

Environmental Studies



Anindita Basak

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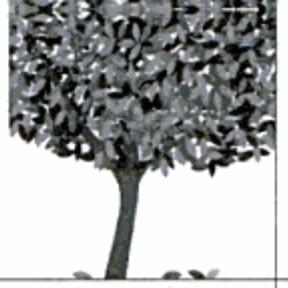
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Dr Anindita Basak, a Reader in Chemistry, has been teaching Chemistry, Polymer Science and Environmental Studies in the government colleges of Orissa like Fakir Mohan College, Balasore (presently Fakir Mohan University); Government Autonomous College, Rourkela; Government Autonomous Junior College, Rourkela; Government College, Sundargarh at the graduate and the postgraduate levels since 1987. She was also deputed as Visiting Scientist in National Institute of Technology, Rourkela during the period of 2004 to 2006.

Dr Basak is not only a popular teacher, a prolific author, an innovative research worker, an eminent administrator and social worker, but also has been a TV anchor. She did her M.Phil. in Chemistry from Ravenshaw College, Cuttack, Orissa (presently Ravenshaw University) and was a university topper. As a Junior Research Fellow at Bhabha Atomic Research Centre, Mumbai, she did advanced research work in the field of Polymer Science and obtained her Ph.D. from Utkal University in 1989. She has to her credit 16 technical papers published in national and international journals of repute. Dr Basak has been a National Scholarship holder throughout her career.

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At present, she is a Reader in Chemistry at Sushilavati Government Women's Junior College, Rourkela



Preface

The present plight of the world as a victim to a plethora of environmental setbacks ranging from global warming, ozone layer depletion to an alarming increase in world pollution levels is threatening the existence of the most intelligent species on earth. This has been enough for both environmentalists and laymen to wake up to the indisputable importance of environmental education. Almost every sphere that man has forged into has undergone a major demarcation from what it was before to suit the needs and greed of man better. Yet this Midas touch that came into major force in the last century was not quite the answer to the big question that it put on the sustainable development of our future generations. Rather, it proved to be a major hurdle in maintaining the ecological balance of nature, leading to the establishment of the United Nations in 1945 which was a natural and obvious decision in such a scenario.

Like all other developing nations, India too has been facing serious environmental deterioration and has suffered major destruction due to all kinds of natural calamities. This led the Supreme Court of India give a landmark judgment in October 2002 that made environmental education mandatory for all students up to postgraduation level irrespective of their major branch of study and, consequently, the introduction of environmental education in the UGC syllabi.

This book on environmental studies attempts to cover the concept of environment, the causes for its deterioration, the measures taken for its preservation and sustainable development. An insight into the contents of each of the eight units is as follows:

Unit-I is an introduction to the multifaceted subject and its importance to the society. Further, it elaborates the scope, significance, components and interdependence of the different components of the environment.

Unit-II describes natural resources, their use and various processes of extraction of resources such as water, mineral, food, land and forests. The consequences of overexploitation of natural resources have been depicted with supporting case studies. The Unit then moves on to the role that an individual can play towards conservation of nature through proper resource management and directs us towards a sustainable lifestyle by identification of the equitable use of resources.

In **Unit-III** the ecosystem and its functional components have been described and supported by updated data. A special thrust is given to ecological pyramids and facts such as balance of nature and biomagnifications. Different ecosystems such as forests, grasslands, deserts and water bodies have been described in great detail.

Unit-IV deals with biodiversity and the need for its conservation, supported by latest facts and figures in a very vivid and scientific manner. Details about the existing hotspots of biodiversity in addition to the recently discovered nine hotspots (exclusive of the book), the two hotspots present in India are discussed in this unit. Data showing the number of species found in India and its rank in the world for the same has also been described in detail. A list of endangered and endemic species of India and the threats posed to the present biodiversity is also included. Several case studies describing poaching of wildlife, conflicts between man and wildlife are incorporated to increase public awareness regarding protecting and conserving wildlife and thereby biodiversity. This Unit also brings up information regarding biopiracy.

Unit-V depicts environmental degradation with respect to air, water, soil, marine, noise and thermal pollution and nuclear hazards (accompanied by up-to-date statistics, information, graphs, photographs and tables) as

per the UGC syllabus. The causes, effects and control measures of all the above types of pollution are specially highlighted in this unit. It also includes a description and disposal of the types of solid waste such as hazardous, non-hazardous, biomedical and e-waste. Recent concepts such as the generation of green electricity, recycling of plastic, mushroom cultivation, etc. are also explained lucidly and from a scientific standpoint.

Unit-VI focuses on the need for sustainable development for better understanding of social issues and the environment and then moves to contemporary subjects of importance such as rain water harvesting, watershed management and resettlement; that have been described after making an exhaustive study. Special emphasis is laid on elaborate discussion over a topic as essential and as sensitive as environmental ethics. A detailed account of climate change, global warming, with a reference to the phenomenon of ozone layer depletion, nuclear accidents and holocausts; ranging from the Hiroshima and Nagasaki incident to the Chernobyl accident have been included for the knowledge of today's students. Wasteland reclamation has been described with proper thrust and successful case studies like the establishment of the City of Dawn (Auroville). Issues such as consumerism, e-waste, and chemical waste which are a consequence of the present day technology boom also find a place in this Unit. The Environmental Protection Act, Wildlife Protection Act, Forest Protection Act, issues involved in enforcement of environmental legislations and public awareness for the same have been cited for reference. A brief discussion on EIA has also been included.

Unit-VII provides exhaustive coverage of recent up-to-date information complemented by appropriate discussions on human population growth in various nations, population explosion, family welfare programmes, human rights and human health in addition to suitable case studies makes up this Unit. HIV/AIDS, the most serious cause for concern for the youth in society and the student community in particular, has not only been discussed vividly but due importance has also been given to its remedial actions. With a view to encourage the nation's future—the youth, to become actively involved in the upliftment of our social environment, suitable case studies have been employed to illustrate the need for the welfare of women and children and various programmes involved in the above cause. It also underlines the role of IT in improving the environment as well as human health.

The uniqueness of the book also lies in **Unit-VIII** which is dedicated to providing guidelines for field study through important experiments so as to aid the practical understanding of environmental study.

Five appendices at the end of the book facilitate the understanding of the subject matter to readers of all disciplines. The first one discusses National River Action Plans for the abatement of river pollution in India. The global environmental summits held till date make up the second appendix, aptly followed by important environmental dates, important abbreviations relevant to the subject, keywords (short notes) and a glossary of frequently used terms.

Keeping in mind the above facts, *Environmental Studies* is presented in a very simple and lucid manner covering the module syllabus designed by UGC for undergraduate students. It also includes up-to-date facts for inquisitive readers. Enough photographs, pie-charts, graphs, tables, suitable case studies and appropriate discussions have been included to make the learning process enjoyable for readers. Above all, the book is well-equipped to assess the comprehension of students by way of a treasure of long, short and multiple choice questions in addition to model question papers and self assessment questions that will prepare students for term ends and for competitive examinations alike.



Acknowledgments

It was a daunting task for me to write a book on environmental studies when there is a plethora of books on this topic. I must acknowledge that my students' inquisitiveness and thirst for a comprehensive book on this topic for the last few years sowed the seed for the present work.

I thank the Department of Higher Education, Government of Orissa; principals of government colleges where I have been working; NIT, Rourkela, where I worked as a Visiting Scientist during 2004 to 2006; UGC; Sambalpur University, and other institutions for giving me the opportunity to turn into an author from a reader.

I am also grateful to my parents, Nabin Chandra Basak and Anima Basak, for their constant inspiration, to Chitta Ranjan Patnaik and Dr Sandhya Patnaik for their support and guidance, to Dr Mukesh Rawal for his valuable advice and also to my daughters, Dipanwita and Nandita, for their support throughout the preparation of the manuscript.

My sincere thanks goes to the team of Pearson Education, specially Anita Yadav and Bhavna Chawla. I also thank D. K. Basak for his ready cooperation and Rajesh Singh for attending to my IT need even at odd hours.

Finally, I would like to thank my husband, Sudip Kumar Basak, without whom this book would have probably remained a mere dream.

ANINDITA BASAK



Core Module Syllabus for Environmental Studies

Unit – I Definition, Scope and Importance, Need for Public Awareness 2 lectures

Unit – II Natural Resources: Renewable and Non-renewable resources 8 lectures

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 overexploitation of surface and ground water, floods, drought, conflicts over water. Dam: benefits and problems.
- (c) **Mineral Resources:** Use and exploitation. Environmental effect of extracting and using mineral resource. Case studies.
- (d) **Food Resources:** World food problems. Changes caused by agriculture and overgrazing. Effects of modern agriculture, fertilizer pesticide problems, water-logging, salinity. Case studies.
- (e) **Energy Resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy source. Case Studies.
- (f) **Land Resources:** Land as a resource. Land degradation. Man-induced landslides, soil erosion and desertification.

Role of individual in conservation of natural resources. Equitable use of resources for sustainable lifestyle.

Unit – III Ecosystems 6 lectures

Concept of Ecosystems. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy Flow in the Ecosystem, Ecological Succession, Food Chain, Food Web and Ecological Pyramids. Introduction, Types, Characteristic features, Structure and function of the following ecosystems:

- (a) Forest Ecosystem
- (b) Grassland Ecosystem
- (c) Desert Ecosystem
- (d) Aquatic Ecosystems including ponds, streams, lakes, oceans, estuaries.

Unit – IV Biodiversity and its conservation 4 lectures

Introduction — Definition, Genetics, Species and Ecosystem diversity, Biogeographical classification of India, Values of diversity, Consumptive use, Productive use, social, ethical, aesthetic and optional values. Biodiversity and global, national and local levels. India as a megadiversity nation. Hotspots in diversity. Threats to diversity: Habitat loss, poaching of wildlife, man-wild life conflicts, endangered and endemic species of India. Conservation of Biodiversity, In-situ and Ex-situ conservation of Biodiversity.

Unit – V Environmental Pollution 8 lectures

Definition, causes, effects and control measure 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 measure of urban and industrial wastes. Role of individuals in prevention of pollution. Case studies.

Disaster Management: Flood, Earthquakes, Cyclones and Landslides.

Unit – VI Social Issues and the Environment

7 lectures

From unsustainable to sustainable development. Urban problems related to energy, measures of water conservation including rain water harvesting, watershed management, resettlement and rehabilitation of people, their problems and concerns, case studies, environmental ethics: issues and possible solutions, climatic changes, global warming, acid rain, Ozone layer depletion, Nuclear accidents and holocaust, case studies, wasteland reclamation, consumerism and waste products, Environment (Protection) Act (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.

Unit- VII Human population and the Environment

5 lectures

Population growth variation among nations, Population explosion, family welfare programme, Environmental and Human Health, Human Rights, value education, HIV/AIDS women and child welfare, Role of Information Technology in Environment and Human Health, Case Studies.

Unit – VIII Field Work

5 lectures

Visit to a local area to document environment problems in 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.

UNIT I

Definition, Scope and Importance of Environmental Studies



LEARNING OBJECTIVES

After studying Unit I, students will be able to:

- ◆ Define the scope and importance of environmental studies.
- ◆ Describe the need for public awareness.
- ◆ Identify the different components of the environment.
- ◆ Describe the history of environmental laws, and myths and misconceptions about the environment.
- ◆ Explain the importance of environmental studies in promoting sustainable development.
- ◆ Analyse the components of natural, man-made environment and social environment of the Earth – and explain the interdependence of these components on each other.

1.1 Definition, Scope and Importance of Environmental Studies

Environmental Studies is a multidisciplinary subject. It employs subjects like chemistry, physics, botany, zoology, physiology, geography, geology, geophysics, and metrology to describe the biological and physical nature of our environment. In order to understand how people function separately and also in a group, **Environmental Studies** involves an understanding of philosophy, ethics, psychology, anthropology, demography, archaeology, economics and political science. Laid against an ecological format, the information gleaned through the study of all these varied disciplines gives us a holistic view of the environment for sustaining life on earth on an infinite time scale.

The unlimited exploitation of nature (environment) by mankind for the sake of development has threatened the survival of not just human beings but also all other living organisms. The number of living species has decreased, a large number are threatened, and many are even extinct. Human beings too, are suffering from various health problems. Today India is one of the top 10 industrialized countries in the world and the ever-increasing pollution levels in its environment are affecting all living organisms. People around the world are enjoying economic growth at the cost of 'quality of human life'. So the need of the hour is to save our environment by following a suitable developmental policy. This necessitates the knowledge of our environment, its components and the different issues affecting the environment.

Education for environmental awareness is required not only for environmental scientists, engineers, policymakers or NGOs, but also for every one of us. Only environmental study can make us conscious and careful about the environment. Environmental education is aimed at developing environmental ethics in people. It teaches them the importance of conservation of life and biodiversity of the environment. **Environmental study** also teaches people to understand their role in the environment and learn to live with limited natural resources so as to avoid future disasters. The casual attitude of human beings towards the environment and its conservation is the root cause of all environmental problems.

Therefore, proper education and public awareness are necessary to tackle environmental problems. Towards this end, **environmental studies** will provide sufficient knowledge about the philosophy, genesis and

consequences of local and global environmental problems and the necessary knowledge for their abatement and control. Thus, for a sustainable environment and for the survival of the present and future generations, environmental education is necessary.

1.2 The Need for Public Awareness

As soon as man acquired the ability to generate fire in the Paleolithic era, the environment began to get adversely affected. In the Iron Age, man discovered the use of tools which he used to grind metals. This led to minor accumulations of discarded materials which were easily dispersed. The vast extent of natural vegetation made up for the minuscule pollution that the activities of man would have caused to air and water.

The end of the Middle Ages saw a growth in population, concentrated within cities. This created areas that suffered from contamination. Air pollution began to be recognized as a health issue, while polluted water in densely populated areas served as a conducive medium for transmission of diseases.

The earliest known writings concerned with pollution were Arabic medical treatises written between the 9th and 13th centuries. They covered a number of pollution related subjects, such as the contamination of air, water and soil. The writings mentioned about the mishandling of solid waste, and environmental assessments of certain localities.

In 1272, King Edward I of England banned the burning of sea coal in London by proclamation. This was done after its smoke had become a problem. Every person who disobeyed the law was executed. However, during the industrial revolution, air pollution continued to be a problem there. London also recorded one of the earliest cases of water quality problems with the Great Stink on the Thames of 1858. This led to the construction of the London sewerage system soon afterward.

These instances prove that environmental consciousness has been prevalent among people since ancient times. All religions too preach environmental conservation. However, rapid industrialization and several developmental projects have disturbed the ecological balance in such a way that the survival of life on earth has been seriously threatened. People are now suffering from contamination in gases, liquids, and solids as well as phase transfer of contaminants.

The London Smog, Los Angeles Smog, Bhopal Gas Tragedy, Chernobyl disaster, DDT Episode, Minamata disease, Itai-Itai disease, oil pollution, and solid waste disposal are all examples of the far reaching effects of pollution. The repeated occurrence of such accidents has drawn the attention of the world towards environmental awareness. The union government of India has also enacted a comprehensive Environment (Protection) Act, 1986 to safeguard and protect our environment. This shows the increased awareness in both the government and the common people about the environment.

Environmental protection requires both preventive and curative measures. This can be achieved through a policy of sustainable development. The increased awareness was also reflected at the Earth Summit at Rio de Janeiro in June 1992, where Agenda-21, a Global Action Plan was adopted with the aim of integrating environmental imperatives with developmental aspirations.

The Indian government has taken some important steps towards environmental protection. For example, no development work can progress without a proper Environmental Impact Assessment (EIA). The government has from time to time set up State Pollution Control Boards for controlling pollution from different industries, and established Green Benches in different High Courts of India. In addition to the government's responsibility, social awareness is a most important factor for conservation and regeneration of environmental resources.

Social awareness can encourage people to use biogas and solar energy or non-conventional energy instead of fossil fuels. An informed citizen can raise his voice against using unfit air and water resources and force the responsible agencies (industry) to treat the particular resources before they are released into the natural environment. Global environmental issues like ozone layer depletion, climatic changes, acid rain,

and biodiversity losses are the result of rapid industrialization, different developmental projects, and fast urbanization leading to deforestation among other problems. In India, we also have problems of solid waste disposal, sanitation, and air and water pollution.

However, the major problems of developing countries like India are their poverty and illiteracy. Moreover, decisions about different environment management programmes are taken by the elite groups of society. People, who cannot fulfil their daily needs, cannot think about the environment. This ignorance and illiteracy has generated a number of misconceptions and superstitions such as:

- (i) Diseases are caused by God's curse and demons. They have nothing to do with infection or hygiene.
- (ii) Famines, floods, droughts are God's punishment for the sins of men and have no relationship with environmental management.
- (iii) Rainfall is dependent on God's grace.
- (iv) Cities are polluted not villages. (In reality, villages are more polluted due to the burning of fossil fuels [such as cow.dung cakes and wood] while cities are polluted due to industrial effluents and automobiles exhaust).
- (v) Deforestation is the result of the industrial revolution but growing urbanization is not responsible for this.

To get rid of these superstitions and misconceptions about nature, environmental awareness is imperative in India. This awareness ensures that everyone, from an environment conscious farmer in the village to a policy planner in the government knows about the consequences of his activities on nature. Agricultural production can get a boost only if people know the patterns of land use, of water resources and irrigation, if they use fertilizers and pesticides judiciously and above all if they are aware of the renewable resources of energy.

In the industrial sector too, people should know about the impact of industrial activity on nature. The demand for more food from more or less the same land has resulted in the use of science and technology for the development of industry. Industries such as fertilizers, chemicals, and pesticides and industries that manufacture different components of the same have come into existence. While it is true that this industrial revolution supports the green revolution, the fact remains that it is responsible for the speedy consumption and pollution of natural resources. However, industrialization is likely to be less of a health hazard if growing green belts around industrial areas, and maintaining wild life sanctuaries and national parks are made compulsory. This will help in maintaining the ecological balance and result in higher agricultural productivity.

Industrial development, along with urbanization, can generate health problems. However, awareness about healthy living conditions and the consequences of ill-health will automatically make people conscious about their health and hygienic living conditions.

From these discussions, we can conclude that public awareness is a must for sustainable environmental development.

1.3 Environment and its Components

Environment: The environment encompasses virtually everything that surrounds an organism in a holistic ecological approach.

Out of all the nine planets, meteorites, and satellites in our solar system, the earth is the only planet known to support life. Life on earth experiences different types of surroundings. These surroundings may be living or non-living. Each living organism constantly interacts with its surroundings and adapts to it. These surroundings are our environment. The physical environment, which consists of soil, air, water, sunlight among others, provides favourable conditions for the existence and growth of different life forms. Living beings constitute the biological environment.

Both the physical and the biological environments closely interact with each other to form a stable self-perpetuating system. Everything that influences an organism and its living processes from outside is collectively known as 'environment.' The living component of the environment is known as the biotic component and the non-living component (things) as the abiotic component. Hence, the term 'environment' can be defined as the sum total of living and non-living components, their influences and events surrounding an organism.

No organism can live without interacting with the environment. Animals depend on green plants for food and oxygen, whereas plants depend on animals for pollination of flowers and dispersal of seed or fruit. Therefore, for the survival of human civilization, the protection of its environment is very important. For this, some fundamental principles have to be followed:

- (i) Maintenance of biodiversity.
- (ii) Maintenance of all gaseous and material cycles and interdependence of living organisms among themselves and with abiotic environments.
- (iii) Maintenance of ecological order and natural balance, which depend on the food chain relationship, sustainable productivity and biotic interaction.

These principles were known to early human beings, who lived in harmony with nature. However, in the course of evolution, man has developed a new type of environment, the man-made environment. A large chunk of the imbalance in nature is caused by this man-made environment. This man-made imbalance has forced us to put restraints on the use of natural resources.

1.3.1 Segments of the Environment

Our environment can be broadly classified into natural and man-made environment.

Natural Environment

Each living organism has a specific surrounding with which it interacts and to which it is adapted. This surrounding is its natural environment. The natural environment can be broadly classified into two categories.

- (i) The non-living or abiotic component, which includes:
 - (a) Climatic factors such as solar radiation, temperature, wind, water current, and rainfall.
 - (b) Physical factors such as light, air, pressure and geomagnetism.
 - (c) Clinical factors such as oxygen, carbon dioxide, acidity, salinity, availability of inorganic nutrients and so on.
- (ii) Living or biotic factors such as microbes, plants, animals and all living organisms and their organic by-products.

Man-made Environment

With the development of science and technology, human beings have begun to alter the environment to suit their requirements. This has led to the evolution of a man-made environment. Hence, the environment—which earlier comprised just air, land, and water—now also includes crop fields, urban areas, industrial space, vehicles, power plants, telecommunications, and much more.

The basic needs of human beings are shelter, followed by potable water and sanitation. The houses of people in the city are made of brick and cement and not of mud with a thatched roof. The resources for urban housing are transported from rural areas in cars, buses, trucks and trains, which consume a large amount of energy and pollute the atmosphere. The ever-increasing demand for comfort has resulted in the migration of people from villages to urban areas. Urban areas, on the other hand, are unable to meet the demands of basic civic amenities. As a result, they are becoming hovels of dirt, disease and crime. This has resulted in the

paradox of concrete skyscrapers coexisting with slums and the atmosphere being polluted with exhaust from traffic, factories and domestic smoke.



Figure 1.1 Park: Man-made Environment

Social Environment

Human beings are social animals. This is why the socio-cultural environment plays an important role in their lives. The social environment is formed by the network of social institutions, which include political, religious and economic institutions. Family is one of the basic institutions of the social environment. It is here that human beings perform various activities, including socialization of children, and the transference of cultural heritage and morals from one generation to the next. Groups of families form communities which are classified according to their occupation, religious faith, and other parameters.

Environment of the Earth

The environment of the earth has been studied with various modern and scientific instruments, such as satellites, rockets, and balloons. The results indicate that the environment of our planet comprises mainly of three segments. These are:

- (i) Air or atmosphere
- (ii) Water or hydrosphere
- (iii) Land or lithosphere

Atmosphere: The earth's atmosphere is an envelope of gases extending up to 2000 feet above the ground level. The gases include nitrogen, oxygen, argon, carbon dioxide, traces of carbon monoxide, oxides of nitrogen, sulphur and hydrocarbon, and very little amount of water vapour. The concentration of these gases decreases with an increase in altitude. The bulk of these gases are present within the atmospheric band that stretches up to 5 km above the earth.

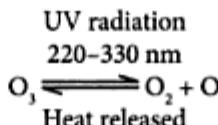
The atmosphere protects the earth's biosphere by absorbing a major portion of the electromagnetic radiation and most of the cosmic rays. The atmosphere also absorbs infra-red radiation and thereby maintains the temperature of the earth at life sustaining levels. It also helps nature in maintaining its balance through different biochemical cycles, namely the oxygen cycle, nitrogen cycle, carbon cycle, and hydrological cycle.

However, scientific advancements of the modern man are polluting this protective blanket by dumping waste materials like carbon emissions and smoke into the atmosphere.

Layers of the atmosphere: The earth's atmosphere is broadly divided into five regions:

Troposphere: The lower portion of the atmosphere is called troposphere. It contains 70 per cent of the atmosphere's mass. The density of the troposphere decreases with altitude. The air near ground level is heated by the radiation from the earth, but the temperature decreases uniformly with altitude. This decrease of temperature with altitude is known as lapse rate. The cold layer (56°C) at the top of the troposphere, which shows a temperature inversion, that is, a negative to positive lapse rate, is known as tropopause. The global energy flow, resulting from the difference in heating and cooling rates between the equator and the poles, makes the troposphere a turbulent region.

Stratosphere: Above the troposphere, the quiescent layer with a positive lapse rate is known as the stratosphere. Very little water vapour is found here. The ozone molecule, present in the layer, absorbs the Sun's ultraviolet radiation, and decomposes into oxygen molecules and an oxygen atom. When these particles combine, energy is released as heat radiation which causes a positive lapse rate.



The stratosphere not only shields life on earth from the injurious effects of the Sun's ultraviolet rays, it also supplies heat for separating the quiescent stratosphere from the turbulent troposphere. The stratopause separates the stratosphere from the mesosphere.

Mesosphere: In the mesosphere, the lapse rate is negative again due to low levels of ozone that absorbs ultraviolet radiation. The mesopause separates the mesosphere from the thermosphere.

Thermosphere: In thermosphere, the positive lapse rate raises the temperature to a maximum of about 1200°C . Hence, atmospheric gases such as oxygen and nitric oxide split into atoms, which absorb solar radiation in the far ultraviolet region and then undergo ionization. That is why this layer is called ionosphere.

Exosphere: The uppermost layer of the atmosphere is called the exosphere. This extends up to a height of about 1600 km and gives way to interplanetary space. It is extremely rarefied. The upper layers of the atmosphere are continuously pressing down on the lower ones. Hence, the density of the lower layers is higher and it decreases as we move upwards.

Having described the layers of the atmosphere, now we shall deal with the hydrosphere which forms the second of the three main segments of the earth's environment.

Hydrosphere: All types of water resources, namely the oceans, seas, rivers, lakes, ponds, polar ice caps, streams, glaciers, ground water, and water vapour are collectively known as the hydrosphere. Water being the elixir of life, all ancient civilizations were linked to major sources of water, be it the Egyptian Civilization along the River Nile, the Indus Valley Civilization along the River Indus, or the Mesopotamian Civilization between the Tigris and Euphrates rivers.

The hydrosphere is an important part of the earth's surface. About 70 per cent of the earth's surface is covered with water. The northern hemisphere is dominated by land surface, while the southern hemisphere is almost entirely occupied by water bodies (oceans).

Water is the most essential component of life for all living organisms. The hydrosphere is of immense importance to mankind. It maintains the availability of fresh water to the biosphere through the hydrological cycle. A major component of the hydrological cycle is the ocean. The oceans are great reservoirs of water and they also regulate carbon dioxide. The oceans can absorb more carbon dioxide than the atmosphere. Oceans

are also the storehouses of vast resources, such as, water, salt, minerals, and food. The oceans are the largest sinks (pollutant receptor) of the planet. Thus, the role of the hydrosphere is critical to the sustenance of life on the earth. This is underlined by the fact that life on the earth originated under marine conditions.

Lithosphere: The lithosphere is the outermost mantle of the rocks constituting the earth's crust. Rocks are subjected to continuous physical, chemical and biological (attack by lichens) weathering. Plants grow and decay on the soil covering the rocks. Soil is the major component of the lithosphere. The organic matter in soil is decomposed by micro-organisms, thus forming biomass. This biomass is mixed with the soil fauna. The major components of soil are air, water, minerals, and inorganic matter obtained from weathering of the parent rock. Organic matter of soil comprises plant biomass that is in various stages of decay. It also includes a high population of bacteria, fungi and animals such as nematodes, micro arthropods, termites and earthworms. Soil plays a vital role in supplying nutrients to the plant kingdom. The nutrient supply power of soil is a measure of its fertility, while the productivity of the soil is a function of crop and animal biomass per unit area. Thus, the yield of crop depends solely on soil and crop management strategies. Therefore, this dynamic balance between the soil and the crop needs to be preserved to maintain the interrelationship between the two.

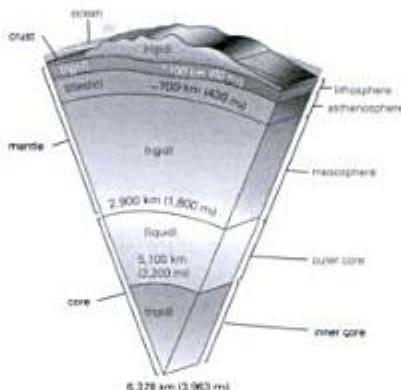


Figure 1.2 Different Layers of Lithosphere

The lithosphere has a thickness ranging from 64 to 96 km. The uppermost part of the lithosphere (the earth's crust) is rich in silica (Si) and aluminium (Al) and is therefore, known as the SiAl layer. The continents belong to the SiAl layer and are made up of granite rocks.

The zone next to the SiAl is rich in silica (Si) and magnesium (Mg). This layer is formed of basalt rocks and constitutes the ocean floors. The basalt rocks are heavier than the rocks formed by SiAl layer. Below the SiMg layer, the density of the layers increases with depth. Such differences in density cause the constituting layers to float, one over the other. The continents are basically large segments or 'plates' of the earth's crust floating on top of this heavier layer. These floating plates are responsible for the tectonic movement of the earth's surface during an earthquake.

Below the lithosphere lies the mantle, which has a thickness of about 2400 km. The upper part of the mantle is known as the Asthenosphere, while the lower mantle is called the Mesosphere. The interior-most part of the earth is called the Core, which consists of minerals such as iron, nickel, cobalt mixed with sulphur, and silica. The thickness of the core extends to about 3500 km. The Core consists of the outer core and the inner core. The inner core appears to be solid, while the outer core is molten and metallic. The temperature of the core ranges between 5000 and 5500°C.

The direct interaction between the atmosphere, hydrosphere and lithosphere for millions of years has made the earth suitable for life and has formed the biosphere.

ESSAY TYPE QUESTIONS

1. Write a note on the fundamentals of the environment.
 2. Why are environmental studies necessary for all?
 3. How will environmental awareness support sustainable development of the environment?
 4. Why is environmental awareness mandatory for all the people in the society?
 5. Write a short note on the environment of the earth.
 6. Define atmosphere with special emphasis on its layers.
 7. What is the Lapse Rate? Describe its nature in different layers of the atmosphere, giving reasons.
-

SHORT-ANSWER TYPE QUESTIONS

1. Define the term 'environment'.
 2. What are the different components of the environment?
 3. Write three major objectives of environmental studies.
 4. Name the fundamental principles of the environment.
 5. Why is social awareness about the environment necessary?
 6. Why is the man-made environment different from the natural environment?
 7. What is meant by hydrosphere?
 8. Define the term 'lithosphere'.
 9. Write a short note on biosphere.
 10. Write a short note on the movement of tectonic plates.
-

MULTIPLE CHOICE QUESTIONS

1. Environmental Study is a subject that encompasses
 - (a) all branches of science only.
 - (b) only social science.
 - (c) branches of science and social science.
 - (d) all branches of science, arts and social science.
2. The unlimited exploitation of nature by human being resulted in
 - (a) environmental pollution.
 - (b) health problems.
 - (c) decrease in biodiversity.
 - (d) All of the above.

3. The primary objective of Environmental Study is to
 - (a) generate an environment-friendly mindset among all classes of people.
 - (b) enjoy economic growth at the cost of quality of human life.
 - (c) realize the value of biodiversity by increased environmental ethics among all classes of people.
 - (d) get a holistic view for the sustenance of life on the earth on an infinite scale.
4. The importance of environment
 - (a) was only recognized in recent years.
 - (b) was recognized in ancient time.
 - (c) was not recognized in ancient time.
 - (d) None of the above.
5. The conservation of natural resources
 - (a) was not encouraged in ancient India.
 - (b) was encouraged in ancient India.
 - (c) is recently being used in India.
 - (d) None of these.
6. Life on earth constantly interacts with its surroundings called environments which essentially consists of
 - (a) biotic components only.
 - (b) only abiotic components.
 - (c) both biotic and abiotic components.
 - (d) None of these.
7. The conservation of environment requires
 - (a) maintenance of biodiversity.
 - (b) maintenance of gaseous and material cycles.
 - (c) maintenance of ecological order and natural balance.
 - (d) All of these.
8. Biosphere is made up of
 - (a) atmosphere and lithosphere.
 - (b) hydrosphere and atmosphere.
 - (c) lithosphere and hydrosphere.
 - (d) lithosphere, hydrosphere and atmosphere.
9. The segment/segments of the environment, responsible for conservation of radiant energy to chemical energy (carbohydrate) through photosynthesis is/are
 - (a) hydrosphere.
 - (b) lithosphere.
 - (c) atmosphere and lithosphere.
 - (d) biosphere.

10. The largest sink (pollutant receptor) of the planet is
 - (a) atmosphere.
 - (b) hydrosphere.
 - (c) lithosphere.
 - (d) biosphere.
11. Which of the following components of the earth has least pollutant-receptor capability?
 - (a) Atmosphere.
 - (b) Hydrosphere.
 - (c) Lithosphere.
 - (d) Biosphere.
12. Biosphere is the
 - (a) envelope of gases surrounding the earth.
 - (b) the outermost layer of earth's crust.
 - (c) the thin layer of organic matter containing all living things on the surface of the earth.
 - (d) None of the above.
13. The Earth Summit at Rio de Janeiro was held with the aim of integrating environmental imperatives with developmental aspirations in
 - (a) June 1972.
 - (b) December 1972.
 - (c) December 1993.
 - (d) June 1993.
14. The Global Action Plan adopted at Earth Summit held at Rio de Janeiro in June 1972 is also known as
 - (a) Agenda 20.
 - (b) Agenda 22.
 - (c) Agenda 23.
 - (d) Agenda 21.
15. Environmental degradation is due to
 - (a) rapid industrialization.
 - (b) onset of different developmental works.
 - (c) fast urbanization leading to deforestation.
 - (d) All of the above.

ANSWERS

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

Apart from these two types of resources, there are some natural resources that can be used continuously.

Water is one such natural resource. After using it for domestic, industrial and other purposes, water can be recycled and used repeatedly.

2.1.1 Natural Resources and Associated Problems

Due to the continuous increase in population, demand for natural resources has also increased. This is catalysed by scientific progress followed by technological advancement for the utilization of natural resources. These two factors are responsible for the overutilization of natural resources, particularly non-renewable resources.

Overexploitation of non-renewable resources will not only lead to economic imbalance between developed and developing countries, but also to environmental and ecological imbalance between nature and population growth. Today, developed countries are consuming up to 50 per cent more natural resources than developing countries and they are producing more than 75 per cent of global waste and Greenhouse gases. Overutilization of underground water has resulted in the depletion of the groundwater table and the drying of streams and rivers and that is why conservation of natural resources is very important for the sustenance of life on earth. The health of the ecosystem is an indicator of the quality of human life. For the maintenance of a quality ecosystem, it is necessary to have:

- (i) control over the use of natural resources;
- (ii) protection of the environment from pollution;
- (iii) conservation of biodiversity and
- (iv) controlled growth of human population.

2.2 Forest Resources

Forests are an important renewable natural resource. In fact, a major part of the earth's lithosphere is covered with forests. Forests which can be considered the centers of biodiversity are complex and they constantly change their environment to house wildlife, trees, shrubs, fauna and flora, microscopic soil organisms and much more. They are not only valuable from the economic, historical, cultural, recreational, aesthetic and religious points of view, but their resources too, are extremely important for mankind. Wood is still a source of fuel for one-third of the human population. While tribals living in and around forests directly depend on forests for their lives and livelihood, the remaining human population also indirectly depends on forests.

Houses, furniture, paper, clothes, dyes, gums, resins and lac are largely made from wood and other forest products. In fact, the photosynthesis of plants regulates the amount of the oxygen we inhale and the carbon dioxide we exhale into the atmosphere.

Harvesting, collecting and processing important forest products like timber generate employment. So does ecotourism including bird watching, outdoor adventures, nature study activities, hiking, camping and so on. Some of the uses of forest resources are listed in Table 2.1.

Table 2.1 Useful Functions of Forest Resources

Function	Types of Benefits
Centre of biodiversity	<ul style="list-style-type: none"> • Forests provide home to unique plants, animals and wildlife.
Watershed protection	<ul style="list-style-type: none"> • Forests reduce the pace of surface run-off of water and thus encourage its percolation. • They stop soil erosion and prevent flash floods. • They help in preventing droughts through prolonged, gradual run-off.

Function	Types of Benefits
Clean water	<ul style="list-style-type: none"> • Trees cleanse the ground because their root system filters water and clears toxins and impurities. • Trees facilitate storing of clean water and maintain the availability of water during summer, when it is most needed.
Land erosion control	<ul style="list-style-type: none"> • Forests hold soil by preventing rain from directly washing away soil. • They reinforce soil to avoid landslides in mountainous areas. • They maintain soil nutrients and structures.
Clean air	<ul style="list-style-type: none"> • Trees absorb solar energy and cool and refresh the air we breathe. • They maintain local climatic conditions. • They absorb carbon dioxide and harmful pollutants and release oxygen into the atmosphere.
Economic benefits	<ul style="list-style-type: none"> • Timber production and other wood-based industries constitute an important part of the national economy. • Forests supply wood for fuel. • They supply fodder for cattle. • Trees provide fibres for weaving baskets, ropes, nets, strings and so on. • Sericulture for silk, apiculture for honey and pollinating crops, medicinal plants for medicines are economically beneficial. • Forests provide shelter for tribal people and building materials for others. • They provide foods, fruits, nuts, flowers, fish and meat. • Forests facilitate ecotourism.
Environment benefits	<ul style="list-style-type: none"> • Trees provide clean air. • They provide clean water. • They prevent global climate change through absorption of carbon dioxide, a leading Greenhouse gas, to produce wood and leaf matter, known as carbon sequestration. • They help in controlling soil erosion. • They absorb noise and reduce stress. • They provide an aesthetic place for mental peace and healing qualities. • They help in controlling climate and heat island effects resulting from city environments. • Forests also help in global recycling of water, carbon and nitrogen.

The overexploitation of forest resources has resulted in a serious threat to mankind. This was the cause of heated discussions at the Earth Summit in June 1972 at Rio de Janeiro on the topic of global transition to sustainable forest management. Forest cover all over the world is depleting fast, thus endangering rare varieties of plants, wildlife and other natural resources. India itself is losing about 15 lakh hectares of good forest land annually, which is estimated to be equivalent to the country's total consumption of oil, coal and electricity.

2.3 Deforestation

A demographic explosion has resulted in a steadily increasing demand for food and fodder for livestock, firewood and industrial raw materials. Croplands are being increasingly used for non-agricultural purposes due to rapid urbanization and industrialization; new croplands are being created by clearing forests. This wanton cutting of trees including lopping, felling, removal of forest litter, browsing, grazing and so on is known as deforestation.

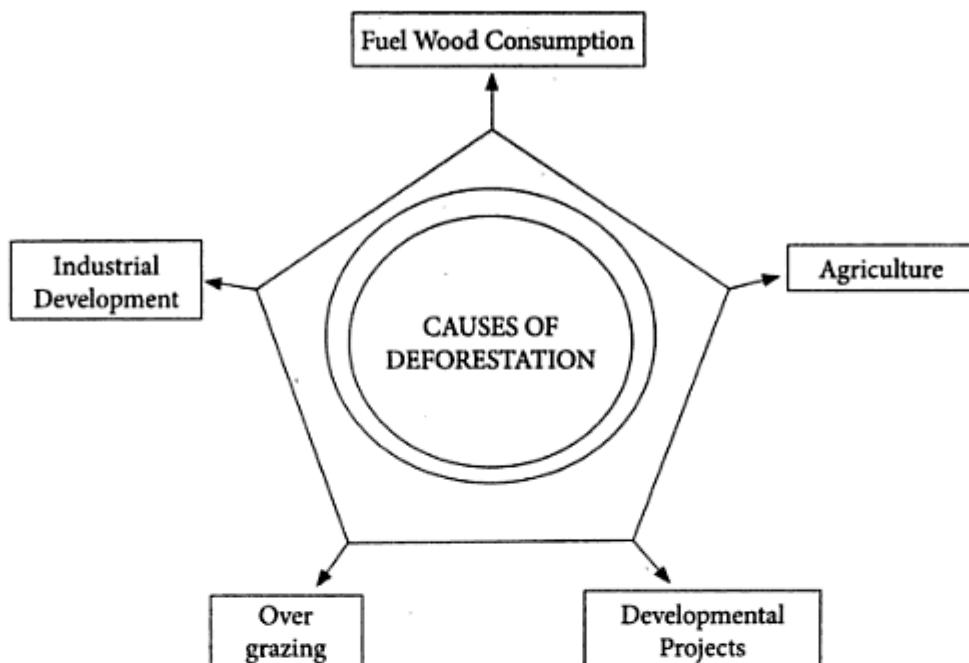


Figure 2.1 Causes of Deforestation

The main causes of deforestation (as shown in Fig. 2.1) are:

- (i) Fuel wood consumption;
- (ii) Agriculture;
- (iii) Industrial development;
- (iv) Overgrazing and
- (v) Developmental projects.

The causes of deforestation are fairly complex and range from a competitive global economy, compelling international debt payment by developing countries, population growth and consequent increase in demands of agriculture to commercial logging, a shift to a cash crop economy and developmental projects like dams and mines.

Around the world, most of the forests are cleared for grazing cattle, planting crops and so on. Poor farmers cut down village common lands and forests, burn down trees to make the land fit for agriculture. Commercial logging of timber also enables the local tribals to enter the forests thus causing further deforestation.

In developing countries, cash crops like rubber, tobacco, oil and palm need marginal lands which results in the clearing of rain forests or dense forests. Mining, industrialization, dams and hydroelectric projects also cause deforestation. The fact is that rich mineral resources are available mostly in forest areas. Similarly, steep embankments of river valleys suitable for dams, hydro and irrigation projects are usually fertile lands sustaining dense forests and biodiversity. Therefore, the construction of dams for hydroelectric projects or irrigation usually submerges forests, displacing tribals from their natural habitat.

The massive cutting of trees for firewood, developmental projects, raw materials for industry and/or other various reasons have resulted in the shrinking of forest cover thereby adversely affecting precious wildlife. A recent study shows that 600 different species of animals have become extinct on earth over the last 2,000 years.

2.5 Mineral Resources

A mineral is a natural substance that forms in the earth's crust over a period of millions of years. It has a definite chemical composition and identifiable physical properties. On extraction from the earth's interior, with or without technological and economic benefits, minerals can be used as raw materials for industries or for domestic purposes. They are of the following categories:

- (i) metals and metallic compounds like iron, aluminum, zinc, copper, manganese, limestone, gypsum and dolomite;
- (ii) rare earth metals such as uranium and niobium;
- (iii) non-metals such as silica;
- (iv) building materials such as granite, marble and mica;
- (v) gems such as diamonds, rubies and emeralds;
- (vi) noble metals such as gold, silver and platinum and
- (vii) fossil fuels such as oil, gas and coal.

Some of these minerals are ores. An ore is a mineral or combination of minerals from which a useful substance such as a metal can be extracted and used to manufacture a useful product. For example, hematite and magnetite are ores used for steel manufacture; bauxite is an ore used for aluminum extraction and rutile is used for the manufacture of titanium.

2.5.1 Mining

The process of extraction of these underground minerals is known as mining. Mining operations follow four phases:

- (i) Prospecting: Searching for the mineral.
- (ii) Exploration: Assessing the size, shape, locations, qualities and economic value of the deposits.
- (iii) Development: Preparing for the extraction of the mineral
- (iv) Exploitation: Extracting the mineral from the mines.

Two types of procedures are followed for mining: Opencast or open-pit mining and deep or shaft mining. Of the two, an appropriate method is selected to get maximum yield at minimum cost and one that provides least danger to the mining personnel.

Mine Safety: Open-pit (surface) mining is always less hazardous than underground or shaft mining and metal mining is safer than coal mining. Since these processes are used when mining is done on an industrial scale, it is undoubtedly a hazardous task. During the process, mining personnel are posed with dangers such as roof felling, insufficient ventilation, release of poisonous gases such as methane (specially in coal mines), flooding and radiation and also long term effects like lung diseases (black lung disease or pneumoconiosis) and bronchitis.

Environmental Problems: Mining also causes irreparable environmental damage. During the prospecting and exploration phases, modern sophisticated and heavy machineries are used by geologists, mining engineers, geochemists, geophysicists and others. Such activities increase access to remote forest areas and disturb the local habitat. The most significant degradation of the natural environment occurs during the next two phases of mining, that is, development, exploitation and also long after exploitation.

Some of the adverse effects of mining on forests and the environment are:

- (i) Minerals are non-renewable natural resources. Their unplanned extraction and exploitation poses a threat to raw material resources for future generations.

- (ii) Disposal of the waste which is generated during the process of mining is a problem as it causes land, soil and water pollution.
- (iii) Land erosion which is the transportation of fine soil particles carried away by water and deposited in the tailing dam causes a problem as it leads to sedimentation.
- (iv) Mining causes damage to forest cover as well as felling of trees.
- (v) Dust generated during mining causes air pollution, which in turn causes respiratory problems and asphyxia of plants and trees.
- (vi) A large quantity of timber is used in underground mining.
- (vii) A lot of water is used in hydro-metallurgical the beneficiation of minerals and the discharge of the same, contaminates water.
- (viii) Movement of heavy machinery used during mining and the process of blasting causes heavy noise pollution.
- (ix) Mining causes large disturbances to the environment adversely affecting terrestrial habitats.
- (x) Some of the adverse social impacts of mining include:
 - (a) Loss of land of local people.
 - (b) Impact on health.
 - (c) Destruction of forms of community subsistence and life.
 - (d) Alteration of social relationships and social disintegration.

Mineral Resources of India

India has a large number of economically useful minerals. About 25 per cent of the world's known mineral reserves are found in India. The availability of various ores and minerals in India is given in Table 2.3.

Table 2.3 Mineral Resources of India

Minerals	Main sources	Other available sources	Remarks
Iron ore	Orissa, Jharkhand	Madhya Pradesh, Maharashtra, Chhattisgarh, Karnataka, Goa, Tamil Nadu, Himachal Pradesh	2nd largest reserve after Brazil.
Coal	Orissa, Jharkhand, West Bengal,	Chhattisgarh, Maharashtra, Tamil Nadu	
Manganese	Madhya Pradesh, Maharashtra	Orissa, Jharkhand	2nd largest reserve after Russia.
Chromites	Orissa, Jharkhand,	Andhra Pradesh, Karnataka,	
Bauxite	Orissa, Jharkhand, Maharashtra	Tamil Nadu, Karnataka	India produces 75 per cent of the world's total production.
Mica	Bihar, Andhra Pradesh, Rajasthan		
Gypsum	Tamil Nadu, Rajasthan		
Nickel	Orissa		
Ilmenite	Kerala		

Minerals	Main sources	Other available sources	Remarks
Silmanite	Madhya Pradesh, Meghalaya		
Copper	Andhra Pradesh, Jharkhand, Rajasthan, Sikkim, Karnataka		
Gold	Andhra Pradesh, Karnataka		
Diamond	Madhya Pradesh,		
Uranium, rare earths	Jharkhand		
Petroleum	Assam, Gujarat, Maharashtra	Tripura, West Bengal, Punjab, Himachal Pradesh Andaman & Nicobar Islands	

CASE STUDY

1. Two-thirds of India's iron ore reserves lie in Orissa and Jharkhand. Due to the growth of the steel industry worldwide, many international steel players have been attracted to the iron ore reserves in these two states and have been coming to Orissa and Jharkhand to mine iron ore reserves and, if possible, to export the ore. They also sign memoranda of understanding, promising to set up steel plants in the states. For example, POSCO signed an agreement with the Orissa Government to set up a Rs 53,000 crore steel plant with a capacity of 12 million tonnes per annum. They want to export iron ore to Brazil also. Similarly Arcelor Mittal, the number one steel maker in the world and Tata also signed agreements with the Jharkhand Government to set up steel plants with a capacity of 10 million tonnes each per annum at an estimated investment of Rs 42,000 crore and Rs 39,000 crore, respectively.

Arcelor Mittal had to withdraw their proposal of right to export iron ore before signing the agreement. If all these recent developments materialize, the states of Orissa and Jharkhand will be leaders in the industrial and economic map of India.

2. A classic example of the local population's right to mineral resources leading to the birth of a new state is Bougainville Island which is a part of Papua New Guinea. On May 17, 1990

Bougainville Island spread across an area of 10,000 sq km with a population of about 1,50,000 people, declared itself an independent nation. The island was a part of Solomon Islands under British Rule till 1899. Then, it was a part of New Guinea under German rule till 1914. In 1947, Australian Papua merged with Guinea and came under Australian administration under the United Nations (UN) trusteeship. Papua New Guinea (PNG) became independent on September 6, 1975. Bougainville's CRA (Conzinc Rio-Tinto Australia) copper mine started its operations in 1972 and accounted for 40 per cent of PNG's export and 20 per cent of government revenue.

Bougainville Island leaders wanted independence from PNG since the 1960s and submitted their demand to the UN's Decolonization Committee. Displacement, environmental pollution and inadequate compensation made Bougainville Islanders fight against the PNG administration which ultimately culminated in the closure of the PANGUA mine in May 1989. After almost a decade of ethno-nationalist conflicts, which started with the Bougainville Revolutionary Army's demand for independence and PNG's resistance and oppression; Bougainville Island headed towards peace in 1997–1998 due to international intervention.

10. Write a note on the conflicts over water around us.
11. Write briefly about the mineral resources of India.
12. Give a clear picture of the present-day world food problem.
13. Write a few lines on global food security in the near future.
14. Explain in detail the impact of overexploitation of productive land on the world food problem.
15. Describe the impact of modern agricultural practice on the environment.
16. Write a few lines on the growing energy needs of the present day urban people.
17. What are the main causes of soil erosion and how can it be prevented?
18. How does land degradation occur? Explain.
19. What is conservation of natural resources? Explain the role of an individual for the same.
20. Write a note on equitable use of resources required for a sustainable lifestyle.
21. Write a paragraph on the interaction between women and the forest.
22. Write short notes on the following:
 - (i) Tidal energy.
 - (ii) Geothermal energy.
 - (iii) Dendrothermal energy.
 - (iv) Wind energy.
 - (v) Biomass energy.
23. Write short notes on:
 - (i) Agro Forestry.
 - (ii) Desertification.
 - (iii) Formation of Bougainville Island State.

SHORT-ANSWER TYPE QUESTIONS

1. What is the importance of forest resources?
2. What is the importance of land resources on earth?
3. What type of environmental degradation occurs due to extensive use of water resources?
4. What is the future threat to the availability of fresh water on earth?
5. What are the major control measures of soil erosion?
6. Write short notes on:
 - (i) *Chipko Movement*.
 - (ii) *Narmada Bachao Andolan*.
 - (iii) Cauvery Water Dispute.
 - (iv) Krishna-Godavari Water Dispute.
7. What is food security?
8. Write a short note on the effects of modern agriculture on the world food problem.
9. Distinguish between renewable and non-renewable sources of energy with suitable examples.

10. Distinguish between nuclear fission and nuclear fusion.
11. 'Large hydel projects are ecologically disruptive.' Discuss the statement.
12. Write a short note on the classification of energy resources.
13. What is fossil fuel and what are the harmful effects of the combustion of fossil fuel.
14. Write a short note on Ocean Thermal Energy Conversion technology (OTEC).
15. Write a few lines describing the generation of energy from urban waste or municipal waste.

MULTIPLE CHOICE QUESTIONS

1. Which of the following is not a renewable resource?
 - (a) Coal
 - (b) Wind power
 - (c) Geothermal Energy
 - (d) Dendrothermal Energy
2. The main causes of deforestation are
 - (a) overgrazing and agriculture.
 - (b) industry and other developmental projects.
 - (c) timber extraction.
 - (d) All of the above.
3. Which of the following methods of timber extraction cause minimum environmental damage?
 - (a) Clear felling.
 - (b) Handlogging.
 - (c) Selective logging.
 - (d) Reduced-impact logging.
4. Forest is responsible for
 - (a) watershed protection.
 - (b) land erosion control.
 - (c) providing economic and environmental benefits.
 - (d) All of the above.
5. The main purpose of dam construction is
 - (a) irrigation.
 - (b) flood control.
 - (c) hydroelectricity.
 - (d) provide water to industry.
6. A sudden uncontrolled descent of a mass of earth under the force of gravity is called
 - (a) soil erosion.
 - (b) mining.

- (c) landslide.
(d) earthquake.
7. The heat of the interior of the earth present at the volcanic regions, geysers or hot springs is called
(a) geothermal energy.
(b) dendrothermal energy.
(c) nuclear energy.
(d) wind energy.
8. _____ is the perpetual source of energy.
(a) Nuclear reactors
(b) Hydropower
(c) Solar energy
(d) None of the above
9. The least quality of coal with 95 per cent carbon content and only 5 per cent volatile matter is
(a) lignite coal.
(b) anthracite coal.
(c) bituminous coal.
(d) peat coal.
10. All sources of water such as the oceans, lakes, rivers and underground water together constitute:
(a) Hydrosphere.
(b) Atmosphere.
(c) Lithosphere.
(d) Biosphere.
11. Famine is mainly the result of
(a) deforestation.
(b) overuse of surface water.
(c) a prolonged drought.
(d) All of the above.
12. Prospecting, exploration, development and exploitation are the four phases of
(a) mining.
(b) urbanization.
(c) deforestation.
(d) industrialization.
13. Burning of biomass produces
(a) thermal energy.
(b) bioenergy.
(c) wind energy.
(d) hydropower.

Keeping in mind Myers' definition of hotspots, biologists have identified areas of high endemism with species richness and labelled them as hotspots. Hotspots are defined as the localized concentration of biodiversity, and are in need of sincere conservation action. Conservation International has identified 25 terrestrial biodiversity hotspots around the world for conservation.

The identified hotspots around the world are:

- (i) Tropical Andes,
- (ii) Meso-American forests,
- (iii) Caribbean,
- (iv) Brazil's Atlantic forests,
- (v) Choco Darien/Western Ecuador,
- (vi) Brazil's Cerrado,
- (vii) Central Chile,
- (viii) California Floristic Province,
- (ix) Madagascar,
- (x) Eastern Arc and coastal forests of Tanzania/Kenya,
- (xi) Western African forest,
- (xii) Cape Floristic Province (South Africa),
- (xiii) Succulent Karoo,
- (xiv) Mediterranean Basin,
- (xv) Caucasus,
- (xvi) Sunderland,
- (xvii) Wallace (Eastern Indonesia),
- (xviii) Philippines,
- (xix) Indo-Burma (Eastern Himalayas),
- (xx) South-Central China,
- (xxi) Western Ghats of India and the Island of Sri Lanka,
- (xxii) South-West Australia,
- (xxiii) New Caledonia,
- (xxiv) New Zealand and
- (xxv) Polynesia and Micronesia Island complex including Hawaii.

A recent global study conducted over four years, by nearly 400 scientists and other experts has identified nine new hotspots; bringing the total to 34. These new hotspots are home to 75 per cent of the world's most threatened mammals, birds and amphibians. Originally, these hotspots covered 16 per cent of the earth's surface which has now reduced to 2.3 per cent due to human encroachment and habitat destruction.

The nine new hotspots are:

- (i) East Melanesian Island,
- (ii) Madrean Pine-Oak Woodland on the US-Mexico border,
- (iii) Japan,
- (iv) Horn of Africa,

- (v) Irano-Anatolian region of Iran and Turkey,
- (vi) Mountains of Central Asia,
- (vii) Maputaland-Pondoland-Albany in southern Africa (parts of Mozambique, South Africa and Swaziland),
- (viii) Himalayan region and
- (ix) Eastern Afro-Montana along the eastern edge of Africa from Saudi Arabia to Zimbabwe.

However, World Wildlife Fund (WWF) replaced the biodiversity concept that Myers had devised in 1977 with the 'Global 200' Strategy in 1998. Global 200 expands the conservation priorities to 233 eco-regions, comprising 19 terrestrial, freshwater and marine major habitats thereby covering major biodiversities of the planet.

4.2 India—A Megadiversity Nation

India has a rich heritage of forests, wetlands and marine areas, which range from the temperate forest to coastal land and tropical rain forest to the alpine region. This richness makes it one of the 12 megadiversity nations of the world.

As per the statistics of the Ministry of Environment and Forest, India accounts for 7.31 per cent of the total fauna, and 10.88 per cent of the total flora of the world. It has different biogeographic zones and 25 biotic provinces and also hosts mega fauna such as rhinoceros, tigers, elephants and so on. Table 4.3 gives a clearer picture of the percentage and ranking of India's biodiversity.

Table 4.3 Comparison between the number of species in India and the World and Percentage and Ranking of India

GROUP	Number of species in		percentage of species of India with respect to the global total	India's ranking in the world
	INDIA	WORLD		
Mammals	350	4,629	7.6	8th
Birds	1,224	9,702	12.6	8th
Reptiles	408	6,550	6.2	5th
Amphibians	197	4,522	4.4	15th
Angiosperm	15,000	25,000	6.0	15th
Total Plant Species	45,000			
Butterflies and Moths	13,000			
Total Insects	50,000			
Fishes	2,546	21,730	11.7	

Of the 75.23 million hectares of forest in India, 40.61 million hectares are classified as reserved and 21.51 million hectares as protected area. This includes over 40 wildlife sanctuaries and 70 national parks spread across 1,40,000 sq km. The remaining 13.11 million hectare forest area is maintained as unclassified. Marine protected area covers 2,76,042 hectares, supporting economically valuable ecosystems such as mangroves, estuaries, lagoons and coral reefs.

Over 70 million years ago, India was formed when a giant continent split up, resulting in the formation of Gondwanaland and the southern land mass. India was attached to Africa, Australia and Antarctica. Subsequently, due to tectonic movements, India shifted northward to converge with the northern Eurasian continent across the Equator. When the intervening Tethys Sea started drying up, plants and animals that evolved in Europe and the Far East began migrating to India.

Subsequently, the Himalayas grew to form a natural barrier in the north, along with the three seas – Arabian Sea, Bay of Bengal and the Indian Ocean – in the south.

Some of the other prominent features of India as a megadiversity nation are its three important biomes: tropical humid forests, tropical dry deciduous forests and the arid or semi-arid deserts.

India has 25 hotspots mainly in the Western Ghats and the Eastern Himalayas. It ranks seventh in its contribution to world agriculture. India has more than 34,000 cereals and 22,000 pulses in its gene bank.

4.2.1 Endangered and Endemic Species of India

Natural and anthropogenic causes have always remained a great threat to biodiversity. Developmental works are only accelerating habitat loss and pushing wildlife (both fauna and flora) towards extinction (1,000 to 10,000 per year). Based on this, the International Union for Conservation of Nature and Natural Resources (IUCN) has categorized wild flora and fauna into eight categories. The list containing these categories is known as the Red List. These categories are: extinct, extinct in wild, critically endangered, endangered, vulnerable, lower-risk, data-deficient and not evaluated. This data, recorded in the Red Data Book is updated every four years. According to the Red Data Book, a threatened species is one whose natural habitat is disturbed. As a result, the species population decreases rapidly and there is a fear that the species may become extinct. As per Schedule I, of the Wildlife (Protection) Act, 1972 of India, a species is considered endangered when its number reduces to a critical level. The species is then provided with legal protection. So far, 38 species of birds, 18 of amphibians and reptiles and 81 species of mammals have been labelled endangered in India.

A species faces a very high risk of extinction in the wild when there is a suspected reduction of at least 50 per cent over the last 10 years or three generations, whichever is longer, based on the following:

- (a) direct observation,
- (b) an index of abundance appropriate for the species,
- (c) a decline in area of occupancy,
- (d) extent of occupancy and/or quantity of habitat,
- (e) actual potential levels of exploitation and the effects of introduced species,
- (f) hybridization,
- (g) pathogens,
- (h) pollutants,
- (i) competition or parasites.

Endangered Species of India

Andaman Shrew (*Crocidura andamanensis*) (endemic to India)

Andaman Spiny Shrew (*Crocidura hispida*) (endemic to India)

Asian Elephant (*Elephas maximus*)

Banteng (*Bos javanicus*)

Blue Whale (*Balaenoptera musculus*)

Capped Leaf Monkey (*Trachypithecus pileatus*)

Chiru (Tibetan Antelope) (*Pantholops hodgsonii*)

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