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Environmental Studies

About the Author

Raj Kumar Singh is currently Head of Department and Associate Professor, Department of Zoology, Sardar Bhagat Singh Government Post Graduate College, Rudrapur, Uttarakhand. He has been teaching biosciences ecology, environmental sciences and wildlife biology since the past 13 years. Dr Singh has completed his MSc, MPhil and PhD.

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Head and Associate Professor
Department of Zoology
Sardar Bhagat Singh Government Post Graduate College, Rudrapur
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Dedicated to

My father-in-law
Kirat Singh Chauhan

Contents

Preface

I am delighted to write a few words about *Environmental Studies*. This book has been written according to the syllabus designed by the UGC for a core course in Environmental Studies. It will be useful for undergraduate students, of all Indian universities, studying this subject as part of their BSc, BCom, BA and BTech course.

Salient Features

- Based wholly on the UGC course curriculum
- Simple and holistic approach using case studies
- Balanced micro- and macro-level analysis of human interaction with the environment
- Dedicated chapter providing guidelines for field work
- A variety of pedagogical features such as summary, chapter-end review and objective questions have been included to facilitate complete test preparation and quick revision

Chapter Organisation

This book comprises 8 chapters. **Chapter 1** elucidates the multidisciplinary nature of environmental studies. It defines key terms with varied perspectives, presents the scope and importance of environmental studies and highlights the need for public awareness about key environmental concerns. It also describes disaster management as part of environmental education. **Chapter 2** on natural resources explains the concepts of renewable and non-renewable resources. It describes forest resources, water resources, mineral resources, food resources, energy resources and land resources with respect to their uses; outlines the advantages and disadvantages of overexploiting these resources; and analyses the future of these resources with regard to current use. This discussion is supported by numerous real-world case studies and enumeration of conservation activities that can be implemented at micro and macro levels. **Chapter 3** provides in-depth explanation of the concept of an ecosystem, highlighting details of structure—abiotic and biotic components, functions and types of ecosystems. Ecological succession has been described along with food chains, food web and ecological pyramids. **Chapter 4** elucidates biodiversity in its essence. The chapter provides information on the levels of biodiversity—species, ecosystem, genetic; along with ecological, social, ethical, commercial, aesthetical value of biodiversity. It gives an account of endangered plants and animals under threat to biodiversity. It focuses on conservation of biodiversity enumerating national parks, wildlife sanctuaries, zoological and botanical gardens in India. Sections on biogeographical classification of India; biodiversity at global, national and local levels; and India as a megadiversity nation, are key features of this chapter.

Chapter 5 highlights the growing concern of environmental pollution. It elaborates on the types of pollution—air, water, soil, marine, thermal, noise and radioactive, enumerating the causes, effects and methods of control. Role of an individual in prevention of pollution and real-world case studies are notable features of this chapter.

Chapter 6 explains social issues related to the environment. It discusses problems of adequate and clean energy, water and land in urban environments. Larger concerns such as ozone layer depletion, climate change, global warming, acid rain, nuclear accidents have been described in view of their cause and impact. Other topics—environmental ethics, rehabilitation of people, consumerism and waste creation have been discussed as concerns with emphasis on waste land reclamation, water conservation and Acts for protection of environment as some of the positives, laying emphasis on sustainable development. **Chapter 7** presents a comprehensive discussion on the relation between human population and the environment. It offers a fresh perspective on population growth and resource share and use, among the nations of the world. Topics such as environment and human health, HIV/AIDS, human rights, value education have also been covered. Further, it discusses family-, women- and child-centric welfare programs. A section on the role of technology comprising Geographical Information System (GIS), geoinformatics, photogrammetry with respect to the environment has also been included. **Chapter 8** provides guidelines for field work through experiments that can be carried out in an urban or rural polluted site, or an industrial site. It also includes documentation of hot spots, and study of common trees, plants and insects in an area/city.

A concise textbook on this core subject, taught across various streams, was long overdue. I hope *Environmental Studies* will fulfill the expectations of faculty and students alike. This book is also an attempt to create mass awareness about the environment and its pressing concerns today.

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Raj Kumar Singh

Publisher's Note

Do you have a feature request? A suggestion? We are always open to new ideas (the best ideas come from you!). You may send your comments to *tmh.sciencemathsfeedback@gmail.com* (don't forget to mention the title and author's name in the subject line).

Roadmap to UGC Syllabus for Environmental Studies

Unit 1: The Multidisciplinary Nature of Environmental Studies

- Definition, scope and importance.
- Need for public awareness.

Go to CHAPTER 1—INTRODUCTION

Unit 2: Natural Resources: Renewable and Non-Renewable Resources

- Natural resources and associated problems.
  - (a) ***Forest resources:*** Use and overexploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
  - (b) ***Water resources:*** Use and overutilisation of surface and ground water, floods, drought, conflicts over water, dams—benefits and problems.
  - (c) ***Mineral resources:*** Use and exploitation, environmental effects of extracting and using mineral resources. Case studies.
  - (d) ***Food resources:*** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertiliser-pesticide problems, water logging, salinity. Case studies.
  - (e) ***Energy resources:*** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
  - (f) ***Land resources:*** Land as a resource, land degradation, man-induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Go to CHAPTER 2—NATURAL RESOURCES

Unit 3: Ecosystem

- Concept of an ecosystem.
- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following ecosystem:
  (a) Forest ecosystem
  (b) Grassland ecosystem
  (c) Desert ecosystem
  (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estauries)

Go to CHAPTER 3—ECOSYSTEM

Unit 4: Biodiversity and its Conservation

- Introduction, definition: Genetic, species and ecosystem diversity.
- Biogeographical classification of India.
- Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values.
- Biodiversity at global, national and local levels.
- India as a megadiversity nation.
- Biodiversity hot spots.
- Threats to biodiversity: Habitat loss, poaching of wildlife, man–wildlife conflicts.

- Endangered and endemic species of India.
- Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Go to CHAPTER 4—BIODIVERSITY

Unit 5: Environmental Pollution

- Definition.
- Causes, effects and control measures of
  (a) Air pollution
  (b) Water pollution
  (c) Soil pollution
  (d) Marine pollution
  (e) Noise pollution
  (f) Thermal pollution
  (g) Nuclear hazards
- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution.
- Pollution case study.
- Diaster management: Floods, earthquakes; cyclones and landslides.

Go to CHAPTER 5—ENVIRONMENTAL POLLUTION

Unit 6: Social Issues and the Environment

- From unsustainable to sustainable development.
- Urban problems related to energy.
- Water conservation, rainwater harvesting, watershed management.
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation.

- Consumerism and waste products.
- Environment Protection Act.
- Air (Prevention and Control of Pollution) Act.
- Water (Prevention and Control of Pollution) Act.
- Wildlife Protection Act.
- Forest Conservation Act.
- Issues involved in enforcement of environmental legislation.
- Public awareness.

Go to CHAPTER 6—SOCIAL ISSUES AND THE ENVIRONMENT

Unit 7: Human Population and the Environment

- Population growth, variation among nations.
- Population explosion and family welfare programs.
- Environment and human health.
- Human rights.
- Value education.
- HIV/AIDS.
- Women and child welfare.
- Role of Information Technology in environment and human health.
- Case studies.

Go to CHAPTER 7—HUMAN POPULATION AND THE ENVIRONMENT

Unit 8: Field Work

- Visit to a local area to document environmental assets—river/ forest/grassland/hill/ mountain.
- Visit to a local polluted site—urban/rural/industrial/agricultural.
- Study of common plants, insects, birds.
- Study of simple ecosystems—pond, river, hill slopes, etc.

Go to CHAPTER 8—FIELD WORK

Chapter 1

The Multidisciplinary Nature of Environmental Studies

1.1 Definition

The 'environment' is a complex entity and refers primarily to the surroundings of organisms. In nature, animals and plants live together and interact with the environment in various ways. The word 'environment' comes from the French word 'environner', which means to encircle or surround. According to Oosting (1948) it comprises variable factors and causes. Maelzer (1965) defined environment as the sum total of everything that directly influences animals' chances of survival and reproduction.

Environment consists of both biotic and abiotic components. The biotic components comprise living things such as plants and animals, while abiotic components include non-living things such as temperature, soil, water, air, light, pressure, etc. It is noteworthy that the environment is constantly changing, which means that it is never static or has been so in the past.

'Ecology' is a term closely related to environment. German naturalist, Ernst Haeckel, coined the word 'ecology' in 1866. In a literal sense, ecology means the study of homes.

British ecologist, Charles Elton (1927) defined ecology as the scientific natural history that studies the sociology of animals. Taylor (1936) defined ecology as 'the science of the relations of all organisms to their environments'. Likewise, S C Kendeigh (1961) defined it as the study of animals and plants in their relation with each other and their environment.

American ecologist, Eugene Odum (1971) defined ecology as the study of the structure and function of ecosystems or broadly of nature. R L Smith (1977) defined ecology as a multidisciplinary science which deals with the organism and its place to live, with special focus on the ecosystem.

Ecology was originally defined in the mid 19th century when biology was a much different discipline than it is today. The definition by Ernst Haeckel, who defined ecology as the study of the relationship of organisms

with their environment is by far the most comprehensive and the most accepted too.

Environmental studies is also a systematic study of human interaction with their environment. It is a broad field of study that includes the natural environments, man-made environments, social environments, organisational environments and the sets of relationships between them. This can be diagrammatically elucidated as

Our environment ⟵ Systemic study ⟶ Our role in the environment

Environmental Studies

The environment has the following four realms:

1. Atmosphere (the gaseous envelop)
2. Biosphere (All living species)
3. Lithosphere (Earth's outer crust)
4. Hydrosphere (water bodies)

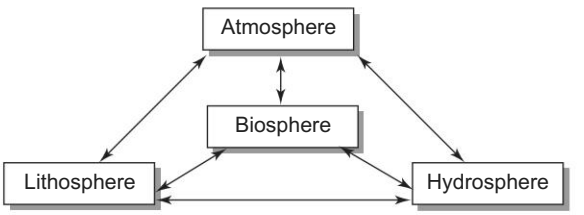

Fig. 1.1 The four realms of environment

The four realms of environment interact with each other to make a life supporting system.

1.2 Scope and Importance

Environmental studies covers large areas and prospects of scientific study. It mainly focuses on industries, mining, biodiversity, conservation of natural resources and their management, environmental pollution and control, population, and social issues in relation to development of the environment. Every aspect of life on the planet has a direct relation to the environment. Hence environmental studies can be studied as a specialised subject with an emphasis on many aspects like environmental sciences, environmental engineering, environmental management, and environmental technology.

Besides these, various global issues like global warming, loss of forest cover, misuse of energy resources, depletion of the ozone layer, loss of biodiversity, overpopulation, etc., are directly or indirectly seriously affecting the environment. Hence, their effects have to be studied on a global level with focused attention. On the other hand, many local problems like

industrial effluent, mining, solid waste management, etc., require efforts to be managed locally. One way to attempt solving all these issues is to make people aware and educate them on the results of interaction between man-made habitats and the natural environment.

Environmental studies is important not only for students but also housewives and farmers, because it involves studying issues and concerns like safe and clean drinking water, clean air, fertile land, nutrient rich food, and hygienic conditions which affects each group equally.

Environmental studies spans coverage of the following areas:

1. Natural resources–Conservation and management
2. Ecology and biodiversity
3. Environmental pollution and its control
4. Social issues in relation to development and the environment
5. Human population and the environment

These are the main focus areas of environmental studies, for these have a direct impact on the society.

1.3 Need for Public Awareness

Environmental conservation is crucial for long term and sustainable economic well-being and overall peaceful existence of humanity and all forms of life on this planet. Increasing industrialisation is necessary for economic growth and development but this should not be achieved at the cost of the environment. For instance, the Bhopal disaster of 1984 was notably one of the worst industrial disasters in the world, which reportedly killed around 10,000 people in one week. In contemporary times around 60,000 to 70,000 chemicals are commonly used all over the world, in various industries. Many of these are injurious to human health. These numbers are not inclusive of several other chemicals that are used but have not been adequately tested for impact on human health. A historic conference on 'Human Environment' was held at Stockholm in 1972 for creating awareness on pressing environmental concerns. Another conference organised around similar theme was the 'Earth Summit', held in Rio de Janeiro in Brazil in 1992. Global issues like population explosion, conservation of biodiversity, protection of the ozone layer, climate change, along with their effects on human and natural environments, trends of their occurrence and growth, predictions of their future and nations' capabilities and patterns to deal with these concerns were some points discussed in these conferences.

'The Earth Summit' was followed by the World Summit on sustainable development at Johannesburg in 2002. The goal of sustainable development is to improve living standards and the quality of people's lives of both present and future generations; emphasising more on the latter. However this, cannot be achieved without committed public participation. Consequentially, efforts are being made to educate people

on environmental issues. In this direction in 1991, the Supreme Court of India issued directives to make academic curricula in India, environment oriented. It is now urgently felt that the public in general and the student community should be made aware of all aspects of effect of human activity on the natural environment so that current environmental issues can be understood properly and appropriate action be taken in the direction of positive change. Henry D Thorean rightly said "What is the use of a beautiful house if you don't have a decent planet to put it on". If we begin today, taking small steps to conserve our natural environment, we will add more to restoration efforts than beginning tomorrow or day after!

1.4 Disaster Management

Various natural processes like floods, cyclones earthquakes, landslides, droughts, etc., are known to cause loss of life and damage to property. These are called disasters. Disaster may be natural or may be induced. These are almost always viewed in terms of the damage they cause to human societies. The magnitude and frequency of these processes are key in determining there severities and depend on factors like vegetation, geology, climate, and human activity in the area/region they occur.

Floods

Floods are caused by heavy rain, rapid snow melts, dam failures, or river blockages. Severity of its consequences depend upon the severity of the above factors, which determines the expansive coverage of this calamity. Floods can be disastrous for housing, roads, rails, trees, bridges, etc. Sometimes animals and people too, die due to severe flooding.

Flooding can be reduced or managed by timely planners and adhering to the following precautionary measures:

1. **Afforestation** Soil erosion can be checked by planting more trees in flood prone areas. Afforestation is helpful because the roots of plants have the capability to retain the runoff water.
2. **Dams** Dams are capable of storing flood water that can be used for irrigation and other water intensive activities. Careful engineering and expertise is required to anticipate maximum flood levels while building dams.
3. **Mining** Mining should be banned in flood-prone areas.
4. **Existing channel improvements** The area of the flood plain can be reduced by deepening and widening the river bed in its vicinity. This is useful for it increases the river's water storing capacity.
5. **Protection against erosion** Animal grazing should be carefully monitored to prevent overgrazing in flood-prone areas because it

induces heavy soil erosion during flooding. Streambeds should be stabilised with stone to contain flood water more efficiently.

6. **Flood proofing** People can reduce the risk of damage due to floods by strengthening their buildings to (i) resist the water's force and (ii) to prevent scouring. Firm building foundations are not susceptible to scouring.
7. **Flood frequency curve** This curve is an instrument for estimating the frequency of floods. Estimations derived using flood frequency waves are based on factual flood records of that region.

Earthquakes

Earthquakes are caused due to rapid and discernible movements of the earth's crust. The earth's crust is made up of many plates referred to as tectonic plates which are essentially layers of rocks. These plates are in motion and their estimated movement is known to be up to 100 mm in a year. Movement of these plates causes friction which builds up a stress. Sudden release of this stress causes an earthquake. The magnitude of an earthquake is measured by the Richter scale, devised by Charles F Richter in 1935. An earthquake with a magnitude over 8 on the Richter scale is considered a massive one usually causing expansive devastation.

Several earthquakes of high magnitudes have occurred in India. Of these, widespread and notable destruction was caused by the earthquakes of magnitudes 7.6 to 7.7 and 9.0 to 9.3 which hit Bhuj in Gujarat in 2001, and South Eastern and Southern parts of India (Kerala, West Bengal Andaman, Pondicherry, Tamil Nadu and Andhra Pradesh) in 2004. The latter was an undersea earthquake that originated off the west coast of Sumatra in Indonesia causing a massive Tsunami that razed to the ground parts of Indonesia, Malaysia, Thailand, Sri Lanka, and Maldives, besides India.

Impacts of Earthquakes

1. Great loss to life and property.
2. Detrimental to communication and transport.
3. Intensive damage to crops, industrial set-ups, economic systems and activities, etc.
4. Disturbance in political and social routines.
5. Flooding in low lying areas.

Preventive Measures

1. Wooden houses should be preferred to reduce its effect.
2. Small dams should be preferred over big dams.
3. Information on the nature of earthquakes in the region along with suggestive precautionary and rescue measures to the local people should be provided.

Cyclones

A cyclone is aid to occur when spiraling winds form a high air pressure region rapidly move towards a low air pressure region at high speeds such as 320 km/hr. Cyclones can be classified as:

(a) Temperate cyclones
(b) Tropical cyclones

Temperate cyclones move with an approximate speed of 30 to 40 km/hr. They are round or egg shaped. Tropical cyclones are of a circular form. Speed of air in these cyclones is approximately 120 to 200 m/hr. In India, cyclones are more frequent in the Bay of Bengal region than in the Arabian Sea. In the Atlantic, cyclones are called hurricanes; willy willies in Australia; and typhoons in the western Pacific region.

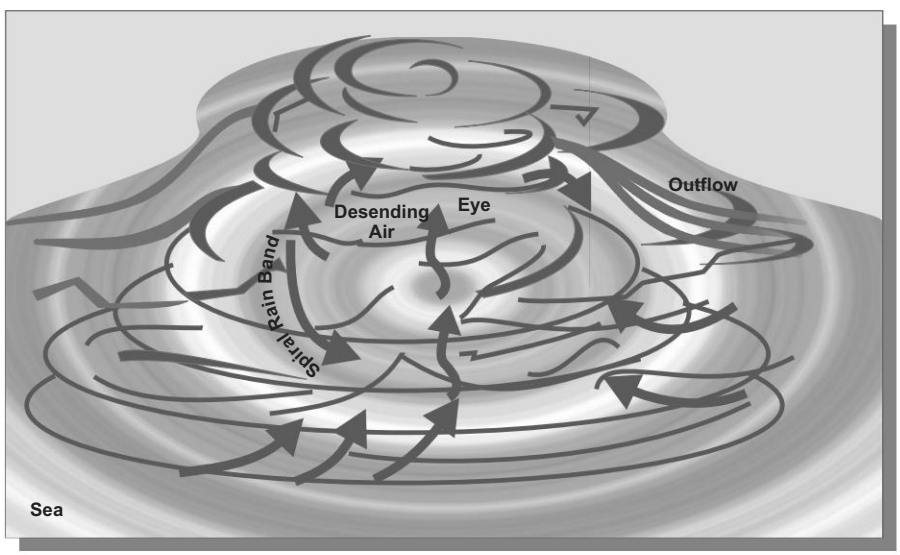

Fig. 1.2 Cyclone

Management of Cyclones

1. More plantation should be done in coastal areas.
2. People should given advance warnings post-detection of cyclones. through remote sensing and other electronic devices.
3. Drainage system should be improved.
4. Small dams should be constructed.

Landslides

Landslides is a natural phenomenon in which a part of land slides or moves away from a bigger land mass. Landslides occur due to environmental causes

such as weathering of rocks, earthquakes, volcanic erruptions, loosening of soil structure, melting of glaciers, etc. This phenomenon commonly can occur over a period of days or with sudden movements. The latter are visibly more dangerous. Human activities that adversely affect the natural compactness of soil such as construction, deforestation, etc., are known to induce landslides.

Management of Landslides

1. Slopes should be supported at the base with wired stone blocks or concrete blocks.
2. Construction of proper drainage systems.

Summary

- Environment can be defined as all biotic (living) and abiotic (non-living) things that surround and influence organisms.
- Environmental studies is the systematic study of human interaction with their environment.
- Environmental studies is distinct from ecology.
- Ecology is a branch of biology that studies relationships between organisms and their environment.
- Atmosphere, biosphere, lithosphere and hydrosphere are the four realms of environment.
- Environmental education is important to facilitate sustainable development in all spheres in a country. People must be made aware of the contemporary environmental issues along with their causes and solutions. Cyclones, floods, earthquake, and landslides are some disasters that occur naturally or are results of adverse effects of human activity. Disasters cause loss of life and property and sometimes can be extremely catastrophic, destroying whole towns and cities altogether.

REVIEW QUESTIONS

Short Answer Questions

1. What is environment?
2. What are the components of environment?

3. Who introduced the term ecology?
4. What is environmental studies?
5. What are the four realms of environment?

Descriptive Questions

1. Explain the term 'environment'. Discuss the importance of environmental studies.
2. Write an essay on the multidisciplinary nature of environmental studies.
3. Discuss the need for public awareness of environmental concerns in the country?
4. Discuss various environmental problems and their possible long-term solutions.
5. How can landslides be controlled?

OBJECTIVE QUESTIONS

Fill in the Blanks

1. Conference on 'Human Environment' was held at _____.
2. _____ teach us how to treat nature.
3. The Earth Summit was held at _____.
4. MAB stands for _____.
5. Ecology is the study of relationships of _____.

True or False

1. Man is the most powerful environmental agent.
2. Biotic environment includes all living things in the biosphere.
3. The environment includes only physical atmosphere or non-living environment.
4. Biotic environment refers to the relationship between different organisms.

Multiple-Choice Questions

Put a √ mark against the correct answer.

1. The environment can be defined as
   (a) a beautiful landscape
   (b) industrial process
   (c) sum total of all conditions that affect the life and development of all organisms on the earth
   (d) None of the above
2. Environmental studies involve studies of
   (a) evolution of life
   (b) all aspects of human environment
   (c) nitrogen cycle
   (d) social aspects of human beings
3. The projective shield for life on earth is
   (a) carbon dioxide (b) oxygen
   (c) ozone (d) sulphur dioxide
4. The term ecology was coined by
   (a) Lingers (b) William
   (c) Odum (d) Haeckel
5. The most drought-prone state in India is
   (a) Gujarat (b) Rajasthan
   (c) Andhra Pradesh (d) West Bengal
6. Which of the following is not a flood-prone state in India?
   (a) West Bengal (b) Assam
   (c) Rajasthan (d) Orissa
7. What part of the earth's surface is covered with water?
   (a) 1/3 (b) 1/4
   (c) 1/2 (d) 3/4
8. The part of the environment which is directly affected by human activities is called
   (a) homosphere (b) lithosphere
   (c) hydrosphere (d) biosphere

9. Man is biologically referred to as
   (a) homo (b) sapiens
   (c) homo sapiens (d) homosapiens sapiens
10. All living things around the world form a
   (a) biotic community (b) ecosystem
   (c) biosphere (d) biotrophism
11. The 'Earth Summit' at Rio de Janeiro was related to
   (a) soil fertility
   (b) survey of natural resources
   (c) conservation of environment
   (d) prevention of afforestation
12. The country which hosted the first World Earth Summit on conservation of environment is
   (a) India (b) Brazil
   (c) Peru (d) Spain
13. International programme on environmental education was launched in
   (a) 1975 (b) 1980
   (c) 1985 (d) 1990
14. Environmental science is a collective study of
   (a) two subjects (b) one subject
   (c) many subjects (d) three subjects
15. 'Ozone Day' is observed on
   (a) 30 January (b) 21 April
   (c) 16 September (d) 25 December

ANSWERS

Fill in the Blanks

1. Stockholm
2. Environmental ethics
3. Rio de Janeiro in 1992

4. Man and Biosphere
5. organisms and environment

True or False

1. T 2. T 3. F 4. F

Multiple-Choice Questions

1. (c)	2. (b)	3. (c)	4. (d)	5. (a)
6. (c)	7. (d)	8. (a)	9. (d)	10. (c)
11. (c)	12. (b)	13. (a)	14. (c)	15. (c)

Chapter 2

Natural Resources—Renewable and Non-Renewable

Any material which can be transformed in a way that it becomes more valuable and useful can be called a resource. In other words, it is possible to obtain use value from a resource. Thus we refer to land, water, minerals, forests, wildlife and even human beings as resources. All natural resources are drawn from nature. Human beings are super consumers of natural resources. They overexploit these resources to make life more comfortable. Consequentially, scientific and technological advancements have increased the pressure on the consumption of natural resources. This escalating consumption of natural resources, has not been accompanied by efforts of the same scale to replenish them, resulting in degradation and visibly less of quantity of these resources.

Natural resources can be classified as follows:

2.1 Renewable Resources

Those resources which can be regenerated or replenished from time to time alongside their exploitation (e.g., soil, water, living organisms, solar energy, etc.) are called renewable resources.

2.2 Non-renewable Resources

Those resources which cannot be regenerated once exploited on a large scale (e.g., minerals, coal, petroleum, etc.) are called non-renewable resources. Renewable resources can become non-renewable if exploited too rapidly in an improper manner, in a dearth of regeneration efforts. Things that we use today such as food, clothes, books, toys, furniture tools, vehicles, etc., are all byproducts of natural resources. Since resources on this planet are limited and with chromos rate of increase in the human population, the demand for these resources is also increasing at an exponential rate.

Hence, it is very important to efficiently manage, conserve and replenish these resources. Equitable distribution of natural resources is necessary to ensure fair consumption and benefaction for various population groups. Care should be taken that exploitation of these resources does not damage the environment in an irrevocable manner.

2.3 Forest Resources

Forest are often referred to as 'biodiversity hot spots', 'green gold' on this planet, and 'lungs of the earth'. They are essential in maintaining the ecological balance on this planet. Forest cover of the world according to recent reports is approximately 31 per cent and in India it is 20 per cent. Forests are national regulators that check air pollution, soil erosion, and control landslides on hill slopes, attract rainfall, etc. Besides, they are of great economic importance since a lot of raw material used for commercial activity is obtained from forests.

2.3.1 Importance of Forest Resources

Forests are useful in the following ways:

1. **Balancing gaseous cycles –** They balance the oxygen (O_2) and carbon dioxide (CO_2) ratio in the atmosphere.
2. **Provide wood –** Forests provide wood for industrial and domestic use.
3. **Shelter to wildlife –** Forests are natural habitats of wild animals and sanctuary varied and rare species of plants.
4. **Control global warming –** Forests absorb CO_2, which reduces its concentration in the air, preventing warming up of the atmosphere; thereby controlling global warming.
5. **Regulation of hydrological cycle –** Forests increase the moisture content in air by transpiration, which helps in regulating rainfall.
6. **Commercial use –** Forest and natural products have great commercial value. Besides wood forests provide resin, tannin, gum, lac, fibers, drugs, spices, medicines, essential oils, insecticides, etc.
7. **Reduce flood havoc –** Trees absorb excess water and help in reducing havoc likely to be caused by severe flooding.
8. **Aesthetic value –** Trees contribute to beautification of the environment and are considered an important source of aesthetic value.
9. **Recreational value –** National parks and sanctuaries are tourist destinations and busy recreational activity spots.
10. **Home to indigenous tribes –** Forests around the world are homes to indigenous tribes. For instance, Pygmies in parts of Africa and South-East Asia.

11. **Reduce erosion –** Forests help reduce soil erosion by roots of trees binding soil particles together. Trees in deserts help in keeping a check on wind velocity.

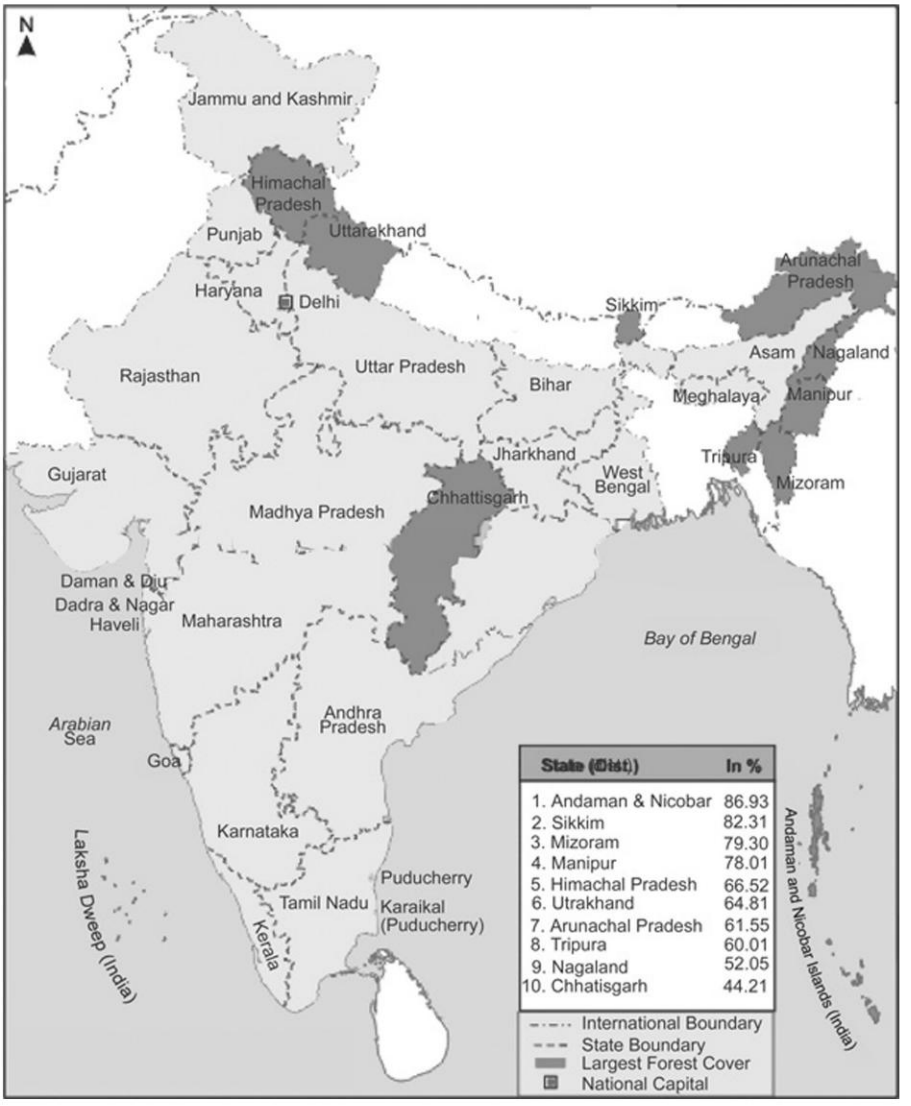

Fig. 2.1 Forest cover in India

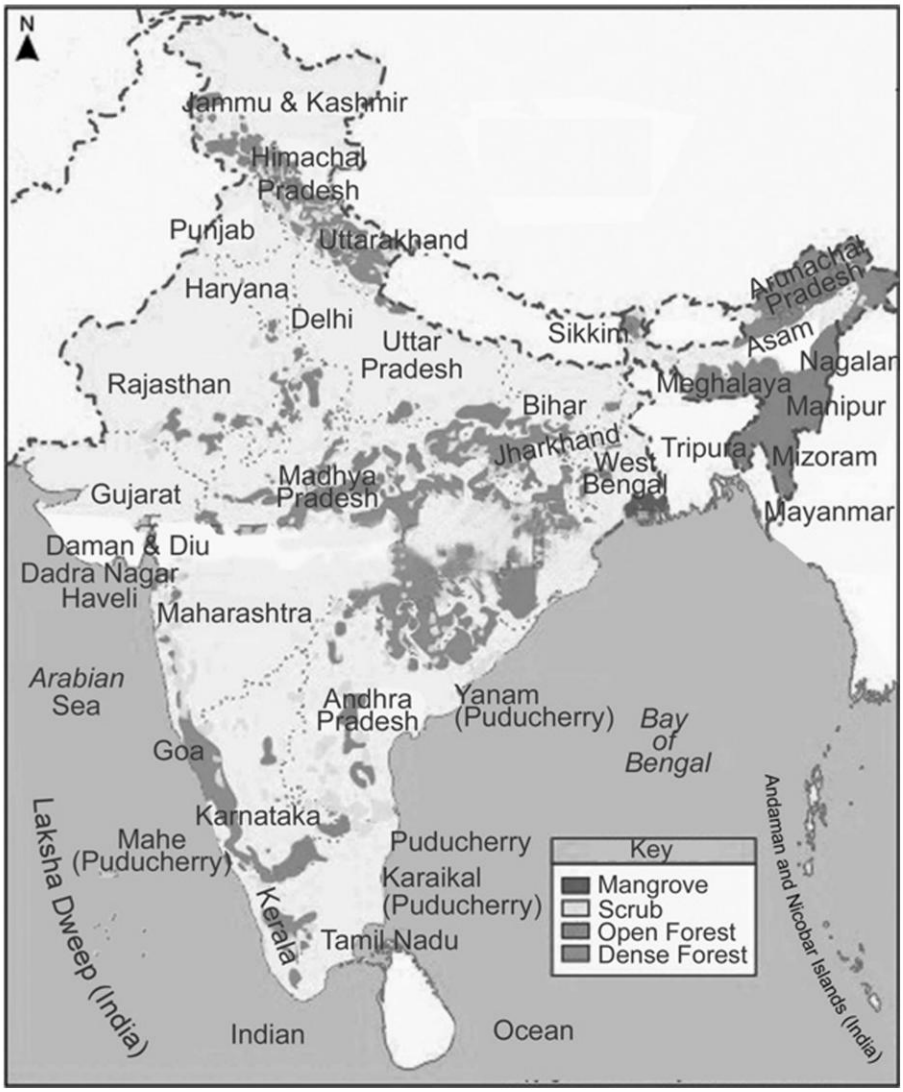

Fig. 2.2 Types of forests in India

2.3.2 Overexploitation of Forests

Forests have been a boon for humans since the very beginning of human existence on this planet. They are vital for maintaining the ecological balance and sustaining all life forms. However, due to overpopulation the demand for raw materials has escalated enormously. This, in turn, has intensified deforestation on a large scale. Large scale wood felling, overgrazing and other inappropriate use of forests and its resources have adversely hit the

ecology of India and the world. Ecological disturbances are also known to affect the weather, as a result of which soil erosion and landslides have become more visibly disastrous and a frequently occurring phenomena.

At the beginning of the 20th century, forest cover in India reportedly was 30 per cent. At the end of the 20th century it has reportedly reduced to 20 per cent. However, according to the National Forest Policy (1988), the forest cover in India, at the end of the 20th century, should have been an estimated 33 per cent. Consequentially visible overexploitation of forests has shown ill effects on productivity, increased soil erosion and landslides and low per capita forest land.

2.3.3 Deforestation

Large scale felling of trees is called deforestation. Unchecked deforestation is dangerous for both present and future generations, as it has an undesirable cascading effect on natural resource base and environmental and climatic cycles.

Loss of forest cover also unfavourably affects the quality of life and economy of a country. In the 1900s, forest cover of the world was about 7000 million hectares. This reduced to only 2300 million hectares by 2000. Today, per capita forest land in India is 0.10 hectare compared to the world average of 1 hectare. Every year we are losing about 1.5 million hectares of forest cover.

Factor Responsible for Deforestation

The following factors are responsible for deforestation:

1. **Human population explosion –** The demand for raw materials has greatly increased due to successive explosion in human population. The consumption of raw materials in India has increased up to 300 to 500 million tons in 2001, compared to only 65 million tons at the time of independence.
2. **Raw materials for industries –** Increasing demand for raw materials, such as wood, for various industrial purposes have put increased pressure on forests. Manufacturing crates, furniture, boxes; the pulp and plywood industry, all require wood as a raw material.
3. **Dams and hydroelectric projects –** Dams and hydroelectric projects cause great damage to the forests as their construction requires clearing of trees and relocation of a large section of the local population.
4. **Shifting cultivation (*Jhoom*) –** *Jhoom* farming is practiced in the northeastern part of India. Agricultural activities are carried out in between rows of trees, till the trees grow out and give shade. Then the trees are cut, and the land is used for farming for 4–5 years; the trees can rejuvenate in this time. This is also called agroforestry.

5. **Mining operations –** Mining has great impact on forest areas. Large forest areas are cleared to make way for mining activities.
6. **Growing food requirements –** To feed the ever-growing population, forest areas are cleared and converted into agricultural lands to grow food.
7. **Roads construction –** Construction of new roads also requires clearing of trees causing degradation of forests.
8. **Other factors –** Fire, overgrazing, acid rains, pollution and bad weather conditions like storms, frost, and excessive heat are also responsible for destruction of forests.

Impact of Deforestation

Following are the impacts of deforestation:

1. It reduces rainfall.
2. It reduces biodiversity.
3. It increases soil erosion.
4. It leads to landslides in hilly regions.
5. It causes global warming.
6. It threatens indigenous tribal communities.
7. It disturbs the economy and quality of life.

Chipko Movement

In December, 1972 the Chipko movement was led by Shri Sunderlal Bahudar and Shri Chandi Prasad Bhatt against large-scale felling of trees by timber contractors in the Chamoli district of Uttrakhand in India. A unique feature of this movement was that local women took active part in the campaign. They embraced trees when the timber contractors reached to clear these and compelled them to leave. This novel campaign of saving hill forests and greenery soon spread all along the hilly regions in India up to Karnataka in 1983 where it was called 'APPIKO'.

Silent Valley Project

The Silent Valley Hydro-Electric project sought to generate more energy for the power-deficit districts of Palghat and Mallapuram in Kerala, by enhancing irrigation facilities to increase agricultural production manifold and to generate employment for thousands of people. However, this project required large scale deforestation of the valley. Forests in this region contained over 900 species of flowering plants and ferns, and a large number of rare species of plants and animals. The valley is counted as one of the world's richest biological and genetic heritages. The KSSP (Kerla Sastra Sahitya Parishath) highlighted the erroneous policies of

distribution of electricity by the electricity board and advocated the increasing irrigation potential by alternative means. Under the pressure of the KSSP, the Kerala government abandoned the project and declared Silent Valley and adjoining areas as a 'biosphere reserve'.

2.3.4 Timber Extraction

Timber extraction implies the cutting of valuable timber such as mahogany, teak, etc. Indigenous tribal communities live in these timber forests and are fully dependent on forest resources. Overexploitation of timber destroys these forests. As a result, the tribal communities lose their livelihood. Construction of roads and dams near hilly areas also affect these forests in an unfavourable manner.

Timber Extraction

The Andaman and Nicobar islands are thickly covered with evergreen forests and very rich in biodiversity. These islands have the finest mangroves and coral reefs found in the world. These islands are also home to several indigenous tribal communities. These tribes have successfully survived here for centuries. Their knowledge and understanding of the forests' is extensive. Today, main commercial timber operations are limited to the Andaman region only. Post-independence from the British, a new phase began in this region. Due to heavy colonisation, timber extraction increased a lot, which proved that growth in timber extraction was directly related to the growth in the population of these islands.

2.3.5 Mining

Mining operations require clearing of large forests areas. Nearly 4,80,000 hectares of land is under mining operations in India. Mining not only removes the vegetation but also the top fertile soil cover, severely disturbing the topography of that particular area and the landscape of that region. Mining also pollutes the air, water and soil. Land destroyed by mining activities is called 'mine spoil'.

2.3.6 Dams and Their Effects on Forests and Tribal People

Dams are built to facilitate irrigation and generate electricity. India's first Prime Minister Pt. Jawaharlal Nehru referred to dams as 'temples of modern India'. There are around 1600 large dams in India, out of which 100 are 30 metres or more in height. Apart from the various advantages, dams also have some evil consequences as they lead to environmental problems like deforestation and displacement of local people from their habitations. Koel and Karo Project in Bihar was abandoned due to opposition from the local people in view of the hazards posed by the dam. The GOI constituted a Dams Safety Organization (DSO) in 1979 in New Delhi. The DSO guides and advises the state governments in providing necessary remedial measures while construction of dams.

The following major projects have been very controversial:

1. Sardar Sarovar Project, Gujarat
2. Narmada Sagar Project, Madhya Pradesh
3. Bodhghat Project, Madhya Pradesh
4. Tehri Dam Project, Uttrakhand

Tehri Dam Project

The Tehri dam was built on the Bhagirathi River in the Tehri district of Garhwal region of Uttrakhand, on the foothills of the Himalayas. This dam displaced over 86000 people and completely or partly submerged about 122 villages. This site is also sensitive to intense seismic activity. Approximately 3200 million tons of water can easily cause a major earth tremor. The approximate expenditure on the project was about 3000 crores.

2.4 Water Resources

Water is an important renewable resource. It plays a vital role in maintaining biological diversity and determining the climate of a place. About three-fourth of the earth's surface is covered by oceans which contains 97.5 per cent of the earth's water. Its misuse can cause soil erosion and its degradation. Thus water management is important for crop yield and other activities. The continuous circulation of water from the earth to the atmosphere and back is called water cycle.

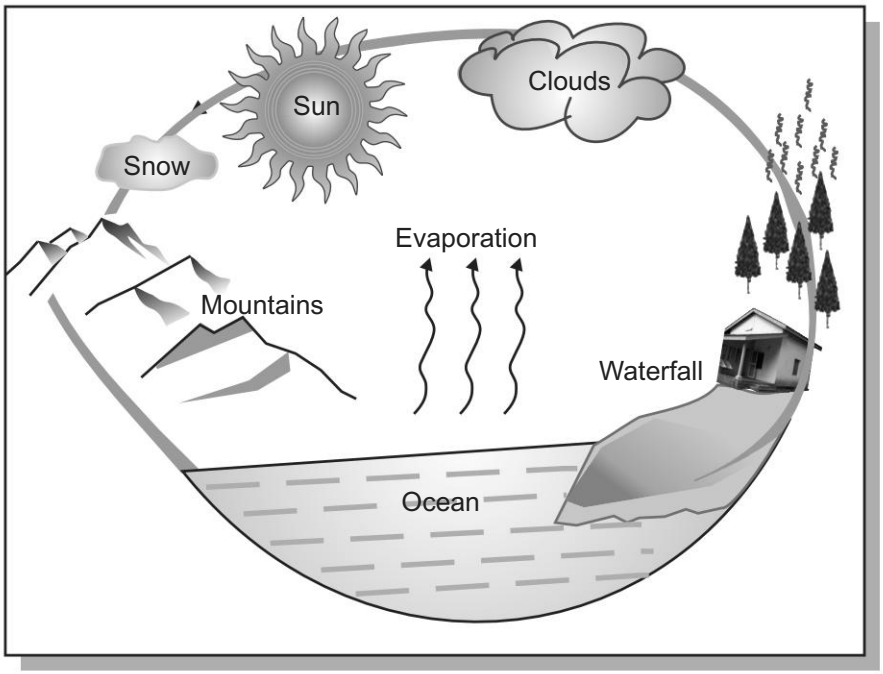

Fig. 2.3 Water cycle

Table 2.1 Resources of water in the hydrosphere

Reservoirs	*Percentage of total water*
Oceans	97.54
Ice	1.81
Ground water	0.63
Lakes and streams	
1. Salt	0.007
2. Fresh	0.009
3. Atmosphere	0.004

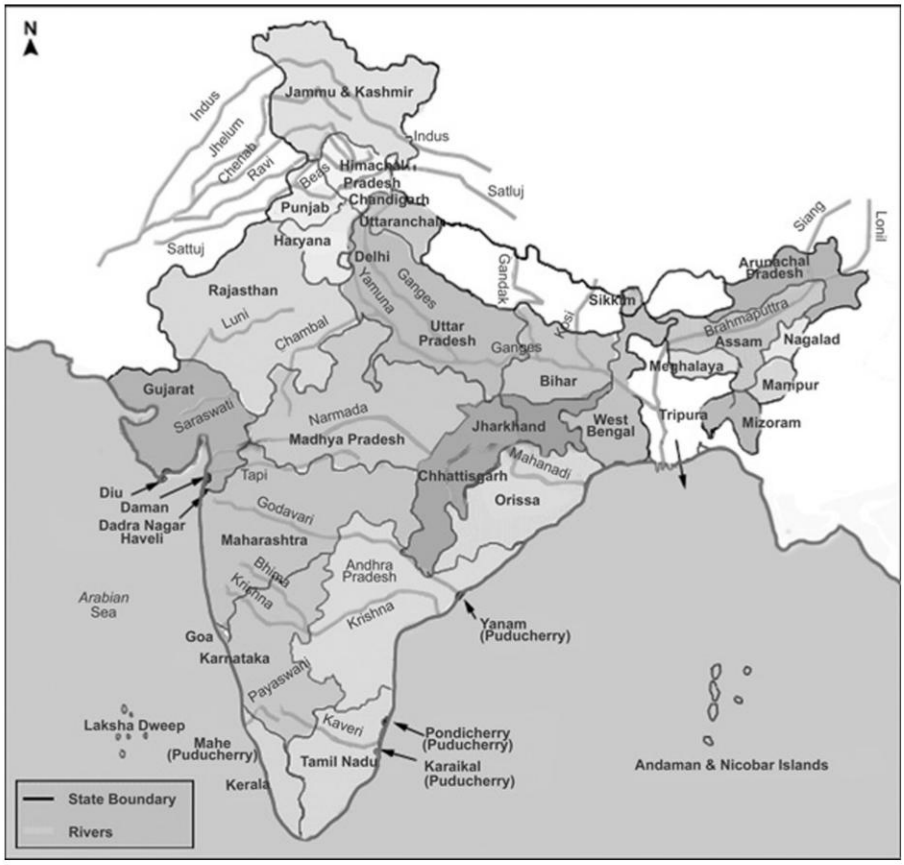

Fig. 2.4 Major rivers of India

2.4.1 Water Use and Overutilisation of Surface and Ground Water

The demand for water is increasing due to increase in population and industrialisation by 4 to 8 per cent per year. The oceans contain about 97.5 per cent of the earth's water. The remaining 2.5 per cent is fresh water. Out of this, about 1.81 to 1.87 per cent occurs as polar ice caps, glaciers, etc., 0.63 per cent occurs as ground water, 0.007 per cent as salty fresh water in lakes and streams, 0.009 per cent as fresh water and 0.004 per cent as moisture in the atmosphere. So only a small fraction of fresh water is available to us and even this is not distributed evenly.

Since 1950, agriculture has been using about 70 per cent of water from the resources available. The agricultural sector consumes maximum water in the world. Only 1.1 per cent water is used for domestic and industrial purposes. Availability of water differs from place to place and time to time. We get bulk of rainfall during the monsoon season from July to October. So for a greater part of the year our country lacks surface water supply.

About 40 per cent of the world's population is confined to arid or semi-arid regions. Most of their time and energy is wasted in obtaining water for domestic and agricultural use.

To fulfill people's demand for surface water, ponds, rivers, lakes, etc., are overdrawn. Due to overuse of surface water, the ground water may also dry out, if not recharged by rainfall or snow melt in time.

2.4.2 Floods

The International Commission on Irrigation and Drainage has defined floods as 'a relatively high flow or stage in a river, marking higher than the usual also, the inundation of low land which may result there from'. Floods arise from abnormally heavy precipitation, rapid snow melting, dam facilities, river blockages, etc. People worldwide are affected by floods. Floods can be classified as river floods, coastal floods and flash floods. Human activities like deforestation, overgrazing, urbanisation mining, etc., contribute to increase in the frequency of floods.

The worst suffering states from floods in India are Assam, Bihar, Orissa, West Bengal and Uttar Pradesh. Following are some effective measures that can be taken to reduce floods:

- ⇨ Growing more trees to keep in check the speed of flowing water.
- ⇨ To create ponds in urban areas.
- ⇨ Excess water can be stored in holding tanks for future use.
- ⇨ Flood-prone areas should be undertaken by the government and developed as bird sanctuaries, water parks, etc.

2.4.3 Droughts

Forty per cent of the world's population or nearly 80 countries today, suffer from severe droughts. Most of the countries from the Asian and the African continent are seriously concerned about droughts. The factors responsible for drought-like conditions are less precipitation during the rainy season, less evaporation, overgrazing, deforestation, mining, etc. We can overcome such situations by proper understanding of the ecological and natural processes. Following are some effective ways of handling this problem:

- ⇨ Social forestry
- ⇨ Wasteland management
- ⇨ Mixed cropping

2.5 Conflicts Over Water

The demand for water has increased due to the increase in human population. Unequal distribution of water causes inter-state and international disputes. Such disputes badly affect farmers as they lead to unavailability of water for irrigational purposes. Some of the more controversial water conflicts are described below.

Middle East

The Middle East countries share water resources of three river basins, namely, Jordan, Nile and Tigris-Euphrates. Ethiopia and Sudan have more water resources than Egypt. There is always a conflict among Jordan, Israel and Syria for using water from the Jordanian river. Turkey has developed a dam on the Tigris-Euphrates, and has more water leading to a conflict between Syria, Iraq and Turkey.

Indus Basin

In 1960, India and Pakistan singed the Indus Water Treaty. In this treaty the rivers Ravi, Beas and Sutlej were allotted to India while Indus, Jhelum and Chenab were allotted to Pakistan. According to the treaty India can use water from the three rivers of Pakistan for non-consumptive purposes. Even after this treaty, there are occasional disputes between the two countries.

Satluj-Yamuna Link and SYL Canal Dispute

This is a water conflict between Punjab and Haryana. Punjab claims Beas, Sutlej and Ravi rivers while Haryana claims the Yamuna basin. Haryana also shares water supply with Uttar Pradesh, Rajasthan and Delhi, leading to water shortage in the region.

2.6 Dams—Benefits and Problems

Our country consists of many dams and river valley projects. Big dams play a crucial role in the development of a country. But at the same time these projects have created many environmental problems.

2.6.1 Advantages

Dams have the following benefits:

- Dams can store huge amount of water. Hence reduce the danger of flooding.
- Generate electricity.
- Supply water for irrigation.
- Provide drinking water.
- Their reservoirs are a source of income for many and can also be used for swimming, finishing, boating, etc.
- They fulfill the demand for water and power shortage.

2.6.2 Disadvantages

Big dams have now become a subject of controversy due to the following reasons:

- Displacement of indigenous tribal communities.
- Loss of biodiversity.
- Loss of fertility in soil.
- Creates breeding sites for vectors, causing water-borne diseases.
- Micro-climatic changes take place.
- Growing of weeds in dams.
- Siltation of reservoir.
- Cities become prone to seismic activities due to the building of dams.
- Destruction of fertile agricultural land.
- They are very costly. Construction of the Tehri dam incurred costs as high as 3000 crores.
- Rehabilitation requires a lot of financial help as well as thousands of hectares of land for settlement of the displaced communities.
- They affect the migration and spawning of fishes.

2.7 Mineral Resources

Minerals are non-renewable resources and are distributed unevenly on the earth's crust.

Following are the two types of mineral resources:

1. Metallic
2. Non-metallic

About 3500 minerals are known to man. Their demand and consumption has increased in our industrialised society with passing time.

2.7.1 Use and Exploitation

Use

As minerals play a crucial role in a nation's economy, their use and exploitation has increased in everyday life. Minerals are important in the formation and proper functioning of all organisms in nature. Apart from this, they are also used as alternative sources of energy. Following are some of the important minerals and their use:

Table 2.2 Important minerals and their use

Mineral	*Use*
Aluminium	Packaging, structural material
Chromium	Steel alloys, chrome plate
Copper	Gold jewellery, silverware, brass and bronze electric wiring, pipes, vessels
Gold	Jewellery, alloys
Iron	Main component of steel
Lead	Battery electrodes, pipes
Manganese	Alloys, steel, disinfectants
Nickel	Alloys, coins, metal plating
Platinum	Jewellery, equipments, industrial catalysts
Potassium	Jewellery, glass, photography
Silver	Jewellery, vessels, alloys
Uranium	Nuclear bomb, electricity
Tin	Cans, containers, alloys
Zinc	Brass, electrodes
Phosphorus	Fertilisers, medicine
Sulphur	Insecticide, medicine
Mercury	Thermometer, dental inlays

Exploitation

The consumption of minerals has increased all over the world due to industrialisation. As a result, minerals like silver, copper mercury, tungsten are now short in supply and it is only a matter of time before they become extinct. Even the plentiful and less expensive minerals like iron and aluminium will become more expensive due to overutilisation.

2.7.2 Environmental Effects of Extracting and Using Mineral Resources

Mineral extraction from its ores, its processing and its disposal cause a bad impact on the environment. Mining not only causes land degradation but also pollutes the soil, water and air. Major mineral producing states in India are Jharkhand, Orissa, Madhya Pradesh, Andhra Pradesh, Meghalaya, West Bengal, Karnataka, Rajasthan and Tamil Nadu.

The following mines have had severe environmental impacts in India:

- Coal fields mines in Orissa
- Bauxite mines in Orissa
- Kudremukh iron ore mine of Karnataka
- Joduguda uranium mines in Jharkhand
- Jharia coal mines in Jharkhand
- Sukinda chromite mines in Orissa

Some important environmental effects of mining are given below:

1. **Mining extraction** – Land degradation, oil spills, loss of biodiversity, pollution of soil, air and water
2. **Processing and transportation** – It pollutes soil, air and water
3. **Purification and manufacturing** – Source of noise pollution and environmental degradation

Pollution by Mining Operation in Orissa

Bramhani is the second largest river in Orissa. It has become severely polluted due to mining operations in the state. It is now one of the top ten most polluted rivers in the country. It is polluted by the effluents of Rourkela steel plant, iron ore mining industries of the Bonai subdivision and the Rourkela fertiliser plant. It has tremendous adverse effects on the livelihood of fisherman and farmers in the state.

2.8 Food Resources

All organisms require food as a source of energy for various activities like growth, movement, respiration, etc. The chief food components are carbohydrates, fats, proteins, minerals, vitamins and water. The main sources of food are cereals, oils, pulses, eggs, milk, meat, cheese, fruits and vegetables. Out of about 80000 edible plant species only 30 types of crops provide food to the whole world. Wheat, rice, corn and potato form a major part of the world's total food production.

2.8.1 World Food Problems

Due to overpopulation, the demand for food has increased manifold. It is imperative to increase the production of food as of today to feed the entire world population. About 20 crore children below the age of 5 are suffering from malnutrition and hunger. We have to increase the food production by nearly 40 per cent. Following are some food related problems being faced by the world today:

- Quantity of food
- Under nutrition, malnutrition and overnutrition
- Food storage problem
- Food distribution problem
- Poverty
- Environmental effects of agriculture

Case Study of Africa

Africa was self-sufficient in its food resources till 1975. However, flat topography, climate change, overgrazing, overpopulation, deforestation, desertification, soil erosion, decrease in rainfall and fuel shortages are together known to be causing millions of premature deaths every year.

Quantity of Food

Food problems are directly proportionate to the population. During the last 50 years, world food production has risen nearly three times, but at the same time the population has increased manifold leading to a stark imbalance.

Undernutrition, Malnutrition and Overnutrition

Food and Agriculture Organization (FAO) has reported that on a global scale, average minimum calorie intake is about 2500 calories per day. People are categorised as undernourished when they consume less than 90 per cent of these minimum dietary calories. People often suffer from malnutrition as they consume insufficient amount of food. India is the third largest stable food producer in the world today and yet 300 million Indians are still undernourished. Nearly 40 million people in the developing countries die due to malnutrition every year.

Food Storage Problem

Food storage is a problem in most developing countries as they lack competent infrastructure in storage facilities. Due to this much of the food produced is spoiled.

Food Distribution Problem

Food processing, distribution and its marketing are great challenges for developing countries with large population. Food often fails to reach people who need it the most.

Poverty

Most people are unable to grow enough food as they do not have enough agricultural land. It is the main cause of hunger and malnutrition throughout the world.

Environmental Effects of Agriculture

Agriculture has adversely affected our air, water and soil. Pressure to produce more food has degraded soil fertility. It is also known to cause deforestation, loss of biodiversity, overgrazing, etc.

2.8.2 Changes Caused by Agriculture and Overgrazing

Modern agricultural practices are mainly focused on increasing productivity by using artificial and/or chemical additives. This severely degrades the environment.

Following are some effects of agriculture:

1. **Soil erosion due to agriculture** – Deforestation results in loss of the top fertile layer. Agriculture requires more clear land which results in soil erosion.
2. **Deforestation** – Due to shifting cultivation there is a great loss of forest cover.
3. **Loss of nutrient** – Due to forest fires the most important nutrients are consumed by the crops and make the soil infertile.
4. **Loss of biodiversity** – Forests are homes to wild animals. Agriculture also induces deforestation which is the main cause of loss of biodiversity.
5. **Soil erosion due to overgrazing** – The top layer of the soil cover gets exposed due to overgrazing, which is carried away by wind and rain.
6. **Loss of species** – Overgrazing destroys many valuable species of plants.
7. **Land degradation** – Overgrazing by cattle causes land degradation as their feet loosens the soil.
8. **Growth of undesirable plants** – Overgrazing promotes the growth of unwanted plant species. Such species pose a threat to our original breeds.

2.8.3 Effects of Modern Agriculture

The uses of hybrid variety seeds, high-tech equipments, fertilisers, pesticides, etc., are the inseparable parts of modern agriculture. Modern agricultural practices formed the base for the 'green revolution'. However, modern agricultural practices have raised several environment-related problems. Following are some effects of modern agriculture:

Use of High Yielding Varieties

Use of high yield varieties promotes monoculture. If a single crop is affected by a disease then all the other crops are destroyed due to the monoculture practice.

Fertiliser and Pesticide Problems

Overuse of fertilisers and pesticides contaminate the soil, water and other living resources and ultimately affect human health. Their overusage causes the following problems:

- Excessive use of NPK causes eutrophication which causes death of aquatic flora and fauna.
- Infants suffer from baby syndrome or *metahaemoglobinenia* due to increase in nitro ion levels in drinking water.
- Oxygen content is reduced due to overuse of NPK fertilisers.
- NPK overdose also reduces natural nitrogen abduction efficiency.
- Overdose of fertilisers decreases the quality of soil.

Pesticides have created the following problems:

- Pesticides do not degrade easily and get circulated in food chains. This process is called biological magnification. It is responsible for mutation. It also destroys wildlife.
- Pesticides kill many species that are not supposed to be eliminated.
- Pesticides contaminate our food and also affect our health.
- Pesticides are also responsible in developing gene resistant pest species.

Integrated Pest Management (IPM) is a modern approach to control population of pests by using many techniques such as

- Natural enemies of pests
- Mixed cropping
- Reducing the use of fertilisers

Water Logging

Water logging refers to the saturated condition of soil, where the water table reaches close to the surface and plants are unable to get air for respiration.

This results in low crop production. Water logging takes place when the soil is saturated with water, such as near dams or excessively irrigated regions. Water logging can be checked using the subsurface drainage technology and by growing trees like eucalyptus which absorb the moisture from the soil.

Salinity Problems

Overdeposition of salts make the soil useless for crops, this process is called salinisation. Nearly seven million hectares of land is badly affected by salinity. Excessive irrigation causes salinity problems. Most part of the land is irrigated through canals and ground water which has high content of dissolved salts. Due to evaporation, the salt gets deposited in the soil causing salinisation. It creates the following problems:

- ⇨ Growth reduction in crops
- ⇨ Increases infertility of soil
- ⇨ Reduction in crop production
- ⇨ Hazardous to wildlife

2.9 Energy Resources

Energy is very important for the social, economic and industrial development of any country. The demand and utility of energy is seen everywhere today. Energy utilisation is an index of advancement of a country. The main sources of energy are petroleum, coal, oil and natural gas, providing 95 per cent of total energy produced. In developed countries, annual energy consumption is about 5–11 kW per person, while in developing countries it is only about 1–1.5 kW per person.

Energy sources are of the following two types:

1. Renewable resources
2. Non-renewable resources

1. **Renewable resources** – Such resources can be generated again and again from natural processes. For example, solar energy, wind energy, geothermal energy, hydropower biomass, etc. These resources are inexhaustible in nature. These are also termed as non-conventional sources of energy.
2. **Non-renewable resources** – Such resources are limited in nature and take a longer period of time to develop. For example, coal, petroleum, oil, natural gas, etc. They are exhaustible in nature. They are also called conventional sources of energy.

Controlled use of such resources is quite necessary and more focus should be on renewable resources.

2.9.1 Use of Alternate Energy Sources

Renewable Energy Sources

One of the important alternate energy sources is solar energy. Sun is the ultimate source of energy. We can get unlimited and inexhaustible energy from the sun. It is a free source and has no polluting effect. It can fulfill our energy demand forever, but capturing energy from the sun requires suitable techniques, so that it can be used properly and converted to other forms of energy as well. At present, this process it is ten times costlier than thermal power. Israel utilises this form of energy on a large scale. In India efforts are being made to utilise this non-conventional form of energy. Solar equipments like water heaters, air conditioners, cooking systems, etc., are being developed for this purpose.

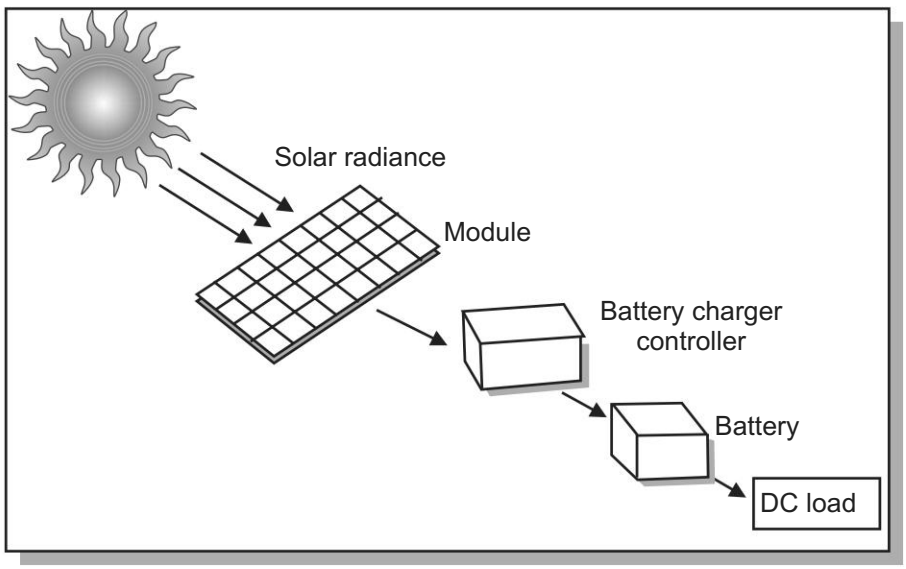

Fig. 2.5 Solar energy

Wind Energy

This kind of energy is produced from the wind by using windmills. This form of energy can be harvested in only those areas that receive continual winds. At least 6.5 metre per second velocity of wind is required. Wind energy is harvested in islands, coastal areas and mountain passes. Countries like Denmark and Holland harvest this source of energy on a large scale. Wind energy has been utilised for pumping water and for grinding grains as well. Wind energy can be converted into mechanical and electric energy.

Hydropower Energy

It is generated from the kinetic energy of water. In this, moving water rotates the turbines to generate electricity. For this purpose water is allowed to fall from a certain height so that it is able to move the turbines adjusted at the bottom of the dam. About one-fourth of the world's electricity is produced by hydropower. It is cheaper than thermal power.

Tidal Energy

Tides are used to spin the turbines near coastal areas. Tidal waves are produced by the gravitational forces of the sun and the moon.

Geothermal Energy

This kind of electricity is generated by using natural internal heat of the earth. For harnessing the earth's internal heat, a hole is drilled inside the rocks and steam form hot water is able to rotate the turbine to generate electricity. Countries like Russia, Japan, New Zealand, Mexico, Italy, etc., are utilising this source of energy on a large scale.

Ocean Thermal Energy

This technology has been developed by using differences in temperature at the ocean's surface. India has set up an OTE plant in Lakshadweep.

Biomass Energy

To meet the growing demand for energy amid the present crisis in developing countries like India, biogas is used. It is a mixture of gases like Methane (Hu), CO_2, H_2, SO_2, etc. Biogas is produced by the action of anaerobic micro-organisms on raw materials like domestic and agricultural waste in simple digesters (biogas plants). Sun provides heat to these biogas plants.

Petro Plants

Plants like euphoria are highly rich in hydro-carbons and are used to obtain products like gases, kerosene, oil cake, etc., under high temperature and pressure.

Non-Renewable Energy Resources

Non-renewable energy resources include fossil fuels like petroleum, natural gas, coal and nuclear energy.

Petroleum

Petroleum is a mixture of alkane hydrocarbons. We obtain a number of products like petroleum gas, kerosene, petrol diesel, fuel oil, paraffin wax,

lubrication oil, plastic, etc., by purification, fractionation and distillation of petroleum at varied temperatures.

Coal

It is an abundant fossil fuel and is produced over millions of years from dead and buried plant and animal parts. India has nearly 5 per cent of the world's coal deposists.

Nuclear Energy

Uranium and thorium are the main sources of nuclear energy. One kilogram of uranium can generate heat equivalent of approximately 16 metric tons of coal. Pitchblende and uranintle are the primary sources of uranium. USA and Canada are leading producers of uranium. The main sources of thorium are thorianite, allanite and monazite. The main sites of atomic power stations in India are Tarapur (Mumbai), near Kota (Rajasthan), Kalpakkam (Tamil Nadu) and Narora (Uttar Pradesh).

Table 2.3 Different sources of power generation in India

S. No.	*Source*	*Electricity Production (Mw)*
1.	Thermal Power	70,200
2.	Hydel Power (Solar energy)	23,800
3.	Nuclear Power	2,700
4.	Wind Power	1,150
5.	Biomass Power	256

2.10 Land Resources

Land is a valuable renewable resource, supporting the whole living system. About one-fourth of the earth's surface comprises land. It is covered by grasslands, forests, water reservoirs, agricultural crops and human settlements. The uppermost layer of land is known as soil. It is rich in humus and supports all vegetation and is home to a number of organisms.

2.10.1 Land Degradation

Due to the growth of human population, land degradation has increased at an alarming rate. Soil formation is a very slow process; compared to it the annual erosion rate is 18 to 100 times faster than the renewal rate. Land has degraded due to factors like topography, wind intensity, rainfall and bad agricultural practices. Land degradation also depends on water logging, deforestation, salinisation and soil contamination.

2.10.2 Man-induced Landslides

Anthropogenic activities like construction of roads and dams, mining and deforestation cause frequent landslides especially in hilly regions. Parts of hilly areas slide or fall due to gravitational pull. Landslides are responsible for loss of biodiversity and also causes soil erosion.

2.11 Soil Erosion

The loss of top soil by wind or water is commonly known as soil erosion. Fertility of the soil is lost as its contents are washed down into rivers, lakes and oceans every year. About 7 per cent soil erosion occurs every year.

Soil erosion is of the following two types:

1. Natural geologic erosion – It takes place through natural processes.
2. Human accelerated erosion – It occurs due to anthropogenic activities like overgrazing, mining, building of roads and dams, deforestation, etc. In this type of erosion the rate of erosion is faster than the rate of renewal as compared to the natural geologic erosion.

2.11.1 Factors Causing Soil Erosion

Two types of factors are responsible for soil erosion:

1. Biotic factors like overgrazing, deforestation, mining, etc.
2. Climatic factors like water and wind

2.11.2 Consequences of Soil Erosion

The following are the consequences of soil erosion:

- It reduces soil fertility.
- It supports desert formation.
- It promotes loss of biodiversity.
- It changes flow of direction of rivers.
- It induces climate change.

Desertification

Various human activities lead to the formation of desert-like areas, and is known as desertification. The leading causes of expanding desert areas are

- Bad farming practices
- Overgrazing
- Deforestation
- Mining
- Water logging

- ⇨ Salinisation
- ⇨ Drought and hot climate
- ⇨ Conversion of forests into croplands
- ⇨ Mismanagement of soil and water resources

About 20 per cent of the earth is threatened by desertification today. However, as per the climatic conditions the total desert area should not be more than 43 per cent of the total land area. Most affected zones of desertification are United States, Central and South America, parts of Asia, Africa and Australia. Europe has no desert area.

2.12 Water Erosion

Erosion by rainwater or melted snow is of many types. Following are a few of these:

1. Rill erosion – In this type of soil erosion, rainwater produces rills or finger-like grooves over the surface.
2. Sheet erosion – It includes uniform displacement of top soil from the area.
3. Gully erosion – In this type, the rainwater forms deeper cavities or gullies in the area.
4. Stream bank erosion – It occurs in rainy season when water from rivers and streams flows in an opposite direction.

2.13 Wind Erosion

Wind erosion is common in deserts, where no vegetation grows. The high velocity winds shift the soil from one place to another. Following are some types of wind erosion:

1. Saltation – In this type, medium-sized particles are blown into air.
2. Suspension – In this type, fine particles are carried away as dust particles.
3. Surface creep – In this type, the heavy soil particles are only pushed due to velocity of the wind.

2.14 Role of an Individual in Conservation of Natural Resources

All natural resources belong to every living organism and every person has to contribute towards their conservation. Conservation means controlled use of natural resources along with careful management in a way that they

yield maximum benefits for the present generation and conserve their potential for future generations.

Every individual can help conserve natural resources by the following means:

- Houses should be built in a way that more natural light is provided.
- Increase in the use of solar light, solar geysers and solar cookers.
- Growing trees near residential areas.
- Use of bicycles instead of cars or bikes.
- Mixed cropping should be followed.
- Usage of cow dung as manure in fields.
- Use of washing machines.
- Ensuring that the taps are closed tightly when not in use.
- Drop irrigation should be preferred.
- Recycling materials like paper, glass, tin, plastic, etc.
- Turning off lights, fans, coolers, and other electronic appliances after use.
- Making compost pits for household waste.
- Timely repairing of leakage in pipes and toilets.

2.15 Equitable Use of Resources for a Sustainable Lifestyle

Today developed countries are exploiting more and more natural resources in comparison to developing countries. However, it is the moral duty of every person to rationalise use of these valuable resources, so that that they remain intact for use by future generations as well. For sustainable development, the following steps should be taken into consideration:

- Natural resources like fossil fuels, water minerals, forests, etc., should be used wisely.
- Ensure conservation of soil, natural vegetation, biodiversity and other ecological niches.
- Educate, spread awareness and empower common people so that they can share their views on sensitive issues.
- Discourage urbanisation by providing basic facilities even in rural areas.
- Provide clean drinking water, clean air to breath and clean food to eat.
- Create awareness about family planning programs.
- Ensure a diseases-free environment.
- Create a pollution-free environment and improve sanitation.

Summary

- A natural resource is an asset or stock that can be drawn from nature and can be classified as a renewable resource or a non-renewable resource.
- Renewable resources are those resources which can be regenerated or produced along with their exploitation. For example, soil, water, solar energy, living organisms, etc.
- Non-renewable resources are those resources which cannot be regenerated or produced if exploited on a large scale. For example, mineral, coal, petroleum, etc.
- The destruction of forests is called deforestation. It is an alarming threat to the economy, quality of life and future of the environment.
- Sustainable development means development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs (WCED, 1987).

REVIEW QUESTIONS

Short Answer Questions

1. What are natural resources?
2. What do you understand by mineral resources?
3. What are fossil fuels?
4. What are renewable resources?
5. What do you mean by deforestation?
6. What is desertification?
7. What is mining?
8. List the main benefits of forests.

Descriptive Questions

1. What are forest resources? Explain their use in detail.
2. Write an essay on the importance of forests.
3. What are the causes of deforestation?
4. Explain the effects of dams on forests and tribal people.
5. Discuss some conflicts over water.

6. Explain the benefits of dams.
7. Discuss in detail the use and exploitation of mineral resources.
8. Discuss the role of an individual in conservation of natural resources?
9. Discuss alternative energy resources.
10. What are the environmental problems in constructing big dams?
11. What is overgrazing and discuss its effects?
12. Writes short notes on the following:
    - Desertification
    - Land degradation
    - Non-renewable energy resources
    - Biological magnification
    - Water logging
13. Discuss the environmental effects of producing more food resources.

OBJECTIVE QUESTIONS

Fill in the Blanks

1. A natural resource is _____ that can be drawn from nature.
2. Biogas contains _____ in bulk.
3. Water is the _____ of life.
4. Minerals are basically found in the form of _____ .
5. Water is a source of clean energy which does not _____ the environment.

True or False

1. Drought is a natural hazard.
2. Growing food in water is called aquaculture.
3. Deforestation does not cause floods.
4. Blue revolution is connected with crops.
5. Soil is a renewable natural resource.
6. Nuclear energy is non-renewable.
7. Uranium is the source of nuclear energy.

Multiple-Choice Questions

Put a √ mark against the correct answer.

1. The most abundant energy resource is
   (a) coal (b) solar energy
   (c) diesel (d) petrol
2. The ideal forest cover in relation to total land area is
   (a) 55% (b) 33%
   (c) 80% (d) 60%
3. Chipko Movement was started in 1973
   (a) for better amenities like food and education
   (b) to grow more food
   (c) to prove electricity in villages to run their tube wells for irrigation
   (d) to prevent felling of trees
4. Chipko Movement was started by
   (a) Sunderlal Bhauguha (b) Medha Patkar
   (c) Salim Ali (d) HG Khurana
5. How much area is covered by forests in India?
   (a) 18% (b) 20%
   (c) 22% (d) 24%
6. 'Van Mahotsava' is observed on
   (a) 1977 (b) 1980
   (c) 1976 (d) 1991
7. Tropical rain forest occur in
   (a) Assam (b) Tamil Nadu
   (c) Himachal Pradesh (d) Uttar Pradesh
8. Which types of forests are found near the equator?
   (a) Deciduous forests (b) Tropical forests
   (c) Coniferous forests (d) Grassland
9. An example of non-renewable resource is
   (a) minerals (b) soil
   (c) water (d) air
10. An example of renewable resource is
    (a) coal (b) petroleum
    (c) soil (d) minerals

11. The amount of fresh water on the earth is
    (a) 97.5% (b) 2.5%
    (c) 10% (d) 5%
12. Cauvery water dispute is between
    (a) India and Pakistan
    (b) Punjab and Haryana
    (c) Karnataka and Tamil Nadu
    (d) Uttar Pradesh and Bihar
13. Which area accounts for the maximum use of fresh water?
    (a) Domestic (b) Industries
    (c) Agriculture (d) Coolers
14. Which of the following energy is eco-friendly?
    (a) Hydropower (b) Fossil fuel
    (c) Nuclear Power (d) Wood
15. Most common forest type in India is
    (a) tropical dry deciduous forests
    (b) tropical moist deciduous forest
    (c) tropical thorn forests
    (d) sal and teak forest
16. A non-renewable resource is
    (a) forest (b) coal/petroleum
    (c) water (d) wildlife
17. Temperate evergreen forests are found in the
    (a) Western Ghats (b) Himalayan Range
    (b) Aravali Range (d) Assam
18. Tropical forests are found in India in
    (a) Jammu and Kashmir (b) Rajasthan
    (c) Kerala and Assam (d) None of these
19. 'Zooming' is related to
    (a) soil erosion (b) desertification
    (c) flood (d) water
20. An example of cold desertification is
    (a) Thar (b) Sahara
    (c) Kalahari (d) Gobi

21. 'World Environment Day' is observed on
    (a) 5th May (b) 5th June
    (c) 5th July (d) 5th August
22. 'World Ozone Day' is observed on
    (a) 16th July (b) 16th August
    (c) 16th September (d) 16th October
23. In developing countries, the main sources of energy is
    (a) wood (b) coal
    (c) gas (d) electric

ANSWERS

Fill in the Blanks

1. stock
2. methane
3. driver
4. ores
5. pollute

True or False

1. T	2. T	3. T	4. F
5. T	6. T	7. T	

Multiple-Choice Questions

1. (b)	2. (b)	3. (d)	4. (a)	5. (c)
6. (b)	7. (a)	8. (b)	9. (a)	10. (c)
11. (a)	12. (c)	13. (c)	14. (a)	15. (a)
16. (b)	17. (b)	18. (c)	19. (a)	20. (d)
21. (b)	22. (c)	23. (a)		

Chapter 3

Ecosystem

3.1 Concept of an Ecosystem

The term *ecosystem* was first coined by A G Tansley in 1935. The term is derived from two words, viz., *eco* and *system*; *eco* refers to the environment and *system* refers to a complex coordinated unit. An ecosystem is a basic functional unit of organisms and their environment. It comprises *biotic* components (i.e., living organisms) and *abiotic* components (i.e., non-living things) that interact with each other to produce an exchange of materials between them.

3.2 Definitions

Varied definitions of ecosystems have been proposed by scholars. EP Odum (1971) defined an ecosystem as a basic functional unit of organisms and their environment; their interaction with each other and the various components. P Haggeh (1975) proposed that ecosystems are ecological systems in which plants and animals are linked to their environment through a series of food chains. As theorised by CC Park (1980), an ecosystem is the sum of all natural organisms and substances within a certain area, and it can be viewed as a basic example of an open system in physical geography.

All ecosystems possess certain basic properties as follows. The flow of energy is continuous in an ecosystem; sunlight is trapped by green plants called producers, these from a food source for animals called consumers. In an ecosystem, the input of energy is equal to the consumed energy, thus it stays in a state of 'dynamic equilibrium' also regarded as system 'homeostatic'. An ecosystem is a self-sufficient unit that is capable of independent existence. For instance, a 'pond' is an ecosystem. Other examples are rivers, oceans, grassland forests, deserts, towns, etc.

3.3 Structure of an Ecosystem

Any ecosystem is made up of the following two components:

1. Abiotic
2. Biotic

Abiotic Components

They include the non-living things such as water, soil, air, temperature, climate, pressure, etc. Biotic components depend on abiotic components for survival.

Biotic Components

These components include the living organisms such as plants, animals, bacteria, viruses, etc. They are classified into three main groups, viz., producers, consumers and decomposers.

Producers All plants containing chlorophyll are known as producers. These plants can produce their own food by a process called photosynthesis. The chemical conversion of carbon dioxide (CO_2) and water (H_2O) to a sugar called glucose in the presence of sunlight is called photosynthesis. In this process, oxygen is released as a byproduct. Plants are also called 'autotrophs'.

Consumers All animals that depend on producers, directly or indirectly, for their food are known as consumers. They are of the following three kinds:

1. **Primary consumers** – Animals that feed on green plants and trees are known as primary consumers or herbivores. Rabbits, deer, sheep, elephants, cows, goats, etc., are some primary consumers.
2. **Secondary consumers** – Animals that feed on primary consumers are known as secondary consumers or primary carnivores. Wolves, foxes, frogs, tigers, cats, etc., are some secondary consumers.
3. **Tertiary consumers** – Animals that feed on both primary and secondary consumers are known as tertiary consumers. Lions, hawks, peacocks, vultures, owls, etc., are some tertiary consumers.

If a consumer eats both plants and animals, it is called an omnivore. Human beings, crows, dogs, etc., are some examples of omnivores.

Decomposers Organisms that help decay dead bodies of plants and animals into simpler abiotic components are called *decomposers* or *reducers*. Fungi and bacteria are decomposers. Consumers and decomposers are collectively known as *heterotrophs*.

3.4 Dynamics or Functions of an Ecosystem

The various components of any ecosystem exchange minerals, matter and energy amongst them. The stability of an ecosystem depends on the flow of energy and the circulation of minerals and nutrients. The dynamics (functions) of an ecosystem include

- Energy
- Primary production
- Secondary production
- Food chain
- Food web
- Trophic levels
- Energy flow
- Ecological pyramids
- Biogeochemical cycles
- Ecological succession

3.4.1 Energy Flow in an Ecosystem

The transfer of energy from one trophic level to another trophic level is known as *energy flow*. The energy flow is unidirectional, i.e., it never takes place in a reverse direction. Hence, energy is used only once in the ecosystem.

Sun is the ultimate source of energy. A large amount of energy is lost at each trophic level. It is estimated that up to 90 per cent energy is lost during transfer from one trophic level to another. Therefore the amount of energy available decreases from step to step. In a short food chain, the final consumer may receive a large amount of energy. But in a long food chain, the final consumer may get less energy. Lindeman (1942) proposed the 'ten per cent law' as only 10 per cent of the food energy is transferred to the next level of consumers, the rest is wasted.

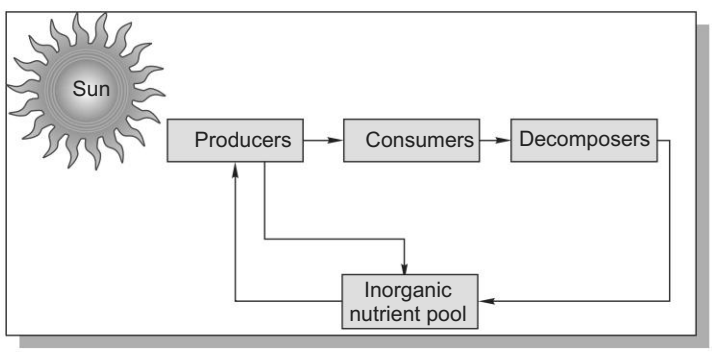

Fig. 3.1 Energy flow model

3.5 Ecological Succession

Communities are never stable. They change progressively with the passage of time and space. The changes occur due to interactions between biotic and abiotic factors in the ecosystem. This process is known as community succession. Smith (1965) stated that 'ecological succession is an orderly and progressive replacement of one community by another till the development of a stable community in that area'. For example, a pond community can be changed into a marshland community, if the pond is filled with sand and mud over a period of time

The first community that appears in an area is referred to as the 'pioneer community'. This community takes time to get modified into an intermediate community called 'serial community', which finally transforms into a stable community known as 'climax community'.

3.5.1 Types of Succession

Succession is of the following types:

1. **Primary succession** – In this type, a community develops in an area which is not previously occupied by any other community. For example, community developed on a newly exposed island or a newly exposed sand dune, etc.
2. **Secondary succession** – Here the community starts to develop on a site which was previously occupied by a well-developed community. For example, development of a community in a deforested zone, crops growing in ploughed fields, etc. Further, based on the dominance of species in a community, succession is classified into autotrophic and heterotrophic succession.
   - ⇨ **Autotrophic succession** – This succession is characterised by the dominance of autotrophic organisms (plants). This succession begins in inorganic environments.
   - ⇨ **Heterotrophic succession** – In this type, the heterotrophic organisms (animals) are dominant. This succession begins in organic environments.

3.5.2 Patterns of Succession

Following are the three different patterns of succession:

1. Xerarch or Xerosere
2. Hydrarch or Hydrosere
3. Mesarch or Mesosere

1. **Xerarch or Xerosere** – When succession begins in the absence of moisture in a dry place, it is called Xerarch or Xerosere. Here the pioneer community, are lichens that appear on rocks. Later on

lichens disintegrate the rocks; as a result, sand begins to appear which in turn leads to the formation of mosses. Then herbs and sorbs develop. These are followed by trees, which form the forest community.

2. **Hydrarch or Hydrosere** – This succession starts in a freshly formed pond. First the plankton forms the pioneer community. The submerged plants such as utricularia, vallisneria and ceratophyllum, etc., appear. Later, floating plants, e.g., nymphaea, trapa, lemna, etc. These communities then enrich the pond with organic matter by their death. This promotes the growth of dragon flies, may flies, cyclops, daphnia, cypris, nydra snails, frogs, fishes, snakes, turtles, etc. Thus a climax community is developed in the pond.
   With the passage of time the pond community is transformed into a marshy land community by the silt deposition at the bottom. When the marshland becomes dry, the aquatic animals disappear completely. Small trees begin to appear which are followed by large trees. This forms a climax forest community.
3. **Mesarch or Mesosere** – This type of succession is intermediate between xerach and hydrarch. It forms in places with moisture.

3.5.3 Significance of Succession

In a fluctuating physical environment, succession forms a well-balanced and stable community. This community is able to maintain the balance of energy and also control physical factors like water, temperature, etc. Succession also helps in the slow disposal of animals.

3.6 Food Chains

The transfer of energy through a series of organisms by repeated eating and in turn being eaten is called 'food chain'. Elton (1927) was the first person who introduced this concept.

Producers (plants) ⟶ Herbivores ⟶ Carnivores

The various steps in a food chain are called 'trophic levels'.

Food chains are of the following two types:

1. Grazing food chain
2. Detritus food chain

Grazing Food Chain

Such chains start from producers, go through herbivores and end in carnivores. These chains are very common in terrestrial and aquatic ecosystems. For example,

Grass ⟶ Grasshopper ⟶ Lizard ⟶ Hawk
1st T.L 2nd T.L 3rd T.L 4th T.L

Phytoplankton ⟶ Zooplankton ⟶ Fish
1st T.L 2nd T.L 3rd T.L

Detritus Food Chain

These chains start from dead organic remains (detritus), go through detrivores (fungi, bacteria, protozoans, insects, earthworm, etc.) and end in inorganic compounds.

Dead organic remains of plants or animal ⟶ Detritivores ⟶ $CO_2 + H_2O$

3.7 Food Web

In an ecosystem the various food chains remain interconnected with each other forming a kind of a web known as 'food web'. In a food web, food from different kinds of sources and in turn may be consumed by different types of organism.

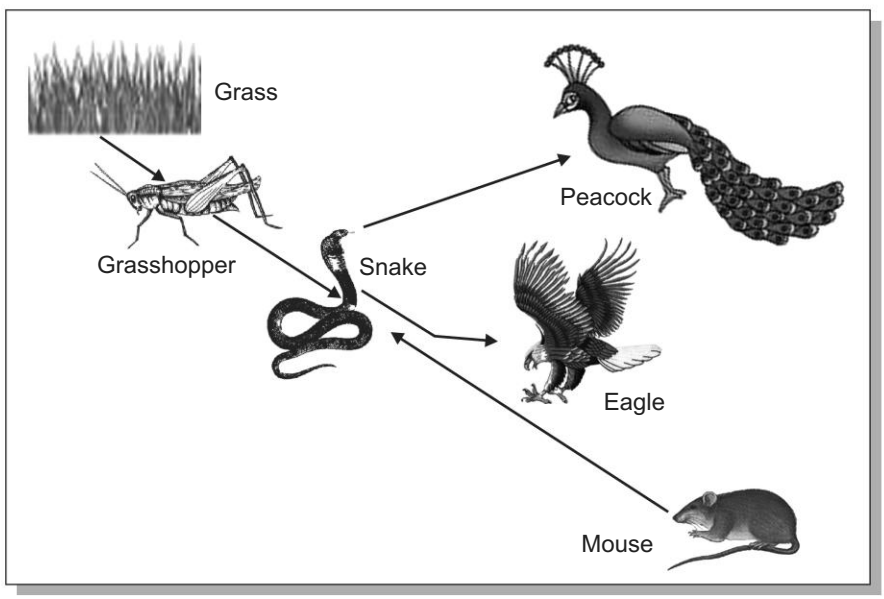

Fig. 3.2 Ecosystem food web

3.7.1 Significance of Food Web

Food webs maintain the nutritional balance in an ecosystem. They control the population size of a species. They also provide alternate sources of food and allow the endangered species to grow in size.

3.8 Ecological Pyramids

Graphic representation of the various trophic levels of an ecosystem is referred to as the 'ecological pyramid'. Elton (1927) used the term 'ecological pyramid' for the first time. In an ecological pyramid, the producers constitute the base and the top consumers make the apex. From the base to the top, the number, biomass and energy of an organism gradually decrease.

Following are the three kinds of pyramids:

1. Pyramid of numbers
2. Pyramid of biomass
3. Pyramid of energy

1. Pyramid of numbers – It shows the number of organisms at each trophic level. In a grassland ecosystem, the producers, i.e., grasses are the largest in number. The consumers decrease in the following way:

Grass ⟶ Grasshopper ⟶ Lizard ⟶ Hawk

Grass ⟶ Rabbit ⟶ Fox ⟶ Lion

Thus, the pyramid becomes upright. It is also upright in case of a pond and a forest ecosystem. But it is inverted in a single tree ecosystem. As the number of producers increase, i.e., big tree is single in number in comparison to the consumers, i.e., fruit eating birds, the birds in turn support the growth of a large number of parasites.

2. Pyramid of biomass – Biomass means the total weight of a living matter per unit area. In grassland and forest ecosystems the biomass decreases from producers to consumers, hence forming an upright pyramid. However, in an aquatic ecosystem, the biomass gradually increases towards the apex. Thus, the pyramid is inverted in shape.

3. Pyramid of energy – The pyramid of energy represents the amount of flow of energy at each trophic level. It is always upright in shape as the amount of energy decreases from producers' level to consumers' level. According to Lindman (1942) only 10 per cent energy is consumed at each trophic level.

3.9 Types of Ecosystem

3.9.1 Forest Ecosystem

About 40 per cent of the earth is covered by forests. In India, the total forest cover is about 22.74 per cent. Forest ecosystem has the following two components:

1. Biotic components
2. Abiotic components

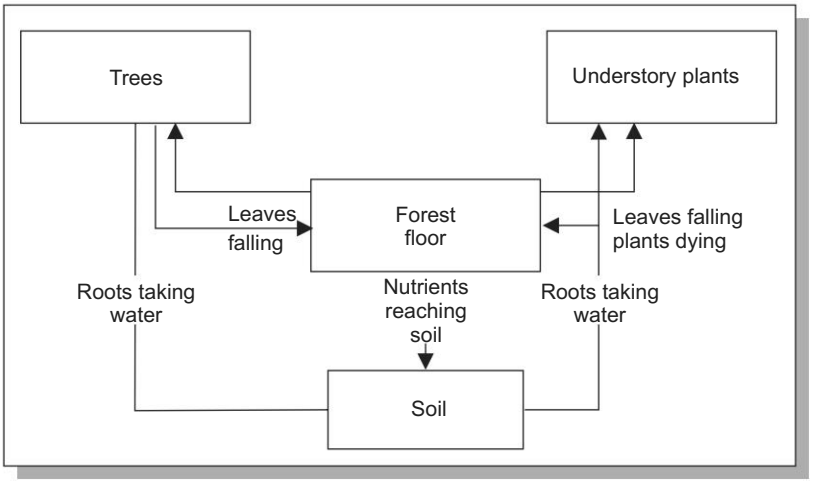

Fig. 3.3 Forest Ecosystem

1. **Biotic components** – The living components in a forest ecosystem are in the following order:
   (i) *Producers* – Different types of trees, shrubs and ground vegetation are the producers in a forest ecosystem. In India depending on climatic conditions, forests have been classified into tropical forests, subtropical forests, temperate forests and alpine forests. All types of forests have their own typical fauna and flora.
   (ii) *Consumers* – Primary consumers (herbivores) are ants, flies, spiders, dogs, beetles, elephants, deer, mongooses, shrews, etc. They are consumed by secondary consumers like, snakes, birds, foxes, etc. Tertiary consumers include owl, peacock, lion, tiger, etc.
   (iii) *Decomposers* – These include the fungi and bacteria. They decompose the dead organic matter of living organisms and release the essential minerals for reuse.

2. **Abiotic components** – In a forest ecosystem, the abiotic components are soil, air, sunlight, inorganic and organic components, and dead and decaying organic matter.

3.9.2 Grassland Ecosystem

It occupies about 19 per cent of the earth's surface. The various components of grassland ecosystem are as follows:

1. Biotic Components
2. Abiotic Components

1. **Biotic components** – The living components of a grassland ecosystem are as follows:
   - *(i) Producers* – These include, mainly grasses of the germinal family, a variety of herbs, shrubs and scattered trees.
   - *(ii) Consumers* – The primary consumers are deer, sheep, rabbits, mouse, insects, cows, etc. The secondary consumers are snakes, frogs, birds, lizards, fox, etc. They are carnivores that feed on herbivores or primary consumers. Hawks are the tertiary consumers as these feed on secondary consumers.
   - (iii) *Decomposers* – Fungi like rhizopus mucor, aspergillus, etc., and bacterium disintegrate dead organic matter.
2. **Abiotic components** – The non-living factors include the aerial environment and components like CO_2, water, nitrates, sulphates, phosphates, etc.

3.9.3 Desert Ecosystem

These are the regions of extreme temperature and occupy about 17 per cent of the land. They have annual of rainfall less than 25 cm. The components of desert ecosystem are as follows:

1. **Biotic components** – These include
   - *(i) Producers* – Producers include xerophytic plants like cacti, shrubs, bushes, grasses some trees, mosses and lichens.
   - *(ii) Consumers* – The primary consumers or herbivores are able to live in xeric conditions. For example, birds, camel, mouse, insects, etc. Secondary consumers are lizards, snakes, birds, etc. Whereas, the tertiary consumers include jungle cats, jackals, panthers, etc.
   - *(iii) Decomposers* – Some fungi and bacteria also act as decomposers.
2. **Abiotic components** – The aerial environment and nutrients in the soil constitute the abiotic components.

3.9.4 Aquatic Ecosystems

Pond Ecosystem

A pond is an example of fresh water, lentic or standing water ecosystem which is self-sufficient and self-regulating. The pond ecosystem is

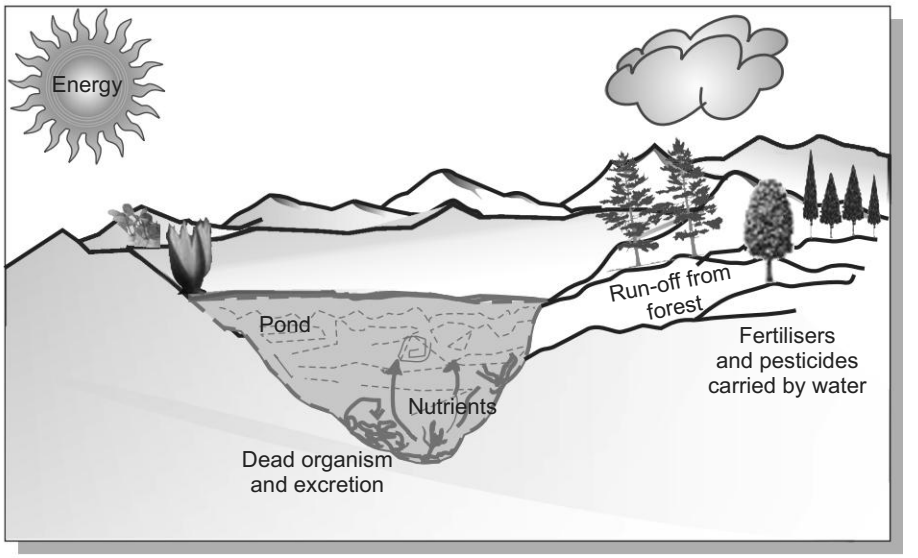

Fig. 3.4 Pond Ecosystem

characterised by surplus vegetation, micro-organisms and other large plants and animals. Its biotic and abiotic components are as follows:

1. **Biotic components** – They are as follows:
   - *(i) Producers* – Producers are phytoplanktons like anabaena, volvox, closterium, ulothrix, spirogyra, oscillatoria, submerged plants and floating plants.
   - *(ii) Consumers* – These are as follows:
     - Primary consumers or herbivores include zooplankton such as cyclops, daphnia, larval of chironomus, dysticvs (insect), lymnaea (snail) etc.
     - Secondary consumers – They are also called carnivores, e.g., small fishes, frogs, etc. Some dwelling annelids and molluscs are also included in this category.
     - Tertiary consumers – The secondary consumers are consumed by tertiary consumers such as large fishes, snakes, etc.

(iii) *Decomposers* – These are micro-organisms like bacteria and fungi present at the bottom of the pond. They feed on the dead bodies of plants and animals to release the abiotic elements for reuse by the producers.

2. **Abiotic components** – The abiotic components of the pond ecosystem comprise water, O_2, CO_2 organic components, inorganic compounds, temperature, light, pressure, pH, etc.

Stream Ecosystem

They are open ecosystems, which include running water. The biotic and abiotic components of stream ecosystem are as follows:

1. **Biotic components** – The biotic components of stream ecosystem are as follows:
   (i) *Producers* – Producers are phytoplanktons like diatoms, blue-green algae and green algae such as *ulothrix*, *cladophora*, water moss, etc.
   (ii) *Consumers* – They are helodes, cephalopteryx, phalacrocera, etc. Fishes are also found.
   (iii) *Decomposers* – Bacteria and fungi are the reducers in streams which feed upon the producers and consumers after their death.
2. **Abotic components** – They include inorganic and organic substances and climatic factors like sunlight, pressure, temperature, pH, etc.

Lake Ecosystem

Lakes are lotic (running) ecosystems are formed by inland depressions. Their depth ranges from a few feet to 5000 feet. The biotic and abiotic components are as follows:

1. **Biotic components** – These include
   (i) *Producers* – They include phytoplanktons like diatoms, green algae (staurastreum, cosmarium), blue-green algae (oscillatoria, microsystems) and some flagellates. Lotus, *trapa*, *hydrilla*, etc., are also found in lakes.
   (ii) *Consumers* – Zooplanktons, insects, prawns, small fishes, etc., are the main herbivores. While the carnivores include big fishes, forges, snakes, snails, thirudinea species and sometimes crowdies also.
   (iii) *Decomposers* – Bacteria and fungi are the decomposers in lakes.
2. **Abiotic components** – CO_2, O_2, Ca, N_2 organic compounds, light, heat, pH, etc., are the main abiotic components in the lake ecosystem.

River Ecosystem

Rivers are freshwater lotic ecosystems. Rivers are quite large in terms of their size, speed of flowing water, amount of water, O_2 quantity and physical and chemical conditions. Their biotic and abiotic components are as follows:

1. **Biotic components** – These include
   (i) *Producers* – They include phytoplanktons, blue-green algae, green algae, water moss and diatoms.
   (ii) *Consumers* – The consumers are cephalopteryx, helodes, phalacrocera, etc.
   (iii) *Decomposers* – Bacteria and fungi are the micro-organisms that feed on the dead organic material.
2. **Abiotic components** – These comprise organic substances, inorganic materials and climatic factors of a region.

Ocean Ecosystem

Oceans are the largest and most stable marine ecosystems. Oceans cover approximately 70 per cent of the earth's surface. Ocean water is saline and highly rich in minerals and gases. The biotic and abiotic components are discussed below.

1. **Biotic components** – They are classified as
   (i) *Producers* – They consists of phytoplanktons, e.g., diatoms, dinotkgellatesred, brown algae, etc.
   (ii) *Consumers* – Crustaceans, molluscs, fishes, etc., are the primary consumers. The secondary consumers are herring, mackerel, shad, etc., whereas the tertiary consumers include fishes like cod, haddock, halibut, etc.
   (iii) *Decomposers* – Saprophytic bacteria and fungi are the decomposers of ocean ecosystem.
2. **Abiotic components** – The main abiotic components are light, heat, pH, inorganic and organic substances.

3.10 Estuaries

The estuarine system is quite rich in flora and fauna. Estuary is formed near the coastline, where the river water mixes with sea water. Estuaries are very fertile in nature. The biotic and abiotic components are as follows.

1. **Biotic components** – These include
   (i) *Producers* – Producers are mainly micro flora like diatoms, green algae like *spirogyra*, *volvox*, *chlorella*, blue-green algae like *anabaena*, *toria*, etc., Macroflora like sea weeds, submerged grasses and rooted plants.

(ii) *Consumers* – The chief consumers are protozoans like noctiluca, euglena, vorticella, etc., and a large number of crustaceans, rotifers, annelids, small and large fishes, etc.

(iii) *Decomposers* – Bacteria and fungi disintegrate the dead organic material of the living.

2. **Abiotic components** – They include the organic, inorganic and climatic factors like heat, light pH, pressure, etc.

In India important estuaries are Chilka Lake in Orissa, Pulicat Lake in Andhra Pradesh and Thailanadu and Hoogly Matta in West Bengal.

Summary

- The term *ecosystem* was first coined by AG Tansley in 1935.
- Ecosystem is a basic functional unit of organisms and environment, interacting with each other and within their components. Ponds, lakes, rivers, oceans, forests, grasslands, towns, etc., are the examples of an ecosystem.
- The flow of energy in an ecosystem is unidirectional, i.e., from producers to consumers.
- Ecological succession can be defined as 'An orderly and progressive replacement of one community by another till the development of a stable community in that area.' (Smith, 1965)

REVIEW QUESTIONS

Short Answer Questions

1. What is an ecosystem?
2. What do you mean by autotroph?
3. Name the different types of ecosystems.
4. Name the different types of structural components of an ecosystem.
5. Define food chain.
6. What is food web?
7. Define ecological succession.
8. Give an example of a food chain.
9. What are ecological pyramids?

10. What is energy flow?
11. Define trophic level.

Descriptive Questions

1. Describe the structure and function of an ecosystem.
2. Explain the process of ecological succession with suitable examples.
3. Describe a pond ecosystem or a lake ecosystem.
4. Write short notes on the following:
   - Forest ecosystem
   - Grassland ecosystem
   - Desert ecosystem
5. What is energy flow? Discuss the different types of energy flow models.
6. Describe the different types of ecological pyramids.

OBJECTIVE QUESTIONS

Fill in the Blanks

1. Plankton is a _____ organism.
2. Standing water is known as _____ .
3. Consumers are heterotrophic organisms, who consume the _____ produced by the producer.
4. The herbivores are the _____ consumer in the ecosystem.
5. The existence of living world depends upon the _____ of energy and circulation of materials through the ecosystem.
6. Ecosystem is the basic functional unit of _____ .

True or False

1. Green plants are autotrophic members of an ecosystem.
2. A deer is a secondary consumer.
3. Grazing food chain starts with carnivores and ends with green plants.
4. Pyramid of energy is always upright.
5. The concept of *pyramid* was proposed by C Elton.
6. A biome is not the largest terrestrial community.

Multiple-Choice Questions

Put a √ mark against the correct answer.

1. The word ecosystem was first coined by
   (a) Weaver and Clements (b) A G Tansley
   (c) R Misra (d) E P Odum
2. In an ecosystem, green plants are called
   (a) producers (b) consumers
   (c) decomposers (d) carnivores
3. The Great Indian Desert lies in the state of
   (a) Gujarat (b) Rajasthan
   (c) Bihar (d) Punjab
4. Ten per cent energy transfer law in a food chain was proposed by
   (a) Lindemann (b) Tansley
   (c) Elton (d) Raunkier
5. Silent Valley is located in
   (a) Uttrakhand (b) Assam
   (c) Kerela (d) Madhya Pradesh
6. The world famous 'Valley of Flowers' is situated at
   (a) Nainital (b) Chamoli
   (c) Uttarkashi (d) Pavri
7. Herbivores occupy which one of the following?
   (a) First level (b) Second level
   (c) Third level (d) Fourth level
8. A food chain consists of
   (a) producers only (b) producer and consumers
   (c) consumers only (d) decomposers only
9. 'Eutrophication' refers to
   (a) high production in an aquatic ecosystem
   (b) low production in a terrestrial ecosystem
   (c) stable production in a terrestrial ecosystem
   (d) low production in an aquatic ecosystem
10. Which one of the following receives maximum energy?
    (a) Producers (b) Decomposers
    (c) Primary consumers (d) Secondary consumers

11. Which one of the following is not a factor of abiotic environment?
    (a) Temperature (b) Water
    (c) Sunlight (d) Consumers
12. Which gas is harmful as well as beneficial, in the earth's atmosphere?
    (a) Carbon dioxide (b) Methane
    (c) Oxygen (d) Ozone
13. When a number of food chains are interlocked, it is called
    (a) food link (b) food chain
    (c) food web (d) pyramid
14. Decomposers of an ecosystem include
    (a) microscopic animals (b) bacteria and fungi
    (c) Both (a) and (b) (d) None of the above
15. A food chain can have ….. number of trophic levels.
    (a) Three/Four (b) Two
    (c) One (d) Zero
16. The sphere of living matter combining water, soil and air on the surface of the earth is called
    (a) hydrosphere (b) lithosphere
    (c) atmosphere (d) biosphere
17. Ecosystem is
    (a) always open
    (b) always closed
    (c) both open and closed depending on biomass
    (d) both open and closed depending on community.
18. 'Wildlife Week' is observed every year from
    (a) 1^{st} Oct to 8^{th} Oct
    (b) 15^{th} Oct to 22^{nd} Oct
    (c) 15^{th} Aug to 22^{nd} Aug
    (d) 1^{st} Sept to 8^{th} Sept
19. Which one of these is an edaphic factor?
    (a) Light (b) Wind
    (c) Rainfall (d) Soil
20. Largest ecosystems of the world are
    (a) forests (b) grasslands
    (c) great lakes (d) oceans

21. Which of the following is the most stable ecosystem?
    (a) Mountain (b) Desert
    (c) Forest (d) Ocean
22. BOD stands for
    (a) Biological Oxygen Deficit
    (b) Biological Oxygen Demand
    (c) Better Oxygen Demand
    (d) Best Oxygen Demand
23. In a lake ecosystem the population rise or its explosion is termed as
    (a) tide (b) bloom
    (c) plankton (d) nekton
24. Food chains are met only in
    (a) sea (b) forests
    (c) lake (d) All the above
25. Which is the best soil for plant growth?
    (a) Clayey soil (b) Gravel soil
    (c) Loamy soil (d) Sandy soil
26. Which components are most common in a pond ecosystem?
    (a) Primary consumers (b) Secondary consumers
    (c) Producers (d) Decomposers
27. Factors related to form and behaviour of the earth's surface are called
    (a) Climatic (b) Topographic
    (c) Edaphic (d) Biotic

ANSWERS

Fill in the Blanks

1. microscopic
2. lentic
3. food
4. primary
5. flow
6. ecology

True or False

1. T
2. F
3. F
4. T
5. T
6. F

Multiple-Choice Questions

1. (b)
2. (a)
3. (b)
4. (a)
5. (c)
6. (b)
7. (b)
8. (b)
9. (a)
10. (c)
11. (d)
12. (a)
13. (c)
14. (b)
15. (a)
16. (d)
17. (a)
18. (a)
19. (d)
20. (d)
21. (d)
22. (b)
23. (b)
24. (d)
25. (c)
26. (c)
27. (b)

Chapter 4

Biodiversity and its Conservation

The phrase 'biological diversity' was coined by Norse and Mecmenus in the year 1980. However, the word 'biodiversity' was used by G Rosen in the year 1985 for the first time in a symposium in Washington. Biodiversity is an important natural resource. Like other resources such as soil, air, water, mountains, rivers, streams, minerals, etc., biodiversity is also a 'gift' of nature and is very essential for the economic growth of any country. Biodiversity is a measure of the health of an ecosystem. Greater biodiversity implies a healthier ecosystem.

'Biodiversity' refers to the wide variety of life on earth, i.e., all plant, animals and micro-organisms, and their various species and various ecosystems that they live in. In simple words biodiversity is the sum total of all species. There are about 50 million species on this beautiful planet. Out of this only 1.5 million have been identified to date. Biodiversity differs from one place to another.

4.1 Definition

Biodiversity has been defined by many as the following:

In simple form, biodiversity refers to number, variety and variability of all life forms inhabiting the earth.

International Union for Conservation of Nature and Natural Resources (IUCN) and United Nations Environmental Program (UNEP) 1992 defined biodiversity as 'The totality of genes, species, and ecosystems in a given region in the world.'

According to the US Office of Technology Assessment, biological diversity is 'The variety and variability among living organisms and the ecological complexes in which they occur.'

Due to human activities like agriculture, mining, growth in population, erosion, deforestation, etc., we are losing invaluable wild species of plants and animals every year.

4.2 Levels of Biodiversity

Biodiversity includes the following three levels:

1. Species diversity
2. Ecosystem diversity
3. Genetic diversity

1. **Species diversity** – It is the basic level of biodiversity and it includes all the species on this planet in the form of micro-organisms (viruses, bacteria, protists), plants and animals. Richer the species, greater will be the species diversity. For example, *Panthera leo persica* (lion), *Panthera uncia* (snow leopard) and *Panthera tigris* (tiger) belong to the same genera, but all are from different species. Plant and animal diversity in India is about 6.5 per cent of the world species.
2. **Ecosystem diversity** – Ecosystem diversity includes different ecosystems. Each ecosystem consists of biotic and abiotic components. Ecosystems may be natural like ponds, grasslands, forests, deserts, oceans, etc., or artificial such as crop fields, a town or an artificial lake, etc. Each ecosystem has its own inter-linked species and specific ecological conditions. Ecosystems are diverse in the following ways:
   (i) *Alpha diversity* – When a variety of organisms share the same community it is known as alpha diversity. It is diversity within a community.
   (ii) *Beta diversity* – It exists when diversity of organisms occur between communities.
   (iii) *Gamma diversity* – It is the diversity in habitats over a geographical area.
3. **Genetic diversity** – Genetic diversity means the variability among individuals within the same species, for example, each human differs from another. This diversity is due to the variations in genes and it gives specific characteristics. A species with more genetic diversity is able to adapt better to changes in the environmental conditions. Genetic diversity is the basis of specification (evolution of new species). It often increases with environmental variability.

4.3 Biogeographical Classification of India

Biogeography deals with the geographical distribution of plants and animals. The various biogeographical regions of India are as follows:

1. Trans-Himalayas
2. Himalayas

3. Desert
4. Semi-Arid
5. Western Ghats
6. Deccan Peninsula
7. Gangetic Plains
8. Coasts
9. North-East India
10. Islands

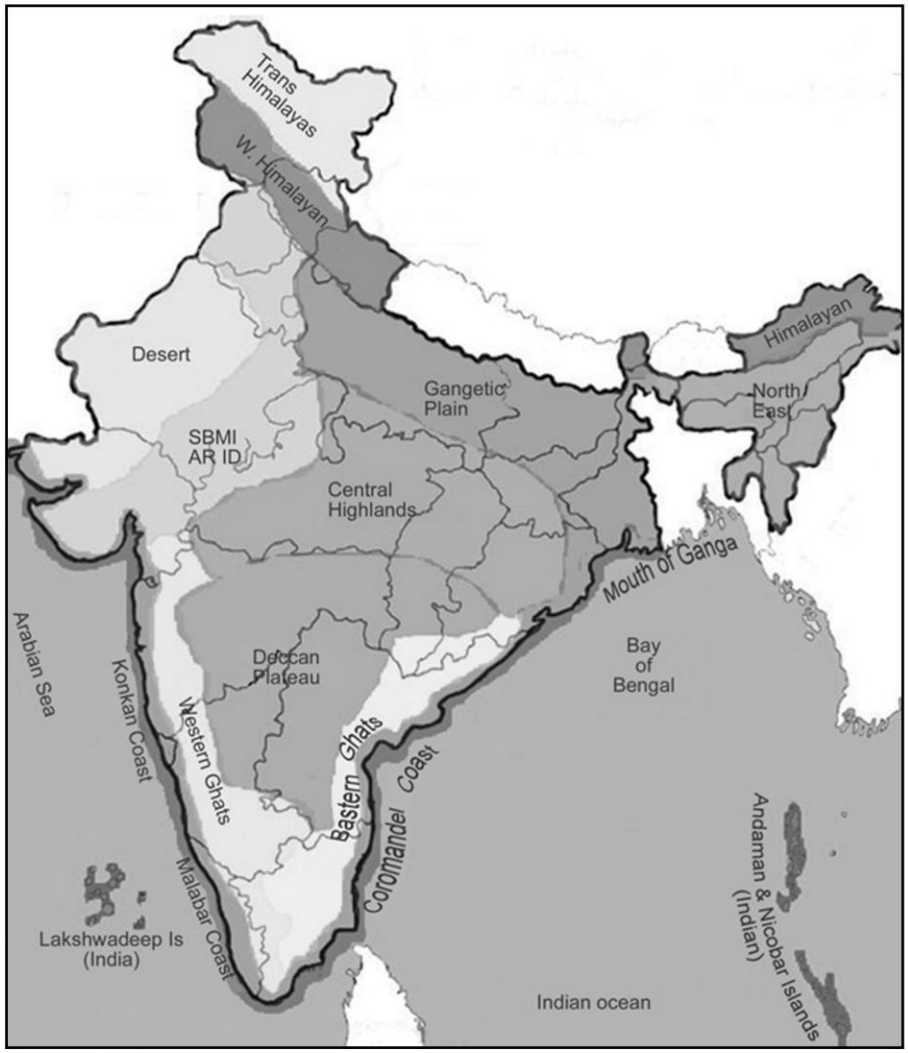

Fig. 4.1 Biogeographical classification of India

1. **Trans-Himalayas** – It ranges from central region in the North Western Himalayas. It mainly includes dry and moist alpine and coniferous trees. The region covers about 186200 sq. km in Ladakh and Lahul–Spiti. The final community includes goats, sheep, asses, leopards, wolves and black-necked cranes.
2. **Himalayas** – This region is highly rich in biodiversity and includes evergreen forests, moist as well as dry temperate forests and alpine forests. The fauna of the region comprises snow leopards, snow cocks, brown bears, red pandas, sambars, etc.
3. **Desert** – These regions are characterised by very hot and dry summers and cold winters. Rainfall is less than 70 cm. Xerophytes are abundantly present in this region. The main animals of this region are wild ass, desert cats, desert foxes, deer and sand grouse species.
4. **Semi-Arid** – This region is characterised by very sparse vegetation and bushes. It has sand dunes and sandy plains. Tigers, lions of Gir, snakes, foxes, asses, camels, etc., comprise the fauna of the region.
5. **Western Ghats** – This region has moist evergreen forests, mixed deciduous forests, subtropical temperate evergreen forests and mangrove forests. Amphibian species are most dominant here.
6. **Deccan Peninsula** – This region covers eastern and western ghats and south of the Vindhyachal mountains. Floral diversity includes rain forests, moist deciduous forests and tropical dry deciduous forests. Leopards, wild bears, chitals, wild elephants, wild buffaloes, etc., constitute the fauna of the region.
7. **Gangetic Plains** – This is one of the most fertile regions in India. It includes tropical moist and dry deciduous forests and tall grasses. The fauna include *barasinghas*, crocodiles, turtles, blackbucks, elephants and rhinoceroses.
8. **Coasts** – It extends up to 6500 km. Mangrove forests are dominant in these regions. The animals include dolphins, crocodiles, tigers and turtles.
9. **North-East** –This region is covered by tropical wet evergreen forests. Moist deciduous forests, broad-leave hill forests and pine forests. Diverse animals such as rhinoceroses, buffaloes, swamp deer, hogs, deer, elephants, etc., are found in this region. Bamboo, orchids, and ferns comprise floral diversity and are found in abundance here.
10. **Islands** – Islands have wide range of coastal vegetation like mangroves and evergreen forests. Around 220 specific *avifaune* are found on these Indian islands.

4.4 Value of Biodiversity

Biodiversity has great resource value. It not only provides enough food but also has psychological and spiritual value. It is a great renewable source to mankind. The importance of biodiversity can be discussed under the following heads.

Ecological Value

Destruction of biodiversity may upset the ecological balance, for example, if the top consumers like lions, peacocks, eagles, etc., are removed from the land ecosystem the number of herbivores will increase. In turn, the herbivores will finish the producers (vegetation), leading to a decrease in the number of consumers. Thus the whole ecosystem will be imbalanced.

Commercial Value

Biodiversity is important from an economic point of view as well. Annually about two million tons of sea food is produced through marine fisheries around the world. Various body parts of one Indian rhinoceros are sold for more than 125000 rupees in the international market. In the same way ivory of elephants, musk deer's glands, skin of snakes, body parts of tigers, etc., are also sold at very high prices.

We get timber, medicines, fuel, fibre, paints, fruits and vegetables, resin, tea, coffee, etc., from plant resources. Only 20 species of the entire plant family provide 90 per cent of the world's food. Fish, sheep, poultry cattle, eggs provide the largest sources of protein in the world.

Social Value

In terms of social value, biodiversity realises pleasure and happiness. For instance, we feel joy and excitement while in a jungle. The beauty of nature attracts one and all.

Ethical Value

Biodiversity has great ethical value. Ethical values establish respect for biodiversity and human beings. Such values emphasise that everyone should protect biodiversity as it maintains the balance in nature. Loss of many species threatens the existence of several other species.

Aesthetic Value

Due to its sheer beauty, biodiversity has got great aesthetic value in terms of ecotourism, bird watching, wildlife, gardening, etc. Beautiful landscapes

and natural ecosystems enhance our emotional and spiritual state of well-being. Aesthetic sense inspires our scientists, artists and poets as well.

Optional Value

Optional values are concerned with the future use of resources. Optional values are not immediately observed, are far reaching and have an impact on living systems.

Some optional values are given below:

1. Maintaining biogeochemical cycle in the nature.
2. Maintaining hydrological cycles and recharging ground water.
3. Soil formation and controlling soil erosion.
4. Keeping the environment clean by decomposing and absorbing pollutants.
5. Pollination, gene flow, etc., are also some optional values of biodiversity.

4.5 Biodiversity at Global, National and Local Levels

4.5.1 At the Global Level

It is estimated that there are about 5–50 million species of plants and animals on the earth. Out of this 1.6 million species have been identified so far. There are about 1217645 species of animals and 393450 plant species including micro-organisms. There are about 34 hot spots at the global level. There are 12 megadiversity nations which are highly rich in biodiversity. They include Brazil, Columbia, Ecuador, China, Mexico, Australia, South Africa, Indonesia, Venezuela, Peru, India and Malaysia. About 70 per cent biodiversity of the world is present in these megadiversity centres.

4.5.2 At the National Level

India is immensely rich in biodiversity. This is due to its varied climate and altitudinal conditions. In our country about 40 per cent land is under cultivation. There are 96 national parks, 572 wildlife sanctuaries, 14 biosphere reserves and 2 hot spots. 81251 spices of animals and 49219 species of plant and micro-organisms are found in India.

Table 4.1 Floral diversity in India and the world

	Species	
Taxa	*India*	*World*
Bacteria	850	4700
Virus	—	5000
Algae	2500	40000
Fungi	23000	47000
Lichen	1940	17000
Bryophyte	2843	16000
Pteridophyta	1022	13000
Gymnosperm	64	750
Angiosperm	17000	250000
Total	**49219**	**393450**

Table 4.2 Faunal diversity in India and the world

	Species	
Taxa	*India*	*World*
Protista	2577	31290
Mollusca	5050	66535
Arthropoda	60383	983677
Other Invertebrates	8329	87121
Protochordata	116	2173
Fishes	2546	21723
Amphibian	204	5145
Reptiles	446	5145
Aves	1228	9672
Mammals	372	4629
Total	**81251**	**1217645**

4.5.3 At the Local Level

Biodiversity at the local level includes various species found in a particular area. It has three basic components like compositional aspects, structural aspects and functional aspects. Compositional aspects include the genetic constitution of a population in a particular area. Structural aspects govern the physical features and vegetation found in a habitat. Functional aspects refer to hydrological, geographical, ecological, climatic and evolutionary aspects that help maintain biodiversity.

4.6 India as a Megadiversity Nation

India is one of the twelve 'megadiversity' nations in the world. India is quite rich in its flora and fauna. It is also rich in endemic species, i.e., those species which are found only in our country and nowhere else in the world. Variation in amount and length of precipitation in different parts of the country plays a crucial role in the variety of local species. Great physical variations are also responsible for local variations in species diversity. The North-Eastern parts of India, the Western Ghats and the Andaman and Nicobar islands are highly rich in biodiversity. But our overpopulous country is rapidly exploiting this great source. Today the diversity of flora and fauna India is only 6.5 per cent of the world species. India has 49219 species of plants and 81251 species of animals. In India about 90 per cent medicines are obtained from plants. Out of the 17000 flowering plants, 8000 species are suitable medicinal use, 3000 species are edible, 500 species provides fibre, 300 species are the source of gum and lac, 300 species provide fodder and 600 species are used for social and religious purposes. The 16 major forest types in our country are at present in 10 biogeographic zones.

4.7 Biodiversity Hot Spots

Norman Myers developed the concept of 'hot spots' in 1988 to represent the richest zone of biodiversity in the world. The key criteria for a hot spot are

1. Number of endemic species
2. Degree of threat (habitat loss)

There are 34 biodiversity hot spots in the world. India has 2 hot spots, namely, Western Ghats and Eastern Himalayas. These areas are very sensitive as far as biodiversity is concerned and show a high degree of endemism.

4.8 Threats to Biodiversity

Biodiversity has faced serious threats, due to various anthropogenic activities. Many wild plants and animals have become extinct and many others face the threat of extinction.

Following are the main threats to biodiversity:

Destruction of Habitats

Natural habitats of plants, animals and even certain tribal communities are destroyed by humans for urban settlement, agriculture, mining, industries,

dam construction, road construction, etc. Many species face the danger of extinction due to loss of habitat.

Hunting and Poaching

Wild animals are killed by poachers for commercial purposes. They are killed to obtain valuable products like skin, tusks, fur, horns bones, meat, perfumes (musk), cosmetics, etc. In the international market the cost of ivory is approximately 150/kg, whereas in the Indian market it costs up to INR 2000/kg. The price of a rhinoceros's horn varies between INR 15000–20000 in a pharmaceutical market in India. Musk deer is hunted for musk (for medicinal purposes), rhinoceroses for their horns, elephants for ivory, tigers, leopards, snakes, crocodiles, etc., are killed for their skin. In this way hunting and poaching pose a serious threat to lives of these animals and in turn our biodiversity.

Climate Change

Global warming and ozone depletion are responsible for the change in climate, which also threatens biodiversity.

Overexploitation

Due to overpopulation, the demand for almost everything has increased, leading to degradation of the environment and overexploitation of valuable resources.

Pollution

Pollution disturbs natural ecosystems. For example, aquatic ecosystems are changing due to water pollution, which is dangerous for the aquatic fauna and flora. In the same way our coastal ecosystems also get affected by pollution.

Introduction of Exotic Species

Exotic species pose a threat to native species as native species are then subjected to competition for food and space.

Apart from the above factors, certain other threats to biodiversity are as follows:

1. Deforestation
2. Desertification
3. Shifting cultivation or *Jhoom* cultivation
4. Ignorance

4.9 Endangered and Endemic Species in India

The IUCN (International Union for Conservation of Nature and Natural resources) has classified plants and animals into the following categories:

1. **Extinct (Ex)** – These species have completely disappeared from the earth. These include dinosaurs, mammoths, dodos, Tasmanian wolves, blue bucks, etc.
2. **Endangered (E)** – Species represented by fewer numbers of individuals, due to unfavourable climatic conditions or some other factors, are known as endangered species. These include Indian rhinoceros, Asiatic lion, great Indian bustard, blue whale, *ghariyal,* etc.
3. **Vulnerable (V)** – Species whose population is decreasing day by day and are facing a high risk of extinction are referred to as vulnerable. These include deer, *golden langur*, *chinkara,* etc.
4. **Rare (R)** – Species that are not at present endangered or vulnerable, but their overall population is small are called rare. Such species are usually localised within certain geographical areas. These include golden cat, Indian pied hornbill, olive ridley turtle, etc.
5. **Threatened (T)** – This term is used for those species which fall into the categories—endangered, vulnerable and rare.

The IUCN on the global level maintains a Red Data Book which provides a complete list of all endangered animals and plant species, from all the regions.

4.9.1 Endangered Plants

In India about 450 species of plants have been identified as threatened. Some of them are given below.

Table 4.3 Plant species in India identified as threatened

Plant species	*Family*
Atropa acuminata	Solanaceae
Aphyllorchis montana	Orchidanceae
Captis teeta	Ranunculaceae
Drosera indica	Droseraceae
Olax nana	Olaceae
Rauvolfia serpentina	Apocynaceae
Vanilla pilifera	Urchidaceae
Piper barberi	Piperaceae

(*Contd.*)

Table 4.3 (*Contd.*)

Pinus gerardiana	Gymnosperms
Santalum album	Santalaceae
Aldrovanda vesiculosa	Drozeraceae
Cycas beddomei	Cycalaceae
Ophioglossum pendulum	Opnioglossaceae
Uvaria nicobarica	Annonaceae
Meconopsis bctonicifolio	Papaveraceae
Iodes Hookeriana	Leacinaceae

4.9.2 Endangered Animals

Some important endangered animal species in India are given below:

Table 4.4 Endangered animal species in India

Common name	*Zoological name*
Andaman wild pig	*Sus scrofa and sus amanensis*
Bharal	*Ovis nahura*
Bison	*Bos gaurus*
Black buck	*Antelope cervicapra*
Blue whale	*Balaenoptera musculus*
Chital	*Axis axis*
Desert cat	*Felis (libyca)*
Golden langur	*Presbytis geci*
Himalayan brown bear	*Ursus arctos*
Elephant	*Elephas meximus*
Lion	*Panthera leo persica*
Wild ass	*Equus hemionus khur*
Leopard	*Panthera Pardus*
Musk dear	*Moschus moschiferus*
Rhinoceros	*Rhinoceros unicornis*
Wild dos or dhole	*Euon aleinus*
Tiger	*Panthera tigris*
Chariyal	*Gavialis gangetievs*
Black necked crane	*Grus nigricollis*
Great Indian bustard	*Ardeotis nigriceps*
Monal pheasants	*Bophopherus impejanus*

(*Contd.*)

Table 4.4 (*Contd.*)

Great Indian hornbill	*Buceros bicornis*
Tibetan snow-cock	*Tetragogallus tibetanus*
Pea fowl	*Pavo cristatus*
Cheer pheasant	*Citrus watlichii*
Mountain quail	*Uphrysia supercilosa*
Wild yak	*Bos grunniens*
Wild buffalo	*Babulus bubatis*
Loris	*Loris tardigradus*
Kashmir stag	*Cervus elephus hangul*
Indian wolf	*Canis typus pallipes*

4.9.3 Endemic Species

Endemic species are those species which are confined to a particular area only and do not extend beyond that one region. Out of the 17000 angiosperm plants, 33 per cent are endemic species. Out of the 272 species of mammals found in India and percent of them are endemic. About 1228 species of birds are found in India. Out of these, 48 species are not found anywhere except India, therefore these 48 species are endemic. Likewise 33 per cent of total reptile species in India are endemic, while 61 per cent amphibians are endemic.

4.10 Conservation of Biodiversity

Conservation of biodiversity is very important for social and economic development of a country. Conservation refers to scientific utilisation of natural resources for the present and future generations. It requires the application of various ecological principles and knowledge of wildlife.

Conservation is of two types:

1. In-situ conservation
2. Ex-situ conservation

4.10.1 In-situ Conservation

In-situ conservation means the conservation of living resources, i.e., animals and plants within their natural habitats. It includes protected areas like national parks, wildlife sanctuaries, biosphere reserves, cultural landscapes, natural monuments, etc. In India, the network of protected areas consists of 96 national parks, 592 wildlife sanctuaries and 14 biosphere reserves. The protected areas have been set up under the legal support of the Wildlife Protection Act of 1972.

National Parks and Wildlife Sanctuaries

National parks and wildlife sanctuaries have been established to protect and propagate wildlife within their natural habitats. A national park or a sanctuary may be defined as 'An area declared by statute, for the purpose of protecting, propagating or developing wildlife therein, or its natural environment, for scientific, educational and recreational value.'

IUCN (1975) has adopted the following definition of a national park: 'A national park is a relatively large area (a) where one or several ecosystems are not materially altered by human exploitation and occupation; where plant and animal species, geomorphological sites and habitats are of special scientific, educative and recreational interest or which contain a natural landscape of great beauty and (b) where the highest competent authority of the country has taken steps to prevent or eliminate as soon as possible, exploitation or occupation in the whole area, to enforce effectively the aspect of ecological, geomorphological or aesthetic features, which have to its establishment and (c) where visitors are allowed to enter, under special conditions, for inspirational, cultural and recreational purposes. Hunting and grazing are absolutely banned in a national park, but in a sanctuary these activities may be allowed under the control of the highest authority.

List of National Parks and Wildlife Sanctuaries in India

Biosphere Reserves

The concept of a biosphere reserve was launched by UNESCO in the year 1971 in its MAB program. These reserves have been set up for ecological research and habitat preservation. Ramade (1984) described a biosphere reserves as 'The means to protect ecosystems, whether natural or modified by human activity, in order to preserve ecological evidence for the purpose of scientific research.'

There are 14 biosphere reserves in India. A biosphere reserve is divided into a core zone, a buffer zone and a manipulation zone.

Table 4.5 List of biosphere reserves

S. No.	*Name*	*State*	*Area (sq. km)*
1.	Nilgiri	Tamil Nadu/ Karnataka/Kerala	5520
2.	Nanda Devi	Uttarakhand	5861
3.	Nokrek	Meghalaya	820
4.	Manas	Assam	2837
5.	Sunderbans	West Bengal	9630
6.	Gulf of Mannar	Tamil Nadu	10500
7.	Great Nicobar	Andaman and Nicobar Islands	885

(*Contd.*)

Table 4.5 (*Contd.*)

8.	Similipal	Orissa	4374
9.	Dibru-Saikhowa	Assam	765
10.	Dehong deband	Arunachal Pradesh	5112
11.	Panchmarhi	Madhya Pradesh	4926
12.	Kanchenjunga	Sikkim	2620
13.	Agasthyamalai	Madhya Pradesh	4926
14.	Aruchanakumar-Amarkautak	Madhya Pradesh and Chattisgarh	3835

Sources: CS Division of MOEF, GOI.

4.10.2 Ex-situ Conservation

Ex-situ conservation includes the conservation strategies of living resources outside their natural habitats such as in zoos, botanical gardens, seed banks, tissue culture labs, etc. Vitro conservation, specially by cryopreservation in liquid nitrogen at a temperature of 196 °C is very useful for conserving seeds, pollen grains or tissues for a long period of time.

National Parks and Wildlife Sanctuaries in India

Some well-known national parks and wildlife sanctuaries of our country are:

Table 4.6 List of national parks and wildlife sanctuaries in India

	NP/WLS	*City (State)*
1.	Corbett NP	Nainital (UK)
2.	Gir NP	Junagarh (Gujarat)
3.	Kanha NP	Mandla & Balaghat (MP)
4.	Desert NP	Jaisalmer (Rajasthan)
5.	Sunderbans (Tiger Reserve)	24 Pargana (WB)
6.	Bandipur NP	Mysore (Karnataka)
7.	Periyar WLS	Idukki (Kerala)
8.	Bhitar Kanika WLS	Cuttack (Orrisa)
9.	Chilka Lake Birds WLS	Balagaon (Orrisa)
10.	Manas WLS	Kamrup (Assam)
11.	Keoladeo NP	Bharatpur (Rajasthan)
12.	Govind Sagar WLS	Bilaspur (HP)

WLS- Wildlife Sanctuaries

NP- National Park

Zoological and Botanical Gardens

Table 4.7 List of zoological and botanical gardens in India

	State/Union Territory	*No. of NP*	*Area (sq. km)*	*No. of WLS*	*Area (sq. km)*
1.	Andaman and Nicobar Islands	9	1153.938	96	466.215
2.	Andhra Pradesh	4	373.23	21	13096.23
3.	Arunachal Pradesh	2	2468.23	11	7606.365
4.	Assam	5	1977.788	16	888.216
5.	Bihar	1	335.6	11	2993.16
6.	Chandigarh	0	0	2	26.009
7.	Delhi	0	0	1	17.76
8.	Goa	1	1.7	6	647.96
9.	Gujarat	4	479.67	22	16602.61
10.	Haryana	2	46.98	19	287.32
11.	Himachal Pradesh	2	1429.4	32	5665.92
12.	Jammu and Kashmir	4	3810.07	16	10163.67
13.	Karnataka	5	2472.18	21	4231.439
14.	Kerala	3	536.52	12	1788.02
15.	Madhya Pradesh	9	3656.35	25	7199.52
16.	Maharashtra	5	955.93	36	14729.64
17.	Manipur	2	40	5	706.5
18.	Meghalaya	2	267.48	3	34.207
19.	Mizoram	2	200	5	775
20.	Nagaland	1	202.02	3	20.35
21.	Orissa	2	990.7	18	7961.94
22.	Punjab	0	0	10	316.71
23.	Rajasthan	4	3859.37	24	5301.84
24.	Sikkim	1	1784	6	265.1
25.	Tamil Nadu	5	307.84	20	2997.57
26.	Tripura	0	0	4	603.08
27.	Uttar Pradesh	1	490.1	23	5185.9

(*Contd.*)

Table 4.7 (*Contd.*)

28.	Uttarakhand	6	4083.3	16	2868
29.	West Bengal	5	1693.25	15	1223.47
30.	Chattisgarh	3	2929.5	10	3419.46
31.	Jharkhand	1	231.67	10	1868.31
32.	Dadra and Nagar Haveli	0	11	92	
33.	Daman and Diu	0	0	1	2.18
34.	Lakshadweep	0	0	1	0.01
	Total	90	36882.13	502	12005.9

Source: Wildlife Division of MOEF, GOI (As on 31st July 2004)

Summary

- Biodiversity is the degree of variations of all life forms within a given ecosystem, biome or an entire planet.
- It can be observed at three levels: species diversity, ecosystem diversity and genetic diversity.
- India is one of the twelve 'megadiversity' nations of the world.
- Hot spots are those areas which are very sensitive regions, with specific reference to biodiversity. There are 34 such hot spots in the world.
- Biodiversity can be conserved in two ways, e.g., ex-situ conservation and in-situ conservation.

REVIEW QUESTIONS

Short Answer Questions

1. Define biodiversity.
2. Name the different levels of biodiversity.
3. How many national parks and sanctuaries are there in India?
4. What are biodiversity hot spots?
5. What are endangered species?
6. Define endemic species.
7. Define ex-situ and in-situ conservation.

Descriptive Questions

1. Explain different biogeographical areas in India with respect to biodiversity.
2. Discuss in detail the threats to biodiversity.
3. Discuss in detail strategies for biodiversity conservation.
4. Why is India known as a 'megadiversity' nation?
5. Write short notes on the following:
   - Protected areas
   - Ecosystem diversity
   - Loss of biodiversity
   - Values of biodiversity

OBJECTIVE QUESTIONS

Fill in the Blanks

1. Protected areas must _____ biogeographic regions.
2. Each area has a _____ of different ecosystems.
3. Agricultural systems have _____ biodiversity.
4. Biodiversity is a valuable _____ resource.
5. Biodiversity deals with a variety of _____.
6. Geological events in the landmass of India have provided conditions for high _____ of biological diversity.
7. The year 2010 has been declared as _____ .

True or False

1. Organisms endemic to India and are found nowhere else in the world.
2. Genetic diversity is not an evolutionary process in nature.
3. The rate at which the extinction of species is occurring throughout the country remains obscure.
4. Ex-situ conservation is related to conservation of biodiversity.
5. Diversity in wild species forms the gene pool.

Multiple-Choice Questions

Put a ✓ mark against the correct answer.

1. Gir forest is home to
   (a) elephant (b) tiger
   (c) lion (d) leopard
2. In India the Rhinoceros is now found in
   (a) Dachigam National park
   (b) Kaziranga National Park
   (c) Sundarbans National Park
   (d) Dudhwa National Park
3. Which animal is the symbol of 'World Wide Fund' for nature?
   (a) Red Panda (b) Polar bear
   (c) Lion (d) None of these
4. Which bird is a symbol of 'Bombay Natural History Society'?
   (a) Hornbill (b) Egret
   (c) Spoonbill (d) Sun bird
5. Which Indian state has named all its tourist resorts after birds?
   (a) Assam (b) Kerala
   (c) Andhra Pradesh (d) Haryana
6. The term 'threatened species' refers to
   (a) endangered (b) vulnerable
   (c) rare (d) All of these
7. A species in immediate danger of extinction are called
   (a) endangered (b) vulnerable
   (c) rare (d) All of these
8. Where is the head quarter of IUCN situated?
   (a) New York (b) Denmark
   (c) Switzerland (d) United Kingdom
9. Corbett National Park is in
   (a) Punjab and is home for antelope
   (b) Uttarakhand and is famous for tigers
   (c) Himachal Pradesh and is famous for birds
   (d) Rajasthan and is famous for camels
10. Which of the following animal has become extinct in India?
    (a) Tusk of elephant (b) Cheetah
    (c) Lion (d) Rhinoceros

11. The source of 'ivory' is
    (a) Tusk of elephant (b) Bones of whale
    (c) Antlers of deer (d) Bones of elephant
12. The number of National Parks in India is
    (a) 56 (b) 69
    (c) 89 (d) 79
13. 'Red Data Book' provides data on
    (a) Red Sea (b) photosynthesis
    (c) population (d) endangered species
14. The number of wildlife sanctuaries in India is
    (a) 497 (b) 421
    (c) 398 (d) 375
15. 'Kanha National Park' is famous for
    (a) rhinoceroses (b) tigers
    (c) birds (d) crocodiles
16. 'Van Mahotsava' is celebrated for
    (a) deforestation (b) afforestation
    (c) cleanliness (d) None of the above
17. Which National Park is a natural abode of the Indian Rhino?
    (a) Kanha National Park, Madhya Pradesh
    (b) Corbett National Park, Uttarakhand
    (c) Kaziranga National Park, Assam
    (d) Dudhwa National Park, Uttar Pradesh
18. When was the Indian Board for Wildlife constituted?
    (a) 1952 (b) 1948
    (c) 1955 (d) 1972
19. 'Project Tiger' was initiated in
    (a) 1973 (b) 1972
    (c) 1971 (d) 1982
20. Where is the Wildlife Institute of India located?
    (a) Delhi (b) Dehradun
    (c) Lucknow (d) Mumbai
21. Forest Research Institute (FRI) is located at
    (a) Dehradun (b) Goa
    (c) Pantnagar (d) Shimla

22. On which day is 'Green Day' celebrated in Uttarakhand?
    (a) 3rd July (b) 5th July
    (c) 8th July (d) 15th July
23. Where is the 'Rajaji National Park' situated?
    (a) Dehradun (b) Chamoli
    (c) Pithoragarh (d) Mussorie
24. What type of education is given at the 'Forest School at Dehradun'?
    (a) Guide (b) Ranger
    (c) Military (d) Forester
25. First National Park of India is
    (a) Kanha (b) Periyar
    (c) Corbett (d) Bandipur
26. Which among the following is not an ex-situ technique?
    (a) Zoo (b) Gene bank
    (c) Seed bank (d) National Park
27. The concept of biosphere reserve was given by
    (a) ILO (b) IUCN
    (c) UNESCO (d) FAO
28. Environment planning organisation is
    (a) NEERI (b) CSIR
    (c) ICAR (d) CPHERI

ANSWERS

Fill in the Blanks

1. represent
2. variety
3. low
4. natural
5. living organisms
6. levels
7. year of biodiversity

True or False

1. T 2. F 3. T 4. T
5. T

Multiple-Choice Questions

1. (c)	2. (b)	3. (a)	4. (b)	5. (c)
6. (d)	7. (a)	8. (c)	9. (b)	10. (b)
11. (a)	12. (c)	13. (d)	14. (a)	15. (b)
16. (b)	17. (c)	18. (a)	19. (a)	20. (b)
21. (a)	22. (b)	23. (a)	24. (b)	25. (c)
26. (d)	27. (c)	28. (a)		

Chapter 5

Environmental Pollution

Environmental pollution has become a global concern today. Developed and developing nations alike are facing the problem of environmental pollution. Once considered to be a part of life, it became a real problem since the start of the industrial revolution. Environmental pollution is understood to be the contamination of physical and biological components of the earth or the atmosphere to such an extent that normal environmental processes begin to get adversely affected. Loss of vegetation cover, excessive concentration of heavy chemicals in the atmosphere and vegetation, growing risks of environmental accidents; in short, threat to the whole ecological system are all a result of this problem. Increasing CO_2 concentration in the atmosphere is said to be causing global warming leading to a climatic change in our planet. Rain, acid rain or any other form of precipitation containing unusually high amounts of acidic pollutants are damaging whole lakes, rivers and forests. Chlorofluorocarbons or CFCs used in a variety of industrial, commercial or household appliances are depleting the ozone layer. Environmental pollution poses a high risk as it cannot be seen, touched or stopped by physical forces or the like. Environmental pollution is seriously affecting the atmosphere of our planet and threatening our very survival.

5.1 Definition of Pollution

Pollution can be defined in several ways. According to Odum, 'pollution is an undesirable change in the physical, chemical or biological characteristics of air, land and water that is likely to harmfully affect human life and other species including raw material resources'. Edward defined pollution as, 'the release of substances or energy into the environment by man in quantities that damage either his health or the natural resources'. According to McLaughlin, pollution is defined as 'the introduction by man, of waste matter or surplus energy into the environment, which directly or indirectly

causes damage to man and his environment'. Pollution is in short *habitat contamination.*

5.2 Pollutants

Substances added into the atmosphere that affect the normal functioning of the ecosystem and cause pollution are called pollutants, e.g., smoke, dust CO, CO_2, H_2S, detergents, heavy metals, pesticides, weedicides, fungicides, fertilisers, radioactive substances, sewage, etc. Pollutants are classified into two main groups, viz., biodegradable pollutants and non-biodegradable pollutants.

5.2.1 Biodegradable Pollutants

Pollutants that can be decomposed by natural processes are called biodegradable pollutants. Some examples are sewage, refuse, heat, noise, etc.

5.2.2 Non-Biodegradable Pollutants

Pollutants that cannot be decomposed by natural processes are called non-biodegradable pollutants. Once they contaminate the atmosphere, it becomes impossible to remove these. Some examples are DDT, BHC, plastic bottles, polythene bags, soft drink cans, etc.

5.3 Types of Pollution

Following are some types of pollution:

1. Air Pollution
2. Water Pollution
3. Soil Pollution
4. Marine Pollution
5. Noise Pollution
6. Thermal Pollution
7. Nuclear Pollution

5.3.1 Air Pollution

Air Pollution refers to any contamination of the atmosphere that causes damage to living organisms and the environment. Air Pollutants are of the following two types:

(i) *Primary air pollutants* – Poisonous gases or substances which cause pollution when injected directly into the air are known as primary air pollutants. Some examples are soot released from incomplete

combustion of fuel, SO_2 (sulphur dioxide), benzophyrene (cigarette smoke), NH_3 (ammonia), CO (carbon monoxide), lead oxides, nitrogen, etc.

(ii) *Secondary air pollutants* – Some of the primary air pollutants react together in the presence of sunlight and form more powerful pollutants called secondary air pollutants. Some examples are O_3 (ozone), PAN (peroxyacetyl nitrate), H_2SO_4 (sulphuric acid), HNO_3 (nitric acid), aldehydes, etc.

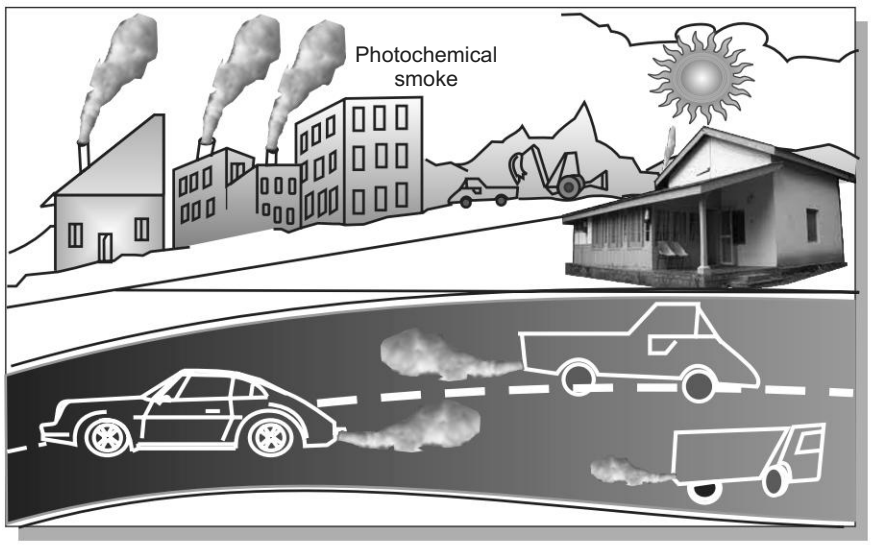

Fig. 5.1 Environmental pollution

Causes of Air Pollution

1. **Agriculture** – Excessive use of pesticides, dust from agricultural practices, burning of fields, hydrocarbons released by plants, etc., are responsible for air pollution.
2. **Dust** – Dust storms, wind, volcanoes, automobiles, etc., add dust to the air causing pollution.
3. **Industries** – Combustion of fossil fuels like coal, petroleum, cement dusts, poisonous gases, etc., all cause air pollution.
4. **Automobiles** – Gases released by the combustion of petrol and diesel in automobiles cause air pollution.
5. **Ionising radiations** – Ionising radiations like alpha particles, beta particles and gamma rays released in the air due to the testing of atomic weapons and atomic explosions cause air pollution.
6. **Chlorofluorocarbons and freon** – Cooling and filling agents used in aerosol packages and refrigerants like chlorofluorocarbons and freon cause air pollution by depleting the ozone umbrella.

7. **Aerosols** – Fine solid particles or liquid droplets suspended in the air are known as aerosols. They block the stomata of plants preventing gaseous exchange between plants and the atmosphere. Aerosols in the atmosphere are also believed to induce climatic changes in the planet.

Effects of Air Pollution

1. **Death** – When air is polluted by poisonous gages it is highly likely to cause death. The Bhopal gas tragedy is a good example. In Bhopal, reportedly, 3000 humans and thousands of animals were killed due to the leakage of methyl isocyanate, a poisonous gas in the air, from an insecticide plant on December 2, 1984.
2. **Chlorosis** – Presence of SO_2 and fluorides in the air causes insufficient production of chlorophyll in leaves. This condition is known as chlorosis.
3. **Necrosis** – The breaking down of cells due to the presence of SO_2, nitrogen dioxide, ozone and fluorides is known as necrosis.
4. **Greenhouse effect** – Concentration of gases like CO_2, CH_4, N_2O and CEFs in the atmosphere increases the temperature of the earth slowly and gradually. These gases (also called greenhouse gases) absorb infrared radiations, but do not allow these radiations to reflect and return back to the earth. This is known as the *greenhouse effect*. Increasing temperature of the atmosphere of the earth as a result of this effect is known as global warming.
5. **Destruction of crops** – Smog which refers to a combination of smoke and fog, causes heavy damage to crops such as leafy vegetables, cereals, textile crops, ornamental plants, fruits, and forest trees, resulting in heavy agricultural losses.
6. **Respiratory disorders** – Excessive ethylene accelerates respiration causing premature aging (old age) and abscission, which is the accumulation of a yellow fluid in the body. Aldehydes irritate the nasal and respiratory tracts, while H_2S causes nausea.
7. **Other disorders:**
   - SO_2 causes vomiting and headache.
   - Carbonyl chloride causes cough.
   - CO reduces O_2 carrying capacity of blood.
   - Cadmium increases blood pressure and causes heart diseases.
   - Ash, soot, smoke, nickel, chromium and radioactive elements cause cancer.
   - Manganese causes pneumonia.
   - Arsines induce RBC breakdown and jaundice.
   - Ionising radiations induce mutation.

8. **Depletion of the ozone umbrella** – Freon and chlorofluorocarbons that are being used in aerosol packages and foam plastics, destroy O_3 molecules in the ozone umbrella and pierce holes in it. UV radiations enter the earth through the pierced holes and cause skin cancer and other diseases.
9. **Acid rains** – In industrial areas a large amount of N_2O (nitrous oxide), NO (nitric oxide) and SO_2 (sulphur dioxide) is discharged in the air. These gases get absorbed by the rain water from the atmosphere and are poured back down on the earth in the form of acid rain. Acid rain not only destroys vegetation but is injurious to aquatic animals in water bodies such as lakes, ponds, etc.

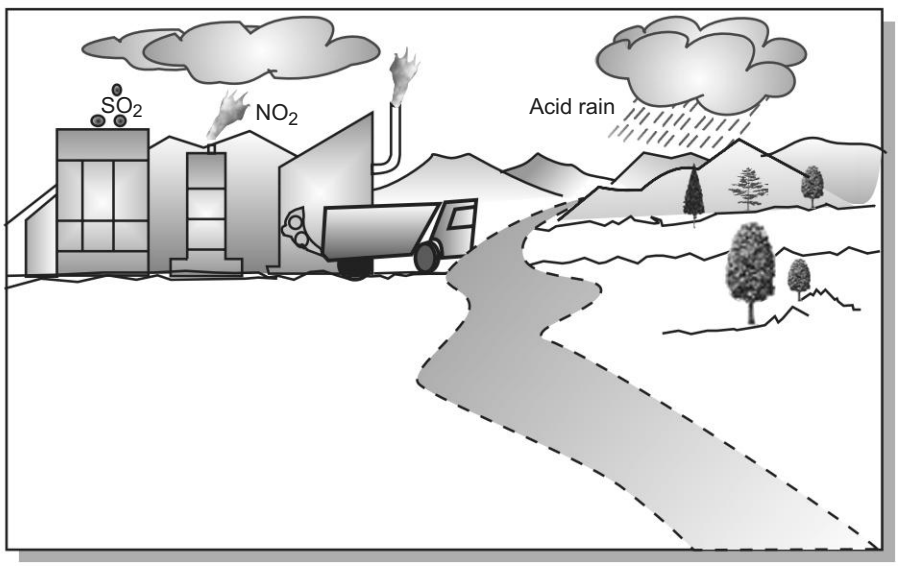

Fig. 5.2 Acid rain formation

Control of Air Pollution

1. The emission of exhaust from automobiles can be reduced by using devices such as a positive crankcase ventilation valve or a catalytic converter.
2. Electrostatic precipitators can be used to minimise smoke and dust from industries.
3. Gaseous pollutants arising from industries can be removed by using the method of differential solubility of gases in water.
4. Removal of pollutants from the emitted exhaust can be done using a fine spray of water. A device called scrubber is used for this purpose.

5. Certain gases can be removed by filtration or absorption through activated carbon.
6. Application of chemical pesticides should be replaced by using alternative bio-pesticides, which are environment friendly.
7. Radioactive waste should be buried safely under the earth.
8. Growth in population should be regulated.
9. Emphasis should be laid on environment-friendly engines in automobiles.
10. At the government level, pollution can be controlled by formulating different laws and legislations.

5.3.2 Water Pollution

Water pollution refers to any contamination in water bodies such as lakes, rivers, seas, etc., which may harmfully affect humans, domesticated species, including organisms that live in water. Increasing urbanisation due to population explosion and industrialisation are the main causes of water pollution.

Causes of Water Pollution

1. **Domestic sewage** – Due to a continuous rise in population, increasing amounts of sewage is being released into water bodies. This sewage contains human excreta, urine, unclean used water from households, etc. Several pathogenic microbes breed in contaminated water, and along with the above, cause water pollution.
2. **Industrial effluents** – Organic and inorganic waste of industries contain heavy metals such as Hg, Cu, Zn and Pb along with detergents, petroleum, phenols, carbonates, alcohol, cyanides and arsenic. These when discharged in an unregulated manner into water bodies cause pollution.
3. **Agriculture** – The use of fertilisers and pesticides such as DDT, BHC, endrin, etc., are washed into ponds and rivers inducing pollution.
4. **Radioactive waste** – Water currents carry liquid radioactive materials released into the sea around most nuclear plants in the world.
5. **Marine transports** – Ship accidents and wastage of oils while loading and discharge during marine transports, cause oil pollution in marine habitats.
6. **Coir manufacturing** – Decaying of coconut husk releases H_2S into the water bodies, which pollutes the water.

Effects of Water Pollution

1. **Disease causing agents are produced** – Diseases like typhoid, cholera and hepatitis are caused due to the production of bacteria, viruses, protozoa and parasites.

2. **Toxic compounds** – Toxic components involve heavy metals, biocides, fungicides, cyanides, pesticides and other organic and inorganic compounds that are harmful to aquatic life. These toxic compounds are non-biodegradable in nature. DDT, aldrin and dieldrin are toxic compounds that are banned.
3. **Radioactive substances** – These substances when concentrated in the food chain cause birth defects, genetic change and cancer.
4. **Biochemical Oxygen Demand or Biological Oxygen Demand (BOD)** – The amount of oxygen required by the micro-organism in water is known as BOD. It is higher in polluted water (sewage) and lesser in drinking water. The contents of dissolved O_2 in water are lowered with the increase in BOD. It causes suffocation and death of aquatic flora and fauna.
5. **Red tide** – When coastal water gets dumped with sewage, din flagellates multiply rapidly and form blooms. These blooms release a toxic metabolic byproduct that can kill fishes. This is known as red tide.
6. **Minamata disease** – This disease was first noticed in Japan in the year 1905 due to mercury poisoning; about 17 people died and 23 became permanently disabled due to the discharge of Hg into the sea.
7. **Methaemoglobinema** – Nitrates used in fertilisers enter the intestines of human beings through drinking water, where it is converted into nitrites. Nitrite is absorbed in the blood where it combines with haemoglobin to form methaemoglobin. Methaemoglobin cannot transport oxygen. This leads to suffocation and breathing trouble especially in infants. This disease is called methaemoglobinema.
8. **Eutrophication** – The water becomes nutrient-enriched when sewage and fertilisers are added into the fresh water system, hence phytoplankton and algae grow well in water. The increased productivity of lakes and ponds brought about by nutrient enrichment is called eutrophication. Eutrophication also has negative effects.

Control of Water Pollution

1. Controlled use of pesticides and fertilisers.
2. Ban on non-biodegradable substances.
3. Establishment of nationwide standards for water contaminants.
4. Proper discharge of sewage waste.
5. Proper treatment of industrial water before their discharge into water bodies.
6. Chlorination of drinking water should be regularly done.
7. Removal of migrates and phosphates by treatment to prevent eutrophication.

8. Enactment of Water Prevention and Control of Pollution Act, 1974 which was amended in 1988, is required for controlling pollution of water.

The National Environmental Engineering Research Institute (NEERT) at Nagpur, Maharashtra, has developed technology for recycling sewage water. It is also done at Okhla in New Delhi.

5.3.3 Soil Pollution

Soil is the topmost layer of the earth that is produced by weathering of rocks. It is a mixture of mineral and organic constituents that are in solid, gaseous and aqueous states. Harmful changes in soil cause severe irreversible damages to the quality of soil which in turn lead to unwanted changes in soil adversely affecting agricultural activities. This is called land or soil pollution.

1. Chemicals used to kill insects, rats, snails, fungi, herbs, etc., are called pesticides. They are collectively known as biocides because they kill life. They are of the following types:
   - Rodenticides are used to kill rats.
   - Fungicides are used to kill fungi.
   - Herbicides are used to kill weeds.
   - Helminthicides are used to kill helminth worms.
   - Pesticides remain in the soil for a longer period of time.
2. Industries release SO_2 and N_2O into the air. These gases get absorbed by the rainwater and fall down on the earth in the form of acid rain. They act as a pollutant in the soil.
3. Domestic waste, sewage and sludge act as major sources of soil pollution in urban areas.
4. Explosive radioactive substances and waste discharged from industries and laboratories, etc., also enter the soil causing pollution.
5. Industrial waste consists of biodegradable and non-biodegradable substances such as metals, toxic substances, paint, plastic, heavy metals, etc.
6. Chemicals released into the air such as radioactive substances, sulphur, minerals and lead finally accumulate on the ground and pollute the soil.

Effect of Soil Pollution

1. The toxicity level of soil is increased due to industrial effluents. Heavy metals destroy useful micro-organisms in the soil and also cause diseases. In 1970 about 200 people died in Japan by cadmium pollution of soil which gave rise to a disease called Itai-Itai (a painful disease of bones and joints).

2. Overusage of agrochemicals causes soil electrioration and biological magnification (increasing concentrations of chemicals in tissues).
3. Diseases like dysentery, gastroenteritis, tetanus, anthrax are caused in human beings due to soil pollution by dumping sewage in water.
4. Fertilisers containing phosphorus and nitrogen are the major cause of eutrophication.
5. The physical, chemical and biological properties of soil change due to these soil pollutants.

Control of Soil Pollution

1. For disposal of solid waste, methods like controlled tipping or sanitary landfill are adopted in New Delhi. In these methods, two metres of refuse is covered by 23 centimeters of earth up to the level of the hole chosen. The surface is then used for housing purposes.
2. Recycling of solid waste should be emphasised.
3. Use of inorganic fertilisers should be regulated.
4. Transformation of sewage waste containing biodegradable waste into organic manure can be done through agriculture. Bio gas or *gobar* gas can be produced using cattle faeces.
5. Pests should be killed either by rearing predators or by introducing selective pathogenic microbes such as bacteria, virus and fungi.
6. Proper insulation of atomic power plants should be done to prevent leakage of isotopes and ionising radiations into the soil.

5.3.4 Marine Pollution

Around two per cent of the earth's surface is occupied by marine habitats. They provide home to a great variety of biotic communities. Marine pollution can be defined as release of harmful substances that cause damage to the marine ecosystems. The pollutants may include sewage, farm waste, and industrial waste or toxic chemicals.

Causes of Marine Pollution

1. Huge amount of sewage, garbage, plastic and agricultural discharge is dumped into river waters which are then transferred to the seas.
2. Accidental oil spills from tankers and offshore oil drilling platforms also cause marine pollution.
3. Dumping radioactive substances in the sea is also a major cause of marine pollution.

Effects of Marine Pollution

1. The sensitive flora and fauna in the sea like phytoplankton, zooplankton, coral reefs, algal species, fishes, invertebrates, birds and mammals are adversely affected by this pollution.
2. The pollution gets absorbed in the food chain resulting into loss of species.
3. Due to the light intensity of oxygen, its dissolution is reduced due to the formation of a thick blanket of oil spills over the sea water.
4. The poisons excreted by various types of waste destroy the eggs of fishes, their foods and cause diseases in fish and other organisms.

Control of Marine Pollution

1. Awareness programs should be organised for the public through media, etc.,
2. Proper treatment of industrial effluents should be done before discharge and dumping of radioactive substances.
3. Dumping of toxic waste, sewage and sludge should be banned.
4. Training and operation procedures should be strictly regulated for offshore wells.
5. Enforcement of Marine Acts and Coastal Acts.

5.3.5 Noise Pollution

Any displeasing or unwanted sound in the environment is referred to as noise pollution. Technological advancement is the main cause of noise pollution. The level of noise is measured in decibels (db). Sound of 25–60 db is accepted in the industrial, educational rooms, hospitals, houses, etc. Noise beyond this limit is termed as pollution.

Causes of Noise Pollution

Some of the man-made sources of noise pollution are scooters, motor bikes, cars, buses, trucks, tractors, aircrafts, loud speakers, ships, machines, fire crackers, generators, kitchen appliances and social gatherings.

Effect of Noise Pollution

1. Noise diminishes the power of hearing and causes pain to the ears.
2. It increases the heart beat and blood pressure.
3. It causes physical or mental fatigue and lack of concentration.
4. It disturbs sleep, causing nausea and dizziness.
5. It increases the rate of accidents on roads.
6. It causes headache and depression.

Control of Noise Pollution

1. Sources producing unwanted sound should be reduced.

2. Noisy automobiles should be regulated.
3. Planting more trees can reduce the level of noise efficiently.
4. Construction of residential buildings should be far away from industries, factories and airports.
5. Cotton plugs or ear puffs should be used by occupational workers.
6. Industrialists must set up necessary rules to control noise.
7. Proper legislations should be framed to regulate noise pollution.

5.3.6 Thermal Pollution

Thermal pollution refers to the increase or decrease in temperature of water, air and land due to human activities.

Causes of Thermal Pollution

1. In recent years, the use of water as coolant in industries, particularly in thermal power plants and nuclear power plants has resulted in the problem of thermal pollution.
2. Various industrial processes use cold water and in turn discharge hot water.
3. Removing vegetation from the banks of streams and lakes causes thermal pollution.

Effects of Thermal Pollution

1. The dissolved oxygen reduces and results in death and decay of water plants and animals.
2. Melting of ice caps, takes place due to climatic changes occurring on the planet. This in turn causes floods in the coastal and low lying areas.
3. Hot water disturbs spawning of fishes and causes death.
4. Respiration of aquatic organisms increase, resulting in their increasing susceptibility to diseases, toxic chemicals and parasites.

Control of Thermal Pollution

1. Hot water should not be discharged in sea water.
2. Installation of cooling towers for recycling the hot water can reduce thermal pollution.
3. Heating effect can be reduced using spray towers.

5.3.7 Nuclear Hazards or Radioactive Pollution

Radioactive substances are the chief sources of nuclear hazards. These substances undergo a natural decay and give rise to alpha (α), beta (β) and gamma (γ) particles. These fast moving particles can remove or introduce electrons from an atom with their high energy radiations. These substances

are more toxic than organic compounds. For example, radium is 25000 times more lethal than arsenic.

Causes of Radioactive Pollution

The two major sources of radioactive pollution are as follows:

1. **Natural sources –** Cosmic rays from space and terrestrial radiation from radio-nucleosides present in the earth's crust, soil, air, water, food and rocks are some of the natural sources of nuclear hazards.
2. **Man-made sources –** Mining, refining of platinum, uranium and thorium nuclear power plants, test laboratories, nuclear explosions, X-rays diagnostic and radiation therapy are chief man-made sources of radioactive pollution.

Effects of Radioactive Pollution

1. Living tissues are damaged by ionisation of ionising radiations.
2. High intensity and exposure for longer duration can cause death within a few days.
3. Bomb blasts cause genetic defects in man and domestic animals due to release of ionising radiations.
4. Leukemia and bone tumors are caused due to the exposure to radioactive substances.
5. Ionising radiations cause tumors, cancers and shortening of life span.
6. Non-ionising radiations can cause injury to skin, sunburns and damage eyes.

Control of Radioactive Pollution

1. Installing nuclear power plants carefully can minimise the adverse effects.
2. Preventing nuclear accidents.
3. Ban on usage of nuclear weapons.
4. Proper disposal of radioactive waste.
5. Strictly checking the leakage of radiation waste from laboratories and reactors can reduce accidents.

5.4 Solid Waste Management

Various types of solid waste are produced from various anthropogenic activities and normally discarded as useless or unwanted. Solid waste includes plastic containers, glass material, polythene, scarp, rubber metals, hospital waste, paints, crop residues, etc. Developed countries like USA, Canada, Japan, England, Germany and France are the main solid waste

producers. The problem is increasing day by day due to urbanisation and industrialisation.

Causes of Solid Waste

1. The increase in solid waste is due to overpopulation, affluence and technological advancement.
2. Increase in hospital waste including glass bottles, plastic, metal syringe, etc., also increases solid waste.
3. A major part of solid waste is released from the mining and agricultural sectors.
4. Municipal waste mainly contains domestic waste like metals, plastic, glass and other solid materials.

Effects of Solid Waste

1. Unhygienic environment causes diseases like diarrhea, dysentery, typhoid, cholera, plague, etc.
2. Solid waste modifies the physiochemical and biological properties of plants and soil.
3. Groundwater gets contaminated.
4. It enhances air and water pollution.
5. Open breeding sites of insects and infectious organisms are produced.

Control of Solid Waste Management

Solid waste is required to be displaced or recycled safely. The solid waste management system includes proper collection, disposal and recycling of waste. Solid waste can be minimised by the following methods:

1. **Sanitary landfill** – After collection of waste, sanitary landfill is the safest method of solid waste treatment. In this solid waste (garbage) is dumped into a natural or constructed pit and left to decompose slowly. However in urban areas such dumping sites pose serious threats.
2. **Composting** – It is a very common practice in rural areas to produce biogas and manure from agriculture waste, dung, domestic waste, animal excreta, etc.
3. **Incineration** – This is the most convenient method of disposal especially in densely populated areas. Burning of solid waste and utilisation of its heat is a common practice at several places.
4. **Recycling –** As a part of waste management, efforts are now being made to recycle materials like glass, old paper cans, newspapers, tin, plastic, rubber, etc.

5.5 Role of an Individual in Prevention of Pollution

It is the foremost duty of every person to keep the environment safe and clean by preventing pollution. There is a need to organise environmental awareness programs for people in the urban as well as rural areas. Such programs will endeavour to change people's attitude towards conservation of nature. Planting more trees will ensure the reduction of CO_2, thereby cooling the environment. More attention should be given to products that are eco-friendly. Increasing dependence on alternate sources of energy rather than traditional ones will ensure a decrease in pollution. Also controlling the release of CFC's in the atmosphere will help reduce the greenhouse effect. Steps should to be taken to reduce the population growth rate. Rules which regulate various kinds of pollution should be strictly adhered to.

5.6 Pollution–Case Studies

Chernobyl Nuclear Disaster, Russia

Chernobyl disaster was the worst nuclear reactor accident that occurred on the 26 April 1986. The reactor exploded due to uncontrolled nuclear reactions. Radioactive fuel and debris shot up into the air like a volcanic explosion and spread out in the surrounding areas. The accident killed at least 2000 people and extensively damaged the soil. Water and vegetation in an area of 60 sq. km around Chernobyl was also destroyed. Several generations of that region became susceptible to radiation-induced diseases including cancer.

Bhopal Gas Tragedy, India

Bhopal Gas tragedy killed about 3000 people by releasing methyl isocyanate (MIC) gas in the atmosphere on 3 December 1984. The factory used to manufacture insecticide named 'SAVIN'. The disaster occurred as the gas leaked out and spread over 40 sq. km area. People complained of nausea, giddiness breathlessness, chest pain and eye pain. Several thousands of people in that area still suffering from diseases of the lungs and eyes.

Pollution at Baltic Sea

According to some experts, the Baltic Sea is the most polluted sea in the world. It requires extensive cleaning strategies. It is the most popular destination for dumping different types of waste like untreated sewage, chemical pollutants, agricultural waste, etc. This causes blooms of algae that choke marine life. If Russia continues to further its plan for even bigger oil and gas expansion, it will totally destroy this area.

Summary

- Pollution is an undesirable change in the physical, chemical or biological characteristics of air, land and water that harmfully affect human life and other species. (E P Odum 1963)
- Pollutants can be classified as biodegradable and non-biodegradable pollutants. The pollutants which can be decomposed by natural processes are called biodegradable pollutants, e.g., sewage, refuse, heat, noise, etc.
- Non-biodegradable pollutants cannot be decomposed, e.g., DDT, BHC, plastic bottles, polythene bags, used soft drink cans, etc.
- Solid waste is unwanted, useless or discarded material. It is important to manage and minimise solid waste.
- It is the duty of every citizen to protect and improve the environment.

REVIEW QUESTIONS

Short Answer Questions

1. Define pollution.
2. Name the different types of pollution.
3. What is solid waste management?
4. Define pollutants.
5. What do you understand by thermal pollution?
6. What is noise pollution?

7. What are nuclear hazards?
8. Define soil pollution.
9. What is smog?
10. What is air pollution?
11. Define water pollution.

Descriptive Questions

1. What are the sources of air pollution?
2. Discuss the effects of air pollution.
3. What are the sources of water pollution?
4. What are the effects of water pollution?
5. How can water pollution be controlled?
6. What are the sources and effects of noise pollution and how is it controlled?
7. How do solid wastes affect the environment?
8. Explain sources, effects and control of soil pollution.
9. What is radiation? Discuss their effects on human health?

OBJECTIVE QUESTIONS

Fill in the Blanks

1. Pollutants are _____ of man's action.
2. The major effect of sewage in water is that it reduces the _____ content of the water.
3. Chlorosis is the loss of _____in leaves.
4. Methane blocks _____ radiations.
5. NO_2 and _____ cause acid rain.
6. Fly ash is produced by _____.

True or False

1. Noise refers to unwanted sound.
2. Water is the driver of life.

3. The sound wave is measured in decibel.
4. SO_2 is an insecticide.
5. Minamata disease is caused by mercury.
6. Pneumoconiosis is a disease of the heart.
7. Hiroshima was bombed in 1946.

Multiple-Choice Questions

Put a √ mark against the correct answer.

1. Acid rains occur due to atmospheric pollution of
   (a) SO_2 (b) NH_3
   (c) CO_2 (d) H_2O vapours
2. The main air pollutant is
   (a) CO (b) CO_2
   (c) N_2 (d) sulphur
3. Ozone layer in the atmosphere is being destroyed by
   (a) chlorofluorocarbon (b) SO_2
   (c) smog (d) CO_2
4. Most hazardous metal pollutant of automobile exhaust is
   (a) lead (b) copper
   (c) mercury (d) cadmium
5. Where was photochemical smog first observed in the world
   (a) London (b) Los Angeles
   (c) Paris (d) Tokyo
6. Ultraviolet radiation from sunlight causes the reaction that produces
   (a) CO (b) SO_2
   (c) O_3 (d) Fluorides
7. Formation of ozone hole is maximum over
   (a) Africa (b) Antarctica
   (c) Europe (d) India
8. The gas which leaked in Bhopal Gas Tragedy is
   (a) methyl isocynate (b) methyl isocyanide
   (c) ethyl isocynate (d) methane
9. Fluoride pollution mainly affects
   (a) brain (b) heart
   (c) teeth (d) kidney

10. 'Taj Mahal' is threatened due to the effect of
    (a) chlorine (b) sulphur dioxide
    (c) hydrogen (d) oxygen
11. Hazardous noise pollution is caused by sounds above what level?
    (a) Above 120 dB (b) Above 100 dB
    (c) Above 80 dB (d) Above 30 dB
12. PAN is
    (a) Photochemical Oxidant
    (b) Primary Air Pollutant
    (c) Particulate Atmospheric Nitrogen
    (d) Poisonous American Nuisance
13. Smog is formed by
    (a) smut and fog (b) smoke and fog
    (c) smoke and bog (d) smut and bog
14. Lead can cause
    (a) brain damage (b) respiratory aliments
    (c) itching of eyes (d) breathlessness
15. Which one is the most toxic
    (a) carbon (b) CO
    (c) CO_2 (d) SO_2
16. Cadmium pollution is associated with which disease
    (a) anemia (b) itai-itai
    (c) minamata (d) pneumoconiosis
17. Which pollutant causes leaf curling
    (a) CO (b) H_2S
    (c) O_3 (d) SO_2
18. Sewage water is purified by
    (a) micro-organisms (b) light
    (c) fishes (d) aquatic plants
19. Major source of methane in India is
    (a) rice fields (b) sugarcane plantation
    (c) wheat fields (d) fruit orchards
20. Spraying DDT on crops produces pollution of
    (a) air and water (b) air and soil
    (c) crops and air (d) soil and water

21. In India, Water Prevention and Control of Pollution Act was enacted in the year
    (a) 1974 (b) 1976
    (c) 1980 (d) 1982
22. The measurement unit of radioactive rays is
    (a) decible (b) calorie
    (c) joule (d) watt
23. Increasing cause of insomnia is
    (a) water pollution (b) air pollution
    (c) noise pollution (d) thermal pollution
24. From among the following which is called invisible pollution?
    (a) water pollution (b) soil pollution
    (c) air pollution (d) noise pollution
25. Carbon monoxide poisoning causes
    (a) itching of eyes (b) asphyxia
    (c) temperature (d) cardiac diseases
26. CO_2 content in the atmosphere is about
    (a) 6.5% (b) 3.334%
    (c) 0.34% (d) 0.034%
27. A large quantity of sulphur nowadays is released into the atmosphere from
    (a) volcanic activities (b) burning of vegetation
    (c) burning of fossil fuel (d) activity of micro-organisms

ANSWERS

Fill in the Blanks

1. byproducts
2. oxygen
3. chlorophyll
4. infrared
5. SO_2
6. coal

True or False

1. T
2. T
3. T
4. F
5. T
6. F
7. F

Multiple-Choice Questions

1. (a)
2. (b)
3. (a)
4. (a)
5. (b)
6. (c)
7. (b)
8. (a)
9. (c)
10. (b)
11. (c)
12. (a)
13. (b)
14. (a)
15. (b)
16. (b)
17. (d)
18. (a)
19. (a)
20. (d)
21. (a)
22. (b)
23. (c)
24. (d)
25. (b)
26. (d)
27. (c)

Chapter 6

Social Issues and the Environment

This chapter presents a comprehensive discussion, as organised under the following aspects, on inter-linkage of social issues and the environment.

- From unsustainable to sustainable development
- Urban problems related to energy
- Water conservation, rainwater harvesting and watershed management
- Resettlement and rehabilitation of people
- Environmental ethics
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accident and holocaust
- Wasteland reclamation
- Consumerism and waste products
- Environment protection
- Air Prevention and Control of Pollution Act
- Water Precaution and Control of Pollution Act
- Wildlife Protection Act
- Forest Conservation Act
- Issues involved in enforcement of environmental legislation
- Public awareness

6.1 From Unsustainable to Sustainable Development

Sustainable development means maintaining a balance between the human needs and usage of natural resources, to ensure that these needs are not only met in the present but also in the future, for generations to come. The term 'sustainable development' was coined at the Earth Summit held in Brazil, in 1992. The World Commission on Environment and Development (1987) describes sustainable development as 'a process of change in which

the exploration of resources, the direction of investment, the orientation of technological developments, and institutional change are made consistent with future as well as present needs'.

Since ancient times, people have relied on natural resources for continuous improvement in their lifestyle and well-being. Unsustainable development occurs when the rate of consumption of natural resources exceeds the rate of replenishment.

Sustainable development can be achieved by the following means:

1. Population control
2. Reduction, reuse and recycling of waste
3. Emphasis on use of clean energy
4. Minimum use of non-renewable fossil fuels
5. Sustainable agriculture
6. Conservation of soil
7. Pollution control
8. Environmental awareness and education

As per the report by United Nations Environment Program, 'Global Trends in Sustainable Energy Investment, 2010', India has made persistent efforts to reduce per capita emission of greenhouse gases and has also made sincere endeavours in the field of tree plantation. The Indian government has promoted the use of renewal energy in a big way. The total contribution of renewable energy to the power business has increased from ten per cent in the year 2000 to almost seventy per cent today.

6.2 Urban Problems Related to Energy

Energy plays a key role in socio-economic development of a nation. It is the most important key element for economic growth and human development. The total usage of primary energy by a nation can be taken as one of the most important contributions to GOP. The consumption pattern of energy in urban areas is much more as compared to rural regions. Unplanned and uncontrolled growth leads to massive energy consumption and wastage and creates a situation of energy crisis.

Following are the main problems related to energy in urban areas:

1. Consumption of large amount of energy by industries and transportation.
2. Use of electric gadgets like air conditioners, geysers, heaters, microwaves, etc., at home.
3. Large amount of electricity is consumed by shopping malls, multiplexes, central places like airports, auditoriums, etc.
4. The technology to check air and water pollution depends on energy.

Consumption of energy is rapidly increasing in Asia in comparison to any other region in the world. This is mainly due to increasing population, rapid economic growth and industrialisation.

6.3 Water Conservation

Water is the most essential natural resource required for human survival. Owing to the importance of water, various civilisations flourished around major rivers and waterways. Nearly thirty to fifty per cent of the available water goes waste. Countries like India, China and parts of Western Africa are facing acute water scarcity. Water conservation is the key to increase the availability of water and effectively fight water crisis. Water conservation includes water preservation and efficient use, to reduce loss or wastage.

Following are some methods that can be adopted for water conservation:

1. Improving irrigational methods like using drop irrigation or overhead irrigation, in which lateral moving sprinklers are used for controlled distribution of water.
2. Treated water to be used for irrigational purposes.
3. Emphasis on usage of hybrid varieties which require less water.
4. Reduction in runoff losses by adopting terrace farming and contour cultivation.
5. Adoption of rainwater harvesting.
6. Historical water bodies to be utilised as recharging points.
7. Water bodies should not to be used for dumping garbage and waste, both human and industrial.
8. Water distribution system should be improved.
9. Afforestation and protection of watersheds.
10. Minimise the loss of water in households by using water efficient gadgets like automatic washing machines.
11. Install small shower heads to reduce wastage.
12. Early repair of leakage in water taps.
13. Install overflow valve in the overhead tanks.

6.3.1 Rainwater Harvesting

Rainwater harvesting is a method of collection of rain water which can be subsequently used for drinking, irrigation and recharging ground water. The aim of rainwater harvesting is to conserve surface water runoff during monsoons, reduce soil erosion, recharge ground water table, altogether leading to water conservation.

Methods of Rainwater Harvesting

1. Capturing runoff water from rooftops and storing in tanks or reservoirs below the ground.
2. Capturing runoff water from local catchments.
3. Constructing dams, pits, pounds, etc.
4. Capturing seasonal flood waters from local streams.

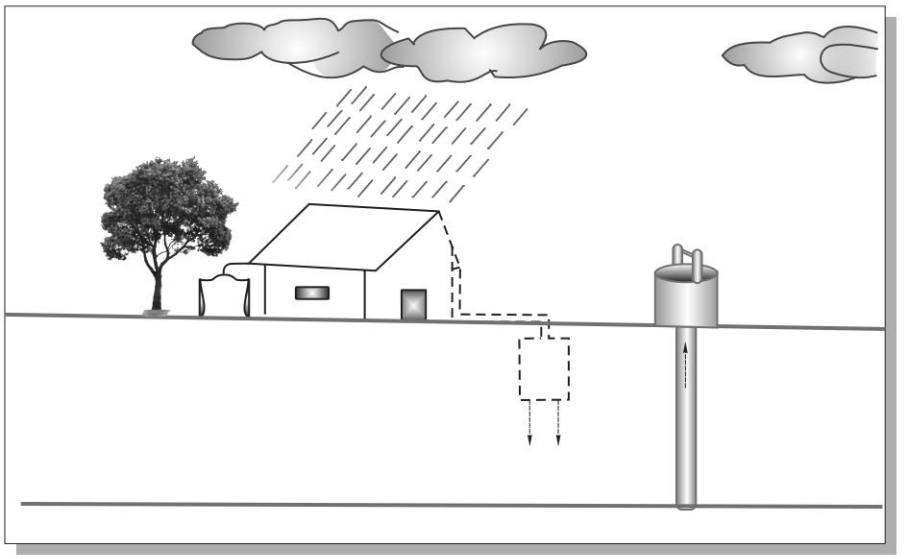

Fig. 6.1 Rainwater harvesting

Techniques of Rainwater Harvesting

In rooftop rainwater harvesting, the roof of a building is utilised as a catchment. The various components of this system include catchment, transportation measure, first flush and a kind of filter. Once the rainwater is received in the catchment, it can either be stored in a storage tank or used for artificial recharge system. It is a very economical and effective method. The other technique is to build an underground water tank. This technique is effective as it minimises losses due to evaporation and reduces the chances of water contamination.

6.3.2 Watershed Management

Watershed can be described as a low lying landform, defined by surrounding highpoints, that descent into lower elevations and stream valleys. Watershed management includes implementation of various means to protect and restore watersheds. In India, the Himalayas are one of the most important watersheds.

Methods of Watershed Management

1. Afforestation is the most important measure, as it reduces the loss of top soil.
2. Agroforestry helps in retention of moisture and limits soil erosion.
3. Water harvesting should be carried out in a scientific manner with the help of domes, tanks, etc.

4. Illegal and indiscriminate mining should be banned.
5. Strip cropping also leads to reduction of top layer soil.
6. Overgrazing by cattle needs to be checked.

6.4 Resettlement and Rehabilitation of People (Problems and concerned case studies)

Displacement of people either due to developmental projects or due to natural disasters causes severe socio-economic problems for the displaced population.

Following are the main problems faced by these people:

1. Income source of the inhabitants is lost.
2. Disruption of community structures and weakening of social networks.
3. Lack of cultural identity and traditional authority.
4. Scarcity of available resources like forest products, water from natural springs, etc.
5. Close relatives get dispersed and this reduces the scope of mutual help.
6. Difficulty in adapting to new environments.

Factors Responsible for Displacement of People

The natural disasters like earthquakes, floods; developmental projects like construction of dams, indiscriminate mining, poor law and order situations, etc., are some of the major factors that force displacement of people.

Construction of dams and river valley projects are one of the significant contributors to displacement of people.

The following projects have been through much controversy for these reasons:

- ⇨ Tehri Dam Project, Uttarakhand
- ⇨ Sardar Sarovar Project, Gujarat
- ⇨ Narmada Sagar Project, Madhya Pradesh
- ⇨ Bodhghat Project, Madhya Pradesh

The Narmada River originates from Maikal range at Amarkantak and flows through Madhya Pradesh, Maharashtra and Gujarat. A total of 30 dams for construction were proposed on the river including the Sardar Sarovar Project and the Narmada Sagar Project. The construction of the Narmada Sagar Project submerged about 50000 hectares of agricultural land and forest and led to the displacement of over one million people residing in and around one thousand villages.

Nearly twenty years after its inception, the Tehri dam continues to be at the centre of controversy. Tehri dam is a coffer dam constructed by diversion of Bhagirati and Bhalinga rivers into tunnels. The dam reservoir would

submerge around 27 villages completely and 80 villages partially and will eventually lead to displacement of approximately ten thousand families. The dispute regarding the compensation in lieu of land and employment opportunities to be provided to the families likely to be displaced, is yet to be resolved by the government.

Indiscriminate mining of natural resources have severely affected the environment and led to the displacement of millions of people. Underground fire in the Jharia coalfields led to the displacement of about 0.3 million people without any comprehensive rehabilitation scheme by the government. As per the recent estimate, almost 115 crore rupees have been spent on measures to control fire, but to no avail.

National parks are the areas which are maintained by the government and reserved for betterment of wildlife and to safeguard natural resources. In 2007, total of 96 national parks in India occupied approximately one per cent of the total land surface of the nation. A total of 166 parks have been authorised and Indian government is making efforts to establish the remaining parks. The commission of these national parks will lead to the displacement of tribal villages, which come under the notified area. In Kerala alone, about 54000 tribes were displaced and have not been rehabilitated till date.

6.5 Environmental Ethics

Environmental ethics is a part of environmental philosophy, which believes in the ethical relationship between human beings and the environment. Human beings have a moral obligation of preserving their environment in its original state.

The Earth Day celebration of 1970 gave momentum to the development of environmental ethics as a separate field. Human population explosion and rapid industrialisation to meet the demands of humans have had serious implications on natural resources. Industries across the globe are utilising and depleting the environment at an ever increasing rate. Rationally, it is the responsibility of these industries to restore these depleted resources.

Traditionally, India has been aware of environmental ethics since the Vedic era. The concept of living in harmony with the natural environment was practiced by *rishis* in their *ashrams*. Famous Indian poet Rabindranath Tagore introduced the concept of *vriksharopan* (Tree Plantation) at Shantiniketan.

It is pertinent for human beings to understand that all living forms constitute the food chain and it is essential that the delicate ecological balance is not disturbed either directly or indirectly by their activities. The conservation of natural resources for our future generations is our moral obligation.

6.6 Climate Change

The United Nations Framework Convention on Climate Change defines climate change as 'change of climate which can be attributed either directly or indirectly to human activities, responsible for altering the composition of the global atmosphere.' Climate change is occurring mainly, due to human activities which disrupt the ecological balance.

India has a large quantum of poor population and this section of society will not be able to safeguard itself from the impact of climate change. Large amount of population depends on sectors like agriculture, forestry, fishery, etc., which are climate-sensitive. Changes in climate are already causing floods, heat waves, cyclones and unpredictable weather and temperature. Hence, it is important for India as a nation to realise the importance of this aspect and make holistic endeavours to work towards resolving these concerns.

In June 2008, the Prime Minister inaugurated the National Action Plan on Climate Change (NAPCC). The main aim of NAPCC is to adapt to climatic changes and to ensure high growth rate is maintained. It also seeks to protect the poor section of the society. The future impacts of climate change, identified by the Government of India National Communications includes increase in flood threats, rising sea levels, changes in monsoons, decrease in snow cover and adverse affects to forests.

6.7 Global Warming

Global warming refers to increase in the average temperature of the earth. One of the major factors of global warming is increase in the concentration of greenhouse gases. Greenhouse gases like carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and hydro-fluorocarbons (HFC-23) trap the heat from the sunlight in the earth's atmosphere. Carbon dioxide (CO_2) contributes approximately 60 per cent to global warming. If the quantum of greenhouse gases increases beyond limit, it will make the earth unusually warm and will adversely affect all living organisms.

Impact of Global Warming

1. Polar ice caps will melt due to increase in temperature, leading to an increase in sea levels and consequently submerging low lying areas of the world.
2. Global warming will lead to the death of algae in our oceans, killing many other sea animals dependent on algae for food.
3. Adverse effects of vector diseases caused by mosquitoes.
4. Intense and unpredictable weather and rainfall will adversely affect agriculture, fishery, etc.

5. May lead to extinction of many species.
6. Due to increase in carbon dioxide content in the atmosphere, the oceans will become more acidic and hence unfit for living.
7. As per the latest IPCC report, global surface temperature may increase by 1.1°C to 6.4°C in the year 2050.

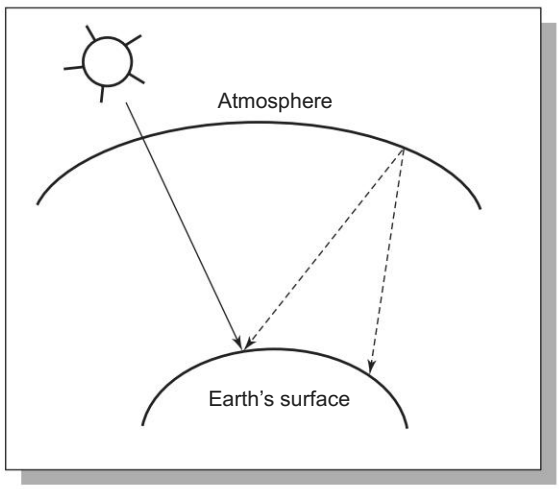

Fig. 6.2 CO_2 of atmosphere permits light rays to pass down and absorbs the infra-red heat rays. Therefore it leads to an increase in the temperature of the biosphere

Measures to Check Global Warming

1. Emphasis on tree plantation.
2. Minimise usage of fossil fuels like petroleum in generation of electricity.
3. Emphasis on renewal sources of energy like solar energy, wind energy, etc.
4. Commissioning of nuclear power plant for generation of electricity.
5. Reduction in usage of CFCs.
6. Photosynthetic algae to be used to remove atmospheric carbon dioxide.
7. Trapping and usage of methane as a fuel.

6.8 Acid Rain

Acid rain can be described as any form of precipitation like rain, snow, fog, etc., containing high levels of sulphuric acid and nitric acid. Acid rain is caused by emissions of sulphur dioxide and nitrogen oxide which subsequently react with water content present in atmosphere and produce acids.

Acid producing gases are fed to the atmosphere either through natural phenomenon like volcanoes or due to various human activities like smoke generated by industries, generation of electricity using fossil fuels and transportation.

6.8.1 Chemistry of Acid Rain Formation

$$\underset{\text{(Sulphur dioxide)}}{SO_2} + \underset{\text{(Hydroxyl radical)}}{OH^-} \rightarrow HOSO_2^-$$

$$HOSO_2^- + O_2 \rightarrow HO_2^- + \underset{\text{(Sulphur trioxide)}}{SO_3(g)}$$

$$SO_3(g) + \underset{\text{(Atmospheric moisture)}}{H_2O(l)} \rightarrow \underset{\text{Sulphuric acid}}{H_2SO_4(l)}$$

$$\underset{\text{(Nitrogen dioxide)}}{NO_2} + \underset{\text{(Hydroxyl Radical)}}{OH^-} \rightarrow \underset{\text{(Nitric Acid)}}{HNO_3}$$

6.8.2 Adverse Effects of Acid Rain

1. Damaging heritage monuments made of limestone and marble, e.g., Taj Mahal at Agra.
2. Increase soil acidity.
3. Increase in acidic content of water bodies.
4. Adverse effects on fish due to lower pH and high aluminum concentrations.
5. Indirect adverse effects on human health.

6.8.3 Methods to Control Acid Rain

1. Control on emissions by vehicles.
2. Conservation of electrical energy by organisations and individuals.
3. Curbing release of pollutants which cause acid rain.
4. Promoting alternative fuel usage.
5. Strict enforcement of environmental acts by governments.

6.9 Ozone Layer Depletion

Ozone layer is present in the stratosphere (15 to 30 km above the earth) and contains naturally occurring ozone gas (O_3). The ozone layer protects the earth from ultraviolet B rays of the sun, by absorbing them.

One of the major reasons for ozone layer depletion is the emission of Chlorofluorocarbons (CFC's) by the industries. When CFC reaches the

upper layer of the atmosphere, it gets exposed to ultraviolet rays and breaks down into various substances including chlorine. This chlorine is responsible for the destruction of the ozone layer.

The ozone layer above the Antarctic region has been significantly depleted by CFC pollution in the last three decades. The Antarctic ozone hole was discovered by scientists of British Antarctic survey in the year 1985. Ozone hole is the geographical area wherein the total ozone amount is less than 220 Dobson units. The ozone hole is steadily increasing in size.

6.9.1 Effects of Ozone Layer Depletion

1. Ozone layer depletion leads to a large quantum of ultraviolet B radiations reaching the earth. The UV-B radiations can cause skin cancer and cataracts in human beings.
2. UV rays suppress the human immune system.
3. People having lightly pigmented skin are more susceptible to skin cancer.
4. Reduction of agriculture and fishery produced in long terms.
5. Inhibits the reproductive cycle of phytoplankton and algae.
6. Can cause mutation in plants and animals.
7. Degradation of paints, plastics and other polymer materials.
8. Life cycle of plants can change, leading to severe disruption of fuel change.
9. May lead to change in wind patterns and thus a change in climate.

6.9.2 Control of Ozone Layer Depletion

1. Most CFCs responsible for ozone layer depletion are emitted by industrialised nations. These nations have now banned the use of CRs but it is likely to take another 50 years for chlorine levels to fall below normally acceptable limits.
2. Use of alternatives of CFCs like HCFC 22, cyclohexane, etc.
3. In the Montreal Protocol, 30 nations agreed to reduce usage of CCs. By the year 2000, the United States and twelve European states agreed to completely ban CFCs.

6.10 Nuclear Accidents and Holocaust

The International Atomic Energy Agency (IAEA) describes nuclear and radiation accidents as events that have led to significant adverse consequence to lives of people, environment and various facilities. Among the various environmental disasters which can be caused by human beings, nuclear accidents, undoubtedly, have the highest damage potential.

It is impossible for any nuclear reactor to explode as an atomic bomb, due to the absence of adequate quantity of extremely enriched uranium to set an uncontrolled chain reaction. Nuclear reactors can meltdown in case of an accident. In a meltdown, due to extremely high temperature, the uranium fuel will melt through the bottom of the reactor and can seep into the earth and thereby pollute ground water.

The radiations released due to nuclear accidents pose acute and chronic risks to immediate environment and the geographic areas. The effect of radioactive contamination will be seen over the population for hundreds of years.

Three Mile Island was the most disastrous nuclear accident witnessed by the United States. The fiasco happened due to malfunctioning of a valve to relieve pressure from the nuclear reactor. Due to draining of cooling water, the core got heated up to 4300° F, threatening a complete meltdown at one stage. Fortunately the problem was resolved just in time by the nuclear designers and operators.

The Chernobyl nuclear accident was the worst nuclear accident in the history of nuclear power generation. IAEA has classified this accident as a 'major accident'. This accident occurred in 1986, basically due to a flawed nuclear design and faulty operation by inadequately trained operators. The plant's safety systems were turned off for a routine test, but the reactor power decreased down to one per cent instead of stabilising at twenty five per cent. This was followed by the power surge leading to a complete meltdown. As per the estimate, this disaster led to relocation of approximately two million people and killed about ten thousand people.

6.11 Wasteland and Its Reclamation

Wasteland is defined as a part of the land neither being used nor capable of producing material or service of some value. At present, 68.35 million hectares of land, is lying as wasteland in India. This degradation of environment can be attributed to indiscriminate exploration of natural resources, population explosion, increase in biotic pressure and faulty land management policies. The various categories of wastelands existing in India are sodium/alkaline bud, snow-covered regions, rooky patches, water logged/marshy lands, industrial wasteland and unclear utilised notified forest lands.

Following are various measures which should be undertaken for reclamation of wastelands:

1. Emphasis on tree plantation over wasteland.
2. Adoption of agricultural practices like mixed cropping and crop rotation.
3. Reclamation of saline soil by use of gypsum, garbage, paddy, straw, etc., for two to three years.

4. Encourage establishing industries or residential areas over wasteland.

In the year 1985, National Wasteland Development Board was established under the Ministry of Forests and Environment with an aim to effectively tackle the problem of degradation of land and to meet rising demand of fuel wood and forests.

6.12 Consumerism and Waste

Consumerism is a social and economic phenomenon that is based on the systematic creation to foster a desire to consume resources in greater amounts. It is essential to promote efficient consumerism so as to improve the nation's economy and minimise waste.

The various adverse effects of inefficient consumerism are as follows:

1. Depletion of natural resources
2. Create environmental imbalance
3. Production of inferior quality products
4. Adulteration of food products
5. Loss of adequate services

There are two types of conditions in population and consumerism:

1. *People over population* – This condition exists in developing countries, when the demand of resources due to population explosion exceeds the availability of resources. This leads to undernourishment and premature deaths.
2. *Consumption over population* – This condition exists in developed nations like United Sates, European countries, etc. In this condition the population size is much smaller than the resources. However, due to luxurious lifestyle the per capita consumption of resources is very high and this puts pressure on exploration of limited resources at an ever-increasing pace.

Table 6.1 Comparison of United States and India

Parameter	*Percent Global Values*	
	USA	*India*
Production of goods	21%	01%
Population	47%	16%
Pollutants/Waste generation	25%	03%
CFC production	22%	0.7%
Energy use	25%	03%
Global production	13%	04%

6.13 Acts for Protection of Environment in India

6.13.1 Environment Protection Act 1986

This Act lays guidelines for protection and improvement of the environment. This Act came into existence in India on 19 November 1986, by a notification published in the official gazette. Vide notification number GSI 1198(E) dates 12 November 1986. The Act is applicable to the entire nation. The Act clearly defines protection of air, water, soil quality and the control of environmental pollutants.

This Act has given powers to the central government to take measures to protect and improve the environment in the following ways:

1. Execute nation-wide program for prevention and control of environmental degradation
2. Lay down standards for quality stress on emission standards
3. Lay down procedures
4. Sponsor researches for environmental problems
5. Establish laboratories

For the prevention, control and abatement of environmental pollution, standards have been specified under Schedules I–IV for emission of gaseous pollutants and discharge of effluents from industries in operation.

Under the EPA (Environment Protection Act 1986 the State Pollution Control Boards have to follow the guidelines provided under Schedule VI. There was an amendment in 1994, for environmental impact assessment of various development projects. These projects require clearance from the central government before their commencement. The Environment Protection Act 1986 has also made an amendment regarding environmental audit, as a means to check whether an industrialist is complying with the environmental laws and regulations or not.

6.13.2 Air (Prevention and Control of Pollution) Act 1981

This Act came into force on 16 May 1981. This Act provides for the prevention, control and abatement of air pollution. This Act is controlled by the Central and State Pollution Control Board. Its functions are to and control pollution and prevent wastage of water. It organises training for improvement of air quality. The Act has provisions for power, functions of pollution, control board funds, accounts, penalties and procedures. The board can declare any area as a control area, in which case, operation of industrial plants in those areas have to be continued with the consent of the board. Emission of air pollutants, in air pollution control areas, is allowed within 'permissible limits', which are controlled by the board.

6.13.3 Water (Prevention and Control of Pollution) Act 1974)

This Act came into force on 23 March 1974. This Act provides for the prevention and control of water pollution and maintaining, restoring the utility of water. The authorities like Central and State Board have been established and entrusted with various functions and powers under the Act. The constitution, functions and powers of central board and state boards are mentioned in the Act. The Act imposes the liability on every person to comply with any direction or order given under its provisions, failing which, he is made punishable with imprisonment or fine or both. This Act has provisions for funds, accounts, budgets and audit of the Central and State Pollution Control Board. Boards have powers to establish laboratories (Section 51(1) and 52(1)) for analysis of quality of water and effluents. Boards can take samples of effluents and have power of entry and inspection.

6.13.4 Wildlife Protection Act 1972

It extends to the whole of India except Jammu and Kashmir. Wildlife legislation was started in 1972 and the Indian Board of Wildlife was established in 1952.

Following are the provisions of the Wildlife Protection Act 1972:

1. This Act defines terms related to wildlife.
2. This Act involves the appointment of wildlife warden and duties.
3. This Act involves prohibition of hunting of endangered species.
4. This Act provides facilities for the establishment of wildlife sanctuaries and national parks.
5. This Act provides ban on the trade of wildlife.
6. It provides breeding programs for endangered species.

6.13.5 Forest Conservation Act 1980

This Act was enacted by the Parliament on 15 October 1980. This Act provides for the conservation of forests and extends to the whole of India except Jammu and Kashmir.

The main objectives of the Act are as follows:

1. This Act prohibits the use of forest land for non-forest purposes.
2. This Act provides for appointment of an advisory committee by the central board.
3. This Act provides provision for penalty in case of contravention.
4. This Act provides punishment when any authority or government department commits an offence.

6.14 Issues Involved in Enforcement of Environmental Legislation

Environmental legislation is for safeguarding our environment and the quality of natural resources. However, destruction of the environment continues. This is due to drawbacks in the environmental legislation and problems of effective implementation of conservation policies.

Following are some of the issues related to the Acts discussed above:

1. **Forest Conservation Act 1980**
   - Tribes or local people have not been included in the decision-making process regarding the nature of use of forest areas. Efforts are now being made to introduce human rights protection forums for locals.
2. **Wildlife Protection Act 1972**
   - Opening avenues for illegal trading in Jammu and Kashmir also serve the purposes of trading.
   - Ownership certificate for articles made of animal body parts also enhance illegal trading.
3. **Pollution related Acts**
   - Illegal mining is nor under the centre in Rajasthan.
   - Position of chairman of the boards is occupied by politicians rather than environmental experts.
   - Public participation in decision-making and formulation of policies yet to be implemented.
   - State boards use allocated funds and expertise to pursue their objectives.

Hence, environmental legislation should be aimed at achieving:

- ⇨ Administrative transparency
- ⇨ Strong penalties to offenders
- ⇨ Decentralisation of power
- ⇨ Environmental law education
- ⇨ Community–state partnership

6.15 Public Awareness

Public must be made aware of the various environmental laws. Protection of environment is the duty of every citizen. Public awareness can be created through the following ways:

1. **Among the people, through mass media** – Use of mass media, i.e., radio, newspaper, magazine, audio/video CDs and cassettes, etc., can create awareness among people.
2. **Among students, through education** –Awareness can be created among students by introducing environment as a compulsory subject from primary school through graduation.

3. **Among politicians and bureaucrats** – Policy makers, politicians and bureaucrats should attend seminars/workshops related to environmental awareness.
4. **National policy on environment** – Ministry of Environment and Forest publishes a magazine related to latest developments in environment policies.
5. **Non-government organisations** – Non-government organisations (NGOs) can play a significant role in creating a link between the government and the local people for addressing environmental issues and generating awareness.
6. **Awareness through movement** – Sometimes movements play an important role in creating awareness among the common people (e.g., Chipko movement, Silent Valley movement, etc.). But they should be well-targeted and well-organised.

Summary

- Sustainable development ensures fulfillment of present needs without compromising with the ability of future generations to meet their needs.
- Unsustainable use of biological resources throughout the planet is a testimony to the fact that societies have failed to value environment and the goods and services it provides.
- Rainwater harvesting is a technique of increasing the groundwater level by capturing structures, such as dig wells, percolation pits and check dams.
- The characteristic pattern of weather elements in an area over a period is called climate. The weather elements include temperature, rainfall, humidity, wind, etc.
- As a result of continuous addition of CO_2 in air, the temperature of the earth increases slowly. This warming up of the earth is called greenhouse effect or global warming.

REVIEW QUESTIONS

Short Answer Questions

1. Define sustainable development.
2. What are the effects of global warming?

3. What are greenhouse gases?
4. What is acid rain?
5. What do you mean by environmental ethics?
6. What is ozone layer depletion?
7. What is meant by the term wasteland?
8. Name some government organisations related to environment.
9. Name some non-governmental organisations related to environment.
10. What do you mean by the term rainwater harvesting?
11. What are the factors responsible for rehabilitation?

Descriptive Questions

1. How can sustainable development be achieved?
2. What are the methods of watershed management?
3. How can wasteland be reclaimed?
4. How do we control global warming?
5. Explain in detail nuclear accidents and their effects on the environment.
6. Discuss consumerism and waste products in relation to developed and developing countries.
7. How does climate change affect the environment?
8. What are the issues involved in enforcement of environmental legislations?
9. Discuss Air (Prevention and Control of Pollution) Act 1981.
10. Discuss in detail the methods of water conservation.

OBJECTIVE QUESTIONS

Fill in the Blanks

1. Food is a basic _____ of every living organism.
2. IFS (Integrated Farming System) is related to sustainability of _____.
3. _____ proposed an integrated farming system.
4. Agenda-21 was framed at _____.

True or False

1. Agenda-21 proposed a global program of action for sustainable development.
2. The terms 'sustainable development' was coined at the Earth Summit held at Rio-de-Janeiro, in 1992.
3. Wildlife Protection Act was established in 1970.
4. Concept of land ethics was put forward by Leopold in 1949.

Multiple-Choice Questions

Put a ✓ mark against the correct answer.

1. Wildlife Protection Act was passed in
   (a) 1949 (b) 1972
   (c) 1912 (d) 1991
2. Aerosols are
   (a) chemical effluents released in water
   (b) gases released as exhaust of vehicles
   (c) mixture of carbon particles and frost
   (d) chemicals released in air in the form of mist or vapour with force
3. Which one of the following is normally not an important atmospheric pollutant
   (a) CO (b) CO_2
   (c) SO_2 (d) Hydrocarbons
4. Rapid increase in world population is due to
   (a) more industrialisation (b) more food supply
   (c) more movement (d) decreased mortality
5. MAB program was launched by UNESCO in
   (a) 1971 (b) 1975
   (c) 1981 (d) 1986
6. When was the National Forest Policy implemented
   (a) 1980 (b) 1978
   (c) 1985 (d) 1988
7. The Air (Prevention and Control of Pollution) Act was passed in
   (a) 1980 (b) 1981
   (c) 1972 (d) 1974

8. NEERI is
   (a) National Ethological and Ecological Research Institute
   (b) National Egenius and Ecological Research Institute
   (c) National Ecological and Environment Research Institute
   (d) National Environment Engineering Research Institute
9. Total number of tiger reserves in India are
   (a) 17 (b) 15
   (c) 18 (d) 20
10. Which of the following dams is Sunderlal Bahuguna opposing?
   (a) Pancheshwar dam (b) Kisav dam
   (c) Tehri dam (d) Lakhwar dam
11. Which of the following minerals is found in abundance in Uttarakhand?
   (a) Limestone (b) Gypsum
   (c) Marble (d) Barite
12. Environment Protection Act was introduced in
   (a) 1986 (b) 1985
   (c) 1984 (d) 1982
13. The highest number of organisms are
   (a) insects (b) mammals
   (c) birds (d) fishes
14. Contribution of which country has been maximum towards the formation of holes in the ozone layer?
   (a) USA (b) Russia
   (c) Germany (d) Japan
15. Bandipur in Karnataka is a popular site of the
   (a) tiger project (b) peacock project
   (c) deer project (d) elephant project
16. Which group of vertebrates is comprised of the highest number of endangered species?
   (a) Mammals (b) Fishes
   (c) Reptiles (d) Birds
17. The periyar sanctuary is famous for
   (a) wild bears (b) elephants
   (c) rhinoceros (d) swam deer
18. Today, concentration of greenhouse gases is high because of
   (a) use of refrigerators

(b) increased combustion of oil and coal
(c) deforestation
(d) All of the above

19. The worst enemy of the ozone layer is
(a) CH_4 (b) liquid NH_3
(c) SO_2 (d) CO

ANSWERS

Fill in the Blanks

1. need
2. food
3. Swaminathan
4. Stockholm

True or False

1. T 2. T 3. F 4. T

Multiple-Choice Questions

1. (b)	2. (d)	3. (a)	4. (d)	5. (a)
6. (a)	7. (b)	8. (c)	9. (c)	10. (c)
11. (a)	12. (a)	13. (a)	14. (a)	15. (a)
16. (a)	17. (b)	18. (d)	19. (d)	

Chapter 7

Human Population and the Environment

This chapter presents a comprehensive discussion, as organised under the following aspects, on the relation between human population and the environment:

- Population growth and variation among nations
- Population explosion and family welfare programs
- Environment and human health
- Human rights
- Value education
- HIV/AIDS
- Woman and child welfare
- Role of information technology in environment and human health

7.1 Population Growth and Variation among Nations

Population can be defined as the number of individuals of the same species present in a clearly defined geographical region. Human population refers only to human beings and the study of various aspects of human population like growth, trends, sex, age groups, status, education level, etc., is known as demography. July 11, every year, is celebrated as the World Population Day.

Population growth can be defined as the change in population of any species over a given time period. Population Growth Rate is actually the fractional rate at which the number of individuals in a population increases. In India the first human population census was taken in the year 1872. Thereafter, the population census is carried out after every ten years, so as to determine the various aspects of population and its growth rate.

Initially the human population was very small and accordingly human intervention with nature to its minimum. It did not pose any significant threat to the environment. The invention of agriculture, hunting and gathering of

food and later varied economic needs, dramatically increased the probability of human survival and helped in the growth of human population. After the industrial revolution in North America and Europe, primary activities like forestry, agriculture and fisheries took a back seat and a significant section of the population was involved in secondary (manufacturing) and tertiary (services) activities leading to enormous increase in the urban population. Due to the industrial and agricultural revolution, the life expectancy of children increased manifold. The population growth rate became more alarming due to a range of developments in the field of medicine and improvement in hygiene and sanitation. According to the latest available data, the world human population is growing two per cent per annum. The estimated population of the world at the present growth rate will be about 8039 million in the year 2025 and about 9366 million in the year 2050.

It is important to understand that different geographical regions have different population growth rates. The various factors that are responsible for variation in growth rates among various regions are as follows:

- ⇨ Availability of portable water
- ⇨ Availability of agricultural land
- ⇨ Accessibility of places
- ⇨ Age of civilisation
- ⇨ Restriction of national boundaries

The consumption pattern of available natural resources also varies from one region to another and accordingly the magnitude of strain imposed on the ecosystem also changes. On the basis of the development index, United Nations has divided the world's nations into developed and developing category. Developed nations are highly industrialised and have high Gross National Product (GNP) per capita such as Canada, Japan, Australia, New Zealand, United States of America and Western European countries. All developed nations combined together constitute 22 per cent of the world's population but utilise about 85 per cent of the world's wealth, 73 per cent of energy, 88 per cent of natural resources and produce maximum pollution and waste. On the other hand developing nations have comparatively low industrialisation and GNP per capita. The countries include China, India, Brazil, Indonesia, Malaysia, Thailand, Chile, etc. These nations support 78 per cent of the world's population and consume a meager 15 per cent of the world's wealth, 27 per cent of energy and 12 percent of natural resources.

Every year, the world's population grows by almost 90 million, at the rate of increase of 2.8 people per second. At present China's population ranks first, followed by India, United States of America, Indonesia, Brazil, Pakistan, Bangladesh, Nigeria, Russia and Japan.

As the human population grows, the population growth curve shows an initial bend that heads straight up to form a 'J' shaped curve. This significant increase in human population accompanied by the increase in usage of natural resources per individual poses a severe threat to the delicate

ecological balance, and if not checked on time, the ever-increasing demand for scarce natural resources, will eventually lead to a population crash.

7.2 Population Explosion and Family Welfare Programs

According to a website *dictionary.com* the word 'population explosion' literally means 'a pyramiding of numbers of a biological population'. In general terms, population explosion can be described as a situation, where the number of organisms grows beyond the optimal carrying capacity of their habitat. Thus for a nation, population explosion will happen when the number of people living in it, exceeds the sustaining capabilities in terms of available natural resources. It is necessary to understand that the population explosion will not only be determined by the measure of human population, but the ratio of it in terms with resources.

India is facing an intense and severe situation of population explosion. India occupies a meager 2.4 per cent of world's total land area, but contributes roughly around one sixth of total world population. India is the second most populated country in the world after China. At present China's population is increasing by 1.24 crores per year, while India's population is increasing by 1.88 crores per year. Accordingly the population density of India has increased from 287 persons per sq km in 1996 to 324 person per sq km in 2001. Population explosion has been one of the major drawbacks for the national economy. It challenges the prosperity and advancement of a nation. The effects of this enormous increase in population are clearly evident by ever-increasing poverty, unemployment, air and water pollution and shortage of food, health and educational resources. Today, every Indian is in an international debt of 100 US Dollars and the average income of an Indian is hardly about 20 US Dollars per day, which is less than the minimum daily wages of an unskilled laborer fixed by the government itself.

Following are the various factors that have led to population explosion in India:

- The availability of better medical facilities has lead to a significant decrease in death rate including infant mortality rate. Moreover, there has been a steady rise in the longevity of people.
- Migration to better places in search of better job opportunities or due to natural disasters/bad living conditions.
- Required attention given to gender equality and women issues.
- Improvement in the quality of education. The percentage of literate population aged seven and above has increased from 18.3 in 1951 to 52.2 in 1991.
- Implementation of Family Planning Programs.

The difference between the birth rate and the death rate indicates the natural growth of population. Larger difference means more population growth rate. The major factor affecting population explosion in India is a huge increase in birth rate and a decline in death rate. Since the nation cannot stop technological advancement to decrease the death rate, the other option is to reduce the birth rate. The government of India is funding several programs to limit the population by reducing birth rate.

India was the first country to launch an official family planning program called 'California Approach' way back in 1952. It was later converted to 'extension and camp' approach, with a view to teach virtues of a small family. India framed 'National Population Policy' in April of 1976. It emphasised the importance of small family, offered better services and included newer contraceptive methods. Family Planning Program has remained a women-centric program to a large extent. The latest approach adopted in April 1996, primarily aims at improving reproductive and child health care facilities.

Family planning is defined by WHO as 'A way of thinking and living that is adopted voluntarily, upon the basis of knowledge, attitudes and responsible decisions, by individuals and couples in order to promote the health and welfare of family groups and thus contribute effectively towards the social development of a country.' The adoption of family planning measure not only helps women in terms of prevention of high risk pregnancies and unsafe abortions, but also helps men by providing better life for their families.

Various family planning methods are being provided by family planning programs across the nation. These include vasectomy, tubectomy, Intra Uterine Devices (IUDs), oral contraceptive pills and various other conventional contraceptives like condoms, diaphragms, jelly/cream tubes, etc.

The success rate of family planning programs being adopted by the Indian government depends on various complex issues like literacy, awareness, religion, culture, belief and the regional area. The successful implementation of family planning program can significantly control/limit the birth rate and thus can go a long way in bridging the gap between the exploding population and scarce resources.

7.3 Environment and Human Health

The natural environment includes all living and non-living things which are by nature present on the earth. Environment comprises air, water, minerals and all other external factors surrounding and affecting a given organism at any given time. Hence, the environment has a direct impact on physical, mental and social well-being of an organism living in it.

The World Health Organisation (WHO) defines health as 'A state of complete physical, mental and social well-being and not merely the absence of a disease or infirmity'. In 1986, WHO at the Ottawa Charter

for Health Promotion defined health as 'A resource for everyday life, and not the objective of living. Health is a positive concept emphasising social and personal resources, as well as physical capacities'. In general health of an organisation can be described as a predefined level of functional and metabolic efficiency.

Health is probably the most important factor for human life and the natural environment or surroundings play a significant role in maintaining good health. The environment influences human health in a variety of ways, i.e., through exposure to physical, chemical and biological risk factors, and through induced behavioral changes, as response to these risk factors. Recently WHO carried out an analysis of impact on environmental factors like air and water pollution, agricultural practices, ecosystem changes, ultraviolet radiation, climate change, noise pollution, etc., on human health. About thirteen million deaths occur annually due to preventable environmental causes. Effective prevention of environmental risk can save about four million children from dying.

The stiff competition among various nations to achieve industrialisation and increase agricultural production has greatly affected human health by disturbing the ecosystem. Proper environmental management is essential to prevent various kinds of illnesses caused by preventive environmental factors. It is our moral duty to protect our environment at different levels:

At Individual Level

- ⇨ Plant more trees
- ⇨ Minimise use of fossil fuels like petrol, diesel, etc.
- ⇨ Restricting use of horns and other devices creating noise pollution
- ⇨ Being a vegetarian and reducing junk food intake
- ⇨ Use of energy-saving gadgets over conventional gadgets
- ⇨ Switching off the lights, fans, etc., before leaving the room

At Family Level

- ⇨ Plant more trees around your house
- ⇨ Growing indoor plants
- ⇨ Use better cooking devices and cleaner fuels
- ⇨ Improving ventilation at home
- ⇨ Keeping children away from smoke
- ⇨ Minimal use of detergent
- ⇨ Use of polyhthene bags should be avoided

At Community Level/National Level

- ⇨ Promoting household water treatment and safe storage
- ⇨ Reducing air pollution
- ⇨ Introducing energy policies, favouring development and health
- ⇨ Restricting use of loudspeakers

- Minimum use of fire crackers
- Minimum use of chemical pesticides and insecticides

7.4 Human Rights

Man is considered to be the most wonderful and unique creation of the universe. It is essential that all fundamental rights be provided to every human being, from birth to death.

The concept of human rights came into existence after adoption of the Universal Declaration of Human Rights (UDHR) by the United Nations in the General Assembly of 1948, partly in response to the brutalities committed during World War II. Although human rights are considered to be universal, the extent of their implementation varies significantly between developed and developing nations. The main reasons for these differences are population and poverty. All human beings are not happy and healthy. Enormous economic and social disparity exists between developed and developing nations. A modern interpretation of the original declaration of human rights was made in the Vienna Declaration and Program of Action, adopted by the World Conference on Human Rights in 1993. It emphatically stressed upon equal economic and social rights for everyone.

7.4.1 Promotion and Protection of Human Rights by the United Nations

- Human Rights consciousness
- Codification of the law of human rights
- Monitoring human rights
- Compilation of information the violations of human rights
- Procedure for individual complaints
- Examination of human rights situation
- Coordination of human rights activities
- By providing advisory services

The three principal regional human rights instruments are the African Charter on Human and Peoples Rights, the American Convention on Human Rights and the European Convention on Human Rights. Apart from these, there are many international non-governmental human rights organisations like Amnesty International and Human Rights Watch.

The Constitution of India provides fundamental rights to all citizens of India. To cater to provision of human rights for every citizen and to ensure that there are no cases of human rights violations, the Indian Parliament passed 'The Protection of Human Rights Act' on 8 January 1994. It is an act to provide for the constitution of National Human Rights Commission, State Human Rights Commissions in various states and Human Rights Courts for better protection of human rights and all related matters.

Despite all these steps, human rights violations cases are being reported frequently. As per the Amnesty International Report on Human Rights released in 2004, only very few countries like Netherlands, Denmark, Iceland and Costa Rica did not have any significant incidents of human rights violations. In several countries like Bosnia, Ethiopia, etc., citizens are being ill treated even today. In various Muslim nations offences are still being punished by specific penalties such as flogging, amputation of a hand or in extreme cases capital punishment for murder, which many western countries think, are contrary to respecting human rights.

Hence, human rights are an instrument of power in this modern ever-changing society. This concept strengthens the development process of nation states and induces sustainable development of the environment.

7.5 Value Education

Values and moral principles form the foundation of an individual's life. Personal values such as honesty, charity, tolerance and personal hygiene, make an individual, an ideal member of the society. Values influence our thoughts, feelings and actions and creating a mindset that affects our life, for the better. Values are guiding principles of life and bring joy, satisfaction, peace, harmony and quality to our lives and hence can truly make our world, a better place to live in.

Values are those principles of life, which enable a person to lead better quality life. Values generally aide the person in deciding what is wrong or right in life. The core idea of value education is to inculcate these values in students, so that they not only become professionals, but also good human beings. Value education helps people of all ages and gender to implement value systems in everyday life.

7.5.1 Components of Value Education

The various components which form value education are the following:

- Environmental education
- Moral education
- Human rights and duties
- Indian culture
- Physical education
- Yoga education
- Study of the Freedom Movement of India

7.5.2 Principles of Value Education

- At the elementary level, education should be free and compulsory to each and everyone.

- Professional education should be freely available to the masses.
- Higher education should be made accessible to all.
- Education should aim at the complete and holistic development of human beings.

7.5.3 Emphasis of Value Education

- To inculcate essential values in students, so as to improve their quality of life.
- To enable a person to know himself/herself, so that he/she understands the purpose of life.
- To distinguish between right and wrong and to be able to take correct decisions.
- Enable everyone to live in harmony with the environment and each other.
- To make a person responsible towards himself/herself, family, neighbours, society/community on the whole.
- To develop all the three aspects of an individual, viz., physique, mentality and character.

7.5.4 Need of Value Education

In today's world, people generally seem to be compromising with their values to a very large extent. This is leads to increasing violence, corruption, unlawful activities, etc., eventually reaching a magnitude that it begins to threaten the existence of a peaceful society. The present education system encourages young minds to engage only with the theoretical aspect of a subject. The emphasis is laid only on 'learning' a particular subject and to reproduce it in an examination to score more marks, instead of understanding logics and concepts.

The traditional joint family system in India ensured that a child received adequate value education. However, in the modern world, with the rise in nuclear family structures and dynamic role of parents, it has become very difficult to impart value education to a child. Hence, it becomes essential for academic institutions to give importance to value education, as part of the curriculum.

Many institutions have introduced various types of experimental models of coaching value education at elementary levels. One of the models adopted by the United States is outcome-based education.

India is a country of varied religions and cultural traditions. Indian Education Commission has suggested a curriculum based on social, spiritual and ethical values. All education systems have emphasised on teaching value education to students. It was in 1986 when the National Education Policy finally put a stamp on value education.

In 1988, the conference of European Ministers of Education provided the basis for better and holistic perception of values and behavior that evolve from recognition of cultural and human values of education. Similarly, in the year 2002, the National Council of Education Research and Training (NCERT), organised a program on 'National Consultation on Value Education in Indian Schools – Experiences and Strategies of Implementation'.

Recently, the National Resource Centre for Value Education (NRCVE) has been established in the Department of Educational Psychology and Foundation of Educations (DEPEE). The aim of the centre is to develop and implement programs and strategies to renew the emphasis on value education. The various activities undertaken by the centre include analysis of NCERT text books, interpretation of materials relating to value education, preparation of relevant supplementary material for students, etc.

Hence, it is essential to lay adequate emphasis on correct and adequate value education, of young minds, to enable them to shape their life in a manner that makes them better human beings and lead quality life.

7.6 HIV/AIDS

Acquired Immune Deficiency Syndrome (AIDS) is a disorder of the immune system caused by Human Immunodeficiency Virus (HIV). HIV is a retrovirus that attacks the immune system by destroying the lymphocytes cells (T4). The first case of AIDS was reported in 1981, when the United States Covers for Disease Control recorded a cluster of Pneumocystis Carini Pneumonia (PCP) in five homosexual men in Los Angeles. The first case of AIDS in India was reported in the year 1986 in Chennai. AIDS reduces the effectiveness of the immune system and leaves an individual susceptible to many infections and tumors. The infections are also known as opportunistic infections, since they take advantage of the opportunity offered by the weak immune system.

HIV/AIDS spreads by the following ways:

- Sexual intercourse: Most common method is having unprotected sexual contact with an infected person. Sexual activities may involve vaginal, anal or oral sex.
- Using needles/syringe contaminated with virus from an infected person. Intravenous drug users are very susceptible to this disease.
- Blood transfusion from an infected person.
- Prenatal transmission, from an infected mother to the child/foetus.

HIV/AIDS does not spread by the following actions:

- Hugging and touching
- Coughing and sneezing

- Sharing foods and utensils
- Mosquito bite
- Working in the same office
- Sharing some facilities like swimming pools, etc.
- Sharing washrooms/toilets
- Contact with sweat and tears of infected person

7.6.1 Symptoms of HIV/AIDS

- The immune system becomes very weak
- Persistent fever and headache
- Muscle ache and joint pains
- Loss of appetite
- Loss of weight
- Skin rashes
- Diarrhea
- Swollen glands

7.6.2 Treatment of AIDS

The Enzyme Linked Immunosorbent Assay (ELISA) is used to detect the presence of HIV. If the blood sample gives a positive result, then it is confirmed by using the 'western blot' test. Till today, no vaccine or drug can cure the disease completely. The prescribed medicines either target HIV directly or treat opportunistic infections. Combinations of anti-retroviral drugs have been found to be most effective in the treatment of AIDS.

India has one of the world's largest numbers of people suffering from HIV/AIDS. The first case of HIV was detected in India, in the year 1986, among the sex workers in Chennai. In India HIV/AIDS cases are more prevalent in the southern states, mainly Andhra Pradesh, Goa, Karnataka, Maharashtra, Tamil Nadu and north-eastern states like Manipur, Mizoram and Nagaland. The majority of infections occur through heterosexual sex and intravenous drug use.

Indian Government has taken proactive measures to restrict the spread of HIV/AIDS infection. The Apex body on HIV surveillance in India is National AIDS Control Organisation (NACO). NACO envisions an India where every person living with HIV has access to quality care and is treated with dignity. Main factors responsible for the spread of HIV in India are low literacy rate, poverty and extensive labour migration. All efforts are being made to spread awareness, motivate people, equip and empower them with knowledge so that they can safeguard themselves from HIV. Moreover, each state has its own AIDS prevention and control society. These societies work under the guidance of NACO and are provided funds for youth campaigns, bloods safety checks and HIV testing.

Although the impact of HIV/AIDS is not as severe as it is in South Africa, it is still important to make sure that it remains in check. Hence, it is imperative that all efforts should be made by the government, NGOs, the private sector and the society to check the spread of HIV/AIDS.

7.7 Women and Child Welfare

Women and children combined constitute approximately three-fourth of the world's population. Traditionally, women have been considered and treated as the weaker sex and have remained socially, politically and economically backward. Similarly children have also been exploited and oppressed. The situation is more critical in developing and warring nations. As per an estimate, approximately eleven million children die due to various diseases and malnutrition. Major chunk of these deaths occur in poor countries.

Due to massive industrialisation in the past two decades, India is witnessing environmentally unsustainable growth. The livelihood of rural population has been critically and severally affected due to deforestation, water pollution, poor wasteland management, unpredictable monsoon and weather. There are several environmental factors that are linked to the general welfare of women and children.

The Indian government has taken various measures in the field of women and child welfare, both at the central and state level. In 1985, the Department of Women and Child Development was established under the Ministry of Human Resource Development to provide for the overall development of women and children. In 2006, this department was upgraded to a full-fledged ministry. The broad mandate of the ministry is to ensure holistic development of women and children in the country.

7.7.1 Various Policies and Acts for Women Empowerment

- National Policy for Women Empowerment
- Women group report on empowerment of women for XI plan
- Protection of Women from Domestic Violence Act, 2005
- Dowry Prohibition Act, 1961
- Indecent Representation of Women
- The Commission of Sati (Prevention) Act and rules
- National Commission of Women Act

7.7.2 Programs for Care and Protection of Children

Various child protection programs have been launched by the Indian Government. These programs focus on children living in slums, street

children, orphaned and abandoned children, children who have been abused, children in conflict with law and children affected by natural disasters. Following are the various programs:

- An integrated program for street children
- Child line services
- Juvenile justice program
- Government of India – UNICEF work plan on child protection
- An integrated child protection scheme has also been proposed

For the welfare of women, there was a convention on 'Elimination of Discrimination against Women'. It was included in the human rights convention and started in 1981. It is mandatory for all the state parties, to eliminate discrimination against women in all fields and to ensure the following with respect to women in India:

- The right to vote.
- The right to be eligible for elections, to publicly elected bodies and to hold public office at all levels.
- The right to participate in the formulation of government policy and in non-governmental organisations, concerned with public and political life.
- Equality before the law.
- Right to work and equal employment opportunities, including equal pay for equal work.
- Equal financial benefits and services.
- Equal access to healthcare including family planning services.

For ensuring children welfare, a convention took place for the rights of children. It was included in the human rights and came into existence in 1990. The state parties protect children from all forms of discrimination and provide adequate care and protection. Rights to be ensured include the following:

- The right to life and protection from capital punishment.
- The right to acquire a nationality.
- Protection of child's interest in adoption cases.
- Freedom of thought, conscience and religion.
- Right of access to health care services.
- Protection from economic exploitation.
- Protection from sexual exploitation and abuse.
- The right to a good standard of living and social security.

7.8 Role of Information Technology in Environment and Human Health

Information technology is extremely useful and has enormous potential in the field of environment and human health, as in any other field like business

and trade. A number of user-friendly software have been developed, which make understanding and assimilation of various aspects of the subjects much easier. Information Technology enables the user to obtain accurate and up-to-date information on change in environmental situations caused either due to natural factors or human activities.

The various roles performed by Information Technology in the field of environment are as follows:

- Information Technology can be effectively used for computer-based modeling and simulation of various kinds of environmental situations.
- The development of World Wide Web, enabled people across the globe to share their knowledge on the subject.
- Satellites can be effectively used to collect actual information about various physical and biological resources.
- Database on the subject can be created at a national level which can be used for various research works. The Ministry of Environment and Forests (MoEF) and the Indian Government have successfully created a repository on environmental subjects known as the Environment Information System (ENVIS).
- IT4 computers are being used to forecast the weather. Specialised computers help researchers and scientists accurately predict forthcoming rains, cyclones, earthquakes, etc.
- *Geographical Information System* (GIS) is a very effective technology used for efficient environmental management. Thematic maps are superimposed on a large amount of inter-related and inter-dependant aspects. GIS is used for mapping and analysing things that exist and events that happen on the earth. The GIS software includes a Data Base Management System (DBMS). GIS provides accurate information of monsoon approach, ozone layer depletion, sites/locations of natural reserves, forest cover, polluted zones, waste and degraded lands.
- *Geoinformatics* can be defined as the science which uses information science infrastructure to resolve problems related to geosciences and geography. Geoinformatics technology includes GIS, spatial decision support system, Global Positioning System (GPS) and remote sensing. It can be effectively used for urban and rural planning and also environmental management.
- *Photogrammetry* is used to obtain accurate information regarding physical objects and the environment by recording, measuring and interpretation of photographic images. Photogrammetry can be used effectively in various fields like topographic mapping and geology among many others.

The various roles performed by the Information Technology in the field of human health are as follows:

- ⇨ Information Technology has helped people determine their illness and get prescriptions accordingly by online use of interactive and user friendly medical information systems. Websites like 'doctor online' helps users in getting their medical analysis performed online.
- ⇨ It is used to spread awareness about various endemic, epidemic and communicable diseases.
- ⇨ It can be use for imparting medical education.
- ⇨ It is used for testing DNA, thereby creating a genetic database for the entire population. These medical records and finger prints are used by investigating agencies for identification of a person.
- ⇨ The Word Wide Web enables collaborations of doctors from various part of the world to share their knowledge.
- ⇨ Advancement in bioinformatics and decoding of human genome has opened various avenues for human race development.
- ⇨ Monitoring of patients remotely and automated drug administration.
- ⇨ Medical transcription, maintaining and recording of patient history and treatment details.
- ⇨ Development of new drugs.
- ⇨ Development of gadgets like pacemaker for heart and cochlea implants, used as hearing aid.

Summary

- The invention of hunting and gathering of food, agriculture, and identification of economies has boosted the growth in population.
- Study of human population is called demography. In India the first human population census was taken in 1872.
- Every year the world population grows by about 90 million due to increase of 2.8 people each second. This explosive rate of human growth is termed as population explosion.
- The environment has a direct impact on physical, mental, economic and social well-being of individuals.
- Information Technology (IT) helps us in many ways, such as business industry, education and training, scientific, research, entertainment, environment and healthcare, etc.

REVIEW QUESTIONS

Short Answer Questions

1. What is population explosion?
2. What do you mean by health?
3. What is value education?
4. Define AIDS.
5. What is information technology?
6. What is family planning?
7. Define the terms mortality and fertility.
8. What are human rights?

Descriptive Questions

1. What are the preventive measures for population explosion?
2. Discuss the methods of family planning.
3. How does AIDS spread and what are the methods to control this disease?
4. Discuss the role of information technology in environment and human health.
5. Discuss the role of women and child welfare in relation to the environment.
6. Discuss value education.
7. How does population growth show variations among various nations?

OBJECTIVE QUESTIONS

Fill in the Blanks

1. Environmental education is a part of _____ ethics.
2. The silica dust deposited in the _____ .
3. One of the most toxic substances currently in industrial use is _____ .
4. _____ is a fatal illness caused by a retrovirus known as the human immune-deficiency virus.

5. _____ is a greenhouse gas.
6. Ultraviolet radiations are _____ .

True or False

1. HIV has infected millions of women, men and children worldwide.
2. Biodiversity increases from pole to equator.
3. The word 'population' is derived from the Latin word 'popular'.
4. Average in-take of lead, by man varies from 20 to 40 mg/day.

Multiple-Choice Questions

Put a ✓ mark against the correct answer.

1. In India 30 per cent male and 35 per cent female population suffers from
   (a) TB (b) AIDS
   (c) malaria (d) cholera
2. Change in population depends on the
   (a) growth rate (b) location
   (c) atmosphere (d) weather
3. Which is the best studied photochemical oxidant?
   (a) O_2 (b) N_2
   (c) O_3 (d) H_2
4. Which is highly prevalent amongst major pollutants?
   (a) CO (b) N_2
   (c) CO_2 (d) Cl_2
5. Which disease has been associated with air pollution?
   (a) Lung cancer (b) Mouth cancer
   (c) TB (d) Skin cancer
6. The word 'population' is derived from the Latin word
   (a) popular (b) populap
   (c) populas (d) populan
7. Study of population growth is called
   (a) demography (b) population ecology
   (c) population biology (d) ecological niche
8. Theory of human population was proposed by
   (a) Charles Darwin (b) T R Mathews
   (c) A R Wallace (d) Lamarck

9. Which of the following factor cannot change the size of a population?
   (a) Density of population (b) Death rate
   (c) Birth rate (d) Migration
10. Most popular bio pesticide is
   (a) neem (b) aloe vera
   (c) tulsi (d) None of these
11. 'World Population Day' is celebrated every year on
   (a) 11 July (b) 7 October
   (c) 10 December (d) 14 November
12. In India, the first human population census was taken in
   (a) 1852 (b) 1892
   (c) 1872 (d) 1902
13. The population growth is measured after every
   (a) 10 years (b) 9 years
   (c) 12 years (d) 4 years
14. 'Cholera' is a
   (a) water-borne disease (b) food-borne disease
   (c) air-borne disease (d) vector-borne disease
15. The shape of growth pattern of the human population is
   (a) S-shaped (b) irregular
   (c) I-shaped (d) T-shaped
16. Most hazardous metal pollutant of automobile exhaust is
   (a) lead (b) mercury
   (c) copper (d) cadmium
17. A group of individuals of any particular kind of organism, living in a particular geographical area form
   (a) a population (b) an ecosystem
   (c) a community (d) the biosphere
18. Which is not a greenhouse gas
   (a) chlorofluorocarbon (b) carbon dioxide
   (c) methane (d) hydrogen
19. Population is a changing
   (a) entity (b) phenomenon
   (c) title (d) form
20. India framed 'National Population Policy' in
   (a) 1977 (b) 1976
   (c) 1980 (d) 1991

ANSWERS

Fill in the Blanks

1. environmental
2. lungs
3. beryllium
4. AIDS
5. CO_2
6. carcinogenic

True or False

1. T 2. T 3. T 4. F

Multiple-Choice Questions

1. (a)	2. (a)	3. (b)	4. (a)	5. (a)
6. (b)	7. (a)	8. (c)	9. (d)	10. (a)
11. (a)	12. (b)	13. (a)	14. (a)	15. (a)
16. (a)	17. (a)	18. (d)	19. (a)	20. (c)

Chapter 8

Field Work

Field work would involve the following activities:

- Visit an urban and a rural polluted site.
- Visit an industrial site.
- To study common insects, plants and birds.
- To study parts of trees and their uses.
- Visit a local area to document environmental assets such as river, mountain hot spots of your city. Document factors responsible for degradation of trees.

Experiment No. 1

- To visit an urban polluted site.
- Requirements – Notebook and pen.
- Observations – Biodegradable and non-biodegradable pollutants in urban areas can pollute the air, water and land.

Table 8.1 Observation of urban polluted site

S. No.	*Polluted site*	*Observations*
1.	Industrial area	Large amount of industrial effluent, foul smell, dizziness
2.	Heaps of solid waste	Spread of infectious organisms
3.	Transportation	Causes air pollution
4.	Ditches	Evolution of gas, foul smell, infectious organisms

Experiment No. 2

- To visit a rural polluted site.
- Requirements – Notebook and pen.
- Observations – Various pollutants in rural areas pollute air, water and land. Mismanagement of resources and adverse human activities also degrade rural environment.

Table 8.2 Survey of rural polluted site

S. No.	*Polluted site*	*Observations*
1.	Solid waste	Heaps of solid waste in large number
2.	Animal dung	Lying at open places near water spots
3.	Uneven roads	Filled with polluted water
4.	Holes of water	Cause infectious diseases
5.	Ponds	Pond water is polluted due to various activities like washing, animal bathing, etc.

Experiment No. 3

- To visit an industrial site.
- Requirements – Notebook and pen.
- Observations – As noted in Table 8.3.

Table 8.3 Observations of industrial site

S. No.	*Activity*	*Observations*
1.	Disposal of industrial effluents	Degrades the nearby land
2.	High stacks of chimney	Install very long stacks of chimney
3.	Plantation	Done
4.	Emission of CO_2 with or without filters	A dark zone is seen in the atmosphere
5.	Industrial acts	Not strictly followed by the owners
6.	Medical facilities for labour	Good medical facilities provided to labour
7.	Solid waste	Produces foul smell

Experiment No. 4

- To study common insects, plants and birds in your surroundings.
- Requirements – Notebook and pen.
- Observations – As noted in Table 8.4.

Table 8.4 Survey of common insects

S. No.	*Name of insect*	*Area*	*Disease caused*
1.	House fly	House	Causes diseases
2.	Mosquitoes	Open ditches/pits	Causes diseases
3.	Cockroach	Sewage water	Causes diseases
4.	Earthworm	Soil	Improves fertility
5.	Butterfly	Garden	Sucks nectar
6.	Zooplanktons	Ditches	Causes diseases
7.	Ant	Surroundings	Causes pain

Table 8.5 Survey of common plants

S. No.	*Name of plant*	*Area*	*Uses*
1.	Neem	Near house	Insecticide
2.	Mango	On the roadside	Nutritive value
3.	Pipal	Temple	Acts as a good air filter
4.	Banyan	On the roadside	Acts as an air purifier
5.	Eucalyptus	On the roadside	Soaks moisture

Table 8.6 Survey of common birds

S. No.	*Name of bird*	*Area*	*Mode of feeding*
1.	Peacock	Near Garden	Omnivores
2.	Sparrow	Surroundings	Eats insects and grains
3.	Parrot	Orchards	Feeds on raw fruits
4.	Vulture	Near dead animals	Feeds dead bodies
5.	Crow	Surroundings	Feeds on solid wastes

Experiment No. 5

- Write the parts of trees and their uses.
- Requirements – Notebook and pen.
- Observations – As noted in Table 8.7.

Table 8.7 Uses of plant parts

S. No.	*Plant parts*	*Uses*
1.	Foliage	Decorations, oils
2.	Gum	Chewing gums, resins, perfumes, ointments
3.	Sap	Syrups, sugar
4.	Bark	Tanin, drugs, oils, dyes
5.	Logs	Veneer, plywood, boards
6.	Cordwood	Fuel, charcoal, tannin, dyes, wood alcohol
7.	Roots	Smoking pipes, til, etc.
8.	Stumps	Veneer, pine oil, wood tar, turpentine

Experiment No. 6

- Study of a river, as an environmental asset.
- Requirements – Notebook and pen.
- Observations – As noted in Table 8.8.

Table 8.8 Survey of a river

S. No.	*Parameters*	*Observations*
1.	Flow rate	Slow
2.	Temperature	Normal
3.	Pollutants	Small
4.	Size	Small
5.	Water colour	Transparent
6.	Presence of water	Throughout the year
7.	Use of river water	For irrigational purposes
8.	Impact on the surroundings	Cools the local atmosphere
9.	Washing of clothes	Yes
10.	Bathing of human beings	Yes
11.	Any industrial unit nearby	Yes

Experiment No. 7

- To study a mountainous area.
- Requirements – Notebook and pen.
- Observations – As noted in Table 8.9.

Table 8.9 Survey of mountainous area

S. No.	*Parameters*	*Observations*
1.	Type of vegetation	Grasses, trees
2.	Profession of local people	Agricultural jobs
3.	Tourism	Good
4.	Population	Densely populated
5.	Means of Transportation	Buses, trains, cars

Experiment No. 8

- Name the hot spots of your city.
- Requirements – Notebook and pen.
- Observations – Hot spots of city are parks, lakes, corners of the city, and areas near a river.

Experiment No. 9

What are the factors responsible for degradation of trees in a given area?

Observations –Factors responsible for degradation of trees are industries, sewage effluent, water logging and transportation.

Appendices

Appendix 1:
Environmental Awareness Levels

First Level of Awareness

- Environmental degradation
- 'Pollution' is the main reason for environmental degradation

Second Level of Awareness

- Population explosion
- Population explosion leads to energy crisis and environmental degradation

Third Level of Awareness

- Sustainable earth
- The earth is not a 'hotel' – It is our 'home' and sustainable development is possible only when sustainable earth is our goal.

Appendix 2

Table A.2 Relative proportion of gases (by volume) in the atmosphere

S. No.	*Gases*	*Symbol*	*Per cent*
1.	Nitrogen	N_2	78.084
2.	Oxygen	O_2	20.949
3.	Argon	Ar	0.934
4.	Carbon dioxide	CO_2	0.0318
5.	Neon	Ne	0.0018
6.	Helvin	He	0.0005
7.	Cryton	Kr	0.00011
8.	Xenon	Xe	0.00009
9.	Hydrogen	H_2	0.00006
10.	Methane	CH_4	0.00021
11.	Oxides ofnitrogen and sulphur	NOxSOx	0.0005
12.	Ozone	O_3	0.000004
13.	Water vapour	H_2O	Variable

Appendix 3
Toxic Chemicals in the Environment

Toxic Chemicals in Air

- Acycylonitrile, Arsenic, Asbestos
- Benzene, Beryllium
- Cadmium, Chromium, Chlorinated solvents, Coke oven emissions, Chlorofluorocarbons
- Ethylene dibromide, Ethylene oxide
- Lead
- Mercury
- Ozone
- Polycylic aromatic hydrocarbons
- Sulphur dioxide

Toxic Chemicals in Water

- Trace elements: Arsenic
- Beryllium, Boron
- Cadmium, Chromium, Copper
- Fluoride
- Lead
- Manganese, Mercury, Molybdnum
- Seknium
- Zinc
- Pesticides

Appendix 4

Table A.4 The time scale of evolution

Time	*Event*
650–700 billion years ago	The big bang
450 billion years ago	The earth was born
350 billion years ago	The blue-green algae formed
300 billion years ago	Animals appeared
0.0025–0.0030 billion (25–30) million years ago	Man appeared

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