates in particular. The donor community also played an important role in pressuring the Indian government to change the focus of its family planning program. For example, donor agencies supported field-based research on women's health and quality of care. They also sponsored an initiative that encouraged discussion between women's groups, primary health care advocates, demographers and family planning service providers in state-level meetings to prepare for the 1994 International Conference on Population and Development (ICPD).

At these pre-conference meetings, participants reached a consensus that ethical considerations, proper procedures and high quality care cannot be compromised in a zealous pursuit of demographic goals. Attendees identified four key issues that the Indian government needed to address if its family planning program was to effectively meet women's needs: maintaining efficient program management; ensuring quality of care; widening the scope of services to cover comprehensive reproductive health; and using communication and media to disseminate information. In 1994, national-level meetings were organized by regional nongovernmental organizations in 18 major states to develop specific action points on the first three issues.

The ICPD, held in Cairo in 1994, and the World Conference on Women, which took place in Beijing the following year, generated additional pressure from the global community for changes in the focus and approach of the Indian family planning program. At these meetings, women's groups from around the world shared their experiences and developed a solidarity that empowered them to successfully petition their own governments to better address women's needs. In December 1994, a small group of individuals involved in the pre-Cairo consultative process formed HealthWatch, a network of like-minded nongovernmental organizations, activists, researchers and concerned citizens, to engage both government and funding agencies in ongoing dialogue about India's population

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policy. HealthWatch provided constructive criticism, offered alternative strategies and facilitated the development of monitoring indicators.

A year later, in April 1996, the government of India took an even bolder step: It announced that the national family planning program would become target-free. This decision also was made without adequate discussion about what would replace the old system and without assessing the experience of several districts that had become target-free in 1995. The target-free approach of 1996 meant that centrally determined targets would no longer "be the driving force behind the program." Instead, the community's service needs would determine the program's priorities. With the new approach, planning was to be decentralized and responsibilities were to reside at the level of the primary health centres: Targets would be set by local health workers, "in consultation with the community at the grassroots level." At the policy level, the central government's shift to a target-free family planning approach was a necessary first step toward enhancing the quality of services nationwide. At the state and district levels, however, where the new program was to be implemented, program staff was offered little guidance other than receipt of the program's target-free manual to orient them to decentralized planning.

During the first year, the new approach was met with a great deal of scepticism and confusion, along with several serious concerns: that the target-free policy was a signal to ignore family planning; that the new approach would reverse gains already made toward population control; that target-free would be interpreted as "responsibility-free"; and that program workers would relax and under perform. Moreover, many questions remained: If no targets were to be imposed, how would worker performance be evaluated? What would happen if family planning performance declined, as it very likely would? In their uncertainty over the consequences of the new approach, many states continued to impose targets, setting local goals based on the previous year's centrally assigned targets.

In 1991–1992, as a consequence of the government's effort to capitalize on fertility changes that were already occurring in Tamil Nadu, the state was freed from pursuing method-specific targets, and became the first to adopt a target-free approach. The program emphasized the role of nurse midwives in the provision of contraceptive services, and workers were not pressed to fulfil sterilization targets. Measures of contraceptive prevalence and of maternal and child health in the state indicate that the program has had some success: By 1995, contraceptive prevalence for all four methods offered (female sterilization, the IUD, oral contraceptives and the condom) had increased.

In October 1997, the government launched the Reproductive and Child Health (RCH) Program. The RCH program entails a change not only in program policy but in management and implementation as well. The goals of the RCH program include: removing all targets; phasing out incentive payments to both providers and acceptors of family planning methods; increasing utilization of existing facilities rather than creating new structures; and using the voluntary and private sectors to increase access to services and fill gaps left by public-sector providers. The RCH program utilizes district-level planning and monitoring to make it more responsive to local needs, and it focuses on improving the quality of care by emphasizing the needs of the client, involving the community, improving the client-referral system and providing local oversight for female health workers. The program strives to revitalize the existing network of rural health facilities by improving supplies of drugs and equipment and enhancing training so workers can provide better information and counselling to clients and communities.

Few models exist that can serve as guides for the provision of comprehensive reproductive health services. However, the experiences of a small but growing number of

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nongovernmental organizations demonstrate that many concerns about the implementation of the RCH program could be allayed. Local programs vary in their approach, but they are similar in their emphasis on comprehensive services for women and children and in their focus on women's rights and choice. These programs include attention to clinical services and counselling; a focus on health promotion; expansion of services to unmarried women, men, adolescent girls and boys and postmenopausal women; reliance on local women as community health workers; innovative and repeated training of workers using folk and other media; and nominal fees for services.

One example of such a program, located in Tamil Nadu, is the Rural Women's Social Education Centre, a grassroots women's organization. In response to the community's needs, the program gradually shifted its focus from health promotion, education and women's rights to include clinical services. It now offers a wide range of educational and clinical services involving local women both as health workers and in the management of the program. Assessments of the performance of local nongovernmental organizations are generally positive. For example, in the case of several Tamil Nadu centres, data maintained by the organization, along with reports from health workers, suggest that health awareness, health-seeking behaviour and health status have improved significantly over time among community members: Women have learned to recognize danger signals during pregnancy and the symptoms of reproductive tract infections, and the proportion of deliveries that are assisted by a health care provider has increased dramatically.

Women remain one of the most underserved segments of the Indian population. The almost singular focus of the Indian Family Welfare Program on female sterilization resulted in the neglect of many areas of women's reproductive health. An expanded reproductive health program must include access to safe, effective and affordable methods of family planning for both women and men, informed choice in contraception and high-quality supplies. It also must promote safe motherhood and the prevention of sexually transmitted diseases, and make efforts to reduce violence against women. It must provide access to safe and affordable abortion services, as well as services for the infertile, and comprehensive and accurate information about reproductive health care, including the risks and benefits of different contraceptive methods. Programs must have well-trained service providers with good interpersonal communication and counselling skills, and must offer appropriate follow-up care and regular monitoring and evaluation of performance, incorporating the perspectives of clients and beneficiaries. An expanded program also must offer services to a wide range of clients, not just to married women of childbearing age. Unmarried women, adolescent girls and boys and postmenopausal women all have distinct needs for information and services. Perhaps most important, an expanded reproductive health program must address men, both in terms of their own health needs and in terms of their role in ensuring reproductive health and choice for their wives. These changes cannot be accomplished without major shifts in the delivery of services. In order to address women's health concerns in a timely manner, for example, weekly visits to primary health centres by a gynaecologist will be necessary. Strategically placed emergency obstetric services and access to specialists will be required, as will attention to overcoming obstacles to accessing facilities, such as transportation to and from remote locations. In addition, counselling capacity and referral chains also will need to be strengthened.

More attention has been paid in the Indian Family Welfare Program to physical infrastructure, personnel and equipment than to standards of care. In addition, expanding the scope of services is a necessary but not sufficient step toward improving women's access to quality health services. The health care delivery system has been largely insensitive to the needs of women and the constraints they face in expressing their needs—let alone

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the obstacles they face in obtaining services. Extension services, essential for secluded women, are rarely undertaken, and health workers are poorly informed about reproductive morbidity. There is little understanding of the perceptions, beliefs and attitudes that workers may need to address in order to enhance clients' compliance and confidence. Accordingly, workers may not ask important probing questions, and they may also fail to recognize symptoms.

Service delivery strategies have not addressed the serious constraints that women face in acquiring good health care: Vulnerability, lack of autonomy, unequal social status and limited access to economic resources inhibit a woman's capacity to seek health care and may even limit her ability to recognize that she is in need of services. Even when a problem has been identified, women may not be able to obtain proper treatment because accessing the service is too difficult or because the expense is deemed unnecessary. Constraints on women, and therefore on their health-seeking behaviour, operate through social beliefs, norms and practices that are dismissive of women, through segmented markets for land, labour, credit and technology that deprive them of independent resources, and through discriminatory legal practices and government insensitivity that limit their rights.

The empowerment of women to gain greater control over the circumstances of their own lives is a necessary condition to overcoming these obstacles. Women must be encouraged to recognize and articulate their health needs and concerns and to access services with confidence. At the same time, they must be prepared to challenge service providers and program managers to make them more accountable. Full access to appropriate care for women requires the creation of an environment that supports women's efforts towards self-determination.

The challenge lies in reorienting communication and education activities to incorporate this wider interpretation of reproductive health, to focus attention on the varying information needs of women, men and youths and to utilize the media most suitable to convey information to these diverse groups. This kind of reorientation requires a fresh look not only at messages and media, but also at the training of communicators.

Questions:

1. Study and analyze the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.guttmacher.org/pubs/journals/25s4499.html

14.10 Summary

- Growing population in developing countries means higher demand for energy, though it may not be of same magnitude as in developed ones.
- Expanding population of the world, especially of the developing countries means more pressure on natural resources.
- In developing countries, as contraceptive use has risen from 10% on average in the 1960s to over 50% today, the total fertility rate has fallen by half.
- The term population explosion means rapid growth in population which affects the economic growth and progress of the per capita income of the people.

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- The current rate of population growth in India is 1.58% and the total fertility rate is 3.
- Population explosion in India can be checked either increasing death rate or reducing birth rate increasing death is suicide method or this is not possible from the humanitarian point of view.
- In India, as in many developing countries, the family planning programme is the most direct public policy measure initiated to reduce the population growth rate.
- As per Constitution of India, Family Planning is in the Concurrent list. The approach under the programme during the First and Second Five Year Plans was mainly "Clinical" under which facilities for provision of services were created.
- Climate change is also posing risks to human population health and well-being and thus is emerging as a serious concern worldwide.
- Environmental health problems vary dramatically from region to region, reflecting geography, climate, and perhaps most important, a country's level of economic development and policy choices.
- Human Rights are internationally agreed standards or rules regulating the conduct of states towards their own citizens and non-citizens.
- In fact, after 1948 Declaration, two organizations were formed namely International Convention on Economic, Social and Cultural Rights and the International Convention on Civil and Political Rights.
- Human rights have been identified and operate through commissions or committees in many countries.
- About one-third of those currently living with HIV/AIDS are aged 15 to 24.
- Among various health problems, women of age group 15 to 20 and those who give birth to babies need special attention.
- Child development not only includes physical health of a child but also whole development that includes mental, emotional and educational aspects.
- Recent development in information and communication technology has opened up new ways of producing data, analysis of data and their dissemination.

14.11 Keywords

Child Development: Child development is the sequential progression of changes in the body and abilities as the child grows from birth to adolescence.

Child Welfare: "Child welfare" is a term used to describe a set of government and private services designed to protect children and encourage family stability.

Climate Change: Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years.

Economy: The wealth and resources of a country or region, esp. in terms of the production and consumption of goods and services.

Environmental information system (ENVIS): The Environmental Information System acronymed as ENVIS was implemented by the Ministry by end of 6th Five Year Plan as a Plan Scheme for environmental information collection, collation, storage, retrieval and dissemination to policy planners, decision makers, scientists and environmentalists, researchers, academicians and other stakeholders.

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Epidemics: Disease that spreads rapidly and affects an inordinately large number of people within a very short period.

Family Welfare Programmes: The Family Welfare Program (FWP) seeks to introduce the concept of promoting the welfare of workers and their families as a key to workplace productivity and improved worker-management relations.

HIV - AIDS: Human immunodeficiency virus infection / acquired immunodeficiency syndrome (HIV/AIDS) is a disease of the human immune system caused by infection with human immunodeficiency virus (HIV).

Human Rights: Human Rights are internationally agreed standards or rules regulating the conduct of states towards their own citizens and non-citizens.

Information Technology: Information technology is the use of computers and networks to store, process, and receive data.

Polygamy: Polygamy is a marriage that involves multiple spouses instead of just two.

Population: A population is all the organisms of the same group or species who live in the same geographical area and are capable of interbreeding.

Population Explosion: The term population explosion means rapid growth in population which affects the economic growth and progress of the per capita income of the people.

World Health Organization (WHO): The World Health Organization (WHO) is a specialized agency of the United Nations (UN) that is concerned with international public health.

14.12 Review Questions

1. "Human population of the world has got doubled during the last 50 years" Elucidate.
2. Critically analyse the rate of population growth has been different in developed and developing countries.
3. How to Ease Pressure Caused by Population Explosion?
4. Define Population Explosion. What are its causes?
5. Throw some light on the effects of Population Explosion.
6. Describe the remedial measures to check the population.
7. Explain the evolution of Family Welfare (FW) Program.
8. What are the objectives of Family Welfare Programmes?
9. How environment affect human health?
10. Write brief note on Human Rights.
11. "AIDS has become the most devastating disease humankind has ever faced." Discuss.
12. Discuss the role of WHO in Health Awareness Programme.
13. Highlight the effect of social, economic and cultural changes on Child Development.
14. Explain the role of Information Technology in environment and health.

Notes

Answers: Self Assessment

1.	True	2.	False
3.	Natural Resources	4.	Family Size
5.	False	6.	False
7.	Medical Termination of Pregnancy	8.	Sixth
9.	True	10.	False
11.	Human Rights	12.	UN
13.	True	14.	True
15.	Child Development	16.	Infant Mortality
17.	False	18.	True

14.13 Further Readings

Books

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http://www.publishyourarticles.net/knowledge-hub/environmental-studies/population-explosion-causes-of-the-rapid-growth-of-population.html

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