ISBN: 978-93-88901-15-4

Environmental Science

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Bhumi Publishing India
First Edition: 2020

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(ISBN: 978-93-88901-15-4)

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Bhumi Publishing

2020

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ISBN: 978-93-88901-15-4

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Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: www.bhumipublishing.com

E-mail: bhumipublishing@gmail.com

Book Available online at:

https://www.bhumipublishing.com/books/

Preface to the first edition

Perhaps no other nation has moved so quickly to a situation of satisfaction in creating environmental alertness by pervading the pro-environmental ideas into proper curricular methods as done by India over the previous few years. This has certainly been quicker by the decision of the honourable Supreme Court of India that environmental education must be compulsory at every stage in our education procedures. For all who have struggled to implement a variety of environment education programs for schools, institutes and colleges this is indeed a welcome change. The book has been written as per syllabus framed by University Grants Commission, India for the undergraduate students at various universities, institutes and colleges. The main aim of this book is to make our current and future generations' environment conscious. The textbook content exposes the students to the basic concepts of environment so that they can escalate their efforts to preserve and save our environment. Sustainable use of our natural resources will not only support the present generation but also help the future generations in meeting their requirements. This can be accomplished by dispersal of environmental awareness.

Various issues like depleting natural resources, change in socioeconomic status, increasing human population, increasing pollution and different associated diseases demands environmental awareness at root level. This book is written to bring about a responsiveness and awareness of a variety of environmental issues. It tries to produce a behavioural change in society and pro-environmental attitude that is essential for making sustainable lifestyles. The book will also be crucial to competitive examinations aspirants, planners, policy makers and educationalists who are interested in environment and its related issues. Conservation can be best brought about through creating a love for nature. If every college student is exposed to the miracles of the Indian wilderness, a new ethic towards conservation will arise.

Although extreme care has been taken to incorporate newest information yet the writer seeks constructive suggestions and criticism to improve the quality of textbook. The author thanks to publisher and editorial team for giving this textbook an attractive get up.

- Dr. Jyoti Rani

ACKNOWLEDGEMENT

Writing a book is a challenging venture and requires an immense energy and active mutual contribution of many people. Without the support, encouragement and guidance of numerous people, this task would not have been completed. So, I would like to express gratitude and thanks to all the people who contributed in completion of this book. Foremost, I am very thankful to almighty "God" for his special blessings on me and for providing me the ability and protection to accomplish this work. I am very grateful towards my husband Ankur Sangwan and all my in-laws and family members without their support and motivating attitude I am not able to move ahead for the completion of the manuscript. A special thanks to my little angel Vasundhara Chaudhary, I am proud of many things in my life, but nothing can beat the feeling of being your mother. You are my inspiration for completion of this work.

My acknowledgements will be incomplete if I do not express my whole-hearted gratitude to my Ph. D. supervisor Prof. Manish Kapoor, the way you guided me in writing my thesis made me worthy of writing this book and even everything which I would write in future. I would also like to thank the publisher Bhumi Publishing, India and their team of for all their support and timely publication of this book.

- **Dr. Jyoti Rani**

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CHAPTER 1 Introduction to Environmental Science

1.1 Environment

The objects, conditions and circumstances by which we are surrounded is known as environment. It is complex of biotic, chemical and physical factors (such as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine their form and survival. We can also say thatenvironment is composed of the aggregate of social and cultural conditions that influence the life of an individual or community.

1.2 Environmental science

Environmental science is a multidisciplinary field which helps in studying the environment and in dealing the problemsor issues that affects standards and conditions of living organisms. It is a multidisciplinary because it integrates biological and information sciences (including biology, ecology, limnology, geology, physical geography, plant science, zoology, physics, oceanography, chemistry, botany, information technology and atmospheric science). It brings about the gratefulness of natural environment and impacts of human activities on its integrity.

1.3 Scope of environmental science

Environment is not a single subject. It is an integration of several subjects that include both Science and Social Studies. To understand all the different aspects of our environment we need to understand biology, chemistry, physics, geography, resource management, economics and population issues. Thus, the scope of environmental studies is extremely wide and covers some aspects of nearly every major discipline.

If we study about around the area in which we live, we found that our surroundings were originally a natural landscape such as a forest, a river, a mountain, a desert, or a combination of these elements. Most of us live in landscapes that have been heavily modified by human beings, in villages, towns or cities. Human being living cities get their food supplyfrom surrounding villages and these villages are further dependent on natural landscapes such as forests, grasslands, rivers, seashores, for resources such as water for agriculture, fuel wood, fodder and fish. For our daily basic needs, we use water, breathe air, use resources from which food is made

and are depends on the community of living plants, animals and other living organism which form a web of life. We and everything around us which we can feed, touch, see, smell, hear or taste and surrounding too effect or lives. Thus, our daily lives are linked with our surroundings and inevitably affects them.

We are completely depending on nature; we cannot continue to live without protecting theearth's environmental resources. Thus, most traditions refer to our environment as 'Mother Nature' and most traditional societies have learned that respecting nature is vital for their livelihoods. This has led to many cultural practices that helped traditional societies protect and preserve their natural resources. Respect for nature and all living creatures is not new to India. All our traditions are based on these values. Emperor Ashoka's edict in Fourth Century BC proclaimed that all forms of life are important for our well-being.

Over the past 200 years however, modern societies began to believe that easy answers to the question of producing more resources could be provided by means of technological innovations. For example, though growing more food by using fertilizers and pesticides, developing better strains of domestic animals and crops, irrigating farmland through mega dams and developing industry, led to rapid economic growth. The ill effects of this type of development, led to environmental degradation.

The industrial development and intensive means of agriculture fulfils all the demands of our increasingly consumer-oriented society, butconsume large amounts of non-renewable natural resources such as water, minerals, petroleum products, wood, *etc*. Non-renewable resources, are those which will be exhausted in the future if we continue the use of these resourceswithout thinking about our future generation. This thoughtless use of these resources maybe called as wastage of these crucial resources.

Renewable resources, such as timber and water, are those which can be regenerated by natural processes such as regrowth and rainfall respectively. But these too will be depleted if we continue to use them faster than nature can replace them. For example, if the removal of timber and firewood from forests isfaster than the regrowth and regeneration of trees, it cannot replenish the supply. Loss of forest cover not only depletes the resources, such as timber and other non-wood products, but also affect our water resources because an intact natural forest acts like a sponge which holds water and releases it slowly.

Deforestation leads to floods in the monsoon and to dry rivers once the rains are over.Such multiple effects on the environment resulting from routine human activities must be appreciated by each one of us, if we need the resources in the long-term.Our natural resources can be compared with money in a bank. If we use it rapidly, the capital will be reduced to zero.

On the other hand, if we use only the interest, it can sustain us over the longer term. This is called sustainable utilisation or development.

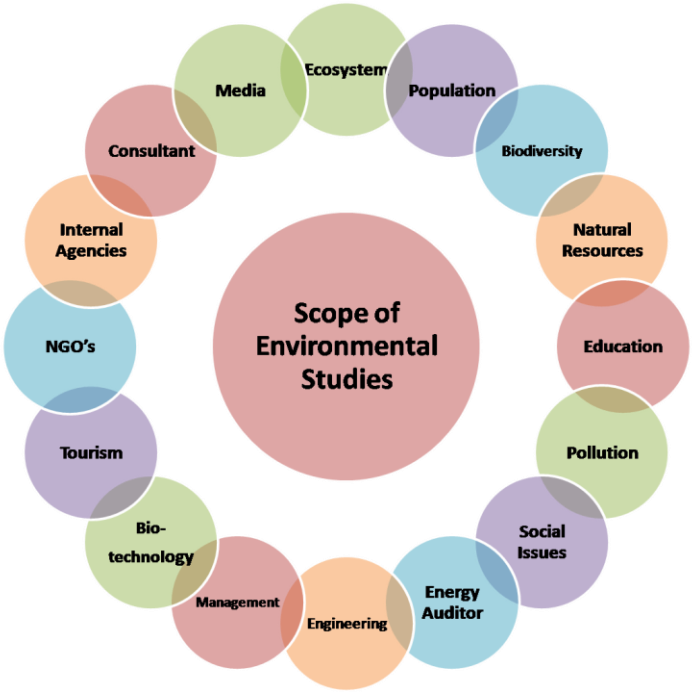


Figure 1.1: Scope of environmental studies

1.4 Multidisciplinary nature of environmental studies

Environmental science is a systematic study of the environment. It is concerned with the different environmental issues that affect all of the living beings. We need some vivid information and ideas to minimize environmental problems. It pursues new and valid knowledge concerning natural resources and surroundings. In other words, environmental science is an applied science as it integrates the knowledge of laws, social science, economic impacts and natural science.

- Environmental law provides permissible measure for guard and organization of environment.
- Economics, sociology and management contribution in environment science is related to different developing activities.
- Nanotechnology and civil engineering make novel way of practical resolution for environmental pollution and waste control.
- Statistics and information technology areeffective approaches for environmental modelling.

- Zoology, botany, microbiology and biotechnology are essential for protection and conservation of endangered flora and fauna by checking environment quality, pollution as well as developing green and eco-friendly technology.

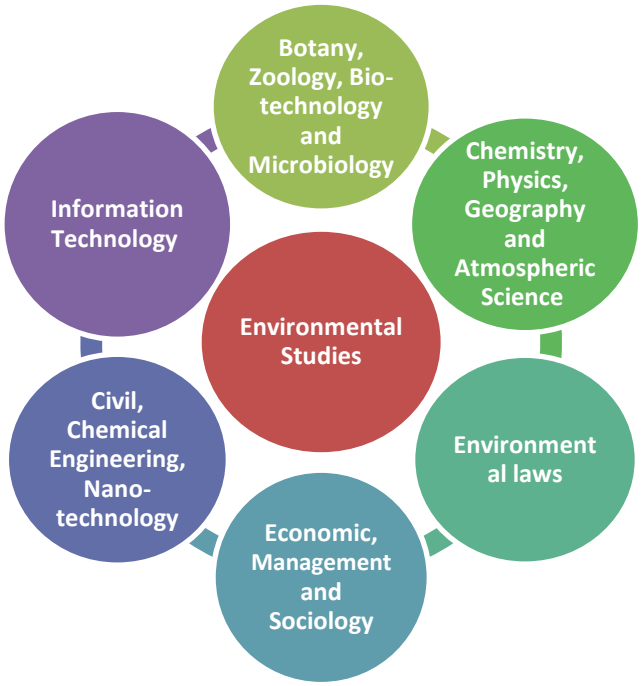


Figure 1.2 Multidisciplinary nature of environmental studies

1.5 Importance of environmental science

We live in a world in which natural resources are limited. Water, air, soil, minerals, oil and the products we get from forests, grasslands, oceans, agriculture and livestock are all a part of our life support systems. Without them, life itself would be impossible. As we keep increasing in numbers consequently the quantity of resources is depleting.This situation can only be improved if each of us begins to take actions in our daily lives that will help preserve our environmental resources. We cannot expect Governments alone to manage the safeguarding of the environment, nor can we expect other people to prevent environmental damage. We need to do it ourselves. It is a responsibility that each of us must take on as one's own.

1.5.1 Local *vs* global importance of environment

Environment is one of the essential subjects that is really required at global as well as local level. Some issues like ozone layer depletion, biodiversity loss, climate change, global warming, depletion of energy resources etc. affect the world's human population and for that we have to think and plan globally. However, few environmental issues which are localized

important like effect of hydro project and mining in a particular area, lake and river pollution, disposal and management of solid waste, water logging, fluorosis problems, arsenic contamination of ground water, soil erosion, salinization etc., we have to think and act locally.

For public awareness about environmental related problems and issues, it is very crucial to first make every one environmentally educated.

Environment calendar

Anti-tobacco day	31 May
International day for Natural Disaster reduction	13 October
International Day for Biological Diversity	29 December
International Biodiversity day	22 May
Earth Day	22 April
Green consumer day	28 September
Ozone week	16-23 September
World forest day	21 march
World farm Animals day	2 October
World car free day	22 September
World consumer day	28 September
World conservation Day	24 October
World day for water	22 march
World environment day	5 June
World habitat day	3 October
World population day	11 July
World ocean day	8 June
World meteorological day	23 march
World wetland day	2 February

1.5.2 Individualistic importance of environment

Environmental studies are essential because it deals with some basic needs and problems of each living individual life, like hygienic living conditions, clean drinking water, fresh air, health food, fertile soil and sustainable growth. If we want to live on a safe, secure, clean and healthy environment for a long time and wants to hand over a safe environment to our next generations, it is required to understand the basics of environment.

1.6 Public awareness is the only solution

As the natural resources are continuously diminishing and our environment is being degraded by human interference, it is obvious that something needs to be done. The environment degradation we all should take part to change our daily habits. To prevent our environment by our practices is economically more suitable than cleaning up the environment once it is damaged. Individually we can play anessential role in environment management. We can reduce waste of natural resources and we can act as watchdogs to inform the Government about sources that lead to pollution and degradation of our environment.

This can only be made possible through mass awareness. Mass media such as newspapers, radio, television, strongly influence public opinion. Nowadays a more effective way of communication and making an information viral is social media. However, someone has to bring this about. If each of us feel strongly about the environment, the press and media will add to our efforts. Politicians in a democracy always respond positively to a strong publicly supported movement. Thus, if we all start working in support of conservation, politicians will make green policies. We are living on spaceship earth with a limited supply of resources. Each of us is responsible for spreading this message to as many people as possible.

Suggested activities for the students:

- Join a group to study the nature, such as WWFI or BNHS, or another environment group.
- Begin reading newspaper articles and periodicals such as ‘Down to Earth’, WWF-I newsletter, BNHS Hornbill, Sanctuary magazine, *etc*. they will help you learn more about our environment. There are also several environmental websites.
- Put effort towards conserving resources by taking up the cause of environmental issues during discussions with friends and relatives Practice and promote issues such as saving paper, saving water, reducing use of plastics, practicing the 3Rs principle of reduce, reuse, recycle, and proper waste disposal.
- Join local movements that support activities such as saving trees in your area, go on nature treks, recycle waste, buy environment friendly products.
- Practice and promote good civic sense such as no spitting, no tobacco chewing, no throwing garbage on the road, no smoking in public places, no urinating or defecating in public places.
- Take part in events organised on World Environment Day, Wildlife Week, *etc*.

- Visit a National Park or Sanctuary, or spend time in whatever nature you have near your home.

1.7 Components of environment

Environment is a composite of different components, mainly it is sum of all external factors either chemical, physical and biotic factors which affect living organism without becoming their internal part. Environmental conditions that surround and affect the living organisms are called environmental factors. These environmental factors are divided into 2 categories: 1) Abiotic or physical factors and 2) Biotic or biological factors.

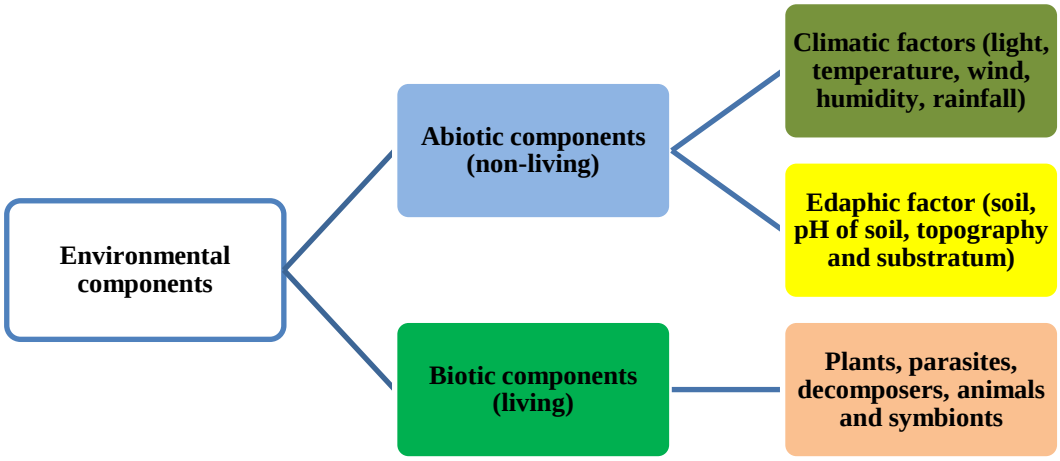


Figure 1.3: Components of environment

Abiotic components

These components comprise non-living factors of environment and further divided into two categories:

1. Climatic factors
2. Edaphic factors

Climatic factors

Climate is average weather of a particular area. Light, temperature and rainfall are important factors which determine the climate of an area.

Light

Light is a central and vital climatic factor. It is essential for different physiological processes in both plant and animals. Light is defined as the visible part of electromagnetic

spectrum of solar radiant energy. Wavelength of electromagnetic radiation lies in the range 400-700nm, thisis known as visible spectrum and photosynthetic active region (PAR).

Effect of light on plants

1) **Photoperiodism:** It is the introductionof flowering in plants in response to the critical length of light period.
2) **Photosynthesis**: Light enhance the photosynthesis by enhancing chloroplast synthesis, photolysis of water and photophosphorylation.
3) In some plants like viscum the seed to start germinate, only in the presence of light. These types of seeds are called positive photoblastic seeds.
4) Light induce phototropism in plants
5) Light stimulate opening and closing of stomata.

Effect of light on animals

1) Intensity of light induces biosynthesis of pigments in animals.
2) Breeding behaviour in animals is also affected by photoperiod.
3) Colour vision of primates and birds is due to presence of different colour in light.

Temperature

It is degree of hotness and coldness of a place and area. It also affects all activities of living organism. Mainly organisms survive in temperature range of 0-60°C except few Archaebacteria.

Effect of temperature on plants

1) In some plants the flowering initiate due to high temperature treatment is known as thermoperiodism.
2) Vernalization is the induction of flowering and seed germination in plants due to low temperature.
3) High temperature also enhances the rate of transpiration.

Effect of temperature on animals

1) Temperature enhances the metabolic rate by increasing enzymatic activities.
2) Various animals regulate body temperature either by hibernation and thermal migration.
3) Temperature also enhances the activity of gametic tissue in some insects like blowfly and grasshopper.

Water

Water is also significant factor for metabolic activities of all living organism like photosynthesis in plants and digestion of complex food compounds in other living beings. It acts as a good solvent and ioniser. Plants and animals living in water bodies are known as hydrophyte and aquatic animal's respectively.Aquatic plants and animals have some specific adaptation to protect themselves in water. For example:

Hydrophytes possess some adaptation to grow well in water habit:

1) Leaves of submerged hydrophytic plants are highly dissected or ribbon like.
2) They have aerenchyma cavities to store air. Examples of these types of plants are *Trapa, Eichhorniaetc*.
3) They have rootpockets to store air of*Wilffia, Pistia* and water hyacinth.
4) Leaf with long petiole found in hydrophytes to adapt them the depth of water, thus keeping the leaf lamina on the surface of water.

Aquatic animals have someadaption to survive in water like:

1) Presence of oily substances in the bone interspaces for lightness.
2) Osmoregulatory structure like nephridia in annelids, flame cells in planarians and kidney in vertebrates.
3) Streamlined body to decreases the resistance of water during swimming.
4) Swim bladder to maintain balance inside the water bodies.

Atmospheric gases

Table 1.1: Permanent composition gases of atmosphere

Gas	Formula	Percentage by volume
Nitrogen	N_2	78.08
Oxygen	O_2	20.95
Argon	Ar	0.93
Carbon dioxide	CO_2	0.036
Neon	Ne	0.002
Helium	He	0.0005
Krypto	Kr	0.001
Xenon	Xe	0.00009
Hydrogen	H_2	0.00005

1) **Nitrogen:** It forms 78.64% of the atmospheric air. It is fixed as nitrates and nitrites.
2) **Oxygen:** It forms 20.84% of the atmospheric air and used for aerobic respiration and oxidative hydrolysis of organic food.
3) **Carbondioxide:** It produced by respiration, combustion of fossil fuel and decomposition. It forms 0.03% of the atmospheric gases.

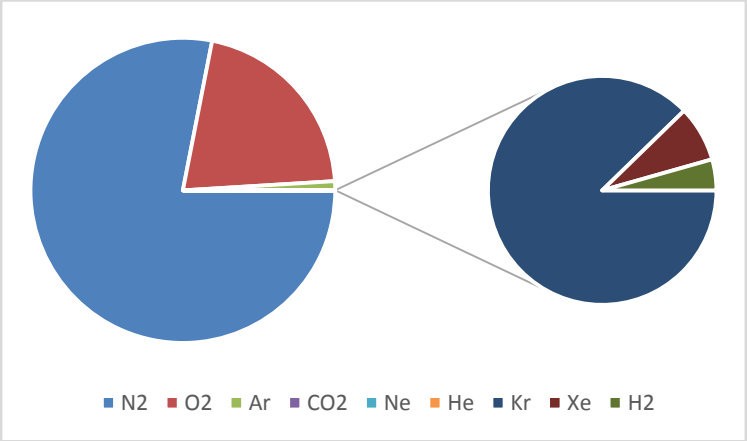


Figure 1.4: Gases composition and their percentage in volume in atmosphere

Edaphic factors

These are comprised by all those factors which are mainly concerned with composition and structure of soil. Soil is the upper most layer of earth crust. It is formed by rock weathering.

Soil composition

1) **Organic matter:** It forms approximate 7-10% of soil. It is made of either humus and litter. It is a good source of different kind of minerals for plants.
2) **Minerals:** It forms 50-60% of soil. It includes macro and micronutrients which are necessary for essential growth of plants.
3) **Soil air:** 25-30% of soil formed by air. This air is required for respiration of roots and soil fauna.
4) **Soil water:** It forms 15-25% of soil and act as a medium for nutrient absorption.

Soil profile

Four different types of layer present in soil are called horizon. They are placed one upon each other and this horizon arrangement is known as soil profile.

Table 1.2: Different soil horizons and their characters

Horizon	Characteristics
A-Horizon	Rich in minerals, humus rich, contain maximum biological activities and dark coloured
B-Horizon	Zone of minerals such as iron and aluminium deposit, dark coloured and contain coarse particle
C-Horizon	Rich in moisture, incompletely weathered rocks, low biological activities
D-Horizon	Unweather parental rock

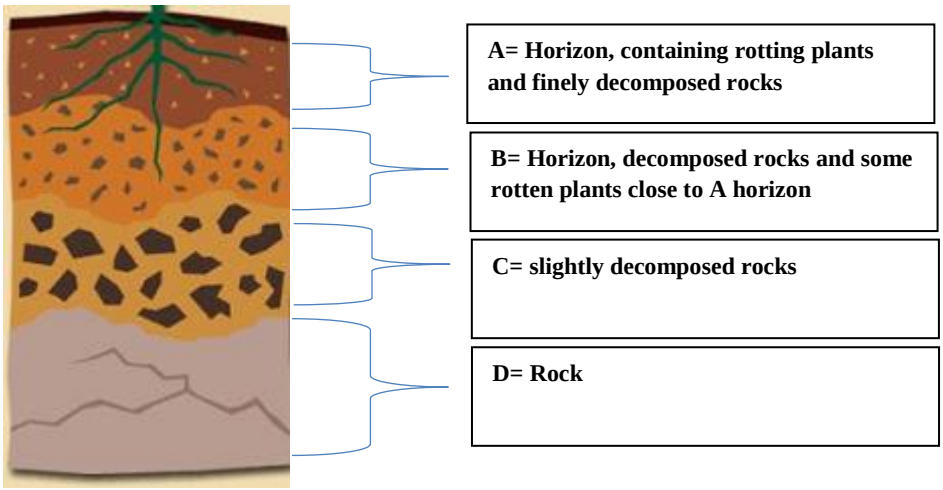


Figure 1.5: Showing basic horizon of soil

Functions of soil

1) It provides minerals, water to flora and fauna.
2) It acts as bedrock for growth of variety of organisms.
3) It provides essential conditions for decomposition of dead and decayed plants and animals.
4) It acts as store house for fossil fuel for man.

Exercise

Short answer type Questions

1. Define environment.
2. Define humus.
3. Mention the name of two component of environment.
4. Write the name of soil horizon in proper sequence.
5. Name the three main component of ecosystem.
6. What is the name of nature entities?
7. What is the atmospheric gases composition?
8. Define troposphere
9. What is soil profile?
10. Which are the main factors that decide the conditions of environment?

Long answer type questions

1. Describe different components of environment in detail.
2. Why we need environmental studies?
3. Discus the scope of environmental studies.
4. What is environment? Discuss its importance. Why there is a need of public awareness?
5. What do you understand by multi-disciplinary nature of environmental studies?
6. How do different disciplines contribute to environmental studies?
7. What are the steps taken by our government for environmental protection?

CHAPTER 2 Natural Resources

2.1 Natural Resources

Natural resources are essential components of environment. These are those substances which are generated by nature over the years. Man has been using these natural resources since the timesimmemorial. The eminence of these resources is varying. There are some resources which are reproduced from time to time by natural processes like flora and fauna on earth surface. These resources are inexhaustible and are called renewable resources. Water, wild life, aquatic life, forest, pastures and grasslands are some renewable resources. Some resources cannot be regenerated and they will be lost for forever. They are known as non-renewable resources. Minerals and petroleum resources are some examples of this type.

2.1.1 Types of natural resources

On the abundance and availability, natural resources are classified into two groups

1) **Exhaustible resources**: These are supposed to be completely exhausted once they are used by human.
2) **In-exhaustible resources**: These resources cannot be consumed completely by their use like sunlight, air, hydro-power and tidal power.

On the basis of their recycling further natural resources are divided into two groups:

1) **Renewable resources**: These natural resources can be regenerated with-in a specific period of time through natural processes. These are never ending resources like animals, trees, biomass *etc*.
2) **Non-renewable resources:** These resources cannot be regenerated again. Some examples are coal, petroleum and natural gases.

2.2 Increasing pressure on natural resources

Growing human population resulted into growing needs of man. With technological, industrial and scientific growth man started to consume natural resources at large levels. This may lead to a condition where exhaustible resources may come to an end in future. As a result, we would empty those natural resources which are assets for future generation. It is a matter of

great worry. There must be some pathway to balance the resource's utilization and population growth. Population growth rate in India has been highest in the last few decades and this shocking population growth has caused depletion of natural resources- water, forest, soil and energy.

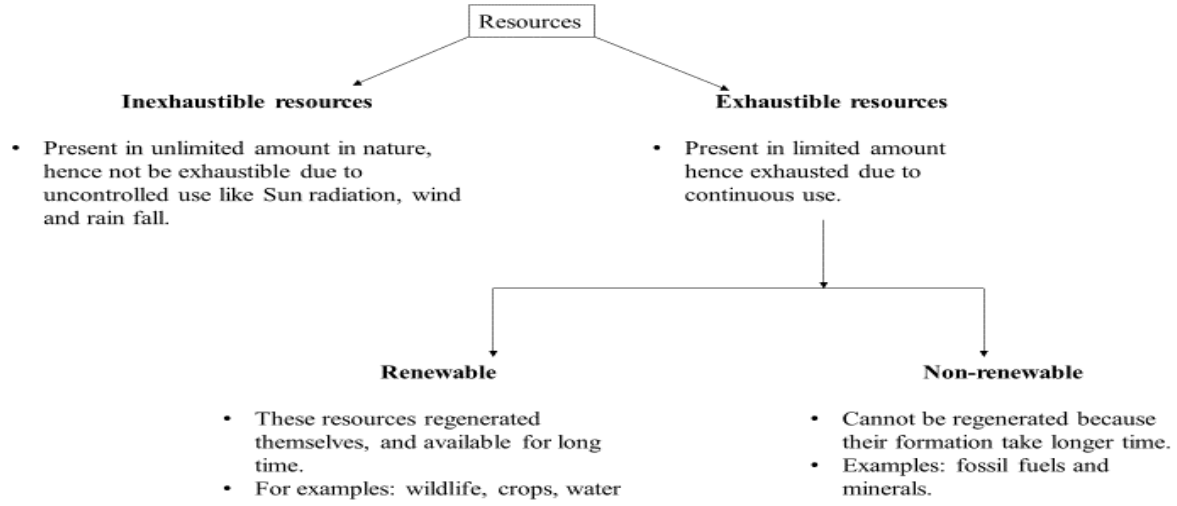


Figure 2.1: Types of natural resources

2.3 Natural resources and associated problems

2.3.1 The unequal consumption of natural resources

Now-a-days main chunk of resources is consumed by the developed countries. The consumption of resources per individual of the developed countries is up to 50 times greater than developing countries. Technologically advanced countries generate more than 75% of global greenhouse gases and industrial waste. Fossil fuels energy is also consumed more in developed countries. For example, the USA is having approximately 4% of the world's population but consumes about 25% of the world's resources.

2.3.2 Non-renewable resources

These are mineral deposits which have been formed in the earth's core from over millions of years. Non-renewable resources include fossil fuels, oil and coal,which if mined at the currentfrequency, will soon be entirely used up. The end products of fossil fuels may be the form of mechanical energy, thermal energy, different types of chemical compounds*etc*, which cannot be rebuilt as a resource.

2.3.3 Renewable resources

Though biological living and water resources are measuredas renewable, they are in fact renewable only within certain limits.

- Water resources are beingwasted and overused to such alevel that they locally run dry. Water sources are being so much polluted by industrial waste, chemicals and sewage that it is not possible to use the water for our necessities.
- Forests, once ruinedwould take approximately thousands of years to regrow into completelyestablished ecosystems with their full complement of species. If we continue overuse of forests,it can be said that they may behave like non-renewable resources.

2.4 Forest Resources

Forests offer an array of assistances to human societies above and beyond their essential roles as environmental controllers and habitat in natural ecosystems. Biotic community which is conquered by herbs, woody climbers and trees are known as a forest. There are no suitable statistics of forest cover in India. According to Central Forestry Commission, forest areais around 22.7% of the total land area. But the actual forest cover at present is verylow.

2.4.1 Uses of forests

On the basis of uses, forests can be divided into two parts:

1. Commercial uses
2. Ecological uses

Commercial uses:

Since from beginning of life on this planet people live as forest dwellers, they were depending upon forest for food, clothing, and shelter. Even today man depends on the forest for timber, paper, fuelwood, fodder and medicine. Forests provide a large number of other commercial products such as:

a) Fuel: Near about half of the cut timber is used as fuel for heating purposes in different industries.Wood is an important source of fuel for cooking in rural areas. Some of the wood is being transformed to charcoal and used for cooking.

b) Timber: Forest provide timber to human for making plyboards, ships, furniture, railway sleepers, bridges, building houses, doors, toys, windows and sports goods.Approximately 1500 species of trees are commercially used for timber.

c) Food and fodder: Forest provide food in the form of vegetables, fruits and tubers *etc*. and the fodder from the forest is asignificant source for grazing animals There are many varieties of herbs,shrubs, trees and grasses,which are nutritious for the cattle.

d) Paper: Tree pulp is commonly used forpaper making.Availability of paper upsurges the economy of the country.

e) **Other essentials but minor products:** Some other commercial products such as medicines, rubber, cane, floss, essential oils, resin and gums are provided by forests.

Ecological uses: Some of the essential ecological services provided by the forests are:

a) **Ecological Balance:** Forests maintain ecological balance by absorbing CO_2 and releasing O_2 by the plants.

b) **Increase of soil fertility:** The fallen leaves and branches of trees add humus to soil after their decomposition. Thus, forests help in maintaining and increasing the soil fertility.

c) **Soil conservation:** Forests play a critical role in soil conservation from wind and water erosion. Plant roots bind tightly with soil particles and prevent erosion from rain off water

d) **Effect on Climate:** Forests have a far-reaching effect on environment. They maintain the extremes of climate by dropping the temperature in summer and cold in winter. They also affect the amount of precipitation by dropping temperature of moisture loaded winds and increase the relative humidity of the air through the process of transpiration.

e) **Control on spread of desert:** soil particles are blown at a distance by winds in the deserts and are carried over long distances, thus resulting in the spread of deserts. The roots of plants bind the soil particles and do not allow their easy transportation by wind.

f) **Pollution control:** Plants have the capacity to absorb different types of toxic gases, greenhouse gases and noise.

g) **Wildlife Habitat:** Forestsare the home of the wildlife. Tropical rain forests cover only are said to be home of more than 50% of animal and plant species.

2.4.2 Over exploitation of forests

Humans have depended mainly on forests because of:

1) Explosion of human and livestock population.
2) Expansion of crop land and grazing land.
3) High requirement of food, medicine and shelter.
4) Large scale mining, road building and construction of river valley projects.

2.4.3 Deforestation

Deforestation is defined as cutting down of the tree from forests at large level by man for their use such as medicines, gum, resin, timber*etc*. Due to population overgrowth, the demand of these products also increased. According to National Forest Policy, we are having only 19.4% of our land covered by forests, we are still lagging behind the target of attaining 33% forest area. The loss of the forest cover also affects the biodiversity which in turn threaten people lives. Shrinking of the forests area generate other problems like soil flooding, soil erosion, disturb

water cycle, changes in the climatic conditions, and biodiversity loss. It is a renewable natural source which plays an essential role into national economy. At present, the tropical rain forests are the most delicate area, which are the victims of deforestation.

Indian Forest Statistics (2015)

Total Geographic area: 3,287,263 km^2

Total forest area: 678,333 km^2 (20.64% of total area)

Forest classes

Sr. No.	Category	Area (km^2)	Percentage
1	Very dense	51,285	1.56
2	Moderately dense	339,279	10.32
3	Open forest	287,769	8.76
4	Scrub forest	40,269	1.23

Source: India State of Forest Report, 2019

2.4.4 Major causes of deforestation

Although issues such as landlessness, poverty, unequal political power, insufficient knowledge are the main reasons of deforestation, but there are more specific reasons also. For example:

Over population:

Due to the population growth, the demand for food, shelter and cloth has also increased. Migration of landless people and urban people to lightly settled areas.

1) **Agricultural activities:** The conversion of forests into agricultural land is a big reason for deforestation. Due to overgrowing demand for food products, many trees are chopped down for crops and for cattle grazing. Over 40% of the forests are cleaned to obtain land and meet the needs of agriculture and wood.
2) **Over grazing:** Overgrazing by domestic animals convert the forests into pasture.
3) **Shifting cultivation:** When the plants and trees are cut down to cultivate crops, small farmers generally burn the tree trunk to release nutrients into soil which are essential for plant growth. When it rains, most of the nutrients are washed away. It leaves the soil much poorer in nutrients. The land can no longer support the growth of crops. Most of this type of activity is observed in tropical rain forests.
4) **Mining**: Minerals and metals extraction by excavating deep pits is additional cause of deforestation.

5) **Development of dams:** Dam construction caused the sinking of thousands of acres of forest.
6) **Forest fires:** Forest fires kill trees and even seeds and useful fauna of forests.
7) **Raw materials for industrial use:** Large scale deforestation is taking place because of increasing needs of railway lines, roads, buildings, and other industries.

2.4.5 Result of deforestation

1) **Increased greenhouse gas emissions:**Plants help to alleviate carbon dioxide and other greenhouse gas productions. It's assessed that deforestation is responsible for around 20% of greenhouse gas emissions.
2) **Acidic oceans:** The oceans are becoming more saline due to enlarged supply of carbon dioxide from burning of fossil fuels and deforestation.
3) **Biodiversity loss:** Asian elephant, giant pandas, orangutans and rhinos are just a few of hundreds of endangered species due to deforestation.
4) **Flooding and Erosion:** Without trees erosion of fertile soil often occurs and sweeps fertile layer of land into nearby rivers. Soil erosion also possess chemicals which will significantly decrease the quality of drinking water.
5) **Harmful effect on productivity:** Decrease in biotic potential of land is the consequence of overexploitation of natural resources, overgrazing and uncontrolled tree cutting.

2.4.6 Strategy to control deforestation

1) To protect treesGovernment should provide other subsidised sources of building materials, fuel, fodder to forest dwellers *etc*. so that they do not cut trees.
2) Approximately 10-20 years moratorium should be upheldon commercial tree feeling in delicate hilly regions.
3) Huge afforestation programmes should be led by people during moratorium.
4) Forest area around residential area *i.e*. community forest should be managed by local people.
5) Working plans should be changed into environmentally sound action plans based on scientific research.
6) Building up of information base should be taken up.
7) Involvement of masses and voluntary agencies should be assured.
8) There should be guarantee of shieldto standing forests.

2.5 Water resources

Water is vital because it is needed for existence of life. several uses of water include household, agricultural, industrial and environmental activities. Almost all of these uses need fresh water. Approximate 97% of the earth surface is covered by water. But only 2.5% of earth water is fresh, and more than two thirds of this is frozen in polar ice cap and glaciers. It is estimated that nearabout 70% of world-wide water has been used for irrigation.Most of the plants and animals have 60-70% of water in their cell. It is a marvellous resource due to some features:

1) Water is an excellent solvent for different nutrients.
2) It has a high vaporization heat.
3) It has the highest specific heat.
4) It exists as a liquid over a wide temperature range.
5) It exists as a solid over a wide range of temperature.

2.5.1 Significance of water

Water is vital because it is crucial to life on earth surface. Humans can only survive 3 to 4 days without water. Water is especially valuable for medicine, agriculture, human health and industry.

1) The human body is made up mostly of water,80 percent of the blood consists water. Water is necessary for every bodily function, including digestion and elimination.
2) It is the good solvent through which nutrients and minerals are transported from one part to other part of plants.
3) It acts as a good reactant in different metabolic reactions.
4) Metabolic and respiratory end product is water.
5) Water also maintains turgidity of cells.
6) Water is essential in photosynthesis and for production of oxygen.
7) Plant cell growth is mainly determined by water absorption.

2.5.2 Surface water sources

Different surface water sources with their features are as under:

1) Lakes and Ponds: Lakes are inland depressions which grip fresh water throughout the year. Ponds are permanent or temporary small shallow water bodies. Both these sources are minor but they are essential water sources. Water in these sources are more confirmed in quality as compared to stream and rivers.

2) Rivers and Streams: both of these are significant sources of water supply. Water quality is highly variable and mainly determined by weather condition, watershed, waste, disposal of sewage *etc*.
3) Artificial Reservoirs: artificial reservoirs are built by man across rivervalleys. It is easy to construct on narrow and deep valley. Water quality in reservoirs is similar to lake and pond.
4) Marine Water: Oceans contain near about 97% of global water which is inappropriate for human drinking due to high salinity. On average, seawater have a salinity of about 3.5%. It is highly costly to make this water drinkable. It can be made potable by different techniques such as demineralization and desalting.
5) The surface water is basically used for public supply, irrigation, industrial use, navigation *etc*. The main environmental problems linked with the surface water resources is the deprivation of these resources by the disposal of industrial and sewage waste without treatment.

2.5.3 Ground water resources

About 9.86% of the total fresh water is present in the form of groundwater. Till some time back, groundwater was thought to be very pure. Even groundwater aquifers have been detected to be dirty by leaching from sanitary landfills *etc*.Ground water is colourless, clearand harder than the surface water. Ground water quality usually uniform. It is frequently withdrawn for municipal, agriculturaland industrial use by operating water withdrawal wells. Wastage of water can create some major problems forenvironment and human humans. The significant effects of ground water wastage are:

1) Lowering of water table: Withdrawal of groundwater is done broadly in arid areas for irrigating. Although, it is not sensible to do extremewater removal as it would cause a loud decline in agricultural yield, due to dropping of water table.
2) Subsidence: When groundwater removal is more than itsrenewal rate, the sediments in the aquifer get compressed, and the phenomenon known as ground subsidence. Subsidence is linked with structural damage in buildings, fracture in pipes and tidal flooding.
3) Water Logging: When extreme irrigation is done with brackish water, it raises the water table which leads to salinity and water-logging problems.

2.6 Floods

In some part of India and Bangladesh flood causeenormous economicloss as well as loss of life. People of Bangladesh are familiar to moderate flooding even during monsoon and they use the flood water for rising paddy. Floods can occur in rivers when the flow rate exceeds the capacity of the river.

2.6.1 Causes of floods: The various causes of floods are as follows:

1) **Failure of hydraulic and other control structures:** breaking of a dam and other accidents can result in the entry of an enormous amount of water in an area.
2) **Blasting:** Flood causes landslides in the slopes of mountains and hills. It may result in the accidental blocking of stream and rivers.
3) **Construction of temporary dams:** This createan obstruction to the flow of a river or stream. Then itsoutcomes in water overflow.

2.6.2 Effects of floods:

The primary effects of flooding comprise:

- Loss of life.
- Agricultural lands are demolished due to crops being flooded in water. This causes a huge economic loss to farmers. It can lead to lacks of food both for humans and animals.
- Damage to buildings and other structures, including bridges, sewerage systems, roadways, and canals.
- Due to floodfresh water may combine with sewage water in the flood rises the risk of waterborne diseases.
- Damage to transport and roads make it obscure to mobilize aid to the affected areas.
- Economic loss because of a provisional decline in tourism, reconstruction costs, and food shortages which lead to price upsurge.
- Psychological damage to those affected, especially where serious injuries, deaths and loss of property take place.
- They cause decay in organic matter, which may lead to growth of infection-spreading germs.

2.6.3 Management and mitigation of floods:

Floods cause tremendous devastation of property and life. But there are some ways of defence against floods:

- Houses in the flood prone region should be built on elevated platforms. River banks should also be elevated.

- Administrative authorities should correctly map areas that are susceptible to flood
- Surrounding areas of rivers should be correctlymapped and prepared for floods.
- Houses should be protected against economic losses from floods.
- Sandbags placed around houses can protect property.
- Construction of dams to prevent against losses from floods. They control the water flow.
- Afforestation programs should be supported because depletion of forests is also a main cause of rise in the number of floods.
- Floods should be well forecasted and warnings systems should be in place.

2.7 Drought

Approximately 80% nations of the world are located in arid and semi-arid regions. During hot and dry weather periods, it is very common to find dry earth without even a single shed of water or wet areas. Drought conditions appear when there is less precipitation than evaporation. Therefore, drought is a natural process rising due to less rain than expected, thus defining the intricacies witnessed when the demands for water supply are higher than the available water.

2.7.1 Causes of droughts:

Some reasons of droughts are:

- Rainfall or precipitation deficiency: Droughts take place whenever there are lengthy periods of rainfall deficiency for a season or more.
- Over utilization of aquifers in the ground: industrial uses, irrigation and hydro-electric dams are some of the man activities that can meaningfully reduce the amount of water.
- Unplanned use of landis also an important factor that is responsible for drought.
- Deforestation and cutting down trees increase evaporation of water and diminishes the ability of the soil to hold water leading to increased susceptibility of desertification.

2.7.2 Control over droughts:

Droughts can be controlled by adopting the following ways:

- By opting for mixed cropping.
- By applying methods such as social forestry and wasteland development.
- By avoiding plantation of plants like Eucalyptus. It lowers the ground water because of heavy transpiration.
- Continuous observation of rainfall levels and comparisons with current usage levels can assist in preventing man made drought.

- Purification and reuse of sewage water.
- Rain water storage and harvesting from roofs or other suitable catchments.

2.8 Water conservation

2.8.1 Importance of water:

Almost all living organisms need water to stay alive. But human beings depend on water more than animals and plants. We need water for many other purposes such as:

- We need water for our day-to-day activities likewashing, bathing, cleaning, drinking *etc*.
- We use water for irrigation in fields.
- Almost all of the industries use water for heating, cleaning, cooling, generating electricity, as a raw material, *etc*.
- It also acts as a temperature regulator because of high specific heat. Therefore, water is an indispensable resource.

2.8.2 Need of water conservation

Total amount of water in hydrosphere is about 1.4 million cubic kilometres. About 97.5% ofit is ocean water. But it cannot be used by human beings. Therefore, only 2.5% of water is available for human use. This requires conservation of water.

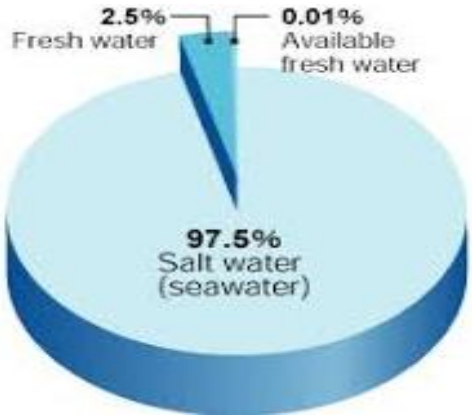


Figure 2.2: Composition of earth water

2.8.3 Steps for water conservation:

Water conservation means a watchful and economical use of water. We should need to conserve water as it is one of the most precious natural resource. Conservation of water can be done in the following ways:

- Use of effective watering systems in irrigation such as sprinklers and drip irrigation to decrease water consumption. Frequency and timing of irrigation can be reduced.

- Building Dams and hydropower projects which help in controlling floods and in regulating the supply of water to agriculture.
- Reuse of treated industrial and domestic wastewater before it's discarded in other water bodies. It will also reducethe water pollution.
- Tree plantation can help water to penetrate deep into the soil and replenish the water table.
- Rainwater harvesting: the rainwater is collected by allowing it to flow from the rooftop through pipes in a storage tank. This water may contain some soil particles from the roof. So, it should be filtered before use.

2.8.4 Global water cycle

Water evaporation into atmosphere mainly occurs from sea, lakes, rivers*etc*. It is thought that about 4.46 x 10^{20}gm of water gets evaporated and precipitated annually. But atmosphere can hold only 0.13x 10^{20} gm water vapour at a time. Approximately 75% of total evaporation takes place from sea.

The clouds blown over the earth's surface, here they are cooled to form hail, rain, snow*etc*. Some part of rain falls into sea and some water falls on ground. The surface run-off water is finally collected in ocean. Water from their water bodies may percolate in the soil reaching the permanent zones and mix with gravitational water. Melting of ice is also useful in water cycling. A large amount of water remains underground as well as in the form of perennial snow in the Polar Regions and mountain peaks above snow line.The evaporation from these water bodies return the water to the atmosphere. The energy for the global water cycle is provided by sunlight, thus, global water cycle involves the interchange of water between the earth's surface and the atmosphere via precipitation and evaporation. The cycle is a steady state one as total precipitation is balanced by total evaporation.

2.9 Mineral resources

Mineral are naturally occurring substances, representable by a chemical formula that is usually inorganic, solid, and has a crystal structure possessing definite physical and chemical properties. Mineral resources are the key substantial basis for socio-economic development. Statistical data indicates that near about 95% of energy used by human, 80% industrial raw materials and 70% agriculture raw materials are obtained from mineral resources There are more than thousands different kinds of minerals present in various parts of the world. Plentiful of the luxury that man enjoys today depends on the ample use of mineral resources. Minerals and other materials that are made of minerals have been extracted from the earth.

2.9.1 Categories of mineral resources

Mineral resources can be divided into two major categories.

1. Metallic Mineral Resources
2. Non-metallic Mineral Resources

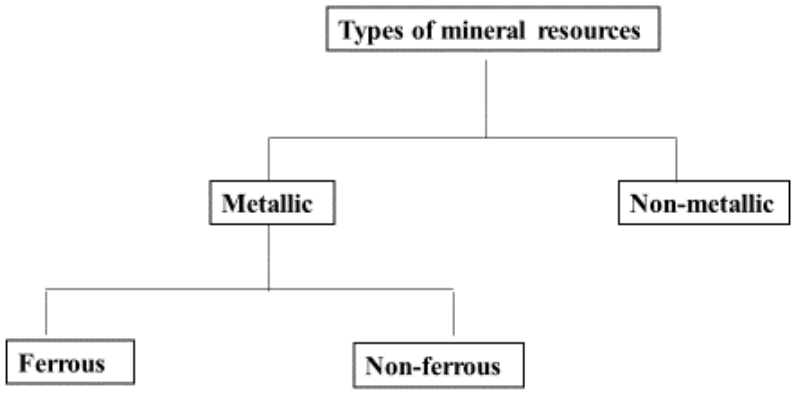


Figure 2.3: Types of mineral resources

Metals that are hard which conduct electricity and heat with characteristics of lustre or shine are called metallic minerals. For example, Silver, Chromium, Tin, Nickel, Copper, Iron, Lead, Aluminium, Gold, and Zinc. On the other hand, Minerals appear with a non-metallic shine or lustre and do not contain extractable metals in their chemical composition,are non-renewable resources like coal, oil and natural gases.

2.9.2 Use and exploitation of minerals

The use of minerals mainly depends upon its deposits. Some nations are rich in mineral deposits, while others are poorly deposits. The chief use of minerals lies on its properties.Near about 200 minerals have found important in various economic activities of agriculture, defence, industries, transport and research equipment's.

Aluminium is light in weight but strong and durable in nature, so it is used for automobiles, shipping and aircraft. Minerals are essentialfor almost all industries. Gold, silver, and platinum metal are used in the jewellery making industry. Copper is used in the coin industry and for making pipes and wire. Silicon obtained from quartz is used in the computer industry. Mineral deposits are limited, there increasing demand and supply may result in their decrease within few years. Thus, we need some scientific approach to control overuse of these minerals.

The following table lists the uses of various kinds of major minerals:

Table: 2.1 Some major metallic and non-metallic minerals and their important uses

Sr. No.	Minerals	Uses
A	**Metallic minerals**	
1	Aluminium	Rockets, electrical, utensils, wiring, aircraft
2	Beryllium	Copper alloy, refractories
3	Cobalt	Radiography, alloy, catalyst
4	Columbium	Nuclear reactor, stainless steel
5	Copper	Electrical products, alloys
6	Chromium	Metallurgy, refractory
7	Iron	Building materials, steel
8	Magnesium	Structural refractories
9	Gold and silver	Dentistry, jewellery
10	Lead	Gasoline, paints, alloys, batteries
11	Manganese	Steel alloys
12	Molybdenum	Steel alloys
13	Nickel	Alloys
14	Platinum	Jewellery
15	Potassium	Glass, photography and fertilizers
16	Radium	Industries, medical radiotherapy
17	Titanium	Aircraft, pigments
18	Thorium	Nuclear bombs, electricity
19	Tungsten	Chemicals, alloys
20	Uranium	Nuclear power, bomb and tinting glass
21	Vanadium	Alloys
22	Zinc	Solder, galvanizing, die casting
23	Zirconium	Ceramics, metals, refractories
B	**Non-metallic Minerals**	
1	Asbestos	Insulation, roofing, textiles, gasoline
2	Corundum	Abrasives
3	Felspar	Artificial teeth
4	Fluorspar	Propellant, refrigerants, acid
5	Mica	Water proofing of wooden
6	Nitrates	Chemicals, fertilizers
7	Rock phosphate	Chemicals, fertilizers
8	Salt	Metallurgy, glass, chemicals
9	Sulphur	Iron steel, fertilizers, acid

2.9.3 Importance of mineral resources

The role of minerals is extremely significant for human life and their survival, are essential raw material for the manufacturing of different chemicals. At the commencement of the 21st century, important mineral resources remain the greatest source of energy for man. Being, therefore, the basis for the production of most goods needed by modern people, minerals are also

quite rare, and their reserves are limited. This cycle of minerals is collectively known as mineral cycle. It mainly includes the following stages:

2.9.4 Extraction of minerals

- Conversion of these extracted minerals into ceramics, chemicals and metals.
- Manufacturing of articles for human consumption such as pesticides, household articles, medicines and metallic structure etc.
- Minerals return into environment as a waste product.
- Non-renewable minerals are used primarily as fuel such as gas, coal, oil.
- Metal minerals include ores from which all metals are extracted.
- Non-metallic mineral resources comprise other minerals that are not metal ores.

2.9.5 Environmental effect of using and extracting mineral resources

Minerals extraction is carried out through mining. Minerals are extracted from beneath the earth surface, processed by different methods, and then used for various purposes. Mineral resources are finite and exhaustible resources, andunnecessary use may affect their accessibility in the future. Environmental expenses of mineral extraction are explained in terms of solid waste, air pollution, land degradation, water pollution and health hazards.

It is relevant to note that, out of the total land area of the India (3.29 million sq. kms.), the area leased out of mining, as on 1994, was 7126.13 sq. kms. Comprising about 9,213 mining occupancies excluding petroleum, natural gas, atomic and minor minerals constitutes about 0.25 per cent of the geographic area of the country and if we include atomic minerals and minor minerals it may be around 0.28 per cent of the total area. Although the area occupied for mining activity is small yet the damage to the environment on account of mining is causing grave concern. Environmental damages resulting from mining and processing activitiesare briefly described as follows:

1) Alteration and degradation of landforms.
2) Air pollution with gases and dusts due to blasting, drilling, transportation and mine haulage,and also from waste heaps
3) Water pollution frequently occurs when atomic elements and other injurious elements present in the mineral mine and effluents get mixed with water;
4) Soil erosion and soil modification with salts and dusts.
5) Alteration of water regimes such as ground water availability, surface flow and lowering down of water table.
6) Noise and vibration problems due to drilling and mining causes huge sound pollution.

7) Deforestation involving loss of flora and fauna.

Some social impact isalso associated with mining at huge level like fast influx of people for work into that area. These create some social issues like:

1) Land use pattern would change from open, forest and agriculture to urban.
2) Pressure on local services of water, electricity, housing and school.
3) Enhance pressure on wilderness and recreation area due to additional people.
4) Pollution due to more power production, vehicles, construction etc.

Land destroyed due to mining is known as mine spoil and derelict. This mainly results from the uncontrolled use of natural resources without caring of future generation. Some harmful impact of dereliction is as follows:

1) Ugliness and defacing of land.
2) Wastage of agricultural useful land.
3) Health hazards such as silicosis, asbestosis *etc*.
4) Accidental hazards.

2.9.6 Measures for sustainable mining

World Summit on Sustainable Development (WSSD) has suggested some measures for sustainable mining:

1) To support efforts to address the social, environmental, economic influences and profits of mining through their life cycle, including workers safety and health.
2) To improve the contribution of stakeholders, including women and local communities, to play a dynamic role in minerals mining.
3) To foster sustainable mining practices through the facility of technical, financial, and capacity-building support to developing countries.
4) To solve the problems of displacement of the native people due to mining sites.

2.10 Food resources

Food is any natural element, which maybe composed of the facts, carbohydrates, proteins, vitamins, minerals water, and any other nutrients it is either eaten and drunk by living beings for their nutritional needs. Substances considered for food may be obtained from plants and animals. Food is the main essential resources which the body needs for its well-being. Historically, people obtained food through two methods: gathering, hunting and agriculture. More recently, most of the food consumed by the world population is provided by the different agriculture and food industry. There has been a growing trend towards more sustainable agricultural practices, which is moderately fuelled by the customer demand.Sustainable practices also boost biodiversity conservation and local self-reliance.

The FAO (Food and Agriculture Organization) of United Nations assessed that on an average the lowest caloric intake on a global scale is 2,500 calories per day. People getting less than 90% of these minimum dietary calories are called undernourished. Ifit is less than 80%, they are called to be extremely undernourished. Besides the minimum caloric intake, we also require different minerals, proteins*etc*. Shortage or lack of nutrition often leads to malnutrition, which results in several diseases.According toFood and Agriculture Organisation:

a) Minimum calorie intake on global scale is 2,500 calories per day.
b) Malnourished people receive 80-90% of this requirement.
c) Extremely undernourished people receive even less than 80% of this minimum calorie intake.

2.10.1 World food problems

During last 50 years total grain production of the world has improved almost three times. At the same time, world population has amplified at such a rate in developing countries that it has outstripped food production. The fact is that population growth beats agricultural production and the development of agricultural technologies. Food shortage and its poor-quality cause a harmful impact on productivity and people's health. This also cause political and social conflicts in the regions suffering from food problems. Every year approximately40 million people die due to malnutrition and undernourishment. The World Food Summit, 1996 has set the agenda to decrease the number of undernourished to just halfby 2015. Main reason of under nourishment is poverty, because of which parents not able to buy adequate and nutritive food for their children.

Table 2.2: Effects of Malnutrition on Human health

Deficiency	No. of cases	Death per year (in millions)	Health effect
Protein	Kwashiorkor, Marasmus, Stunted growth	750 million	15-20
Iron	Anaemia	350 million	0.75-1
Iodine	Cretinism	150 million	
Vitamin A	Blindness	6 million	

2.10.2 Change caused by agriculture

Agriculture is the world's largest and oldest industry. More than half of the world's population depends upon agriculture. Processing, distribution and production of food is responsible for environmental changes and therefore these environmental changes are

unavoidable. Environmental changes induce by agriculture can be divided into three categories, *viz*., regional, local and global.

Local changes:

These occur at very close to the farming site. These changes mainly include:

1) Soil erosion
2) Upsurge in sedimentation and downstream in local rivers
3) Fertilizers and pesticides carried by water flow into local water bodiescauses Eutrophication.
4) Destroy fisheries and aquatic flora and fauna.

Regional changes:

These changes generally occur from the combined results of farming practices in a particular region. Regional effects are:

1) Deforestation
2) Desertification
3) Pollution at huge level
4) Increase in sedimentation in major rivers and in the estuaries at the mouths of the rivers and changes in the chemical fertility of soils over large areas.
5) In tropical waters, sediments entering the ocean can destroy coral reefs.

Global changes:

These comprise climate changes as well as possible general changes in different biogeochemical cycles.

2.10.3 Effect of modern agriculture

The agriculture is asignificant source of livelihood because it is the procedure of producing feed, food, fibre and many other necessary. Modern agriculture makes use of hybrid seeds of single crop variety, technologically advanced equipment, fertilizers, pesticides and water to produce large amounts of single crop. Modern agriculture practices have sustainablychanged the agriculture practices, farming and harvesting practices and it leads to some ill effects on environment.

Fertilizers:

Plants require air, water, light along with minute amount of inorganic nutrients for their normal growth and metabolism. The main significant minerals needed by plants are nitrogen, phosphorus, potassium along with magnesium, sulphur and calcium. These are usually added into soil. These elements are provided to plants mainly in the form of inorganic minerals. These minerals further added into fertilizers and further stimulate the crop production and

growth.Artificial generated chemical fertilizers offer the several advantages over organic fertilizers:

- Risk of pathogenic contamination is less.
- Odourless
- Easy to handle, transport, store and application in field.

Food production of the world is mainly dependent on chemical fertilizers. That's why use of chemical fertilizer increases day by day in agriculture sector. Meanwhile, excessive use of chemical fertilizers generates some major problems such as:

Micronutrient imbalance:

Chemical fertilizers used in agriculture contain Nitrogen, Phosphorus and Potassium (N, P, K) which are macronutrients. Extra use of fertilizers in agriculture land causes micronutrient inequality. For example: Over use of fertilizers in Haryana and Punjab caused shortage of micronutrient Zinc thereby affecting productivity of soil.

Nitrate pollution:

Overuse of nitrogenous fertilizers in fields percolate deep into the soil and finally infect the groundwater. If the concentration of nitrate in drinking water exceeds 25 mg/L, this condition is termed "Blue Baby Syndrome.

Eutrophication:

The overuse of fertilizers in agriculture lands leads to wash off of the nutrientscontaining water into nearby water bodies causing over-nourishment. This is called Eutrophication. Eutrophication is responsible for formation of algal blooms. Algal blooms use these nutrients for fast and rapid growth.

Pesticides:

Pesticides are chemical compounds mainly used to kill pests. To improve crop production, pesticides are used extensively in agriculture. Pesticides are mainly of two types:First generation pesticides that use Arsenic, Sulphur, Lead and Mercury to destroy pests.Second generation pesticides like Dichloro Diphenyl Trichloroethane (DDT) which are also used to kill pests.Pesticides generally are organic in nature. Although pesticides defend crops from losses due to pests, but they have numerous side-effects as described below:

Pesticide resistance:

Some pests could be able to survive under pesticideeffects and produce highly resistant generations that are safe to all kinds of pesticides. These pests are called superpests.

Death of other non-target organisms:

Several insecticides kill not only the target species but also several beneficial organisms which are not our target to kill.

Bio-magnification:

Almost all of pesticides are non-biodegradable and gathers in the food chain. This is called bio-accumulation and bio-magnification. These accumulated pesticides in food chain are harmful to human beings.

Risk of cancer:

Pesticide increases the risk of cancer in two ways (i) It acts as a carcinogen and (ii) It suppresses the immune system.

2.11 Water logging

If water stands on terrestrial area for most of the year, it is known as water logging.In water logged conditions, soil pore get occupied with water and soilair gets exhausted. At that condition the plant roots cannot get sufficient air for respiration. Water logging also leads to low crop yield.

2.11.1 Causes of water logging

- Extreme water supply to the croplands
- Poor drainage
- Heavy rainfall

2.11.2 Measures to prevent water logging

- Avoid and stopunnecessary irrigation
- Develop sub-surface drainage technology
- Bio-drainage by trees like Eucalyptus

2.12 Salinity

If water is not absorbed by soil, it evaporatesslowly and leaves behind a thin layer of dissolved salts in the top soil. This is called salinity of the soil. Saline soils are characterized by accumulation of salts like calcium chloride, sodium bicarbonates, sodium chloride, magnesium chloride, sodium sulphate and sodium carbonate. Saline conditions are displayed when pH is higher than 8.0.

In order to improve the condition of saline soils the following two techniques may be used

- Use pure and good quality water.
- Use underground network of perforated drainage pipes for salt removal.

Table 2.3: Salinization and water logging conditions arise in India due to some irrigation projects

State	Irrigation Project	Area affected (thousand hectares)	
		Salinity	Salinity
Andhra Pradesh	Sri Ram Sagar	1	60
Bihar, Gujarat	Gandak	400	211
Madhya Pradesh, Rajasthan	Chambal	40	98
Rajasthan	Indira Gandhi Canal	29	43
Uttar Pradesh	Ram Ganga	352	195

Source: B.K Garg and I.C. Gupta (1997).

2.13 Energy resources

Energy is simply defined as the capability to do work. Sun is the definitive source of energy in solar system. Energy is the basic need of living organisms and life cannot occur without energy. Plants capture the sun energy for their photosynthesis. In cyclic manner we get the indirect energy from the plants. Energy resources are vital for any society, be it one dependent on agriculture or an industrialised country. There are many different sources of energy, like heat, sound, tidal, wind, light, mechanical and chemical energy. There is a huge difference in energy consumption per person between developed and developing countries.

2.13.1 Growing energy needs

Major energy resources are fossil fuel like coal, natural gas and petroleum. The ancient man required 2000-4000K Cal. energy per day. Due to industrialization, per capita energy consumption increased. In USA energy consumption is 2,50,000 K. cal. per person but in other developing countries energy consumption is 10,000 K. cal. per capita. At present the fossil fuel like oil, coal, petroleum and natural gas are the source of 95% of the commercial energy.

2.13.2 Types of energy resources

Energy sources are classified into two main types: renewable and non-renewable resources.

Renewable resources*:* Renewable resources are almost all elements of nature which can restart them. For e.g. forest, sunlight, wind and water.

Non-renewable resources: These energy sources are formed long ago and are collected in nature but are exhausted very easily. The resource for non-renewable energy includes fuels from fossil deposit like coal, natural gas and petroleum.

2.13.3 Wind energy

Winds blowingwith high speed have a lot of energy. Key driving force for the wind blowing is sun. Wind power is formedfrom natural and renewable sources by usingrecent technologies. It does not damage and pollute the environment and aninexpensive source of energy. Wind power is a renewable source, which has no waste by-products. But it is quite 'unpredictable'. When wind swiftness is slow, less electricity is generated. Mainly the wind mills are used to produce electricity. The large size blades of wind turbines move with the high speed of the wind. The rotation of blades further rotates turbines which induce rotation of magnets, to produceessential electricity.

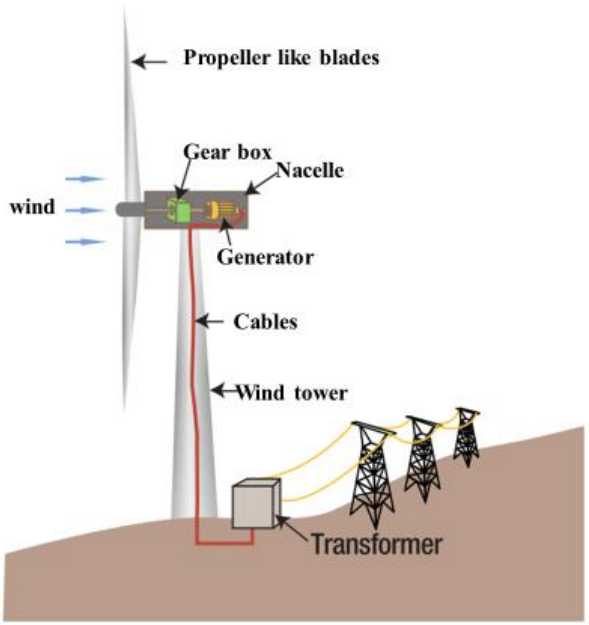


Figure 2.4: Wind Energy Mills

Geographically location of India is suitable with largedesert, coastal areasand hills to exploitwind energy. In India, Gujrat, Kerala, Tamil Nadu and Goa mainly produce wind energy. At the world level China, Denmark, Germany and USA are the chief producers of wind energy. India is fourth largest producer of wind energy after Germany, Spain and USA. The wind power potential of India is around 49000 MW at 50m above sea level. In rural and remote areas wind energy is used for pumping water.

2.13.4 Solar energy

Sun radiations are capable of generating heat, initiating some chemical reactions, and more producing electricity. The amount of solar radiation incident on earth surface is in very excess of the world's present and expected energy requirements. If appropriately harnessed, this extremely diffused source has the potential to gratify all future energy demands. In the 21st century solar energy is probable to become gain attention as a renewable energy source because of its infinite supply. India get more than 5,000 kWh of solar energy yearly.

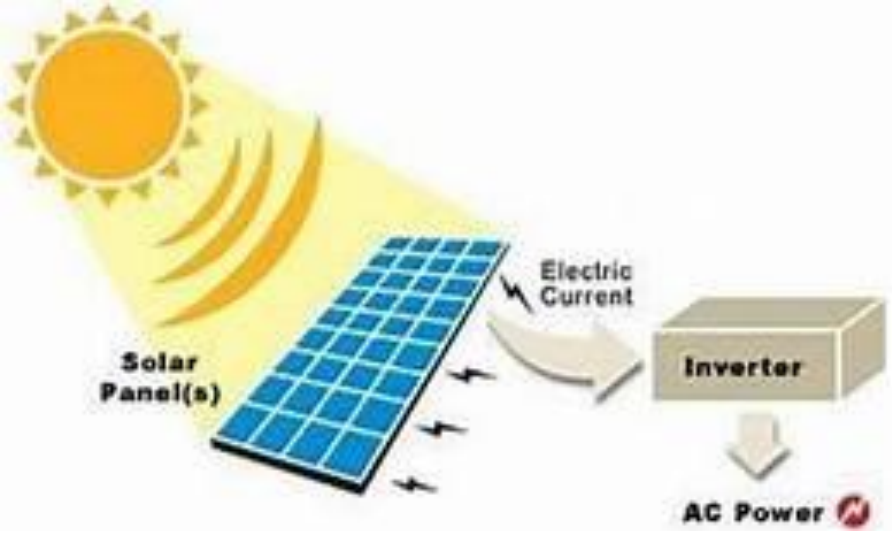


Figure 2.5: Solar Energy

Different technologies have been established to use solar radiationfor energy production. Solar energy can be collected and converted to other operational energy forms using photovoltaics or solar thermal collectors. Solar energy is a pollution free, clean, renewable energy resource, and plays a significant role in the world's energy future.

Solar heater:

The Sun rays may be used for water heatingto substitute gas or electricity. There are two elementary types of solar heating systems which are based on the type of fluid used to be heated by solar energy collectors. The collector is a device in which a fluid is heated by the sun. In air-based system air become hot by air collector whereas, in liquid-based systems water or an antifreeze solution heatsin a "hydronic" collector.

Solar cells:

Solar cells are also known as photovoltaic cells and can be used to generate electricity from the solar radiation. It is a device that change light energy into electrical energy. Solar cells mainly made of thin wafers of silicon and gallium or other semiconductor materials. When sun radiation falls on the solar cells, a potential difference is generated which is responsible for flow

of electrons and generate electricity. Solar cells commonly used in street lights, smart watches, calculators, traffic signals etc. Large numbers of solar cells have seenjoined in an arrangement solar cell panel that cans transportsufficient electricity for practical use. It is a significant system in remote area where conventional electricity is not possible.

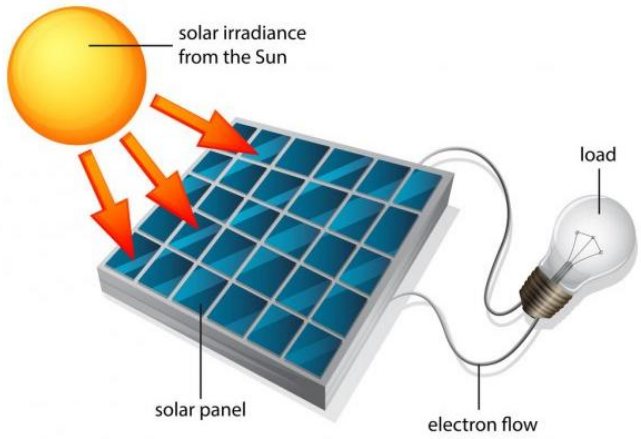


Figure 2.6: Solar Cell

Solar cooking:

Solar cooking is done by a devicenames solar cooker, which use the sun rays as the source of energy instead of coal, charcoalor gas. Solar cookers are cheap and environmentally safesubstitute to traditional ovens. Cookers reflect the sunrays by using a mirror on a glass sheet which covers the black insulated box where food is kept. They are widely used in developing countries where deforestation is an issue, financial income to buyfuel limited, and where exposed flames would pose a serious danger to people and the environment.

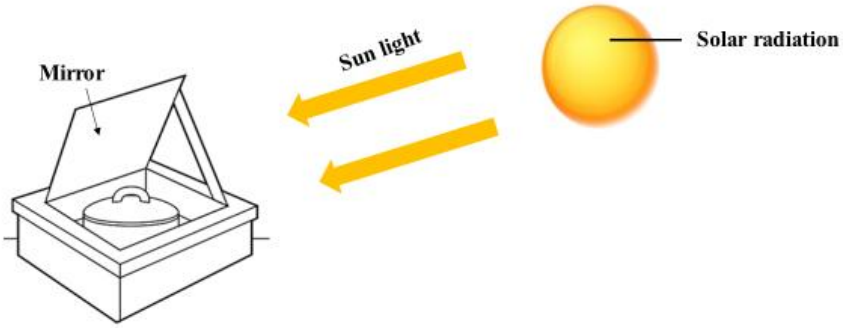


Figure 2.7: Solar Cooker

Solar furnace:

More than thousands of plane mirrors are organized in the form of concave reflector, all of which collect the solar radiation and maintained a temperature of 3000°C.

Solar water heaters: It consists of insulated black box from inside with a glass lid to capture and storing sun heat. Inside the box,the water flow through a black copper coil to get hot w and then stored in a tank.

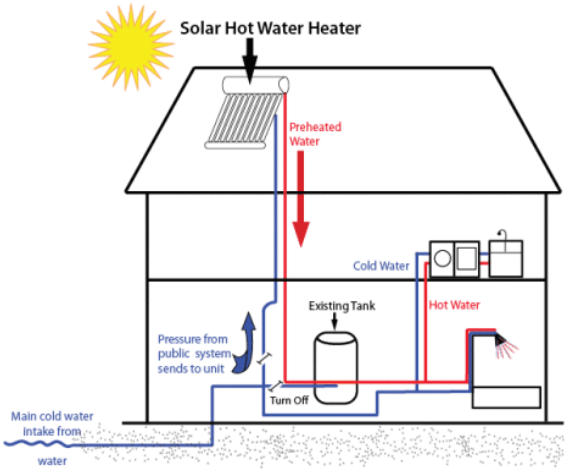


Figure 2.8: Solar Water heater

Solar power plants:

Solar power plants convert sunlight into electricity, either directly using photovoltaics or indirectly using concentrated solar power. Concentrated solar power systems use mirrors to focus a large area of sunlight into a small beam. Photovoltaics changes light into electric current using the photoelectric effect.

2.13.5 Hydropower

It is power derived from the energy of falling of fast-moving water. Hydropower is the main contributor of all renewable energy resources and responsible for 6.7% of worldwide electricity generation. Additional development of this established technology may be thinkable, though many countries have already developed cost-effective sites. The river water is collected by constructing large dam where water is allowed to falls from a suitable height. The turbine blades at the bottom of dam move along with water which in turn produces electricity. We also construct mini or micro hydropower plants in hilly regionsto generate the hydel power but the height of water fall should be more than 10 meters.

There are three main different types of hydro power plants:

1) Impoundment facilities are the greatest and most common methodology which uses a dam as large reservoir of water. Electricity is generated when water is permitted through turbines in the dam.

2) Pumped storage facilities are very much similar to impoundment facilities but have a second reservoir present below the dam. Water can be moved from the lower to the upper reservoir, which create and store energy for use at a later time.
3) Run-of-river facilities depend mainly on natural water flow rates, diverting a portion of water through turbines, sometimes without the use of a dam or reservoirs. Since run-of-river hydro is subject to natural water variability, it is more intermittent than dammed hydro.

It is more flexible and reliable source of electricity as compared to other renewable sources, as it may be stored for later time. Dammed reservoirs can also be helpful for flood control, reliable water supply and may be used for entertaining purposes.

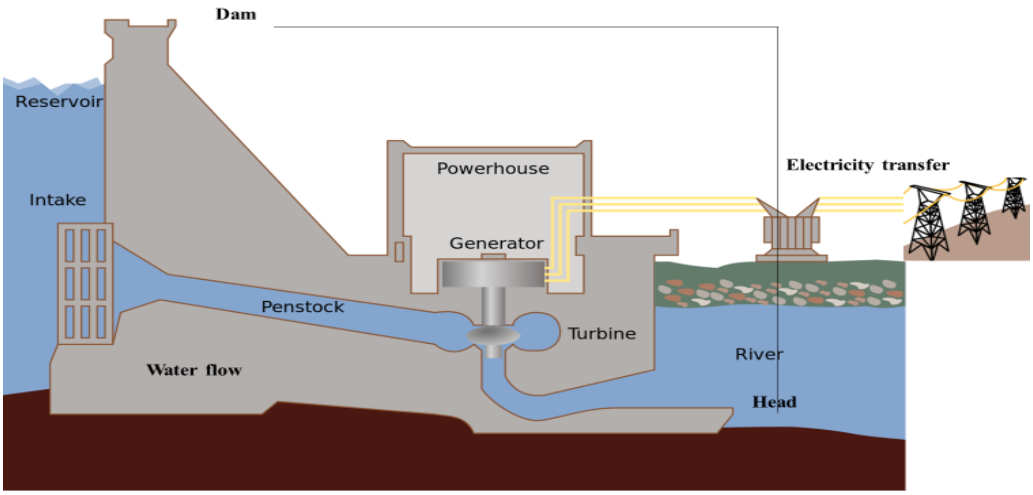


Figure 2.9: Dam for Hydropower Generation

2.13.6 Tidal energy

The gravitational forces of the moon and sun joint with the revolution of the earth result in an alternative rise and fall of the sea water levels. The rise of the sea level is called the high tide, whereas the fall is called the low tide. Tides are a systematic natural phenomenon. They can be forecasted over months and years in advance. This is why the energy from this gigantic movement of water can be harnessed and changed into other operational form of energy. A difference of few meters is essential between the height of low and high tide to rotate the turbines.

Types of Tidal Energy Generation

The two main ways of electricity production from tides are:

Tidal Barrage:

It uses the potential energy difference between high and low tide. Water from high tide is channelized through underwater tunnel in the dams, as water move through tunnels; it moves the turbine to generate electricity by rotating the generators.

Tidal Stream Generator:

This method of tidal energy production uses the kinetic energy of the moving water to move turbines. When water flows across the rotor blades it rotates the turbine, and thus tidal streams are formed by the constant incoming and outgoing of the tide, thereby generating tidal energy.

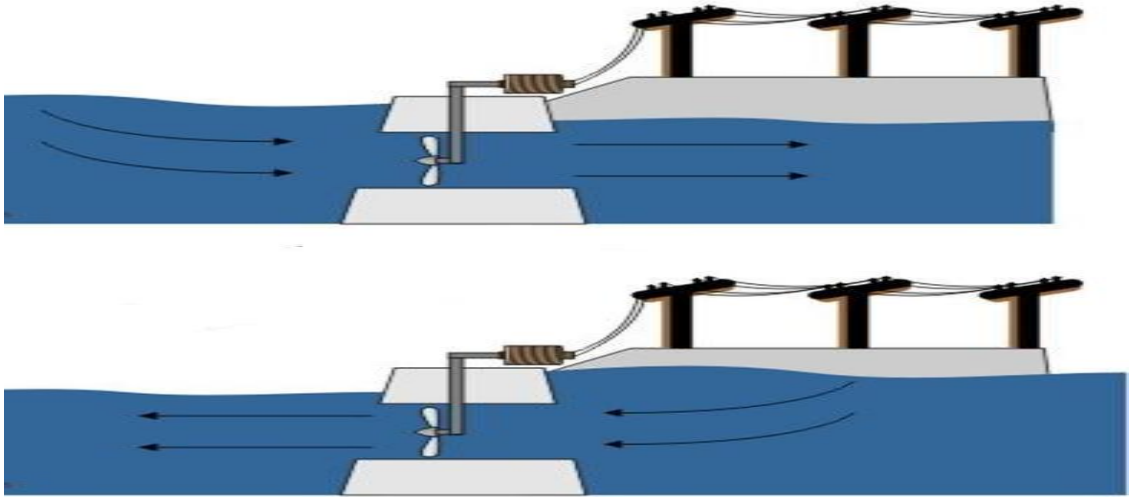


Figure 2.10: Tidal energy generation

As of March 2017, India declared of its approximate 7500 Km coastline, where the height of tide was documented more than 5 meters which can basically capture the potential tidal power. The Ministry of New and Renewable Energy projected that the country is able to produce 7000 MW of tidal power in the Gulf of Khambhat in Gujarat, 1200 MW of power in the Gulf of Kutch in Gujarat and about 100 MW of power in the Gangetic delta of Sundarbans in West Bengal.

2.13.7 Geothermal energy

Geothermal energy is the heat energy stored underground from millions of years since the earth's formation. Geothermal energy is site specific but can be very inexpensive especially when used for direct heating. There is a vast temperature difference exist between the earth's surface and the crust, which is known as geothermal gradient. This temperature is even adequate

to melt rocks. Geothermal energy is also used to generate electricity. Heat from earth's innerpart produces surface phenomena's such as fumaroles, geysers, lava flows, hot spring, and mud pots.

Heat in earth interior is mainly produced by the radioactive decay of thorium, potassium and uranium and also by friction generated along the boundaries of continental plates. Geothermal heat can be recovered and used for human use, and it is available everyplace on earth's surface. In some places, the hot water and steam comes out naturally from the ground through cracks in the form of geysers as in Kullu, Sohana and Manikaran. The predictable energy that can be exploitedand recovered on the surface is 4.5×10^6 exajoules/ year which equates to roughly three times the world's annual consumption of all types of energy. India has a huge potential for production of geothermal energy with 340 hot springs with temperature range of 80-100°C. China, Japan, USA, France, Italy and Germany are some other countries which successfully used geothermal energy.

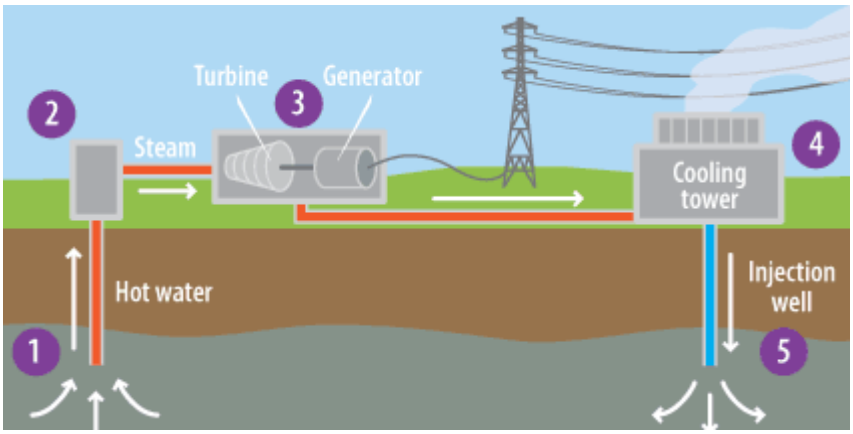


Figure 2.11: Geothermal energy production

There are three types of geothermal power plants *i.e.* dry steam, flash, and binary.

1) Dry steam, the eldest technology for production of energy, takes steam out of cracks in the earth crust and uses it to drive a turbine.
2) Flash plants pull high-pressure hot water into cooler, low-pressure and deep water. The steam obtained from this method is used to drive the turbine.
3) In binary plants, the hot water is passed by a secondary fluid with a much lower boiling point than water. This causes the secondary fluid to turn to vapor, which then drives the turbine. Most geothermal power plants in the future will be binary plants.

2.13.8 Ocean thermal energy

Temperature variance between the surface warm waters, and thedeeper cold waters of ocean can be used to produceelectricity is a conventional heat engine. The temperature variation between the surface and the lower water can be more than 50°C. The efficiency of this system mainly lies on the temperature difference. More the temperature difference, more will be the efficiency. The temperature difference between the deep and shallow parts is maximum 20-25°C for functioning of ocean thermal energy conversion power plants (OTEC). The warm shallow water is used to boil a liquid like ammonia. The high vapour pressure of ammonia is used to rotate turbine and produce electricity. The cool water is pumped to condense and cool the vapours into liquid. In this way, the procedure keeps continue for 24 hours.

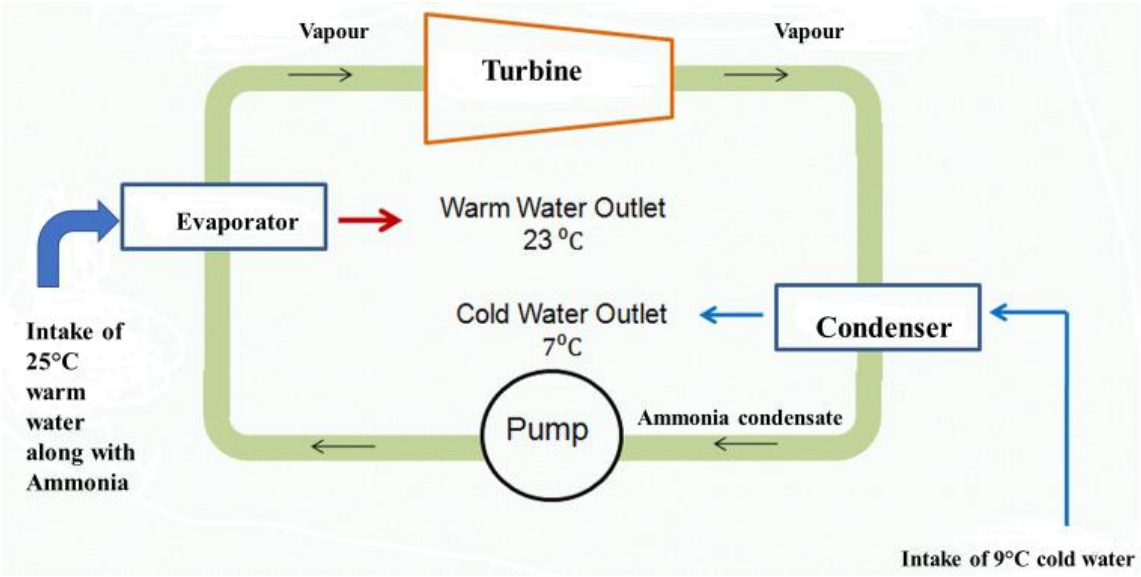


Figure 2.12: Ocean Thermal Energy Conversion (OTEC) System

Types of ocean thermal energy conversion systems

Closed cycle:

This system uses a working fluid with a low boiling point like ammonia to rotate a turbine in which warm sea water taken in from the surface of the oceans and cold water from the deep. The warm water vaporizes the ammonia in the heat exchanger which then rotates the turbines. The vapour of fluid brought in contact with cold water which turns it back into a liquid. The fluid is recycled in the system that is why it is called a closed system.

Open cycle:

The warm water from surface of sea is first pumped in a low-pressure chamber where due to the decline in pressure, it undergoes a drop in boiling point as well. This causes the water to boil. This steam drives a low-pressure turbine which is attached to an electrical generator.

2.13.9 Biomass energy

Biomass energy is a type of energy which uses a biological organism like plant or animal as its basis. Biomass is so wide, fuels that can be considered "biomass" include an extensive variety of items and researchers are discovering new biomass energy sources. Wood, animal waste, landfill waste, algae, crops like sugarcane, corn, switchgrass, and other plant materialcan be used as a biomass fuel source. Biomass energy is of different types:

Energy plantation:

Energy plantation is the exercise of planting trees, purely for their use as fuel. Energy plantation means rising selected shrubs and trees which are harvested in a shorter time and are precisely meant for fuel. The fuel wood may be used either directly in burning or processed into ethanol, methanol and natural gas. Energy plantations provide wood either for homes or for industrial use, so as to satisfy energy needs in a decentralised way. Some striking features of energy plantations are:

1) Heat content of selected woody plants is very much similar to that of Indian coal,
2) Low sulphur content in wood and not likely to pollute the air,
3) Ash obtained from burnt wood is a good fertiliser,
4) Erosion prone area selected for raising these plantations helps in minimising hazards from floods and erosion.

Fast growing trees like poplar, Leucaena, cottonwood, sugarcane, sorghum, sugar beet, some aquatic weeds like sea weeds, water hyacinth and carbohydrates rich plant like potato, cereals etc. are significant for energy plantation.Biomass fuel can be transformed directly into heat energy through combustion. In other cases, biomass is converted into another fuel sources like ethanol and gasoline and methanewhich are made from corn and animal waste.

(a) Sugarcane

(b) Cottonwood

(c) Water hyacinth

Petro-crops:

There are few species of certain families which collect the photosynthetic by-products known as hydrocarbons with high molecular weight of 10,000. They are commonly known as

Petro plants or petroleum plants. These plants provide the liquid hydrocarbons which further converted into petroleum hydrocarbons. Mainly, latex containing plants like Euphorbias and oil palms are used to produce oil like substances under high pressure and temperature. Hydrocarbons may be burnt in diesel engine or may be refined to produce gasoline.These plantscan be cultivated in agriculture unfit land.

(a) Oil palm

(b) Euphorbia

Urban and agriculture waste biomass:

Fishery, poultry, animal and even human waste are used to produce biomass energy. Bagasse, crop residue, peanut, coconut shell and cotton stalks are some of the most common agricultural wastes which are used to produce energy by their burning.

2.13.10 Coal:

Coal is one of the greatest used fossil fuels. It was formed more than 300-350 million years ago in hot, swamps covered by water during carboniferous period. Later, swamps dried and all organic material in diversedecay stages got buried beneathdifferent layers of soil.Coal is non-renewable not only because its development took millions of years, but also because the earth climate was totally different at that time. According to the World Coal Association, at present consumption rate, we have coal but only for the next 150 years.

India has about 5% of worlds coal but it is not very good in term of heat capacity. Important coal field in India are Bokaro, Jharia, Raniganj, Singrauli and Godavari valley and states are Orissa, Jharkhand, Madhya Pradesh, Maharashtra, Andhra Pradesh and west Bengal. Burning of coal produces carbon dioxide, a greenhouse gas which is responsible for global warming. Coal also possess sulphur therefore as it burns, the smoke contains some toxic gases like nitrogen and sulphur oxides.

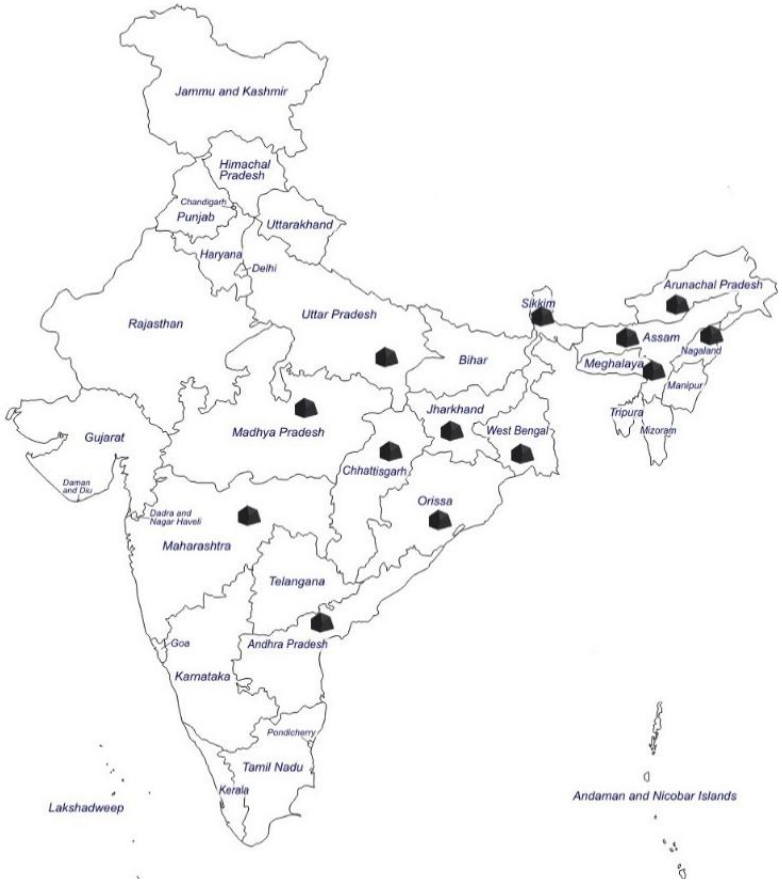


Figure 2.13: Coal mines of India

2.13.11 Petroleum:

It is a liquid fossil fuel which is now a life line for global economy. It is also called crude oil. Crude oil is complicated mixture of alkane hydrocarbons. Oil contains different chemicals and purifying the oil takes some of these chemicals out. half of the world's petroleum is transformed into gasoline. The rest can be further processed and used in liquid products such as nail polish and rubbing alcohol, or solid products such as water pipes, shoes, crayons, roofing, vitamin capsules, and thousands of other items. Crude oil is purified by fractional distillation. Petroleum is a cleaner fuel as compared to coal because as it completely burns without leaving any residue. It is also easy to transport and use.

2.13.12 Natural gas:

Natural gas is another significant fossil fuel that is stuck underground in different reservoirs. It is made up of methane (95%) with small amount of ethane and propane. The decomposition of bio material in landfills also produces methane. Natural gas is found in deposits a few hundred meters underground. It is used as industrial and domestic fuel, and also used for production of electricity. It is a source of hydrogen gas in fertilizers and source of

carbon. Natural gas can also be twisted into a liquid form, which is known as liquid natural gas (LNG). LNG is much cleaner than other fossil fuels. Liquid natural gas takes up much less space than the gaseous form. Compressed Natural Gas (CNG) is used in vehicles to reduce air pollution. Synthetic natural gas (SNG) is generated by combining natural gas with carbon dioxide. It constitutes connecting link between a fossil fuel and substituted natural gas.

2.13.13 Nuclear energy:

Nuclear energy is considered asadditional non-renewable energy source. It is commonly known for its high destructive power. Nuclear energy harvests the powerful energy in the nucleusof an atom. Nuclear energy is released either through nuclear fission or by nuclear fusion.

Nuclear fission:

Nuclear fission is the process where the nucleus of certain large mass atom splits into lighter nuclei by bombardment of neutrons. Nuclear fission release huge energy through several chain reactions.

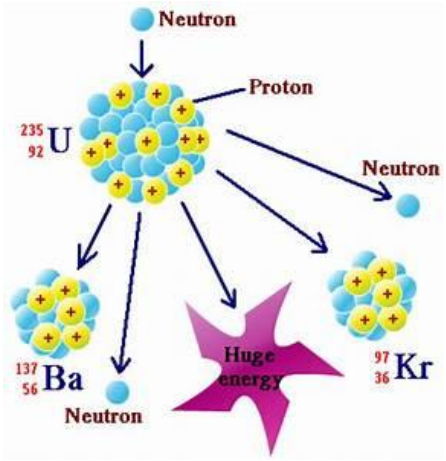


Figure 2.14: Nuclear Fission Reaction

Nuclear fusion:

In this, two light mass atom nuclei are joined together at high temperature of about 1 billion °C till fusion. It leads the generation of heavier nucleus and produce highamount of energy.

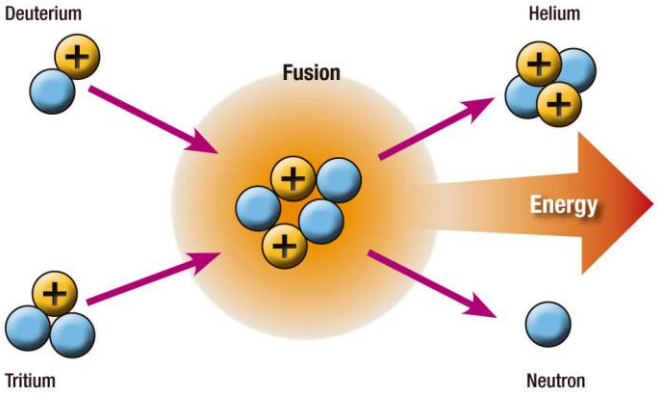


Figure 2.15: Nuclear Fusion Reaction

Nuclear power plants are multifacetedtechnologies that can control nuclear fission to produce electricity. The material most commonly used in nuclear power plants is uranium.Although uranium is found in rocks, but nuclear power plants use a very infrequent type of uranium, U-235 and it is a non-renewable resource.Nuclear power is a widespread way of making electricity around the world. Nuclear power plants do not cause any type of pollution or do not emit greenhouse gases. Leakage from nuclear reactors cause devasting nuclear pollution and also produces radioactive waste material. Radioactive waste can be very toxic, which may cause burns and grow the risk for cancers, blood diseases and bone decay among people. In India nuclear power is still under development.

2.14 Land resources:

Land is a major part of lithosphere. It is one of the essential parts of natural environment besides plants, water and air. It is the source of several materials which are essential for living organism. It constitutes one fifth of the earth surface. The soil forms the upper most and the fertile layer of earth which covers more than 80% of land. It is composed of different minerals and organic matter. It is essential resource because:

1) It is composed of large number of microbes which are essential for mineralization and decomposition of dead organic matter and recycling of nutrient elements.
2) It provides support to the flora and fauna.
3) It acts as a natural reservoir of water due to its porosity and water holding capacity.
4) It acts as natural buffer system to maintain pH of soil.
5) It prevents excessive leaching of important essential ions.
6) Due to its ion exchange ability it ensures supply and availability of micro and macro nutrients for the plants, animals and microbes.

2.14.1 Land degradation

Land degradation refers to modern technologies and human practices that degrade the land's resources quicker than they can be refilled and thus fail to confirm the sustainability of the land. Land degradation is an extensive term that can be used differently across a huge range of scenarios. There are numerous types of land degradation and its effects on the environment:

1) A decline in the land productive capacity. This can be measured by biomass loss, a loss of real productivity, or a change and loss in soil nutrients and natural vegetative cover.
2) Reduction in land capacity to provide resources for human livelihoods. This can be measured from a base line of past land use.
3) Biodiversity loss: A loss of species richness, diversity or ecosystem complexity as a result of deterioration in the environmentquality.

2.14.2 Land degradation types

There are many types of land degradation that have been described:

Traditional types include:

- Water-induced land degradation
- Wind-induced land degradation
- Mechanicallyinduced land degradation (mechanised agricultural practices)
- Chemicallyinduced land degradation (e.g. nitrogen runoff)
- Biologicallyinduced degradation (e.g. cattle grazing)

Emerging in more recent times

- Pollution, often chemical, due to agricultural, industrial, mining or commercial activities
- Loss of arable land due to urban construction
- Artificial radioactivity, sometimes accidental
- Land-use constraints associated with armed conflicts.

2.15 Conservation of natural resources-role of an individual

Various types of natural resources like water, food, soil, minerals, forests and energy resources play an essential role in growth of economy of a nation. The modern life-style, advancement in technology and its overuse possess bad impact on the natural resources. Natural resources like petroleum, coal and natural gas arereducing at a fast rate, and once they are exhausted, we will have to depend on other sources of energy. Therefore, it is very essential for us to act in a way which confirms the preservation of these resources. There are different ways of preserving natural resources. The main idea of preservation is theoptimised use of natural

resources and not overuseof natural resources. While natural resources conservation efforts are underway at international, national and individual level. For instance, using bicycles occasionally saves a lot of oil. Using public transport also helps in saving a lot of oil. Saving water while bathing, cleaning, *etc*. helps in water conservation.

2.16 Aims and principles of conservation

The aims of conservation are two-fold:

- To ensure the conservation of environmental quality that reflects aesthetics and recreation.
- To confirm a constant yield of useful materials by creating a stable cycle of harvest and renewal.

2.17 Principles of conservation

Conservation is accomplished through procedures accepted in favour of a natural resources in order to upsurge its durability and recover usage patterns. Some such measures are as follows:

Restoration:

It is a widely used for conservation, which is fundamentally the alteration of past uncaring activities that have impaired the efficiency of the natural resource base.

Rational use of the resources:

Rational use of the natural resources is one of the important concepts in conservation. It is an essentially unobstructed state because they are of scientific interest, have aesthetic appeal or have recreational value.

Reutilisation:

Reuse of waste materials, like water, plastic is the best way to preserve natural resources, environment awareness and education, protection, sustained yield, allocation and substitution.

2.18 Need for conservation

1) It takes time to cure the mistakes committed in past by human being like reforestation in an area will require energy and time for plantation. After planting tree nature takes its own time to come at original state of forest.
2) Uncontrolled use of resources causing depletion of these resources.

3) National and international efforts to conserve these resources not properly organised. Even the priorities are also different from each other. For avoiding duplication of agendas and efforts we need some common approach.

2.19 Objectives of conservation of natural resources

As per the Ministry of Environment and Forests, Government of India, the objectives of conservation of natural resources are:

1) To conserve the biodiversity at the specific habitat so that the development and evolution of the life not effected.
2) To maintain some significant ecological processes-air, soil, land, water, plant and animals.
3) To ensure the sustainability and availability of natural resources which accept the existence of the species in an easy and healthy manner.

2.20 Soil conservation

1) Use suitable irrigation techniques like sprinkling and drop irrigation.
2) Do not irrigate with a strong water flow, as it would wash off top fertile soil layer.
3) Plant more tree to prevent soil erosion.
4) Use mixed cropping so that soil nutrient maintains at specific level.
5) Prevent over watering of agriculture fields which don't have proper drainage system.

2.21 Water conservation

1) Do not keep taps open while washing, brushing, shaving and bathing.
2) Rain water harvesting system for water conservation.
3) Reuse the water after washing soapy water.
4) Install water saving toilets in houses and other commercial buildings.

2.22 Energy conservation

1) Obtain energy from renewable and non-exhaustible natural resources.
2) Turn off fans, lights and other electronic appliances when not in use.
3) Build houses, offices with provision for sunlight which will provide light and keep house warm.
4) Recycle and reuse of metal, paper and glass.

5) Try to ride bicycle for small distances instead of using car and other appliances.

Exercise

Short answer type question

1. What are natural resources?
2. What do you mean by renewable energy resources?
3. What are exhaustible natural resources?
4. What is deforestation?
5. What is meant by shifting cultivation?
6. What do understand by biomass energy?
7. Define soil conservation.
8. What is desertification?
9. What is energy plantation?
10. Name any two plants which are used as a petro-crop.
11. Define drought.
12. Name the minerals which are used in nuclear energy production.
13. What is tidal energy?
14. What is solar energy?
15. Name any two-renewable energy sources.
16. What is water logging?
17. Define hydropower.
18. What is solar cooker?
19. What do you mean by biological control of pests?
20. What is salinity?

Long answer type questions

1. Describe about different energy resources and their importance.
2. What is water aquifer? Describe about its types and uses.
3. Write a note on role of individual in conservation of natural resources.
4. What is soil erosion? How do we control and prevent it.
5. Describe in details about nuclear energy.
6. What are the significant reasons and effects of deforestation? Write some methods of forest protection.
7. Write a note on geothermal energy and its importance.

8. Write the problems associated with use of modern agriculture practices.
9. What is overgrazing? How it contributes in environmental degradation?
10. What are pesticides and pests? How they degrade environment? Give some examples.
11. Give name and describe about the major food problems of world.
12. Discuss the major impact of mineral extraction on environment.
13. What is the major impact of underground water usage? Describe about different methods of water conservation.
14. What are natural resources? Describe about equitable use of resources for sustainable life style.
15. Discuss about the various types of minerals and their uses.
16. Discus about flood and drought with respect of occurrence and impacts.
17. Benefits and problems associated with dams.
18. Describe about major causes and outcomes of deforestation.
19. Describe in detail about land degradation.

CHAPTER 3 Ecosystem

3.1 Concept of an ecosystem

An 'Ecosystem' (eco means environment; system means interdependent and interacting complex) is a region with a recognizable and specific interacting system resulting from integration of both living (biotic) and non-living (abiotic) components of the environment. These interactions create conditions that support a community of animals and plants in a given specific area. The term ecosystem was first given by A.G. Tansley (1935).

Ecosystems are divided into natural and artificial ecosystem. Natural ecosystemsaremaintaining under natural conditions without any significant interference by man *e.g.* terrestrial: forest, grassland, desert *etc.* and aquatic: fresh and marine water ecosystems. Artificial ecosystems are man-made ecosystems like crop land, grass land and gardens. All biotic and abiotic components of an ecosystem interact with each other by means of chemical cycles, food chain resulting in energy flow.

The biotic community of animals and plants in any area living together with the abiotic components of the environment such as air, soiland water, create the ecosystem.

Few ecosystems are less affected by a certain level of human interference. But some are highly effectedand quickly destroyed by human actions. Mountains are extremely sensitive as degradation of forests leads to heavy soil erosion.Similarly, Island ecosystems are easily disturbed by any form of human activity which can lead to the speedyloss of their unique species. Wetland and riverecosystems also affected by pollution and changes in surrounding land use.

3.2 Kinds of ecosystem

Different types of ecosystem found in nature, collectively constitute the large ecosystem called biosphere. The ecosystem is of two types:

1. **Artificial ecosystems:** These are artificially created and managed by man. These may be: Terrestrial (agricultural land) and aquatic ecosystem (aquarium).
2. **Natural ecosystems:** These ecosystemsworkthemselves under natural conditions without any interference by man. Natural ecosystem further divided into 2 ecosystems:

a. Terrestrial like grassland, desert and forest
b. Aquatic such as marine and fresh water.

3.3 Ecosystem Structure

Ecosystem is composed of the biotic assemblage of animals, plants and microbes and abiotic physico-chemical components like air, water and soil. Every living component is in some way dependent on each other. Plants are food for herbivorous which are in turn food for carnivorous. Thus, there are various tropic levels in the ecosystem. Some microorganisms such as bacteria and fungi live on inorganic and dead material. These components and their interaction form a stable, natural and self-sufficient ecological functional unit. The structure of ecosystem is characterised by:

1. The composition of biotic communities
2. The range of existing environmental conditions like light, temperature, rainfall *etc*.
3. Distribution and quantity of abiotic components like nutrients, water *etc*.

Ecosystem is mainly formed from two major components:

1. Living (biotic) components
2. Non-living (abiotic) components

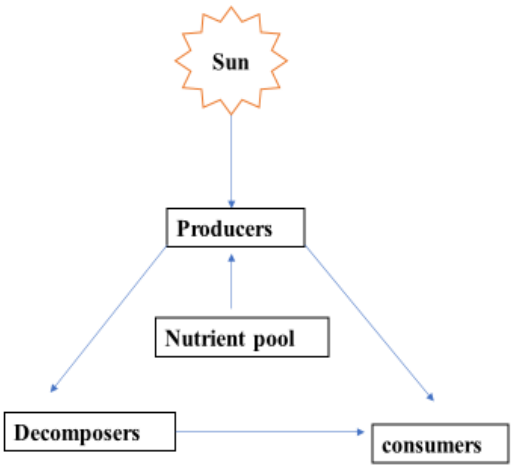


Figure 3.1: Schematic representation of structure of ecosystem

3.3.1 Living components

This includes the living organism and is divided into two major categories on the basis of their nutritional interdependence.

i. Autotrophic components
ii. Heterotrophic components

Autotrophic components

These include the photosynthetic organisms which are able to synthesize their organic food by using sun energy and by using simple inorganic substances through the process of photosynthesis. These may be herbs, shrubs and trees or photosynthetic, microscopic phytoplankton and large seaweed.

Figure 3.2: Different types of autotrophs

Heterotrophic components

These include those components which use either producers or decompose complex organic food particles. These organisms are known as consumers. They don't have photosynthetic pigment chlorophyll. Depending upon their food,heterotopic organismsare further divided into five categories

Herbivorous

Herbivorous are primary consumers they feed on the producers. The herbivorous animals includeblackbuck, chinkara, cow, elephants, deerand goat that live on plants. They graze on grass or feed on the foliage from trees. In aquatic ecosystem small fish that live on algae and other aquatic plants comes under this category.

Carnivorous

At a higher tropic level, carnivorous or secondary consumers, live on herbivorous. In terrestrial ecosystem, common carnivorous animals are jackals, foxes, tigers, leopards and small wild cats. In aquatic system carnivorous fish live on other small fish and aquatic animals.

Decomposers or detrivores

These are group of non-green, microscopic organisms consisting of worms, insects, bacteria and fungi, which breakdown large dead organic material into small and simple substances that are used as nutritionby plants. Decomposer are vital for the recycling of the nutrients in the ecosystem.

The producer, consumers and decomposers are important biotic componentsof an ecosystem and mainly considered as three functional kingdoms of nature. Though the ecosystem

has animals or macroconsumers as their integral part the basic requirements of self-sufficient ecosystem are:

1. Inorganic nutrients (CO_2 and H_2O)
2. A source of energy (Sun)
3. Producers(plants)
4. Decomposers (fungi and bacteria)

3.4 Function of ecosystem

Function of an ecosystem pertains to exchange of energy and nutrients between living and non-living components of the ecosystem. In an ecosystem, two process occur simultaneously.

Energy flow: Plants gain energy from sun and pass it into different components of ecosystem through food chain

Biogeochemical cycles: Various nutrients, minerals and water are also exchanged between biotic and abiotic components of ecosystem. Bio-geochemical flow is cyclic in nature while energy is non-cyclic.

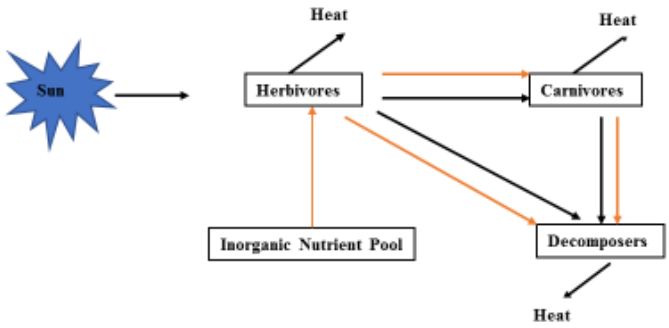


Figure 3.3: Function of ecosystem: unidirectional energy flow is shown with light arrow and cyclic nutrient flow is shown with dark arrow

3.5 Major ecosystem types

On the basis of functions, structure and characteristics some major ecosystem found on earth:

3.5.1 Terrestrial ecosystem

A community of organisms and their environment that occurs on the land masses of island and continents.The terrestrial part of the biosphere is divisible into vast regions called biomes.No two biomes are similar, they are categorized, by different climatic conditions, flora and fauna, and soil type.Terrestrial ecosystem is of three types: forest, grassland and desert ecosystem.

Forest ecosystem

These ecosystemsare dominated by large trees that are interspersed with herbs, shrubs, lichens, climbers and a huge variety of wild animals. Depending upon the climatic conditions forest ecosystem can be of different types:

Tropical Rain Forests:

These are broadleaf evergreen forests mainly found along equator and near to equator. This area is featured by high humidity, temperature and rainfall. Climatic condition remains stable and uniform throughout the year. Tropical forest is stratified into different layers the understory trees receive dim sunlight and the ground layer known as forest floor do not receive any sunlight.

Tropical deciduous forest:

These forests commonly found little away from equator. Rain occurs during monsoon season and these are featured by warm temperature throughout the year. Therefore, different types of deciduous trees are found here.

Tropical scrub forests:

Dry season is longer and prolong warm climatic condition. Here small deciduous trees and shrubs are found.

Temperate rain forest:

These forests characterized by grasses but large trees and shrubs are absent. They have hot summer and cold winter with an average annual rainfall is 25-75 cm. these forests dominated by pines, redwoods and firs.

Temperate deciduous forests:

They are found in areas with moderate temperature. There is a featured seasonality with long summer period, cold winter and abundant rainfall throughout year. The major plants include deciduous broad leaf trees like poplar, oak and hickory etc.

Evergreen coniferous forests:

These forests are found in south of arctic tundra. Winters are long, dry and cold. The major trees found in these forests are spruce, cedar, pines*etc*. Here sunlight is available for a very short period. The leaves are known as needles which fall on the forest floor. Soil are acidic and possess very few nutrients. Species diversity is low.

3.5.2 Grassland ecosystem

Grassland ecosystem is dominated by grass species but also permit the growth of some shrubs and trees. Average rainfall occurs, ranging from 15-75 cm per year. These are known by different names in different regions of the world like downs in Australia, steppes in Asia and

Europe, pampas in South America andveldt in South Africa. Three different types of grassland are found on earth:

Polar grasslands:

They are found in polar and arctic region. Soil cover with a thick layer of ice and remain frozen throughout the year, it is known as permafrost. Winters are long, cold, windy along with snow falling create too harsh condition for trees to grow. Summer remarked due to the presence of bogs and shallow lakes.

Temperate Grasslands:

These grasslands are outstanding for farming because of their profound and nutrient-rich soils. They receive 25 to 75 cm of rain a year. They are mainly found in gentle and flat sloped hills. Summer is dry and hot but winter is cold. Summer fires and overgrazing prevent tree growth in these ecosystems.

Tropical grasslands:

Tropical grasslands are warm throughout year with recognized rainy and dry seasons. During the rainy season, tropical grasslands obtain between 50-130 cm of rain. Most distinguished tropical grasslands are the African savanna, contain very few trees and is home to many of the spectacular animal species, such as antelopes, lions, elephants, giraffes, gazelle and zebras. During summers, fires are very common.

3.5.3 Desert ecosystem

This ecosystem is found in the region where evaporation is more than the precipitation. Rainfall is less than 25 cm per year. Climatic condition is very dry. Based on the climatic conditions desert ecosystem are of three types:

Tropical desert:

Wind-blow with sand dunes is very common. Namib and Sahara Desert in Africa and Thar Desert of India is the driest pace of the world.

Temperate desert:

Day temperature is extremely hot in summer but cool in winters like Mojave in California.

Cold desert:

This ecosystem featured by cold winter and hot summer like Gobi Desert in China.

3.5.4 Aquatic ecosystem

Aquatic ecosystem deals with diverse water bodies and biotic communities present in them like marine and fresh water bodies. Fresh water bodies further are of two types: lotic (free

moving water bodies like rivers) and lentic (standing types like ponds and lakes).Different types of aquatic ecosystems are as follows:

Freshwater Ecosystem:

These ecosystems cover only a minor portion of the earth which is nearly 0.8 percent. Freshwater means ponds, lakes, rivers, streams, wetlands, bog and temporary pools.Freshwater habitats are further classified into lentic and lotic habitats.

Lotic Ecosystems:

These are the swiftly flowing waters that move unidirectionally including the stream and rivers. Furthermore, these environments have numerous species such as beetles, mayflies, stoneflies and several species of fishes including trout, eel, minnow, etc.

Lentic Ecosystems:

They include standing water bodies like lakes and ponds. These ecosystems contain algae, crabs, shrimps, frogs and salamanders.

Wetlands:

Wetlands are marshy and sometimes covered with water which has a wide variety of plants and animals. Swamps, marshes, bogs, black spruce and water lilies are the main examples of the plant species. The animal life of this ecosystem consists of dragonflies, damselflies and various birds and fishes.

Marine Aquatic Ecosystem:

Marine ecosystem covers amajorpart of earth surface. Two-thirds of the earth surface is covered by water which constitutes oceans, seas, intertidal zone, reefs, seabed, *etc*. Form of each life is unique and native to its habitat.

Ocean Ecosystems:

Our earth is having five major oceans; these oceans are like a home to more than five lakh aquatic species. Some species of this ecosystem include shellfish, Shark, Tube Worms, Crab Small and large ocean fishes.

Coastal Systems:

These are open systems of land and water, joined together to form the coastal ecosystems. A wide variety of species of aquatic plants and algae live in the bottom of it. The diverse fauna consists of crabs, fish, insects, lobsters' snails, shrimp, *etc*.

3.6 Energy Flow in an Ecosystem

In any ecosystem there should be unidirectional flow of energy. Energy required by all living organisms is obtained from the chemical energy of their food. This chemical energy is

obtained by the conversion of the light energy of sun which is the main and primary source of energy on earth. Only 1.5% of sun light is used by producers for synthesis of organic food (glucose) through the process of photosynthesis. During photosynthesis radiant sun energy is converted into potential energy of organic food. The energy conserving capacity is 10-20% for sugarcane field, 5% for modern crop, 1.15% for grassland and 0.8% for mixed forest. The green plants consume a part of organic food obtain chemical energy for various functions. Dissipation of energy occurs as heat.

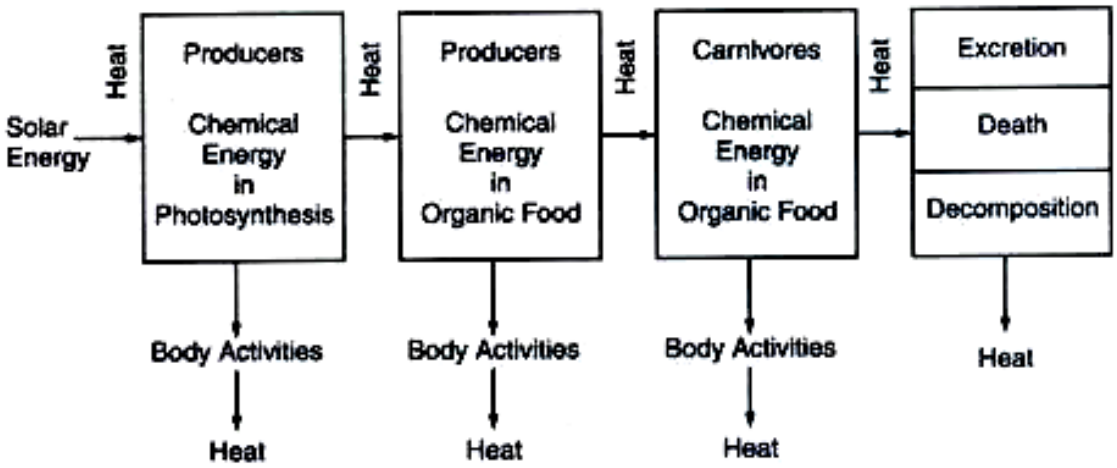


Figure 3.4: Energy flow in an ecosystem

The remaining energy used in the synthesis of body biomass is called net photosynthesis which would available to next tropic level. This loss of energy is not due to inefficiency of photosynthesis but is due to occurrence of second law of thermodynamics. The total biomass synthesized by the plants during photosynthesis is known as gross primary productivity and represented by PG. A part of this energy is used by the plants themselves for respiration (R), the remaining biomass is known as net primary productivity (PN). It can be shown by:PN= PG-R

When a primary consumer eats a producer, it oxidizes the food to liberate energy required for synthesis of organic food by plants. Some energy lost in form of heat while only a part of it is used in formation of biomass of the herbivore, called gross secondary productivity. The similar trend repeats when a primary consumer is eaten by secondary consumer and so on. At each level, 80-90% of potential energy would be lost only 10-20% of energy would be available to next tropic level. So, the energy decreases when it passes from higher level to other.

Every ecosystem has several interrelated mechanisms that affect human life. These are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle.

While every ecosystem is controlled by these cycles, in each ecosystem its abiotic and biotic features are distinct from each other.

Table 3.1: Annual average gross primary productivity of some major ecosystem

Ecosystem	Gross primary productivity (K Cal/m^2/year)
Agro-ecosystem	12,000
Desert	200
Estuaries	20,000
Grassland	2,500
Moist-temperate forests	8,000
Open ocean	1,000
Tundra	200
Wet-tropical forests	20,000

Energy flow generally two laws of thermodynamics:

First law of thermodynamics:

It states that the energy cannot have created nor be destroyed; it can be transformed from one form to another. The solar energy captured by plants gets converted into biochemical energy and then transformed at consumer level.

Second law of thermodynamics:

It states that the energy would be loss as it is used. The loss of energy takes place through respiration and other physical activities.

All the functions of the ecosystem are in some way or other related to the growth and regeneration of its plant and animal species. These linked processes can be depicted as the various cycles and depends on energy from sunlight. During photosynthesis carbon dioxide is taken up by plants and oxygen is released. Animals depend on this oxygen for their respiration. The water cycle depends on the rainfall, which is necessary for plants and animals to live. The energy cycle recycles nutrients into the soil on which plant life grows. Our own lives are closely linked to the proper functioning of these cycles of life. If human activities go on altering them, humanity cannot survive on earth.

Energy flow models

The flow of energy through different trophic levels in an ecosystem can be explained by different energy flow models:

Universal energy flow model:

Universal energy flow model is given by E.P. Odum. According to this model as energy flow, there is gradual loss of energy at each level. It causes the less amount of energy available at next trophic level. The loss of energy is known as not utilized (NU). Energy loss in respiration R for maintains. Remaining energy is use for production (P).

Single channel energy flow model:

The energy flow is unidirectional manner through a single channel from producer to herbivores to carnivores.

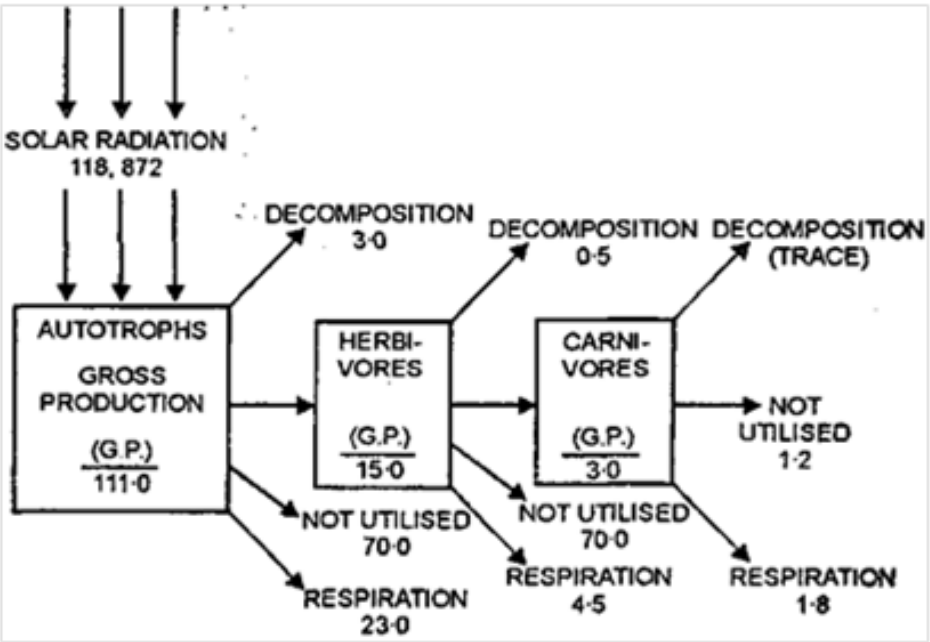


Figure 3.5: Single channel energy flow model (given by Lindeman)

Y-shaped and double channel energy flow model:

This model show that energy flow and passage occur through two different food chains which are separated in both time and space like grazing and detritus food chain operated in same ecosystem.

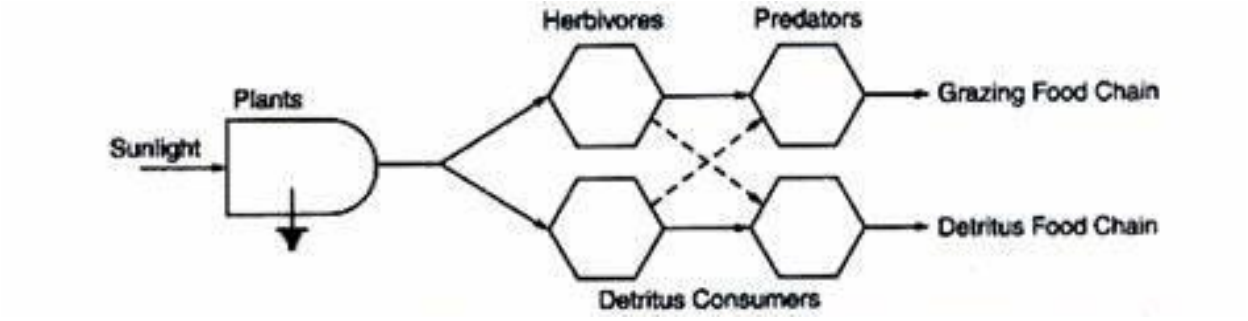


Figure 3.6: Y-shaped energy flow model of an ecosystem (E. P. Odum)

3.7 Biogeochemical cycle

The cyclic pathway through which the important elements circulate in biosphere from organism to environment and return back to its origin are known as biogeochemical cycles. There are two different types of cycle:

a. Gaseous cycle: It involves movement of gaseous substances like oxygen, nitrogen, carbon and water.

b. Sedimentary cycles: It involves circular movement of non-gaseous materials like calcium, phosphorus and magnesium.

Carbon Cycle

After sometimes man interference disturbs the ordinary nutrient cycle and create several disparities. For example, nature has a well-balanced carbon cycle (Fig. 3.7)

- Carbon mainly exist in the form of carbon dioxide in atmosphere and taken up by plants as a raw material for photosynthesis. Through photosynthesis different kinds of carbohydrates and some other organic substances are produced.
- By food chain int transfer and finally organic carbon present in dead organic matter is returned to the atmosphere as carbon dioxide produce by microorganism.
- Carbon dioxide also produces by respiration, while the latter is used by plants.

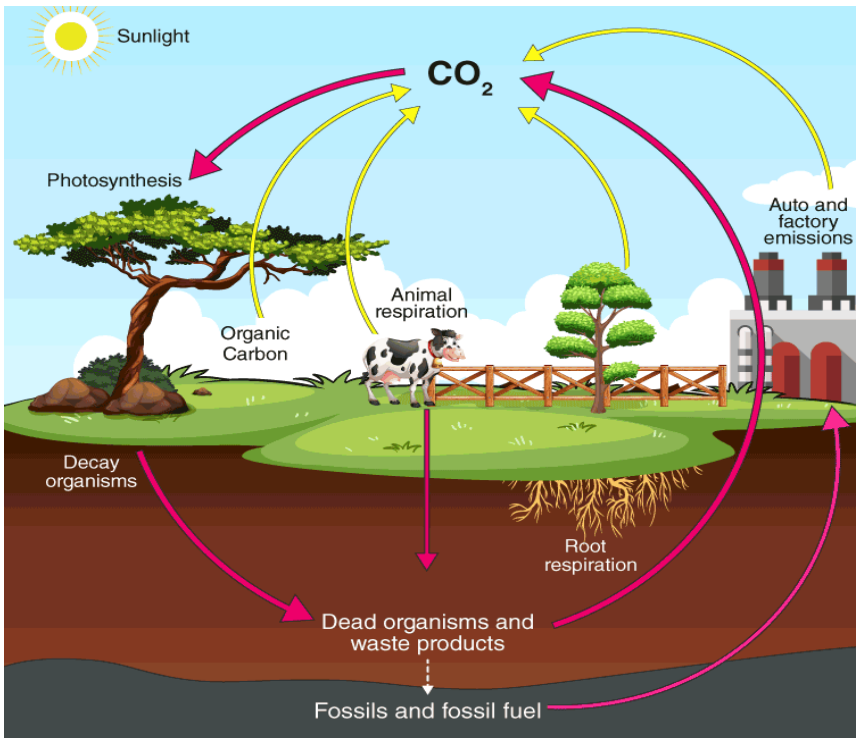


Figure 3.7: Carbon cycle

Nitrogen Cycle

Cycling of one of the most important nutrient nitrogen is given in Figure 3.8

- 78% of nitrogen is present in the atmosphere and it is fixed either by some physical process of lightening or biologically by some cyanobacteriaand bacteria.
- The nitrogen is basically taken up by plants and used in basic metabolism for production of proteins, amino-acid, vitamins, lipids *etc.* and passes through the food chain.
- After of animals and plants, the organic nitrogen in dead tissue is decomposed by various nitrifying and ammonifying bacteria which convert organic matters into ammonia, nitrates and nitrites, which further used by plants.
- Some microorganism converts nitrates into N2 which released back into atmosphere and cycle goes on.
- Some of nitrogen lost into deep sediment of ocean.

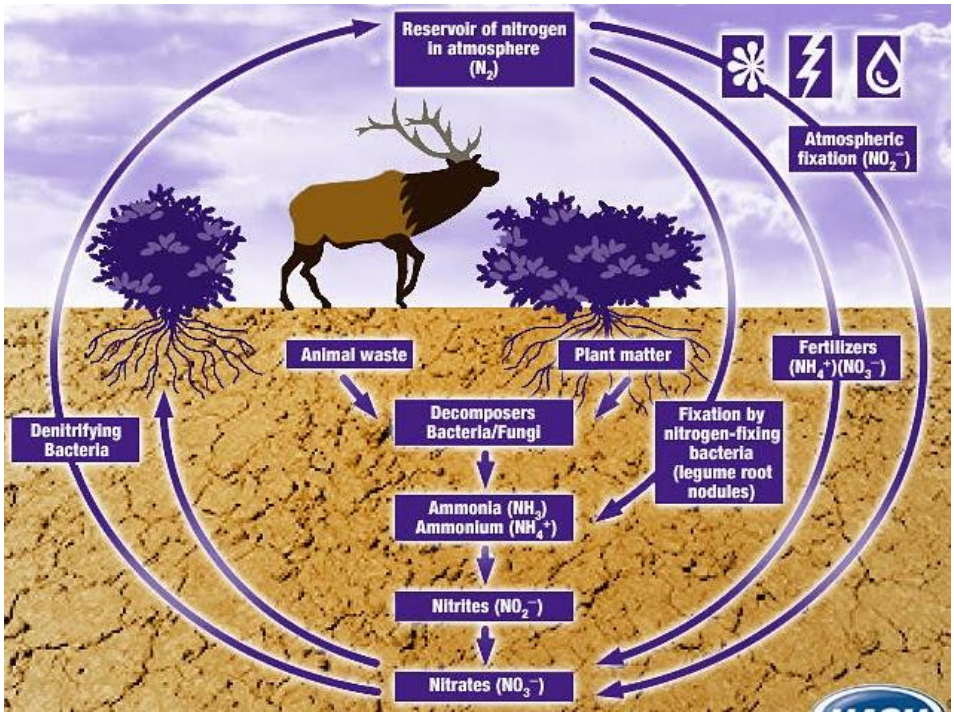


Figure 3.8: Nitrogen cycle- a gaseous cycle

Phosphorous cycle

It is an important sedimentary nutrient cycle, which shown in figure 3.9. The main reservoir of phosphorus lies in fossils, rocks etc. which mined by human for using it as a fertilizer to enhance the agricultural yields. Farmers use phosphate indiscriminately and as a result excess of it lost as run-off, which enhance the problem of over-nourishment and eutrophication in lakes leading to growth of algal blooms.

A significant portion of phosphates lost in deep ocean along with surface run-off water. On the other hand, sea birds play a significant role phosphorous cycle. They eat phosphorus rich

sea fishes and dropping their excreta on the land. The Guano deposits on the coast of Peru are rich source of phosphorus.

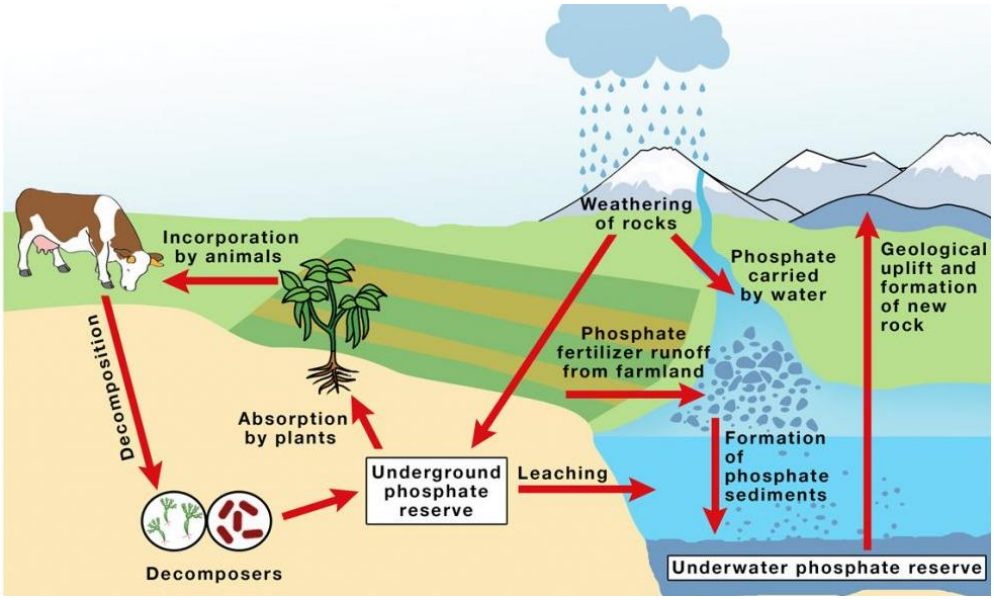


Figure 3.9: Phosphorus cycle

3.8 Trophic levels

The organisms which derive their energy from same sources and same number of steps are assumed to belong to the same trophic level. Thus, the producers, which derive their energy from sun belong to first trophic level or T1. All the primary consumers or herbivores animals derive their food from producers are belong of second trophic level or T2, whereas all secondary consumer or carnivores'animals belongs to third or T3 trophic level and the tertiary consumers belongs to fourth trophic level T4. Decomposers are the last of detritus trophic level.

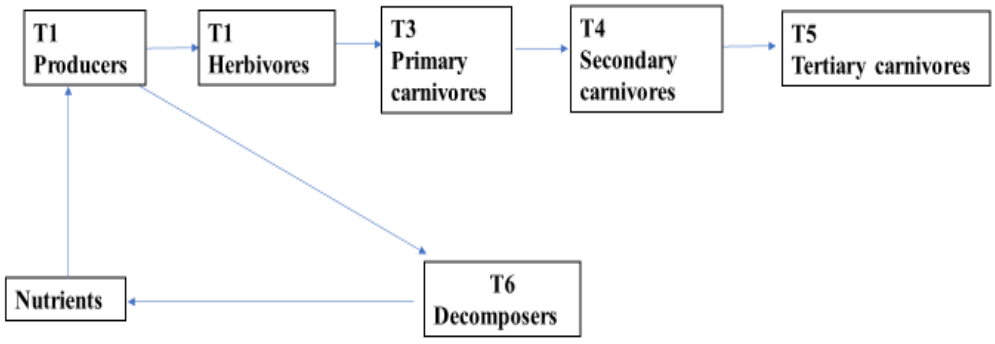


Figure 3.10: Different Trophic Levels of an Ecosystem

The food chains

The most understandablecharacteristic of ecosystem is flow of energy from one living organism to another. When herbivorous feed on plants energy transforms from plants to animals.

In an ecosystem, some of the animals feed on other living organisms, while few feeds on dead organic matter. The latter form is 'detritus' food chain.

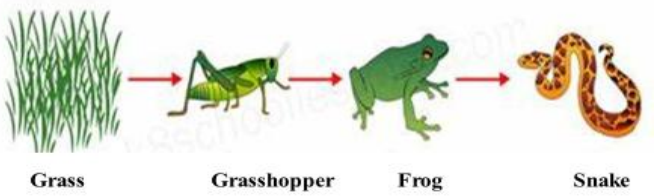


Figure 3.11: Grassland food chain

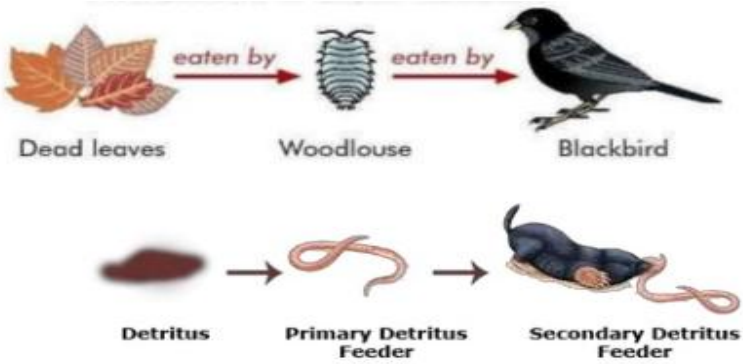
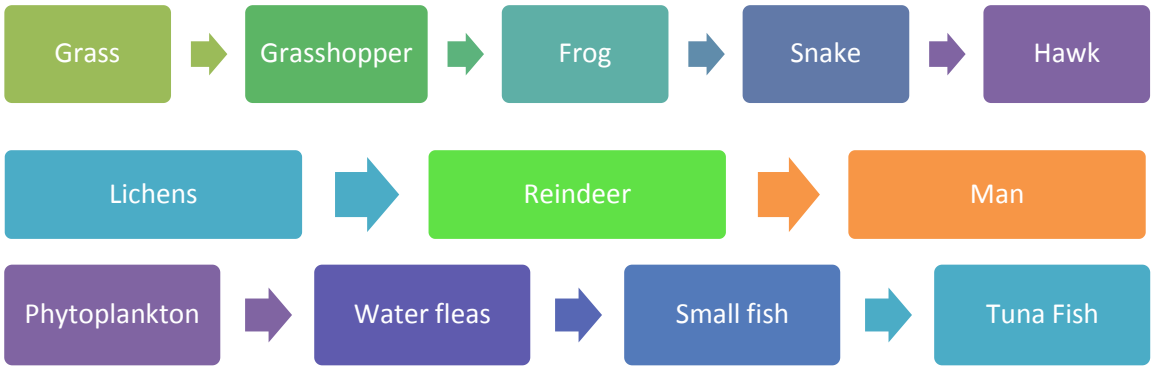


Figure 3.12: Detritus food chain

At each linkage in the chain, a major part of the energy from the food would be lost for daily activities. Usually in each chain there are four to five trophic levels. Shorter food chain will transfer more energy and vice-versa. In a food chain, a single species may be linked to a large number of species.

Some common example of food chains:



The food webs

It is an interconnected network of food chains which are interconnected at different trophic level. This linkage forms a food web. A food web generally formed of three different type of food chains: parasitic, predatory and saprophytic chains. Food web checks overpopulation of highly fecundate species of animal and plants. If the linkages in the chains that

make up the web of life are disrupted due to human activities that lead to the loss of species, the web breaks down.

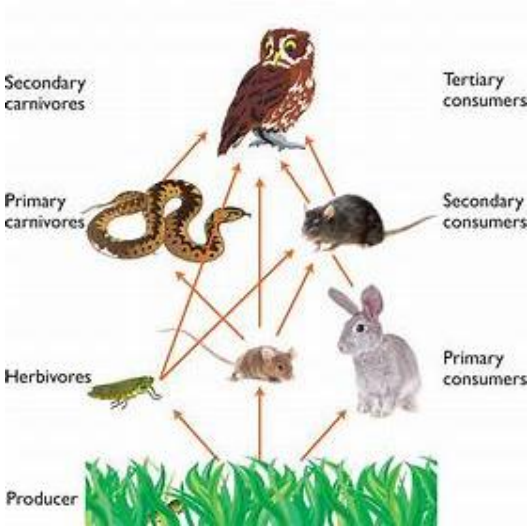


Figure 3.13: Food web

Nature evolved the food web in ecosystem toprovides stability to the ecosystem. In a straight food chain, if one species become extinct then the species from other trophic level can be used as a food. In a food web there are a number of options available at each trophic level.

3.9 The ecological pyramids

Graphical representation of ecological parameters like biomass, accumulated energy and number at various trophic levels in a food chain of an ecosystem is known as ecological pyramid. Pyramid may be of upright, inverted or spindle shape depending upon number and size of producers. On the basis of ecological parameters, pyramids may be of three types:

Pyramids of number:

In this the graphic representation show the population size (number of individuals) at per unit area at different tropic levels of food chain at any time in an ecosystem.

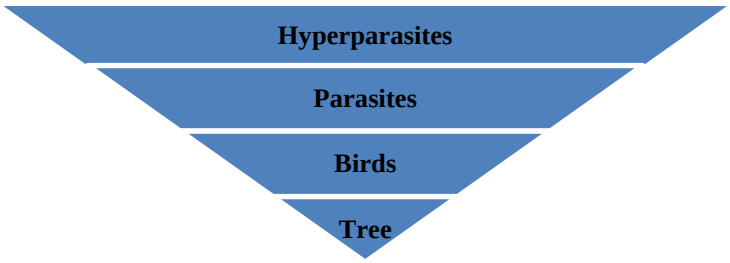


Figure 3.14: Pyramid of Number is inverted in a parasitic food chain

Pyramids of biomass:

Total amount of organic and living matter in an ecosystem at a particular time is called biomass. Biomass pyramid is the graphic representation of biomass present per unit area of different trophic level.

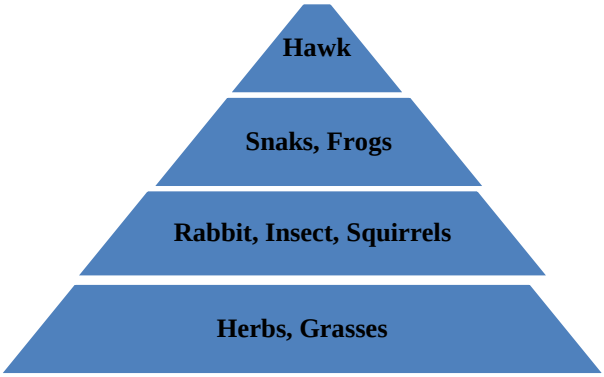


Figure 3.15: Pyramid of biomass in a grassland

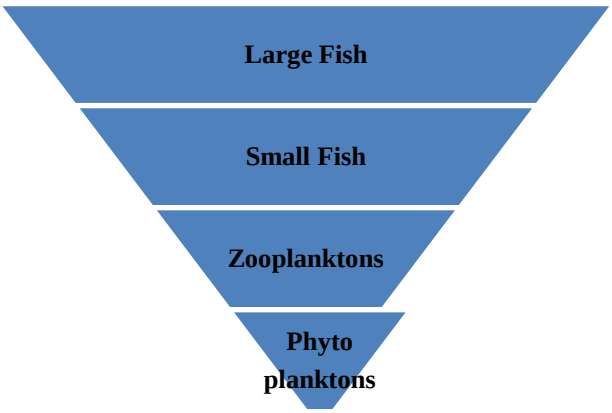


Figure 3.16: Pyramid of biomass in a pond ecosystem

Pyramids of energy:

It is representation of amount of energy trapped per unit time and area at different trophic levels of a food chain. Pyramids of energy are always straight and upright.

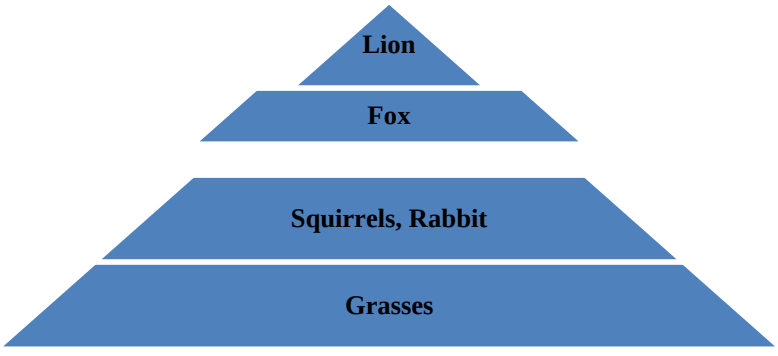


Figure 3.17: Pyramid of energy in a grassland ecosystem

3.10 Ecological succession

The orderly process by which the structure and function of a biological community change over time is called as Ecological succession. Each stage of succession is known as sere.

3.10.1 Types of succession

Primary succession:

It occurs in bare and lifeless areas, regions in which the soil is incapable of sustaining life.

Secondary succession:

It occurs in areas where formerly existed community has been removed; it is typified by small-scale disturbances that do not eliminate all life and nutrients from the environment.

Autotropic succession:

There is dominance of green plants (autotrophs) in this succession and substratum is rich in inorganic matters.

Heterotrophic succession:

Heterotrophs dominate here and substratum is rich in organic matters.

Autogenic succession:

In this, the already existing community reacts with environment and changes its own environment. It causes its own replacement with new community.

Allogenic succession:

In this, external conditions and physical factors are unsuitable for existing community.

3.10.2 Mechanism of succession

The complete process of succession is completed through a number of steps. These steps occur in sequence:

1. **Nudation**: It the development of bare area due to deforestation, soil erosion, land slide and soil deposition.
2. **Migration**: the seed and propagule of the organism reach to bare land through migration. It occurs through air, animal, water and man. The first species appear on a bare land is known as pioneer.
3. **Ecesis**: Stabilization of a new species on a new area, as a consequence of adjustment with the new environmental condition.
4. **Aggregation**: After stabilization, the increase in number of individuals is called aggregation.
5. **Invasion**: From time to time new species go on reaching area under colonisation. If they are able to establish in the new area, this process is known as invasion.
6. **Competition and coaction:** After aggregation of a large number of the species in the limited space and nutrition. The individual species start affecting each other in many different ways. This is known as coaction.

7. **Reaction**: The colonizer species induce some changes in soil, water and temperature of habit. Because of all these, the environment starts changing which is known as reaction.
8. **Stabilization**: Continuous competition, reaction and invasion modified the environment and vegetation also. After a long time, some individual arise which shows harmony with the climate. They become dominant and are able to create condition, which are favourable for their own growth. No further change occurs in flora. This vegetation is known as climax community.

3.10.3 Hydrosere

It is a type of succession taking place in an aquatic environment. Hydroserestarts with anestablishment of phytoplankton and lastly reaches a climax forest stage. The various sere stages of succession are given below.

1**. Phytoplankton Stage**

Phytoplanktons and zooplanktons are the initial and pioneer settlers in aquatic body. These organisms add large amount of organic matter and nutrients, which settle at the bottom of pond.

2. Rooted submerged stage

As a result of death and decomposition of phytoplankton's a soft mud develops at the bottom of pond. This new habitat now becomes suitable for the growth of rooted hydrophytes like *Myriophyllum, Elodea, Hydrilla, Potomogetan, Vallisneria, Utricularia etc*. These plants further build up the substratum. This new habitat now replaces these plants giving way to another type of plants of floating types.

3. Floating stage

In the beginning the submerged and floating plants grow intermingled but very soon the submerged plants are replaced completely. The habitat becomes changed chemically as well as physically. The dead remains of plants are deposited at the bottom. The substratum rises up in vertical direction. The important plants of this stage are *Nelumbium, Trapa, Pistia, Nymphaea* and*Limnanthemum*.

4. Reed-swamp stage

This stage is also known as 'amphibious' stage as the plants of this community are rooted but most parts of their shoots remain exposed to air, species of *Scirpus, Typha, Sagittaria* and *Phragmitesetc*. are chief plants of this stage. Their rhizomes form a dense vegetation. The water level is very much reduced and becomes unsuitable for growth of these amphibious species.

5. Sedge meadow stage

Further decrease in water level changes the nature of substratum. Species of some Cyperaceae and Gramineae such as *Carex, Juncus, Cyperus* and *Eleocharis* colonise the area to form marsh or swamp. Thus, mesic conditions approach the area and marshy vegetation disappears gradually.

6. Woodland stage

In the beginning some shrubs and later medium sized trees form open vegetation or woodland. These plants produce more shade. They render the habitat drier. The prominent plants of woodland community are species of *Butea, Acacia, Cassia, Terminalia, Salix, Cephalanthusetc.*

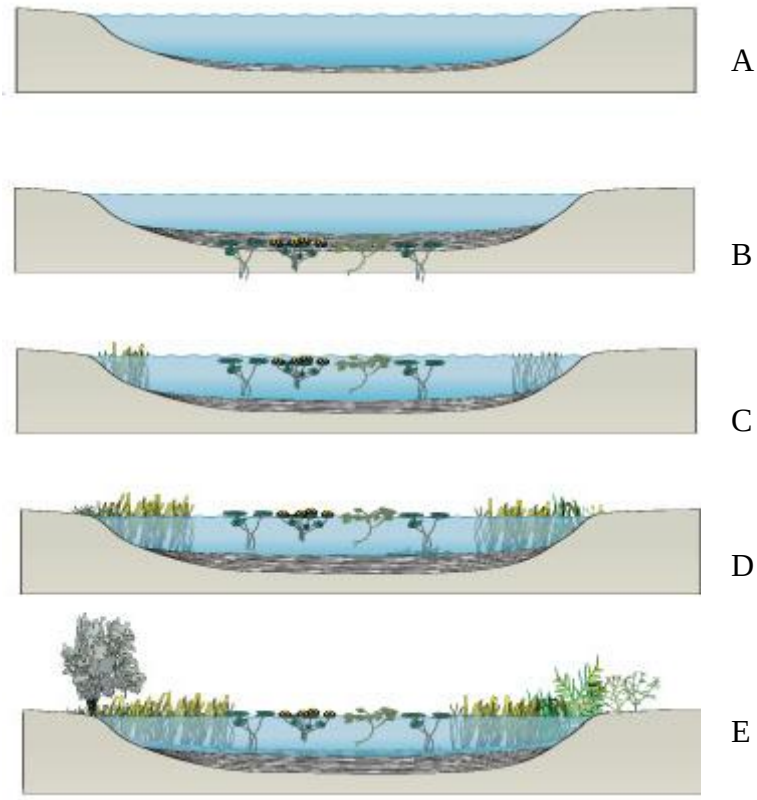


Figure 3.18: Hydroseric succession through different stages A to E depict slow silting of pond decreasing water depth and finally formed terrestrial climax community

7. Forest stage

This is the climax community invaded by several trees. In tropical climate with heavy rainfall there develop tropical rain forests. In temperate regions, mixed forest of *Almus, Acer* and *Quercus* are formed.

3.10.4 Xerosere

The Xerosere originates on rock surfaces which is in an unweather state. The pioneers to colonize these primitive types of substratum are lichens. In a Xerosere successive, changes take place in both plants and animals. The various stages are described below.

1. Crustose - lichen stage

The soil is absent for the complete penetration of roots. Blue-green algae and lichens are the pioneer species. In cooler climates, crustose lichens like *Rhizocarpon, Rinodina* and *Lecanora* are the common pioneers. They produce acids which bring about weathering of rocks. The dead organic matter of algae and lichens become mixed with the small particles of rocks to form a thin layer of moist soil on the rocks.

2. Foliose - lichen stage

They appear on the substratum partially built up by the crustose lichens. It includes species of *Parmelia*and*Dermatocarpon* which have large leaf-like thalli. The weathering of rocks mixed with humus results in the development of a fine thin soil layer on rock surface and thus there is a change in the habitat.

3. Moss-stage

The development of thin humus-rich soil layer on rock surface favours the growth of certain xerophytic mosses such as *Grimmia, Tortula, Polytrichum, Bryum, Barbula* and *Funaria*.

4. Herb-stage

Due to the extensive growth of mosses, more soil accumulates. Minerals are added to it due to leaching. This favour the growth of some herbaceous plants like *Aristida, Festuca, Justicia, Tridax etc.*

5. Shrub-stage

Due to much accumulation of soil, the habitat becomes suitable for shrubs. Species of *Rhus, Phytocarpus, Zizyphus* and *Capparis* dominate this stage. The shrubs overshadow the herbaceous vegetation and produce more organic matter.

6. Forest-stage

It represents the climax community. Due to the weathering of rocks, thin layer of soil is formed, which supports small trees like *Acacia, Prosopis, Boswelliaetc*. Plants require high rainfall to reach climax stage. In moist and wet climates and also in temperate climates dense climax forest is developed.

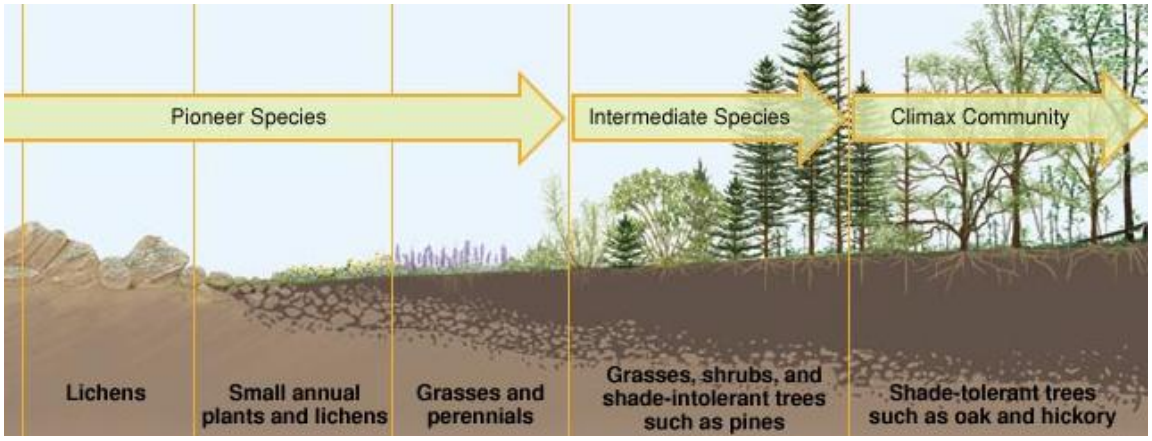


Figure 3.19: Different stages of Xeroseric succession

3.10.5 Characteristics of succession

1. It results from alteration of the physical environment of the community.
2. It moves towards stable biotic community from unstable i.e. adjustment with present environmental condition.
3. It is an orderly process of community development.
4. It is intermediate and seral stages are directional and definite that an ecologist is able to predict the future communities.
5. It involves variations in species structure and increases in biomass, humus content of soil, diversity of species and niche specialization.
6. Nutrient variation determines the settlement of new community.
7. It tends to move from simple food chains to complex food webs.
8. Succession cumulates in a stabilized ecosystem.

3.10.6 Importance of succession:

The succession is of great importance in different activities of human.

1. It assistsin forest management programmes and reforestation.
2. It also provides information, which assist controlled growth of other species in forest by preventing invasion.
3. Pasture can be maintained by not permitting biotic succession to proceed through fire and grazing.

Exercise

Very short answer type question

1. Who gave the term of ecosystem?
2. Describe the term ecology.

3. What is food chain?
4. What is trophic level?
5. Name the two main components of the ecosystem.
6. Define biome.
7. What are biogeochemical cycles?
8. What is lotic ecosystem
9. What is seral stage?
10. What is climax community?
11. What are ecological pyramids?
12. Define ecological successions.
13. Define desert ecosystem.
14. Give the name and types of important ecosystem.
15. What are estuaries?
16. What are saprophytes?
17. What is food web?
18. Define biotic components of an ecosystem.
19. What are decomposers?
20. What is primary productivity?

Long answer type question

1. What isan ecosystem? Describe in details about biotic and abiotic components of ecosystem.
2. What are the biogeochemical cycles? Explain their types diagrammatically.
3. Discuss the salient feature of aquatic ecosystem.
4. Describe energy flow in ecosystem and briefly given description of energy flow models.
5. Discus the complete process of succession.
6. What are ecological pyramids? Explain its types in different type of ecosystems.
7. What is the decomposer and explain its role in the function of ecosystem?
8. Write a note of forest ecosystem.
9. What are food chains and food webs? Explain with example and discus its significance.
10. Explain the process of succession on hydrosere and xerosere.
11. Describe the characteristics feature of grassland ecosystem.
12. Describe the characteristics features of desert ecosystem.

CHAPTER 4 | Biodiversity and its conservation

4.1 Biodiversity

The term biodiversity was firstly coined by E. O. Wilson in 1985. Biodiversity may be defined as the variability and richness of living organisms and the ecological systems in which they exist. In other words, biodiversity is the occurrence of different species, types of ecosystems, with the whole range of their genes and variants adapted to different environments along with their interactions with each other and processes.

4.2 Levels of Biodiversity

Biodiversity is found at three different levels:

1. Genetic Diversity
2. Species Diversity
3. Ecosystem Diversity

1. Genetic diversity

Genetic diversity describes the dissimilarity in the types and number of chromosomes as well as genes present in different species. The degree of diversity in genes of a species increases with increase in environmental parameters and size of the habitat.The genetic variabilityarises by chromosome and gene mutation in individuals and in sexually reproducing organisms, and it is mainly spread in the population by genetic recombination during cell division.

2. Species diversity

This is the richness and number of the species within a given region. The species diversity may be defined as the number of different species per unit area. The richness of a species tells about the degree of biodiversity of a particular site and also provides a means for comparing different places. The species richness depends on climatic conditions. The number of individuals of various species with in a region represents species equitability and evenness. Species richness and evenness also provide species diversity of a region. When a species is limited to a specific area, it is called as endemic species.

3. Ecosystem diversity

It relates varieties of biotic communities, habitats and ecological processes in biosphere. It tells about the variability within the ecosystem. It is stated as land escape diversity because it also includes size and placement of various ecosystems.For example, the landscapes like deserts, grass lands, forest, mountains etc. show ecosystem diversity. The ecosystem diversity arisesdue to diversity of trophic level, nichesand ecological processes Such type of diversity can create more stable and productive ecosystems or communities capable of enduringdifferent types of stresses *e.g.* drought, flood *etc*.

4.3 Biogeographic classification of India

Biotic communities may not be similar at two different localities. India has a rich heritage of bio-diversity and also occupied 10th position among biodiversity rich nations. Biogeography comprise of zoogeography and phytogeography concerning distribution of plants and animals. In order to improve vision about the distribution and environmental interaction of plant and animals of India, it has been divided into ten biographic regions. Each of these biogeographic regions has specific soil, topography and climatic conditions.

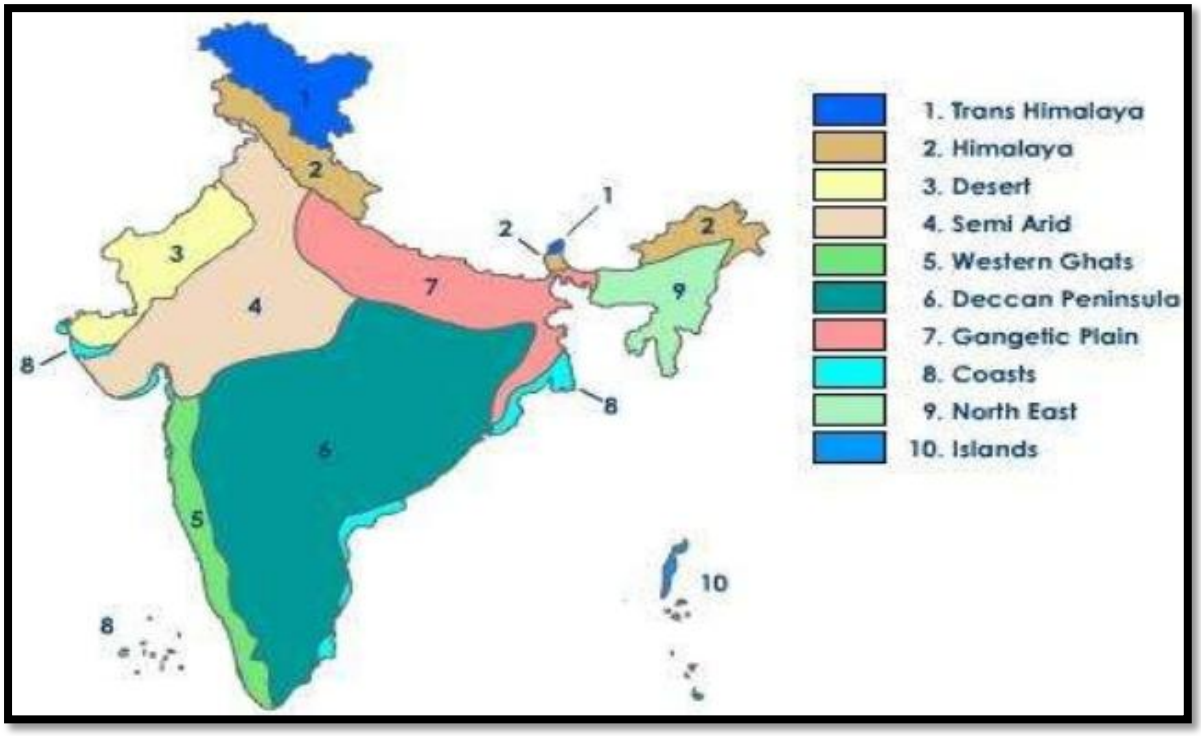


Figure 4.1: Major biogeographic zones of India

Table 4.1: Different biogeographic zones of India

Sr. No.	Biogeographic zone	Biotic province
1.	Trans-Himalayas	Tibetan Plateau, Laddakh, LahaulSpiti
2.	Himalayas	North-western to north-eastern
3.	Desert	Kutch, Thar, Ladakh
4.	Semi-Arid	Central India, Gujarat-Rajwara
5.	Western ghats	Hill and plains running along the western coast line
6.	Deccan peninsula	Southern and south-central plateau
7.	Gagnetic plain	Upper and lower Gagnetic plain
8.	North-east India	Plains and non-Himalayan hill ranges of north eastern India
9.	Islands	Andaman and Nicobar Islands
10.	Coasts	East and West coast

4.4 Importance of biodiversity

The living organisms on earth are of great diversity, they are living in different habitats possessing different qualities and are essentialfor human existence as they provideclothing, food, shelter, medicines *etc*.

The biodiversity has the following importance:

1. Productive values

Biodiversity produces a huge number of products which are harvested and sold in commercial markets. Indirectly it offers different economic assistances to people including water, soil, equalisation of climate, scientific research, recreation *etc*.

2. Consumptive value

The consumptive value of biodiversity can be assigned to goods such as woods, leaves and forest products *etc*. which may be used locally and do not count in national and international market.

3. Social value

Damage of biodiversity directly affects the social life of the country through influencing ecosystem processes (biogeochemical cycle and energy flow). This can be simply understood by detecting harmful effects of climate change, global warming and acid rain which cause a harmful modification in normal processes.

4. Aesthetic value

Aesthetic values like melodious songs of birds, taste of berries, softness of mossed, refreshing fragrance of the flowers, etc.force the human beings to save them. The earth's beauty with its hues, forest, river and graceful beasts has enthused the human beings to take vital steps for its conservation. Botanical and zoological gardens are the means of biodiversity conservation and are of aesthetic values.

5. Legal values

Since earth is homeland of all living organisms, all have equal right to coexist on the surface of earth with all benefits. Unless some legal value is attached to biodiversity, it will not be possible to protect the rapid extinction of species.

6. Ethical value

Biodiversity also holds some ethical value. Since man is the smartest amongst the living organisms, it should be prime accountability and moral obligation of man to conserve other living organisms which will directly or indirectly favour the survival of the man.

7. Ecological value

Biodiversity possess great ecological value because it is necessary to preserve the ecological balance. Any disturbance in the ecological balance maintained by various organisms, will lead to severe problems, which may threaten the survival of human beings.

8. Economic value

Biodiversity hold great economic value because economic development depends upon efficient economic management of different biotic resources.

Biodiversity value of few selected organism in monetary terms

- The mountain gorillas in Rwanda are fetching $ 4 million annually through eco-tourism.
- Kenyan elephant can earn 1 million $ as a tourist revenue.
- Tourism to Great Barrier Reef in Australia fetching 2 billion $ annually.
- Whale watching on Hervey Bay on Queensland's coast earn approximately 12 million $ each year.
- A tree provides 196,2150 $ worth of ecological services like clean air, oxygen, water recycling, fertile soil, wildlife habit etc.

4.5 Factors responsible for the loss of biodiversity

Biodiversity is considered as a huge reservoir of natural resources to be used for medicine, food, shelter, industrial products, *etc*. But with an increased demand of natural

resources due to rapid population growth, biodiversity is progressively depleting. A large number of plants and animal species have already become extinct and many are endangered.

The different factors responsible for loss of biodiversity are as follows:

1. Habitat destruction:

The main and primary cause of biodiversity loss is habitat destruction which is resulted due to the industrial and commercial activities associated with agriculture, fishing, construction of dams, irrigation, mining, *etc*.

2. Poaching of wild life:

From decades, humans use wild biodiversity for their basic needs. A number of wildlife species are becoming extinct due to poaching and hunting.

3. Habitat fragmentation:

With increased population, the habitats are fragmented into different pieces by canals, roads, fields, towns *etc*. The isolated piece of habitats limits the dispersal and colonization of species. In addition, the habitat fragmentation is also responsible for microclimatic changes like light, temperature, wind *etc.*

4. Pollution:

Pollution is the most crucial factor which increases the loss of biodiversity. It include air pollution, Water pollution, industrial pollution, pollution due to pesticides, radioactive materials *etc*.

5. Over exploitation:

The natural resources are exploited to meet thedemand of growing population, rural poverty, and globalization of economy. All these factors collectively responsible for the extinction of a number of species.

6. Natural calamities

Except human activities biodiversity is also damaged by some natural calamities like:

a. Drought, floods and earthquakes
b. Critically low population
c. Lack of pollinators
d. Diseases
e. Exotic and invasive species
f. Air, water and soil pollution

4.6 Extinction of species

Extinction means complete disappearance of species from earth; it is a natural and essential part of evolution. Current diversity on earth is a final product of extinction and

speciation from 3.8 billion years of life. Extinction occurs when environmental reasons or evolutionary difficulties cause a species to die out. The vanishing of species from Earth is ongoing, and rates of extinction varied with time. The fossil record showed that of all the species that have ever lived on earth, about 99.9 % have gone extinct. According to IUCN red list it is estimated that a quarter of mammals is at danger of extinction.

At some degree, extinction is natural phenomenon. Variations to habitats and poor reproductive ability are crucial among the factors that can make a species' mortality rate higher than its natality rate for long enough that eventually, none are left.Humans also cause other species to become extinct by overharvesting, hunting, pollution, introducing invasive species to the wild andby changing wetlands and forests to urban and croplands. Even the fast-humangrowth is causing extinction by debasementof natural habitats.

Among the most well-known species driven to extinction by man is the dodo. The normal extinction rate or background extinction rate is about one to five species per year. The rapid loss of species we are seeing today is projected by experts to be between 1,000 to 10,000 times higher than the natural extinction rate. Experts calculate that between 0.01 to 0.1% of all species will become extinct each year. In past 100 years, approximately 20 mammal's species and more than 40 bird's species have become extinct. The term biodiversity crisis is mainly used to describe this elevated species loss.

4.6.1 Mass extinction

There have been different periods in the earth's geological history when a huge mass of species become extinct due to catastrophes. Two most important mass extinctions happened at the end of Permian period and the second at the cretaceous period. More than 80% of species have been extinct in Permian period. In the cretaceous mass extinction at least half of species went extinct. Climatic condition, volcanic eruption, asteroidal collisions, change in habit, change in sea level are the major reasons behind the mass extinction.

4.6.2 Susceptibility to extinction

Susceptibility is not similar to all species. Some are more susceptible than other. The species with following characteristics are more susceptible to extinction:

Small population size

- Large body size
- Fixed migratory route
- Narrow range of niche distribution
- Feeding at high trophic level in food chain

- High specialization
- Poor dispersal rate
- Low reproductive rate

4.7 International Union for Conservation of Nature (IUCN) red list criteria and categories

IUCN Red List of Threatened Species, also called IUCN Red List, one of the most well-known objective assessment systems for classifying the status of plants, animals, and other organisms threatened with extinction. The IUCN unveiled this assessment system in 1994. It contains explicit criteria and categories to classify the conservation status of individual species on the basis of their probability of extinction.

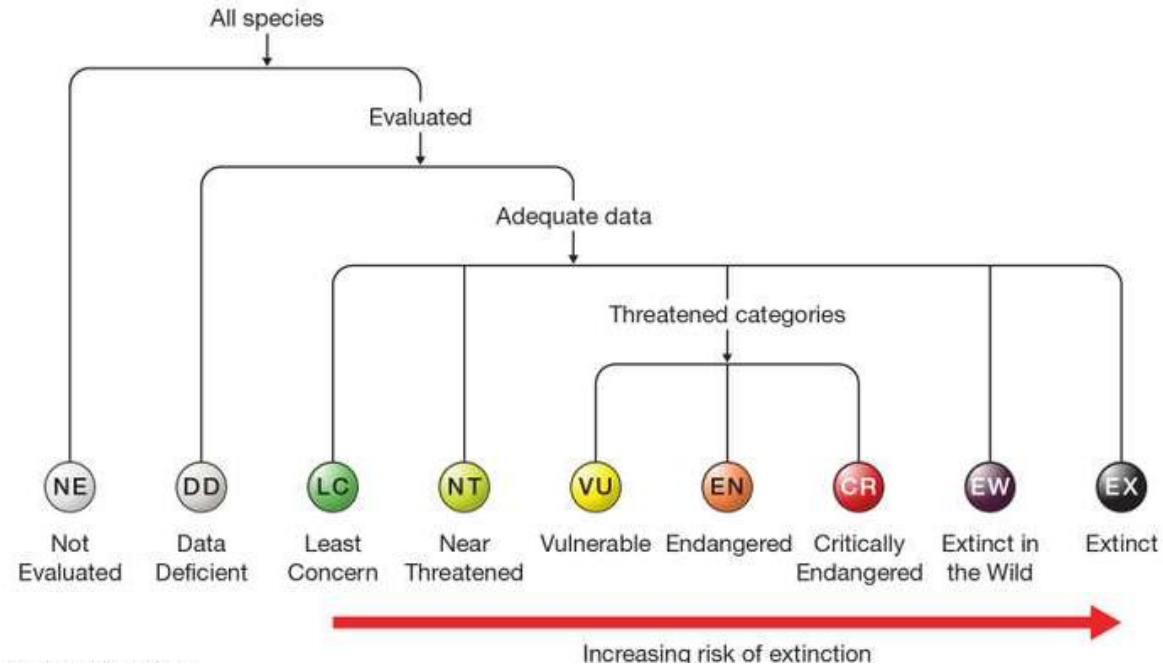


Figure 4.2: structure of different categories of IUCN red list

The IUCN system uses a set of five measurablestandards to evaluate the extinction risk of a given species. In general, this criterionconsiders:

- The rate of population decline
- The geographic range
- Whether the species already possesses a small population size
- Whether the species is very small or lives in a restricted area
- Whether the results of a quantitative analysis indicate a high probability of extinction in the wild

After a given species has been systematicallyassessed, it is placed into one of several categories. In addition, three of the categories (CR, EN, and VU) are contained within the

broader notion of "threatened." The IUCN Red List of Threatened Species identifiesome categories of species status:

Extinct (EX)

Atitle used for to species in which the last individual has died or where systematic and time-appropriate surveys have been unable to log even a single individual. Example: Passenger pigeon and Dodo.

Extinct in the Wild (EW)

This category contains those species whose members survive only in cultivation (plants) or in captivity (animals). Examples: *Alagoas curassow*.

Critically Endangered (CR)

Aspecies which will possess an extremely high risk of extinction in the wild in the immediate future, due to rapid population decline of 80 to more than 90 percent over the previous 10 years. These are having a current population size of fewer than 50 individuals. Example: Ganges shark, Pygmy hog, Gharial.

Endangered (EN)

A species that possess a very high risk of extinction as a result of rapid population decline of 50 to more than 70 percent over the previous 10 years. These are having a current population size of fewer than 250 individuals. Example: snow leopard, red panda, one horned rhinoceros, Bengal tiger.

Vulnerable (VU)

This category contains those species which possess a very high risk of extinction as a result of rapid population decline of 30 to more than 50 percent over the previous 10 years. These are having a current population size of fewer than 1,000 individuals.

Near Threatened (NT)

This designationis applied to the species that are close to become threatened or may meet the criteria for threatened status in the near future. Example: polar bears, white rhinos and polar bears.

Least Concern (LC)

A category containing species that are pervasive and abundant after careful assessment.

Data Deficient (DD)

A condition applied to species in which the amount of available data related to risk of extinction is lacking in some way. Consequently, a complete assessment cannot be performed.

Thus, unlike the other categories in this list, this category does not describe the conservation status of a species

Not Evaluated (NE)

This category includes any of the nearly 1.9 million species described by science but not assessed by the IUCN.

4.8 Biodiversity conservation

Biodiversity conservation is the upliftment, protection and management of biodiversity so as to keepbiodiversity at its threshold level and derive sustainable assistances for the present and future generation. In other words, bio-diversity conservation is the suitable management of the biosphere by man in such a way that it gives maximum profits for the present generation and also develops its potential so as to meet the needs of the future generations. Biodiversity conservation is of two types:

4.8.1 In-situ conservation:

The conservation of species in their natural ecosystem or habitat is known as in situ conservation. In this process, the natural surroundings of organisms are maintained and protected so that all the constituent species are conserved and benefited. It is a convenient way of saving biodiversity. It offers a way to preserve a large number of organisms simultaneously, known or unknown to us. The management and protection of biodiversity through in situ conservation involve certain specific areas known as protected areas likeBiosphere reserves, National parks, Sanctuaries. As per World Conservation Monitoring Centre, India has 581 protected areas, national parks and sanctuaries. There are about 89 national parks in India.

Table 4.2: Major wild life sanctuary is in India

Name of sanctuary	State	Major wild life
Ghana Bird sanctuary	Rajasthan	Near about 3000 different bird species
Sultanpur bird sanctuary	Haryana	Migratory birds
Abohar wildlife sanctuary	Punjab	Blackbuck
Hazaribagh sanctuary	Bihar	Leopard and tiger
Wild ass sanctuary	Gujarat	Wolf, Nilgai, Wild ass, Chinkara
Jaldapara wildlife sanctuary	West Bengal	Tiger, Elephant, Rhinoceros
Mudamalai wildlife sanctuary	Tamilnadu	Elephant, leopard, Tiger

Table 4.3: Major national parks in India

Name of national park	State	Major wild animals
Dachigan	Jammu and Kashmir	Hangul
Ranthambore	Rajasthan	Tiger
Corbett	Utter Pradesh	Tiger
Gir national park	Gujarat	Indian lion
Kanha	Madhya Pradesh	Tiger
Kaziranga	Assam	One horned rhino
Bandipur	Karnataka	Elephant
Periyar	Kerala	Elephant, tiger

Table 4.4: Major biosphere reserves in India

Name	State
Nilgiri biosphere reserve	At boundary of 3 states-Kerala, Karnataka and Tamilnadu
Nanda devi biosphere reserve	Uttarakhand
Gulf of mannar	In between India and Srilanka
Sunderbans	West bengal

4.8.2 Ex-situ conservation:

Ex-situ conservation involves breeding and maintenance of endangered species under controlled conditions in specific areas like gardens, nurseries, zoo *etc*. That is, the conservation of selected species in selected areas outside their natural habitat is known as ex-situ con-servation.

The stresses imposed on organisms by competition for shelter, lack of food and water *etc*. can be avoided by ex-situ conservation strategies there by providing conditions suitable for a secure life and breeding.

Some important areas under these conservations are:

1. Seed gene bank
2. Field gene bank
3. Botanical gardens
4. Zoos

4.9 Global biodiversity

Earth is largest storehouse of biodiversity. Millions of species of animals, plants, amphibians, mammals, birds and insectsare present in tropical rain forests. Approximately 50-80% of global biodiversity lies in these rainforests. Most of these species developed over time in highly specialized niches. This makes them more vulnerable to extinction when their niche is destroyed. Approximately 1,25,000 flowering plant species are reported in tropical rainforests. In India, the silent valley of Kerala is the only region of tropical rain forest.

Temperate rain forest, possessed less biodiversity then tropical region.Globally, we have approximated 170,000 flowering plants, 30000 vertebrates and 2,50,000other species.

4.10 Biodiversity at India

Biodiversity of any country depend upon climatic condition. India has great variability in environmental condition and also rich in flora and fauna biodiversity. India occupied 10^{th} position among biodiversity rich nations of the world and 11^{th} in term of number of endemic species. India is also one of the 12 mega biodiversity nation of world.

4.10.1 India as a mega diversity nation:

India is one of the 12 mega biodiversity nations of the world. India contain approximately 7% and 6.5 % of global flora and fauna.

Table: 4.5 Distribution of species in major groups of flora and fauna in India

Group-wise distribution of species			
Plants	**Number**	**Animals**	**Number**
Algae	2500	**Lower groups**	9979
Bacteria	850	**Mollusca**	5042
Bryophytes	2564	**Arthropoda**	57,525
Fungi	23,000	**Pisces**	2546
Gymnosperms	64	**Amphibia**	428
Pteridophytes	1022	**Reptiles**	1228
Angiosperms	15,000	**Birds**	204
		Mammals	372

4.10.2 Centre of origin

A large number of species are known to have originated in India. India has been centre of 320 species of wild relative of crops and near about 166 crop plant species. Approximately 5000 flowering plant species are originated in India.

4.10.3 Endemism

Species which are restricted only to a specific geographical area are known as endemic. India contains a good number of endemic species and Western Ghats are the location of maximum endemism.

4.11 Hot spots of biodiversity:

Distribution of organisms are not uniform on earth in some area are rich in species due to more environmental stability. This Hot spot term was first time given by Myers in 1988. There are 25 hot spots of biodiversity are on the global out of which two presents in India, the Western Ghats and Eastern Himalayas.

These hotspots cover 2% of the world land area. Currently, 35 different biodiversity hotspots are identified, most of them are in tropical region. These hot spots are in Madagascar, western amazon, north eastern Australia, west Africa, north and east Borneo and Brazilian Atlantic forests. These hot spots are having high biodiversity and endemic species. Some key criteria for determining a hotspot are:

- Endemic species present in that area i.e. the species which are found nowhere else.
- Degree of threat, which is measured in term of habitat loss.

4.11.1 Indian hot spots

The Indian hot spots are not only rich in floral diversity but also possess great diversity in reptiles,insects, amphibians and mammals.

Eastern Himalayas:

It extended from Bhutan to north east India. Various deep and semi-isolated valleys in Sikkim are significantly rich in endemic species.Some species like Sapira Himalayan are found only this region.

Western ghats:

It covers forests of Kerala, Tamilnadu, Maharashtra and Karnataka. Approximately 77% of the amphibians and 62% of the reptile species found here are found nowhere else. There are more than 6000 vascular plants belonging to 2500 genera in this hotspot, of which approximately 3000 are endemic. Much of the world's spices such as black pepper and cardamom have their

origins in the Western Ghats. The highest concentration of species in the Western Ghats is believed to be the Agasthyamalai Hills in the extreme south.

4.12 Biodiversity conservation: international and national efforts

Biodiversity is a wealth for any nation, the survival of human races is dependent on biodiversity conservation. It is evident that these valuable resourcesare destroyed at an alarming rate. Different measures are adopted at national and international level for its conservation. The earth summit formed a plan as Agenda 21 to ensure conservation of biodiversity.

4.12.1 International conservation strategies

Biodiversity conservation is not an issue restricted to any one community or country. It is a crucial world concern. Various international agreements and treaties are framedto strengthen international efforts and participation towards biodiversity conservation.

Some of these are:

World Heritage Convention

WHC is an international treaty established in 1972. This convention concerns with the protection of natural heritage. Convention identified the way in which the man interacts with the nature and the basic need to protect the balance between the nature and human. The convention members assign duties to various states in identifying potential sites and for preserving and protecting them.

World heritage sites are places on earth which are of outstanding universal value (OUV) to humanity. These places are inscribed into world heritage list to protect them for future generations. Unique and diverse places like Galapagos islands in Ecuador, Great barrier reef in Australia and Grand Canyon in the USA are the places inscribed in the world heritage list. The World Heritage Convention 1, which has been approved by 191 nations, was adopted by United Nations Educational, Scientific and Cultural Organisations general conference in 1972, came in force in 1975 for the identification, conservation, presentation, protection and transmission of natural and world heritage.

CITES

CITES (The Convention on International Trade in Endangered Species of wild fauna and flora) also called Washington convention. It is aninternational treaty to protect endangered species of plants and animals. It is framed as anoutcome of a determination accepted in 1963 at a meeting of the international union of conservation of nature (IUCN) members. The convention was signed in 1973 and CITES came into force on 1 July 1975. Main aim of this convention is

to ensure protection of wild animals and plants from treating effect of international trade. Till now more than 35,000 species of plants and animals are protected by CITES. India became its member in 1976.

Convention on Biological Diversity

Convention on biological Diversity is also known as Biodiversity convention. It is a multilateral agreement; the notion of this convention was considered at a United Nations Environment Programme (UNEP) by Ad Hoc working group of skilled on Biological Diversity in November 1988. The convention was opened first time for signature at Earth Summit on 5 June 1992 in Rio de Janeiro. It has three main agendas:

i. Biological diversity conservation
ii. Sustainable use of biodiversity and its components
iii. Equitable and fair distribution of benefits arising from genetic resource uses.

Convention on the conservation of migratory species of wild animals

This convention is also known as the Convention on Migratory Species (CMS) or the Bonn Convention. It is an international treaty that goals to save migratory species within their migratory ranges. The Agreement was signed under the sponsorships of the United Nations Environment Programme and is worriedabout conservation of wildlife and their habitats on a global scale. It also affords a global platform for the protection and sustainable use of migratory animals and their habitats. Treaty was signed in 1979 in Bonn, Germany, the Convention came into force in 1983.

International treaty on plant genetic resources for food and agriculture

International Treaty on Plant Genetic Resources for Food and Agriculture, stated as the Plant Treaty, was accepted in 2001 by Members of the Food and Agriculture Organization (FAO). Main aim of this treaty is to promote the conservation and sustainable use of plant genetic resources for food security. Conservation includes both seed bank and on farm conservation. As a result of long conversation within the FAO, the Plant Treaty recognized a principle of Farmers' Rights, which recognized farmers as holders of traditional knowledge and stewards of agricultural biodiversity.

Convention on wetlands (Ramsar convention)

Main objective of this treaty is to provide protection to the wetlands and their resources at international level. The Convention was signed in 1971 in city of Ramsar in Iran. It covers all parameters of wetland conservation,and has recognised wetland as a significant ecosystem for biodiversity conservation as well as for human welfare.

International plant protection convention (IPPC)

It provides a framework for protection of plant resources and wild plants by preventing the development of plant pests and promoting the control measure for pests. The convention also provides some international standards for phytosanitary measures (ISPMs) and help countries to implement the ISPMs.

4.12.2 National conservation strategies

India actively contributed and participated in different biodiversity conservation treaties. Biodiversity was considered as a common concern of mankind. Due to genetic, ecological, educational, cultural, economic, aesthetic and recreational values of biodiversity, a significant number of initiatives have been taken up at national level.

Biological diversity act

The Biological Diversity Act, 2002 is an Act of the Parliament of India for conservation of biological diversity in India, it delivers device for unbiased sharing of aids arising out of the use of traditional biological resources and knowledge. The Act was enacted to meet the obligations under Convention on Biological Diversity (CBD), to which India is a party. The National Biodiversity Authority is an autonomous body,the headquarter is located at Chennai under the Ministry of Environment and Forests, Government of India. The main objective of the Act is conservation of natural resources and facilitating use to them in a sustainable way.

Wildlife protection act

The Government passed Wildlife (Protection) Act 1972 with the aim of efficientlycaringand protecting the wildlife of country and to control smuggling, poaching, and illegal trade of wild animals, plants and their derivatives. The Act was amended in January 2003 and sentence and consequence for crimes under the Act have been made more severe. The Ministry has plannedadditional amendments in the law by introducing more stiff measures to fortify the Act.

India constituted a statutory body, the wildlife crime control bureau in 2007 by amending wildlife protection act, 1972. It is a multifunctional body formed by government of India under Ministry of Environment and Forests to control wildlife crime in the country.

Project tiger and elephant

Different projects have been launched for special animals which identified as endangered and needed a special protection effort by the government for their protection. These projects are planned to protect the animal in situ, by protecting and shielding their natural habitat.

Project tiger

Project Tiger is active since 1973 as a Centrally Funded Scheme of Government of India to protect the tigers. The key objective of the organization is to confirm a feasible population of tigers in India for scientific, economic, aesthetic, cultural and ecological values and to preserve areas of biological importance as natural heritage for the benefit, education and enjoyment of the people. Main objectives under the scheme include Wildlife management and protection measures. Initially, the project initiated with 9 tigers reserve, covering an area of 16,339 Km^2, with total 268 tigers. But now there are29 tiger reserve, with a population of 2226 tigers.

Project elephant

Project Elephants, a wildlife conservation project was initiated in 1992 with the aim to offer financial and technical support to major elephant bearing states in the country for protection of elephants, their habitats and corridors.Scientific and strategic organization is developed for conservation of elephant habitats, research on elephant management related issues, Public education and awareness programmes and Eco-development.

National wildlife action plan

The first National Wildlife Action Plan (NWAP) was drafted and adopted in 1983, based upon the decision taken in the twenty fifth meeting of the Indian Board for Wildlife held in 1982. The plan had drawn the approaches and action points for wildlife conservation which are still appropriate. The National Forest Policy was also formulated in 1988, giving primacy to conservation of forests. The second National WildlifeAction Plan was come into force in 2002-2016. From 2017-2031 the third National Wildlife Action Plan was drafted for sustainable development of life supporting ecosystem.

Forest conservation act

It shall be deemed to have come into force on the 25th day of October, 1980. It extends to the whole of India except the State of Jammu and Kashmir. This Act provides some regulatory mechanism for conservation of forests, natural heritage and permit use of forest only for essential matters and for developmental purposes. Under this act, prior approval of central government is required before conservation of any forest land into non forest land and for declaration of any reserve forest as deserved. After approval, compensatory afforestation has to be done in degraded forests.

Exercise

Very short answer type questions

1. Define the term of Biodiversity.
2. What is cryopreservation?
3. What are three levels of Biodiversity?
4. What is hotspot?
5. How many biogeographical regions are identified in India?
6. What is extinct species?
7. What is biosphere reserve?
8. Mention the name of hot spots in India.
9. What is genetic diversity?
10. What is ecosystem diversity?
11. Why Kaziranga national park is famous?
12. What is botanical garden?
13. What is the full form of IUCN?
14. What are vulnerable species?

Long Answer Type Questions

1. What is biodiversity? Explain types of Biodiversity.
2. What do you mean by productive, consumptive use of value, social and ethical value of biodiversity?
3. Describe the different vegetation zones of India.
4. Describe the different biogeographical zones with respect to floral diversity in India.
5. Discus the biodiversity at national and global level.
6. How is the diversity conserved at all levels?
7. Describe the hotspot and mention the name of hotspots in India.
8. What is meant by ex-situ and in-situ conservation of biodiversity? Explain with examples.
9. What are the differences between wildlife sanctuaries and biosphere reserves?
10. What is national park? Write its importance?
11. What are scared forests and lakes?
12. Describe Indian biodiversity with special reference to a megadiversity nation.
13. How is diversity at all levels can be conserved?
14. What are the major causes of man-wildlife conflicts? Discuss the remedial steps that can curb the conflict.

CHAPTER 5 | Environmental Pollution

5.1 Pollution

Pollution is an undesirable change of biological, chemical or physical nature in air, soil and water quality that may harmful" for environment as well as living organism.

5.2 Pollutant

Pollutant is a substance, factor or chemical which possess some adverse effect on living organisms. In other words, substance which depletes the environment quality is known as pollutant.

5.3 Types of pollution

Pollution is divided into seven main categories:

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

5.4 Air pollution

Air pollution means the occurrence of poluutants in the atmosphere in such amount that causes injury to animals, human being and plants. Air pollution can be caused by anything that makes the air dirtyand makes it injurious to breathe for birds, plants, humans and animals.

- **Indoor air pollution:** Indoor air pollution is the air pollution in enclosed spaces such as ourhomes, shops, schools *etc*. It can be produced by many things, like smoke from a domestic use or the emission of smokes inside a factory. It can be controlled by means ofpollution detectors within the home or offices.
- **Outdoor air pollution:** Pollution of the outside air and is frequently caused by the emission of harmful gases from the fossil fuels burning, car exhausts etc. It can be restricted by dropping the gas emissions in both homes and businesses and by reducing our reliance on fossil fuels.

5.4.1 Composition of air

Air is a heterogenous mixture of different types of gases that makes the atmosphere. Atmosphere is a gaseous envelop around the earth and retained by gravitational force of earth. Atmosphere is divided into four different layers. Lower most layer is known as troposphere it contains approximately 80% atmospheric mass. Dry and clean air contain 78.08% of Nitrogen, 20.9% of oxygen, 0.9% of argon, 0.033% of carbon dioxide and trace of other gases.

Table 5.1: Composition of dry and clean air

Constituent	Percentage by volume
Nitrogen	78.08
Oxygen	20.9
Argon	0.93
Carbondioxide	0.033
Others	0.065

5.4.2 Causes

Air pollution is caused by harmful gases like Carbon dioxide, Sulphur dioxide and Nitrogen oxide *etc*. Air pollutants are mainly of two types smoke and gases. Smoke: this can fill the air with particles of soot that make it physically dirty.Gases: poisonous gases are particularly dangerous.

5.4.3 Source of air pollution

There are two main source of air pollution:

Natural sources: Such as volcanoes, wind blow dust and wildfires.

Man-made sources: Man-made sources are of two types: mobile and stationary.

Mobile sourcesare movable sources which causesair pollution. Primary mobile source of air pollution are automobiles.

Stationary sources are not able to move from one location to other. These can be either point or area source.

Point sources include pollution from oil refineries, power plantswhich emit huge pollutants from a single and fixed location.

Area sources include emission from many small static sources present in commercial and industrial area.

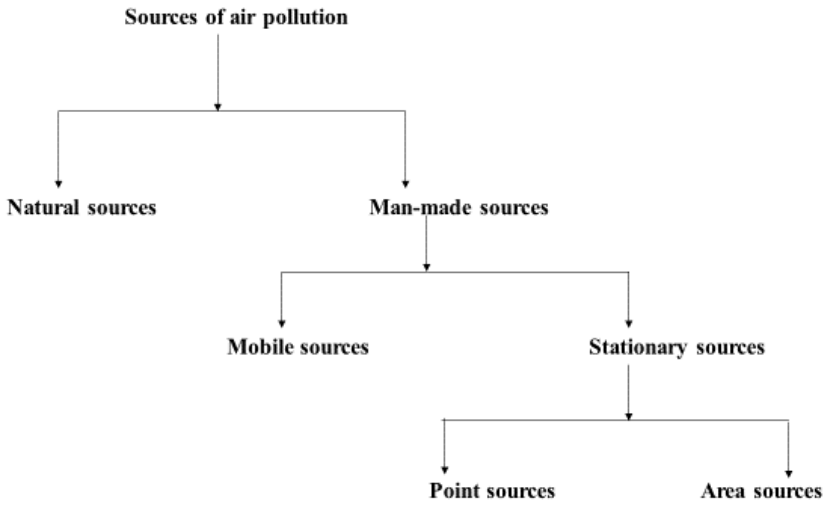


Figure 5.1: Sources of air pollution

5.4.4 Types of air pollutants

Air pollutant can be classified into following basis:

- The basis of origin
- The physical state of the pollutant
- The nature and occurrence of the threat

Classification based on origin

On the basis of origin, pollutants are divided into primary and secondary sources:

- **Primary air pollutants** are substances which are directly released into atmosphere from anthropogenic and man-made sources such as SO_2 from volcanic eruption.
- **Secondary air pollutants**are not released directly, although they are formed in air when primary pollutants interact and react with each other in atmosphere. Example of secondary pollutant is ozone.

Classification based on the physical state of pollutant

On the basis of physical state pollutants may be particulate and gaseous in nature.

- **Particulate pollutants**are small and minute solid particles suspended in air.
- **Gaseous pollutants**are composed of Carbon dioxide, oxides of nitrogen, oxides of sulphur, volatile organic compounds, ammonia, chlorofluorocarbons and other gases.

Classification on the basis of nature and occurrence of the threat

On the basis of this criteria air pollutant divided into two classes *i.e.* criteria and toxic air pollutants.

- **Criteria air pollutants:** Pollutants are ubiquitous and are identified as harmful for man and environment. Six pollutants are placed in category of criteria air pollutants. These are

sulphur dioxide, ozone, carbon monoxide, nitrogen dioxide, lead and particulate matter (PM_{10} and $PM_{2.5}$).

- **Toxic air pollutants:** These are not widespread but suspected to cause cancer and other serious disease in man such as birth defects, reproductive defects *etc*. These pollutants are also known as hazardous air pollutants and are obtained from multiple sources. Most significant air pollutants are benzene released from gasoline, perchloroethylene and methylene chloride. Some other identified toxic air pollutants are dioxin, toluene, asbestos, cadmium, chromium and mercury. Approximately 70% of pollutants are classified as toxic and hazardous air pollutants which are placed in the volatile organic compounds categories (VOCs).

5.4.5 Effects of air pollution

1. Damages to respiratory health.
2. Makes buildings grimy.
3. Aggravates allergies.
4. Causes diseases.
5. Reduces biodiversity.

5.4.6 Air quality standards

Ambient air quality means condition and quality of surrounding air in the outdoor environment.An ambient air quality standard (AAQS) simply puts a boundary on the pollutant quantity in the air. Different countries have their own standards prescribed for a territory. These standards are preserved in nationallaw and are legally compulsory. The standards are intended to defend people's health and have been considered to permit a margin for people at risk likechildren's and old people and the people with pre-existing health problems. Looking around the world, most AAQS involves a trickle of important pollutants that are collectively referred to as criteria pollutants like ozone, particulate matter, sulphur oxides, nitrogen oxides, carbon monoxideand lead. Although countries often have different standards for the same types of air pollutants, the limits are quite different. EPA established primary and secondary levels of national ambient air quality standards (NAAQS) for pollutants which are considered harmful to environment and public health. Primary standards are required to set at levels that protect human, even the most sensitive person. Secondary standards are required to protect publicwelfare and these are stronger than primary standards.

Table 5.2: Pollutant level and average time they stay in environment

Pollutant		Standard	Level	Average time
Lead		Primary	0.15μg/m^3	Rolling 3 month
Carbon monoxide		Primary	9 ppm	1 hour
				8 hours
Ozone		Primary	0.070 ppm	8 hours
Nitrogen dioxide		Primary	100 ppb	1 hour
Sulphur dioxide		Primary	75 ppb	1 hour
Particulate matter	PM2.5	Primary	12.0 μg/m^3	1 year
			35 μg/m^3	24 hours
	PM10	Primary	150 μg/m^3	24 hours

Ambient air quality standards in India

In India central pollution control board (CPCB) has set some standards for national ambient air quality that are applicable nationwide. The current NAAQS were published in 2009.

Table 5.3: National ambient air quality standards in India

Pollutant	Time weighted average	Concentration in ambient air	
		Sensitive area (notified by central government)	Industrial, residential, rural and other areas
SO_2 (μg/m^3)	Annual	20	50
	24 hours	80	80
NO_2 (μg/m^3)	Annual	30	40
	24 hours	80	80
PM_{10} (μg/m^3)	Annual	60	60
	24 hours	100	100
$PM_{2.5}$ (μg/m^3)	Annual	40	40
	24 hours	60	60
Ozone (μg/m^3)	8 hours	100	100
	1 hour	180	180
Lead (μg/m^3)	Annual	0.50	0.50
	24 hours	1	1
CO (mg/m^3)	8 hours	2	2
	1 hour	4	4
NH_3 (μg/m^3)	Annual	100	100
	24 hours	400	400
Nickle (ng/m^3)	Annual	20	20
Arsenic (ng/m^3)	Annual	6	6
Benzo (a)	Annual	1	1

5.4.7 WHO air quality guidelines

World health organization works on environmental well-being andoffers the basis for world standards in environment excellence and effective investment for public health such as

drinking water and air quality strategies. The WHO air quality parameters provide an assessment of health effect by air pollution and threshold for levels of harmful pollution for health.

Table 5.4: WHO air quality standards

Pollutants	Time weighted average	Standard limits (µg/m^3)
Ozone	8 hours mean	100
Nitrogen dioxide	Annual mean	40
	1 hour mean	200
Sulphur dioxide	24 hours mean	20
	10-minute mean	500
$PM_{2.5}$	Annual mean	10
	24 hours mean	25
PM_{10}	Annual mean	20
	24 hours mean	50

5.4.8Air Quality Index

Air Quality Index (AQI) is a device to display status of air quality. It transforms multifaceted air quality data of numerous pollutants into a single nomenclature and colour to the people in easy and understandable form.Different country has their own air quality indices. An increase in air quality index indicates increased air pollution and severe threats to human health. In most cases, AQI indicates how polluted the air in our surrounding is, and the associated health risks it might present. AQI calculations focus on main air pollutants including: particulate matter, tropospheric ozone, sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO). Particulate matter and ozone pollutants pose the highest risks to environment and human health. The air quality indices values, concentration as well as health effects of the identified pollutant are given in table below:

AQI	Health effects	Remark
0-50	Minimal impact	Good
51-100	Some breathing discomfort	Satisfactory
101-200	Breathing abnormalities in people with asthma, lung and heart disease	Moderate
201-300	Breathing discomfort to most of people on prolonged exposure	Poor
301-400	Respiratory problem on prolonged exposure	Very poor
401-500	Affects healthy people	Severe

5.4.9National Air Quality Monitoring Programme

The National Ambient Air Quality Monitoring Programme (AAMP) contain a significantly prolonged national air quality monitoring network providing improved real-time information to the public, added by an additional local authority to conduct local monitoring. It is used to control emission processes and devices. The national ambient air quality monitoring programme is built around three key pillars:

- An expanded national monitoring network with 38 new automatic monitoring stations, providing information to the public.
- Modelling and forecasting capability to provide an ongoing air quality forecast to the public.

Central pollution control board (CPCB) is executing programme for air quality monitoring known as NAMP. Under NAMP, four pollutants SO_2, NO_2, PM10 and PM2.5 are being screened and regularly monitor at various locations. The monitoring of different meteorological parameters such as wind direction, wind speed, temperature, humidity is also correlated with the air quality. Pollutant monitoring is carried out for 24 hours with a frequency of twice a week.

5.4.10Control of air pollution

- Air pollution can be controlled by increasing forest cover area, reforestation and protecting forests.
- Industry should be located at long distance from housing areas.
- By using low sulphur coal in factories.
- We should be watchful and attentive that our surrounding is cleaned.
- By using renewable energy sources.
- Smoke free heaters should be used.
- Electric engines should be used.
- Lastly air pollution can be controlled by way of mutual effort of Government, private, players and individuals.

5.5 Water pollution

Water pollution is controlled by alteration in biological, chemical and physical properties of water by means of discharge of industrial effluent or any other gases, liquid, or solid material into water bodies which is injurious for public health, agriculture and commercial activities.

5.5.1 Forms of water pollution:

Biological water pollution:

It takes place due to presence of fungi, algae, viruses, pathogenic bacteria and parasitic worms. Domestic and sewage waste are main source of biological water pollution.

Chemical water pollution:

It takes place due to organic and inorganic substances like acids, pesticides, toxic organic and inorganic compounds and fungicides.

Physical water pollution:

The physical water pollution brings the change in water colour, taste, temperature, odour and turbidity.

Sources of water pollution:

Domestic waste water and dirty municipal waste or sewage are the chief source of water pollution. On the basis of source water pollution is divided into two categories, *viz*. point and diffused sources.

Diffused sources:

Diffused or non-point sources are the sources which discharge polluted water and whose location cannot easily be identified.

Point sources:

The main source can be identified at a single location like municipal sewage, treatment plant, industrial waste *etc*.

Some other and common sources of water pollution are:

- **Agriculture pollution:** Use of fertilizers, pesticides, insecticides, weedicides are also responsible for water pollution.
- **Natural pollution:** Soil debris enter into water bodies due to rainfall, ice melting, animal and plant organic matter and animal excreta.
- **Municipal pollution:** Sewage water obtained from domestic usages in institutes, houses and commercial buildings.
- **Mining pollution:** Water pollution caused due to trailing or fines from washing, acid drainage and soluble toxic materials.
- **Synthetic detergent:** Detergents used in washing and cleaning pollute water due to foaming.

5.5.2 Effects of water pollution:

Polluted water has various effects on human life. The harmful effect of polluted water is as under:

- Fertilizer, sewage and agriculture run off water possess organic matter which causes the eutrophication of water bodies and enhance the growth of phytoplankton and algae. Eutrophication possesses different damaging effect on aquatic life.
- Pesticides contaminate ground water and causes reproductive damage in wildlife.
- Drinking of contaminated water causes cancer, typhoid fever, stomach problems.
- Oil spills causes the death of aquatic biodiversity.
- Aquatic ecosystem damaged by high water temperature like coral reef is affected by bleaching effect due to hot water.
- Various physiological and metabolic disorder in man and animals are caused due to chemical pollutants like nitrates, ammonia, mercury, selenium, boron, nickel etc. some common diseases are:
    - Itai-itai disease is caused by use of cadmium contained rice.
    - Fluoride in drinking water causes skeleton fluorosis.
    - Black foot diseases iscaused by arsenic contamination.
    - Blue baby syndrome is caused by nitrates contamination in drinking water.
    - A Minamita disease is caused due to mercury contamination.

5.5.3 Biomagnification

It is also known as bio amplification or biological magnification;it is the process by which some undesirable chemical substances get concentrated and accumulated in body of living organisms through the food chain. The pollutants include different heavy metals namely mercury, arsenic, pesticides such as DDT, and polychlorinated biphenyls (PCBs) compounds, which are then taken up by organisms through the food they consume or the intoxication of their environment.

Food-web accumulation characteristics of DDT are well known. DDT has very small concentrations in water and air, and also a very lesser amount in soil produce harmful effects. However, amount is much higher in organisms, especially in animals at the top of their food web, such as humans and predatory birds. The food-web biomagnification of DDT can be illustrated by the case of Lake Kariba, Zimbabwe. Although banned in most industrialized countries since the early 1970s, DDT is still used in many tropical countries for agriculture purposes and to control the growth of insects. The concentration of DDT in the water of Lake

Kariba was less than 0.002 ppb, but concentrations in sediment were 0.4 ppm. Planktonic algae contained 2.5 ppm. A filter-feeding mussel had 10 ppm (values for animal tissues are for DDT in fat), while two species of plant-eating fish contained 2 ppm, and a bottom-feeding fish contained 6 ppm. A predatory fish and a fish-eating bird, the great cormorant, contained 5-10 ppm. The Nile crocodile is the toppredator in Lake Kariba (other than humans), and it had 34 ppm. Therefore, the data for Lake Kariba illustrates a substantial biomagnification of DDT from water, and to a lesser degree from sediment, as well as a marked food-web accumulation from herbivores to top carnivores. DDT stores in animal fat and takes many years to break down.

Effect of biomagnification

- DDT interferes with egg shell formation in birds. Shell remain weak and thin;it may break by birds' weight during incubation. Dieldrin is 5 times more toxic than DDT and 40 times more toxic when absorbed by tissue.
- Mercury accumulated into fishes passed to human through food chain causing minamita diseases in Japan.
- Chlorinated hydrocarbons effect central nervous system of human, it is responsible for brain softening, liver cirrhosis, cancer, cerebral haemorrhage, hypertension and malformation of hormones.
- Selenium accumulation in the plants growing in selenium rich soil, and causes stunted growth in plants, and through food chain causegastro-intestinal disorder and loss of appetite.

5.5.4 Eutrophication

It is a process in which a water body becomes extremelyaugmented with nutrients, leading to profuse growth of plants. The excessive growth of algae and plankton in a water body are keyindicators of this process. Eutrophication is considered to be a thoughtful environmental concern since it often results in the decline of water quality and the reduction of dissolved oxygen in water bodies. Eutrophic waters can eventually become "dead zones" that are unable of supporting life.The availability of nutrients such as nitrogen and phosphorus limit the growth of plants in an ecosystem. When water bodies are overly enriched with these nutrients, the growth of algae, plankton, and other simple plant life is favoured over the growth of more complex plant life.

Phosphorus is considered as one of the main factors for growth of plants in freshwater bodies. Some sources also claim that the availability of nitrogen is asignificant factor for the growth of algae.Phosphates tend to stick to the soil and are transported along with it. Therefore, soil erosion is a major contributor to the phosphorus enrichment of water bodies. Some other

phosphorus-rich sources that enrich water bodies with the nutrient are untreated sewage, fertilizers, domestic water and industrial waste water. Among these sources, the primary contributors to eutrophication include agriculture and industrial wastes.

5.5.5 Indicators of water pollution

There are two main system of measuring water quality. One is measuring the concentration of various chemicals in water. If the chemicals are harmful or the concentration is too high, we can say that water is polluted**.** This measurement is known as chemical indication. Another way to analyse water quality is examining the living organism like fishes, insects and other vertebrates. If biodiversity is high then the quality to be good; if the river support less or no aquatic life, the quality is poor. This measurement is known as biological indicators.

5.5.6 Control of water pollution

Water pollution can be controlled by taking appropriateactiontoward domestic and municipal wastes. Domestic and sewage water can accurately be mixed with soil which will intensifysoil fertility. The industries must not be allowed to discharge toxic waste water in the land.

5.5.7 Reduce water pollution by proper sewage treatments

The treatment procedures should be done through fine engineered functioned systems. The good systems clean about 90% of the sewage water.

- Continued maintenance including repair and replacement of leaky and faulty sewage processing infrastructure.
- Green agricultural exercise techniques like mulching, contour ploughing, crop rotation, perennial crops planting and installing silt fences can diminish the effects of water pollution. Animal manure and commercial fertilizers applied to lands.
- Industrial waste water treatment required to reduce water pollution. The fitting of pre-treatment services and acceptance of quality waste treatment procedures can widely help to remove the toxic contaminants.
- Anti-pollution laws can put limitations on water pollution problems such as domestic, sewage and industrial waste treatments and garbage management.
- Individual efforts and educative campaigns canpossess significant effect on control of water pollution.

5.6 Marine pollution

Marine pollutants can be defined as whatever that pollutes the ocean. Common marine pollutants include small plastic beads, chemicals and toxic bio-matter. But, noise due to extreme traffic around the ocean can also induce pollution if it disturbs marine life.

5.6.1 Sources of marine pollution

1. Oil spillages

A leakage in oil tankers spills vast quantities of oil in ocean. This cause marine pollution and damage marine life.

2. Toxic chemicals in water

Chemical from factories endanger marine life. Industrial waste dumped into the sea, household cleaners poured down the sink, and atmosphere chemicals that dissolve into the sea can pollute oceans significantly.

3. Polluted water from rivers

The rivers have a significant amount of garbage, agriculture waste, untreated sewage waste, pesticides and metals. Almost all of rivers fall into ocean and make the water polluted.

4. Small particles.

Small plastic beads in exfoliating creams and other small particles that we dischargein the water bodies without being thoughtfulalso pollute the ocean.

5. Plastic, litter, and human waste

Aluminium cans, Plastic bagsand other man wastes act askey pollutantsfor the oceans.

6. Dissolved greenhouse gases.

Greenhouse gases produced from fossil fuel consumption are making the sea more acidic.

5.6.2 Effects of marine pollution

1. **Oxygen depletion:**Decomposing sewage waste and other biological materials in oceans can result in an oxygen depletion. This makes it hard to survive for oxygen loving marine life – plants, fish and animals.
2. **Choking marine life:** Plastic and small pieces of other litter are progressively found in the body of marine animals. These pieces choke alimentary canal of marine animals and hinder their digestion.
3. Discharging of nuclear waste in ocean generate several mutations and change genetic makeup of individuals and also effect reproductive potential.
4. Bioaccumulation of different pesticides like DDT, Benzepyrene in food chain induce different deformities in marine organism.

5.6.3 Control measures/solutions for marine pollution

1. Be careful with use of chemicals.
2. Don't flush or rinse away harmful particles.
3. Public awareness by campaigns.

5.6.4 Waste water treatment

Waste water is the end or by product of industrial, municipal and agricultural activity. It possesses different types of organic and inorganic compounds of natural and anthropogenic origin. The pollutants in waste water include nutrients, heavy metals, pathogen, biodegradable organic matter and suspended solids.Amount of each substance depends upon its sources. Waste water treatment is used to remove contaminants before they released into water bodies.

Treatment procedure

Waste materials in wastewater are classified into three different classes*viz*. domestic, agriculture and industrial wastes. Each of these waste materials have their own characteristics that's why treatment methods also very. These methods include physical, chemical and biological treatments.

Physical treatment:

It includes screening, flocculation, filtration and sedimentation, which are mainly used for the separation of floating and insoluble materials.

Chemical treatment:

It includes chemical precipitation and oxidation.

Biological treatment:

It includes aerobic and anaerobic treatment of water by a mixed culture of microorganism.Otherwise, treatments processes further categorised into primary, secondary and tertiary treatment.

Primary Treatment

This procedure involves the separation of macrobiotic solid matter from the wastewater. Primary treatment is done by pouring the wastewater into large tanks tosettle down solid matter. The solid waste that settles at the bottom of the tanks, is removed by huge scrappers and is pushed to the centre of the cylindrical tanks and later pumped out of the tanks for further treatment. The remaining water is then pumped for secondary treatment.

Secondary Treatment or Biological Treatment

It involves the microbial oxidation of organic waste to lower the Biological Oxygen Demand (BOD) of waste water under controlled conditions. Mainly two approaches are used for

the treatment. In the first approach microorganism are suspended in waste water, in contrast the microorganisms get fixed on stationary surface and the water flows past the microorganism.The secondary treatment may be achieved aerobically and anaerobically in a number of ways. The widely used aerobic processes are trickling filters, activated sludge processes and their modification. The anaerobic processes are used both in treatment of specific wastewater and sludge conditioning.

Activated Sludge

In the activated sludge process, the dispersed-growth reactor is an aeration tank or basin containing a suspension of the wastewater and microorganisms. The contents of the aeration tank are mixed vigorously by aeration devices which also supply oxygen to the biological suspension.Commonly used aeration devices include submerged diffusers which release compressed air and mechanical surface aerators which introduce air by agitating the liquid surface. Hydraulic retention time in the aeration tanks usually ranges from 3 to 8 hours but can be higher with high BOD wastewaters. Following the aeration step, the microorganisms are separated from the liquid by sedimentation and the clarified liquid is secondary effluent. A portion of the biological sludge is recycled to the aeration basin to maintain a high mixed-liquor suspended solids (MLSS) level. The remainder is removed from the process and sent to sludge processing to maintain a relatively constant concentration of microorganisms in the system. Several variations of the basic activated sludge process, such as extended aeration and oxidation ditches, are in common use, but the principles are similar.

Trickling Filter

A trickling filter is consisting of a tower or basin filled with support materials such as plastic, stones and wooden slats. Wastewater is applied over the media. Microorganisms become attached to the materials and form a biofilm. Organic matter in the wastewater spreads into the film, where it is digested. Oxygen is supplied to the biofilm by the natural flow of air. Aeration is achieved by exploiting the variation in temperature between outside and inside of the reactor, resulting in a counter current of air. High microbial growth in reactor causes a rise in temperature and hot air rises and allows fresh air to enter at the reactor bottom.

Tertiary treatment

This stage is similar to the one used by drinking water treatment plants which clean raw water for drinking purposes. The tertiary treatment stage has the ability to remove up to 99 percent of the impurities from the wastewater. This produces effluent water that is close to drinking water quality. Unfortunately, this process tends to be a bit expensive as it requires

special equipment, well trained and highly skilled equipment operators, chemicals and a steady energy supply.

Sludge Treatment

The sludge that is generated during the primary and secondary treatment by activated sludge and trickling filter needs concentration and thickening to enable extra processing. It is further put into thickening tanks that permit it to settle down and later separates from the water. This process can take approximate 24 hours. The residual water are collected and sent back to the gigantic aeration tanks for extra treatment. The sludge is then treated either by aerobic and anaerobic digestion. During aerobic process biodegradable materials are converted into carbon dioxide and produce large amount of biomass. Traditional method used for sludge treatment is anaerobic treatment. Most of the organic matters are converted into methane and carbon dioxide gas. The sludge is then treated and sent back into the environment and can be used for agricultural use.

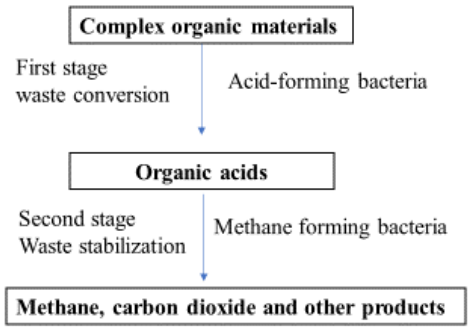


Figure 5.2: The two phases of anaerobic digestion

5.6.5 Water quality standards

Water is an essential natural resource used for various purposes such as agriculture, domestic uses, drinking and industrial uses. Water quality standards develop the various parameter to impose limitation on use of water according to the purpose water usage. There are some standards for water quality and uses, while setting the standards, agencies make scientific and political decision about how the water used. The aim of water quality standards is to protect environment and public health, and to maintain standards of water quality consistent with its designation uses.

Water quality standards in India

Central pollution control board which comes under ministry of environment and forest, Government of India has categorized the water into 5 different classes: A, B, C, D and E. This

categorization is based on the it's designated use. The following classification is adopted in India: -

Class A Drinking water sources without any conventional treatment but after disinfection.

Class B Water used for outdoor bathing.

Class C Water sources used for drinking after conventional treatment and disinfection.

Class D Water sources useful for wild life propagation and mainly for fish culture.

Class E Water used for agriculture, industrial cooling and controlled waste disposal.

The acceptance limits of different parameters are specified as per classified use of water depending upon numerous uses of water.

Surface water quality criteria for different uses

These criteria were specified by Central Pollution Control Board of India in 1979 and Bureau of Indian standards in 1982.

Criteria of class A

- Water pH ranges from 6.5 to 8.5.
- Dissolved oxygen is 6 mg/L or more.
- Biological oxygen demand (BOD) is 2mg/L for 5 days at 20 C.
- Amount of total coliform organism is 200 per 100 mL of water.

Criteria of class B

- Water pH ranges from 6.5 to 8.5.
- Dissolved oxygen is 5 mg/L or more.
- Biological oxygen demand (BOD) is 3mg/L for 5 days at 20 C.
- Amount of total coliform organism is 2000 per 100 mL of water.

Criteria of class C

- Water pH ranges from 6 to 9.
- Dissolved oxygen is 4 mg/L or more.
- Biological oxygen demand (BOD) is 3 mg/L for 5 days at 20 C.
- Amount of total coliform organism is 20,000 per 100 mL of water.

Criteria of Class D

- Water pH ranges from 6.5 to 8.5.
- Dissolved oxygen is 4 mg/L or more.
- Free ammonia 1.2 mg/L or less.

Criteria of Class E

- Water pH ranges from 6.5 to 8.5.

- Sodium absorption ratio maximum 26.
- Maximum electrical conductivity at 25°C of temperature is 2250 micro mhos /cm
- Maximum amount of Boron is 2 mg/L.

5.7 Soil pollution

Soil pollution is defined as the presence of toxic chemicals in soil, in high concentrations to pose a danger to the ecosystem and human health. The pollution of soil is a common thing these days, and it happens due to the presence of man-made elements.

5.7.1 Sources of soil pollution

1. Industrial waste

Industrial action has been the main contributor to the soil pollution in the last century, especially since the quantity of mining and manufacturing has increased. The industrial waste when remain on the soil surface for a long period itmakes the soil unsuitable for use.

2. Agricultural activities

Increased uses of pesticides, herbicides, fertilizers and weedicides, and advanced agriculture practices resulted in the mixing up of these harmful chemicals deepinto the horizon of soil and are gradually decreasing the soil fertility.

3. Urban waste disposal

Industrial and domestic wastes are the main to sources of soil contamination. These wastes may contain following pollutants.

Radioactive pollutants: Radioactive pollutants are produced from nuclear explosion in nuclear devicesthrough radioactive wastes, which penetrate deep into soil and cause soil pollution.

Chemical and metallic pollutants: A number of manufacturing industries like dyes, soap, textile, drug, cements and rubber generate and add large number of chemicals in soil. Metal industries also add their dangerous effluents in soil.

4. Biological factors

Soil possesses huge quantities of animal, human and bird’s excretory products which constituent as major source of soil pollution.

5. Acid Rain

Acid rain is caused when pollutants present in the air mix up with the rain and fall back on the ground. The polluted water could dissolve away some of the important nutrients found in soil and change the structure of the soil.

5.7.2 Control of soil pollution

Some important control measures taken by different countries for soil pollution are:

1. Soil erosion can be controlled by a different agriculture practice. For example:

- Planting trees on infertile hill slopes
- Contour cultivation and strip cropping may be adopted as an alternative of shifting cultivation
- Reducing deforestation and replacing chemical manures by animal wastes also helps arrest soil erosion in the long term.

2. Proper dumping of unwanted materials: Extra wastes by man and animals pose a discarding problem. Open dumping is the usually practiced technique. Nowadays, controlled tipping is followed for solid waste disposal.

3. Production of natural fertilizers: chemical pesticides and fertilizer should be replaced by organic and biopesticides. For example: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.

4. Recycling and Reuse of waste materials: To diminish soil pollution, the wastes such as glasses, metals, plastics, organics, petroleum products, papers and industrial waste *etc*. should be recycled and reused.

5. Proper hygienic condition: People should be trained regarding sanitary habits.

6. Ban on harmful toxic chemicals: Ban should be imposed on toxic chemicals and pesticides like BHC, DDT *etc* which are lethal to animals and plants.

7. Public awareness: public awareness programs should be imparted to teach people about health hazards caused by soil pollution.

5.7.3 Classification of solid waste

Based on effect on environment and human health, solid waste is classified into two main categorises:

1. Hazardous waste
2. Non-hazardous waste

Hazardous waste

As per Resources Conservation and Recovery Act (RCRA), a substance is hazardous if it possesses any of four properties*viz*. ignitability, corrosivity, reactivity and toxicity. Hospital and industrial wastesare considered hazardous as they may comprisemany toxic substances. Certain types of household waste are also hazardous. Approximately, India generates around 7 million

tonnes of hazardous wastes every year, most of which are concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu.

In the industrial segment, the main producers of hazardous waste are the chemicals, dyes, metal, paper, pesticide, refining, and rubber goods. Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be deadly. Household wastes that can be categorized as hazardous waste includes old batteries, shoe polish, paint tins, old medicines, and medicine bottles.

Hospital wastes are contaminated by chemicals used in hospitals which are hazardous. These chemicals include phenols and formaldehyde, which are used as antiseptics, and mercury, which is used in equipment that measure blood pressure and temperature. Most hospitals in India do not have proper disposal facilities for these hazardous wastes.

Non-hazardous waste

These are further divided into two main categories:

Municipal and non-municipal solid waste

Municipal solid waste commonly known as garbage and trash, consists of household waste, clothing, newspapers, paints, construction and demolition debris and sanitation residue. This garbage is produced from commercial and residential complexes. With expanding urbanization and change in food habit and lifestyle, the amount of municipal solid waste has been growing quickly and its structure is changing. Approximately, 25% of the municipal solid waste is not collected at all and more than 70% of the Indian cities lack satisfactory capacity to transport it and there are no sanitary landfills to dispose of the waste. The current landfills are neither well equipped or well managed and are not lined properly to protect against contamination of soil and groundwater.

Non-municipal solid waste is produced by agriculture, mining and industrial processes. Agriculture solid waste are created from different farming activities but mostly it is biodegradable. Industrial solid waste is generated by manufacturing and processing units of different industries like petroleum, metal gas, paper, chemical and coal.

5.7.4 Solid waste management

Solid-waste management is the process of accumulating, treating, and disposing of solid material which is rejected because it is no longer useful. Inappropriate disposal of municipal solid waste can create unhygienic conditions, and these conditions in turn can play a principal role in pollution of the environment and outbreaks vector-borne diseases spread by insects and rodents.

Hazardous waste treatment

Treatment technologies are categorised as chemical, physical, biological, thermal and stabilization.

Chemical, physical and biological treatment processes

These procedures are most commonly used today for treating aqueous hazardous waste.In biological treatment microorganisms are used to degrade organic waste in water.Chemical processes transform harmful waste into less hazardous substances using different methods such as precipitation, oxidation, reduction and pH neutralization.Physical treatment processes involve phase change system, gravity separation, separation of volatile compounds by steam stripping, filtration and carbon adsorption.

Thermal destruction processes

These processes include burning which is increasingly becoming an ideal option for the treatment of dangerous waste and pyrolysis through chemical decomposition of waste by heating the material in the absence of oxygen.

Fixation and stabilization processes

They involve removal of extra water from waste and solidification of the remaining either by mixing it with stabilizing agent, such as polymeric substance, Portland cement, or vitrifying it to create a glass like substance.

5.7.5 Functional elements of the waste management system

There are six main functional components of the waste management system, as outlined below:

Waste generation: This includes activities which are useful for identifying materials that are no longer usable and are either collected for systematic removal or thrown away.

Onsite handling, storage, and processing: This relates to actions at the point of waste generation, which facilitate collection. For example, waste bins are placed at sites that generate sufficient waste.

Waste collection: It is a critical phase of waste management, this includes activities such as employing waste collection bins, collecting waste from those bins, and accumulating trash in the location where the collection vehicles are emptied. Although the collection phase involves transportation, this is typically not the main stage of waste transportation.

Waste transfer and transport: These are the activities involved in moving waste from the local waste collection locations to the regional waste disposal site in large waste transport vehicles.

Waste processing and recovery: This refers to the facilities, equipment, and techniques employed to recover reusable or recyclable materials from the waste stream and to improve the effectiveness of other functional elements of waste management.

Disposal: The final stage of waste management. It involves the activities aimed at the systematic disposal of waste materials in locations such as landfills or waste-to-energy facilities.

5.7.6 Effect of soil pollution

- Mine dust induces several abnormalities in plants, animals and human also.
- Excessive use of pesticides, weedicides and fertilizers causes the accumulation of nitrates in land and may induce blue syndrome and cyanosis.
- Excess of fluorides induce fluorosis.
- The toxic chemicals present in the soil can decrease soil fertility and therefore decrease in the soil yield.
- Soil pollution due to sewage waste leads to several diseases like tetanus, giardiasis and fever.
- Plants that are grown in polluted soil may accumulate high concentrations of soil pollutants through a process known as bioaccumulation. When these plants are consumed by herbivores, all the accumulated pollutants are passed up to the whole food chain.

5.7.7 Control of soil pollution

- Bioremediation and microbial digestion of degradable substances are the best scientific and significant approaches for decreasing soil pollution.
- Biodegradable and animal waste should be use for production of biogas and methane.
- Industrial waste and harmful effluent should be treated properly before disposing on soil.
- Solid waste should be collected properly and discharged off by appropriate method.
- Recycling and recovery of useful products should be done by new and advanced technology.

5.8 Noise pollution

Noise is the undesirable and unpleasant sound which interferes with health, welfare and comfort ofman. Noise is a physical form of pollution. The intensity of sound is measured in decibels unit (dB). Some of its mainreasons are aircraft, crackers, vehicles, industrial machines, loudspeakersetc. Some other appliances also cause to noise pollution like radio, television, transistor etc. when used at high volume.

5.8.1 Causes and Sources of Noise Pollution

Following are the main sources of noise pollution:

- **Vehicles:** Increased number of transport vehicles on the roads are the main reason for noise pollution.
- **Industrialization:** Industrialization has led to an increase in noise pollution as the use of heavy equipment's such as mills, generators, huge exhaust fans, *etc*areresulting in producing unwanted noise.
- **Events:**Public gathering and weddingsinvolve loudspeakers to play music resulting in the production of unwanted noise in the neighbourhood.
- **Construction sites:** Mining, construction of buildings, *etc* add to the noise pollution.

5.8.2 Effects of noise pollution

Noise pollution can be dangerous to human health in the different ways, some of them are given below:

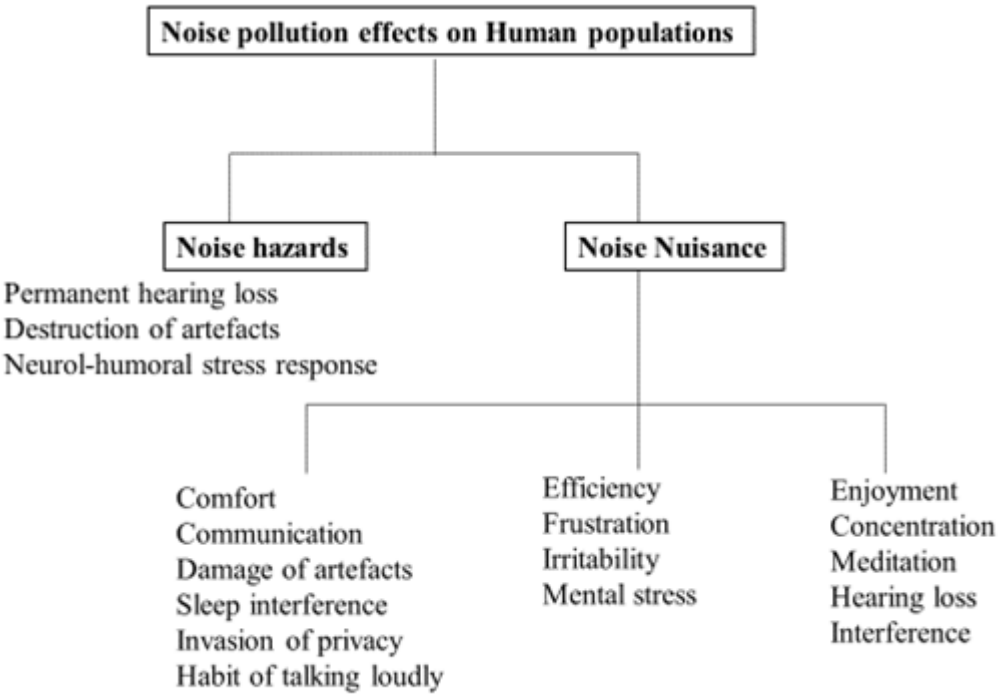
- **Hearing loss:** Continuous exposure of human to loud noise that are outside the range of sound that human ears can withstand damages the eardrums resulting in loss of hearing.
- **Hypertension:** It is a common and direct result of noise pollution which is caused due to raised blood levels for a longer period.
- **Sleeping interference:** Lack of sleep might result in low energy and fatigue throughout day. Noise pollution hampers the sleep cycles leading to irritation and uncomfortable state of mind.
- **Behaviour effect:** Noise pollution changes the individual behaviour.
- Conversation interference: High background noise induce disturbance in conversation.
- **Cardiovascular issues:** Heart related problems such as blood pressure level, stress, and cardiovascular diseases might come up in a normal person and person suffering from any of these diseases might feel the sudden shoot up in the level.

5.8.3 Control of noise pollution

Some common noise pollution preventive actions are provided in the points below.

- Honking in public places like hospitals, school and other teaching institutesshould be banned and restricted.
- Silencer should be used because they reduce noise by absorbing sound.
- In commercial, hospital, and industrial buildings adequate soundproof systems should be installed.

- Green muffler approach involves planting more green plants along roadside and unused land to reduce noise pollution.
- Planting more trees with broad leaf bases.
- Loud musical instruments sound should be controlled to neededlimits.
- Explosives should not be used in forest, mountainous, and mining areas.



5.8.4 Standards of ambient noise level in India

Due to the increasing noise level in public places from different sources, Indian government has taken some essential provisions to control noise production with the objective of maintaining the ambient air quality standards in respect to noise. Under the environment protection act, 1986 central government of India has made the Noise Pollution (regulation and control) Rulesfor the regulation and control of noise sources.

Table 5.5: Ambient air quality and standards in respect of noise

Area code	Category of area	Limits in dB (A) Leq*	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

5.9 Thermal pollution

The adding of excess heat water to the water bodies causes thermal pollution. Water is used as coolant for machines of any factory or plant, afterwards, used water with high temperature is ejected back to the natural resources. This causes abrupt increase in temperature of water bodies. The transformed water also makestrouble in the oxygen level of water bodies. This in turn, produces illseffect on the marine life.

Therefore, thermal pollution is caused in water by spilling back the used not water in, water bodies which produce adverse effects, is known as thermal pollution.

5.9.1 Sourcesof Thermal Pollution:

The following sources contribute to thermal pollution:

1. **Nuclear power plants:** It including drainage from research institutions, hospitals, nuclear explosions. It releases more heat along with traces of toxic radio nuclides into nearby water streams. Heated wastes from power plants are discharged at 10°C higher than the receipt waters bodies that affects the aquatic flora and fauna.
2. **Industrial effluents:** Different industries like pulp, paper, textile and sugar manufacturing release high amounts of cooling water along with some wastes into nearby water bodies. The waters polluted by unexpected and organic loads result in severe drop in levels of dissolved oxygen leading to death of aquatic organisms.
3. **Domestic sewage**: Domestic sewage is directly discharged into natural water bodies with minimal or without treatment. This leads to reduction in dissolved oxygen in the receiving water and results in the anaerobic conditions causing release of foul and offensive gases in water.
4. **Coal fired plants:** The condenser coils in plants are cooled with water taken from water bodies. The heated water is released into streams thereby raising the water temperature by 15°C. Heated wastedeclines the dissolved content of oxygen resulting in death of fish and other aquatic organisms.
5. **Hydro-electric power:** Generation of hydroelectric power sometimes leads to negative thermal loading in water systems.

5.9.2 Effects of Thermal pollution

- Toxicity of detergents, chemicals, fertilizers and pesticides in the industrial waste increases with increases in temperature.
- Concentration of Dissolved Oxygen (DO) decreases with increase in temperature.

- High Temperature is considered to be of significance effect to metabolism, physiologyand biochemical processes that control development and other function of aquatic organisms.
- **Interference in reproduction:** In aquatic organism, several activities like spawning, hatching, migration and reproduction depend on optimum temperature.
- Fish migration is also affected by thermal pollution due to formation of different thermal zones.

5.9.3 Controlmeasures for thermal pollution

The following methods can be used to control thermal pollution:

1. **Cooling towers**: Use of water from water systems for cooling, with subsequent reappearance to the water system after channel through a condenser, is called cooling process. Coolingtowers are of two types:
   (i) **Wet cooling tower:** Warm water coming out from the reactor is sprayed over baffles with high velocity cool airis passed from sides, which takes away the heat and further cools the water.
   (ii) **Dry cooling tower:** Warm water is permitted to flow in long spiral pipes. Cool air by using fan is passed over these hot pipes, which cools down warm water. Further this cool water can be recycled.
2. **Cooling ponds:** Heated water and effluents is stored in cooling ponds to maximise heat dissipation to the atmosphere and cool water to further recirculate in nearby water body.
3. **Spray ponds**: The water coming out from reactor is passed into the ponds by using sprayers. Sprayed water through nozzles as fine droplets releases all heatwhich gets dissipated to the atmosphere.

5.10 Nuclear hazards

Radioactive substances are present in nature. They decay naturally in which unstable radio isotopes spontaneously give out high energy radiation and fast-moving particles at a constant rate until a stable new isotope is formed. Radioactivity is a process of spontaneous emission of ionization particles like alpha and beta particles, and gamma rays (short wave electromagnetic waves) due to breakdown of atomic nuclei of radioactive elements. These cause radioactive pollution. Alpha particles are commonly known as proton, carries positive charge and beta particle is known as electron and carries negative charge.

Ionising radiations have high penetration power and cause breaking of several macro molecules.

5.10.1 Sources of radioactive substances

Sources of radioactive isotopes mainly divided into two groups:

- **Man-made sources:** Man-made sources are nuclear accidents, power plants, test labs *etc*. mining and refining of plutonium and thorium,
- **Natural sources:** Cosmic rays from outer space, soil, rocks, radon-222 and water.

5.10.2 Effect of radiations

Ionization radiation produced by radioactive substances effect living organism by inducing harmful changes in the body cells and also produce mutagenic effect.

- Some radioactive elements like iodine, caesium, and strontium have carcinogenic properties.
- Radiation induces structural and numerical chromosomal aberration.
- The huge heat production will result in burn, both to the skin and Skelton.
- Nuclear explosion releases large amount of radioactive radiation. This can cause the blindness sue to melting of retina.
- Low exposure causes nausea, vomiting, hair loss and fatigue.

5.10.3 Control of nuclear pollution

i. Leakage from labs and nuclear reactor should be stopped and safety control protocols should be enforced.
ii. Regular monitoring, maintenance of nuclear reactor and appropriate steps should be taken against nuclear accidents.
iii. Disposal of nuclear waste must be efficient, safe and effective.
iv. Use of nuclear weapon should be banned.
v. Sitting of power plant should be carefully done after studying long term and short-term effect.

5.11 Bioremediation

Bioremediation is a biotechnical procedure, which subsides or scrubs contamination. It is a type of waste management technique which mainly involves the use of organisms to eliminate the pollutants from a polluted area.There are numerous remedies where polluted solid and water is cleansed by chemical treatment, incineration, and burial in a landfill. There are some other types of waste management techniques which include solid waste management, nuclear waste management, *etc*. Bioremediation is different as it uses no poisonous chemicals.

Microorganisms like Bacteria and Fungi are the main part when it comes to performing the process of Bioremediation. Bacteria are the most vital microbes in bioremediation as they

break down the waste into organic matter. Bacteria can easily digest contaminants like chlorinated pesticides or clean oil spills but microorganisms fail to destroy heavy metals like lead and cadmium.

5.11.1 Bioremediation procedure

It can be in-situ or ex-situ. *In-situ* involves treating the harmful substances at the site of production while *ex-situ* involves the removal of the contaminants to another site. *In-situ* techniques are most desirable due to lower cost and less disturbance.

An *Ex-situ* and *in-situ* strategy involves different technologies such as bioventing, biosparging, bioreactor, composting, landfarming, bioaugmentation and biostimulation.

Bioventing

It is an in-situ strategywhich use microorganisms to degrade organic waste adsorbed in soil in unsaturated zone. Bioventing increases the activity of indigenous bacteria in soil by inducing oxygen and air flow**.**

Biostimulation

Microorganismsare stimulated to initiate the process. The contaminated soil is mixed with special nutrients elements including other vigorous components either in the form of liquid or gas. It stimulates the growth of bacteria thus resulting in efficient removal of contaminants.

Bioaugmentation

In some cases, selected and standardized microbes are added to an area that has been contaminated with an unknown substance. These bacteria cause the breakdown of contaminates.

Biosparging

This technique uses indigenous microbes to degrade organic waste in the saturated zone. Nutrients and oxygen are injected into saturated zone to enhance the activity of indigenous microbes.

Composting

It is a controlled decomposition of organic waste. In this process contaminated soil is mixed with harmless organic materials. These organic materials support the growth of microbes which induce and enhance decomposition.

Bioreactors

Bioreactors are of two types, slurry and aqueous reactors are used for *ex-situ* treatment of polluted water and soil. Bioremediation in reactors involves the processing of pollutant solid materials through an engineered containment system.

A slurry reactor is an apparatus which is used to generate a three-phase (solid, liquid and gas) mixing condition to increase the decomposition rate of water soluble and soil bound pollutants as water slurry of the polluted soil and biomass.

Landfarming

Landfarming is an *ex-situ* bioremediation technology in which polluted soil is mixed with nutrients to form treatment beds which are occasionally twisted or tilled to aerate the soil. Soil conditions are often controlled to optimise the rate of pollutant biodegradation, including moisture content (by irrigation or spraying), aeration (by tilling the soil), pH (addition of crushed limestone or agricultural lime), and other amendments such as bulking agents and nutrients. Landfarming is a medium to long term remediation that successfully treats petroleum hydrocarbons including diesel fuel, heating oils, oily sludge, creosote and pesticides.

5.11.2 Advantage of bioremediation

1. Bioremediation is a natural process:

Bioremediation is a natural procedure and recognized by the public as a waste treatment process for polluted soil. Microbes degrade the pollutant, increase their number and release harmless products. The residues for the action are generally harmless products such as carbon dioxide, water, and cell biomass.

2. Complete destruction:

It is valuable for the whole destruction of a wide variety of pollutants. Numerous hazardous compounds can be transformed into useful products. This decreases the chance of future liability related with the treatment and removal of contaminated material.

3. On-Site Treatment:

Bioremediation can be carried out on the site of contamination itself, without causing a main disturbance of normal activities. This removes the need to transport huge quantities of waste off-site and thus reduce potential harm to human health and the environment that can arise during transportation.

4. Cost-Effective Process:

Bioremediation is less expensive compared to other approaches that are used for the elimination of hazardous waste.

5.12 Phytoremediation

Phytoremediation is the use of plants and associated soil microbes to decrease the amount or toxic effects of contaminants in the environment. Phytoremediation is generally recognized as a cost-effective environmental restoration technology. It is an alternative to engineering events that are usually more damaging to the soil. Phytoremediation is, however, limited to the root-

zone of plants. Also, this technology has limited application where the concentrations of contaminants are toxic to plants. Phytoremediation technologies are available for various environments and types of contaminants.These involve different processes such as *in situ* stabilization or degradation and removal (*i.e.*, volatilization or extraction) of contaminants.

Phytoextraction or phytoaccumulation is the process used by plants to concentrate heavy metals into roots. It is also known as phytomining.

Phytostabilization or phytoimmobilization is a process in which plant decreases the mobility leachable pollutants.

Phytotransformation or phytodegradation is a process for the metabolization and degradation of organic pollutants taken up by plants from soil by enzymes secreted by plants.

Phytovolatilization involves the uptake of contaminants by plant roots and its conversion to a gaseous state, and release into the atmosphere. This process is driven by the evapotranspiration of plants. Plants that have high evapotranspiration rate are sought after in phytovolatilization. Organic contaminants, especially volatile organic compounds (VOCs) are passively volatilized by plants.

5.13 Environmental Impact Assessment

Environmental Impact Assessment is defined as an action designed to recognize the impact on the bio-geophysical environment, on man and well-being of governmental proposals, policies, projects, operational procedures and to interpret and communicate information.EIA is a systematic process of identifying future consequences of a current or proposed action on environment.

EIA is a structural approach for evaluating and obtaining environmental issues prior to the developmental process. This approach consists basically of predictions of how the environment is expected to change if some action is applied and information on how to manage environmental changes.

5.13.1 Steps in EIA process

EIA is a tool that examines the effect of developmental actions on environment, in advance. The emphasis of an EIA is on prevention and therefore is more proactive. By using EIA both economic and environmental profits can be achieved, such as reduced cost and time of project design and implementation, avoided treatment costs and impacts of laws and regulations. Although legislation and exercisediffer around the world, the fundamental components of an EIA would essentially involve the following stages:

- **Screening** to determine which developments and projects need a full or partial impact assessment study.
- **Scoping**seeks to detect which possible impacts are applicable to assess, to identify substitute solutions that mitigate, avoidor compensate impacts on biodiversity and lastly to arise terms of reference for the impact assessment.
- **Assessment and evaluation of impacts and development of alternatives**, to expect and recognize the likely environmental impacts of a planned project or development, including the detailed elaboration of alternatives.
- **Reporting the Environmental Impact Statement (EIS) or EIA report,** including an environmental management plan (EMP), and a non-technical summary for the general audience.
- **Review of the Environmental Impact Statement (EIS),** based on the terms of reference (scoping) and public (including authority) participation.
- **Decision-making** on whether to approve the project or not, and under what conditions; and
- **Monitoring,** compliance, enforcement and environmental auditing. Monitor whether the predicted impacts and proposed mitigation measures occur as defined in the EMP. Verify the compliance of proponent with the EMP, to ensure that unpredicted impacts or failed mitigation measures are identified and addressed in a timely fashion.

5.13.2 Advantage of EIA

The main benefits and advantages of EIA are:

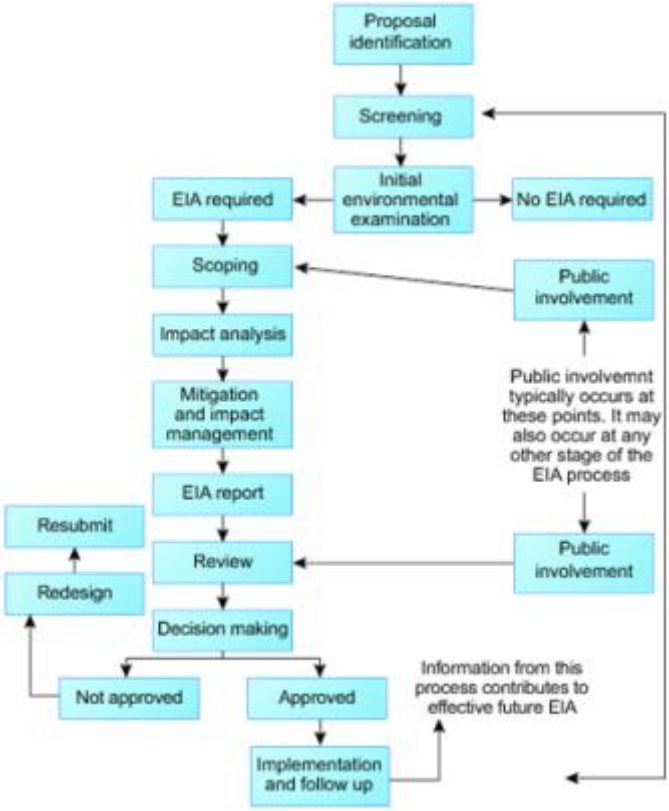
- More environmentally sensitive decisions.
- Provide opportunity for public involvement in decision making.
- Improved project design.
- Increased transparency and accountability during development process.
- Reduce environmental damage.
- A positive contribution towards achieving sustainability.

5.13.3 EIA guiding principles

International Association for Impact Assessment (IAIA, 1999) and others have developed guided principles for EIA. The principles are:

- **Participative**: The procedure should offer suitable chances to inform and involve the interested and affected public and private sector by taking their input in decision making.

- **Certainty**: The timing and procedure of the assessment should be accepted and agreed in advance and follow by all participants.



- **Transparency**: Assessment issues, decisions and outcomes should be accessible and open.
- **Accountability**: The decision makers and project proponents are accountable for all parties for their work and decisions under the assessment process.
- **Credibility**: Assessment is assumed with objectivity and professionalism.
- **Cost-effectiveness:** The assessment protocol and outcomes will ensure protection of environment at the least cost to the society.
- **Practical**: The assessment procedure should result practical outputs, which can be applied by proponent.
- **Relevant**: The procedure should focus on information that is important for developmental planning and decision making.
- **Focused:** The process should focus on important environmental effects and significant issues that need to be taken into account in decision making.
- **Interdisciplinary**: The process ensures that the suitable method and specialists in the relevant field are working, including use of traditional knowledge as essential.

- **Integrated:** The process should address the relationship of social, economic and biophysical aspects.

5.13.4 EIA system in India

Environmental impact assessment (EIA) was first introduced in India based on the Environmental Protection Act (EPA), 1986. But properly it came in to force, when Ministry of Environment and Forest (MoEF) has approved a main legislative measure under EPA in January 1994 for Environmental Clearance known as EIA Notification, 1994. Subsequently, EIA processes have been strengthened by MoEF by different amendments and acts. The current exercise is following to EIA Notification, 2006 and its alterations. The fragments of indication collected and examination in the present assessment propose that, despite a sound legislative, organizational and technical set-up EIA has not yet evolved satisfactorily in India.

An evaluation of the EIA system against systematic assessmentstandards, based on deliberations with numerous stakeholders, approval authorities, NGOs, EIA expert committee members, project proponents and consulting professionals, exposesdifferentdisadvantages of the EIA system. These mainly involves; deficiencies in screening, inadequate capacity of EIA approval authorities, inadequate public participation, poorquality EIA reports, and feeble monitoring. Overall, EIA is used currently as a project defence tool rather than as a project planning tool to contribute to attaining sustainable development.

While deficiencies are challenging, Government of India is showing a high degree of promise. The EIA system in the country is undergoing progressive modifications by steadily eliminating the constraints. All projects are divided into two categories: category A and B, based on the spatial extent of potential effect on environment, man health and on natural resources. The category A actions require prior environmental clearance approval from Ministry of Environment and Forest and climate change on the recommendation of Expert Appraisal Committee (EAC) formed by the central Government.

The category B activities need prior environmental clearance from State Environment Impact Assessment Authority (SEIAA) on recommendation of State Level Expert Appraisal Committee (SEAC). The SEIAA and SEAC are formed by central government. Project of this category further divided into B1 and B2. The project categorized as B1 require EIA report for appraisal and also have to undergo public consultation process. The projects under B2 are to be appraised based on the application accompanied with pre-feasibility report.

5.13.5 Strategic environmental assessment

Impact assessments are mainly carried out to assess the effect of individual projects-environmental impact assessment or programmes and policies- Strategic environmental

assessment (SEA). It is a tool used to integrate environmental considerations into planning, policy or program suggestions. When used initially in the development of a suggestion, SEA contributes to informed decision-making. It provides decision-makers with environmental impact information for altering the design of plans and programs so that the undesirable impacts can be eliminated and the positive impacts optimized.

SEA by its nature covers a huge range of actions or area and often over a longer time period than the EIA of projects. SEA can be applied to an entire geographical area. It does not replace and reduce the EIA for any project needs, but it can help to focus and streamline incorporation of environmental concerns into decision making process. EIA focuses on the physical developmental processes such as power stations, road, highways and large-scale industrial facilities. SEA focuses on proposed plan at higher level such as new law, amended laws, policies, plan and programmes.

Exercise

Short Answer type Questions

1. What is pollution?
2. Define pollutants.
3. What is biodegradable pollutant?
4. Mention different types of pollutions?
5. What causes Itai-Itai diseases?
6. What causes the minimata diseases?
7. What is acid rain?
8. Define global warming.
9. Name any two important greenhouse gases.
10. Give examples of non-biodegradable pollutants.
11. What is ozone depletion?
12. What is noise pollution?
13. Mention the name of unit of noise pollution measurement.
14. Give the two-ill effect of noise pollution.
15. Which toxic gas was thought to be responsible for Bhopal Gas tragedy?
16. Name the most serious water pollutant.
17. Which pollutant of Mathura refinery is threat to Taj Mahal?
18. What is phytoremediation?
19. Define EIA.

20. What is biomagnification?
21. What is oil spill?

Long Answer type Questions

1. Write brief sources, effects and control of water pollution.
2. Give some suggestive measure to control noise pollution.
3. Describe about harmful effect of air pollution.
4. Discuss various method for control water pollution.
5. What do you know about ocean water pollution?
6. Define biomagnification. Discuss its types with DDT example.
7. Give the different reason of land degradation.
8. Explain the different methods which commonly used for solid waste management.
9. What should be the role of an individual in pollution preventing?
10. What is thermal pollution? Discuss the causes and effect of thermal pollution.
11. Explain nuclear pollution and how can it be controlled?
12. Discuss the various ways by which we can control soil pollution.
13. Define phytoremediation, its types and importance for environment.
14. Define EIA and its principal.
15. What is global warming, what are its on human health?
16. Define acid rain, its causes and impact on human health.

CHAPTER 6 | Environment and Sustainable Development

6.1 Environment and social issues

Environment is sum off all factors and conditions which affect the life and development of living beings.The development of a country depends upon its environmental and geographical circumstances.

The necessity of life depends upon the relation between environment and organisms. On earth's surface human beings become the most dominant and successful organism and also have the ability to change and explore the nature according to needs due to his intellectual capacities. The human interference is responsible for environmental damage and it has reached at a critical stage. Some important social climate related issues are described below:

6.2 Sustainable Development

Sustainable development was popularised as a, "Our common Future",prepared by the World Commission on environment and development in 1987.Sustainable Development means" meeting the needs of the present population without compromising the ability of future generations to meet their own needs." According to this, sustainable development is divided into two parts:

1. **Concept ofneeds:** Needs in particular are the basic needs of people. For *e.g.* drinking water, health and sanitation *etc*.
2. **Concept of limitation**: This will help us in meeting the needs of present without compromising the requirements of future generations. For instance, technology and development should be in harmony with the environment.

6.2.1 Salient principles of sustainable development

Salient principles and responsibility for sustainable development and environment protection provided by Brundtland Commission are as follows:

1. **Fundamental Human Right:** All human beings have some fundamental right to protect Environment for their well-being and health.
2. **Inter-Generation Equity**: State shall use and conserve the natural resources and Environment for the profit of present and future generations.

3. **Sustainable Use and Conservation:** State shall preserve Ecosystem and various Ecologicalprocesses which are essential for functioning of biosphere.
4. **Environment Monitoring and Standard:** Government shall createsome environmental standards, screenenvironmental changes and publish yearly reportsregarding to that.
5. **Prior Environment Assessment:** For futureclimate protection policies, proper assessment of current and prior environmental conditions is essential.
6. **PriorNotification Access andDue Process:** All people who are going to be affected by implementation of any planned policy, should be given previous notification. They should have suitableprocedure in organizational and legal proceedings.
7. **Assistance for Sustainable Development:** Especially in developing countries specific assistance should beprovided for sustainable development.
8. **Obligation to cooperate and Assist:** State shall co-operate in decentconfidence with other states in executing the proceedings right. It should be made integral part of our policy.

In Rio De Janerio,during Earth Summit 1992, we deliberatedsome important principles for sustainable development for 21st century which is known as Agenda 21. Basically, it is a complete blue print for global, regional, national and local level to affect the change to sustainable development.

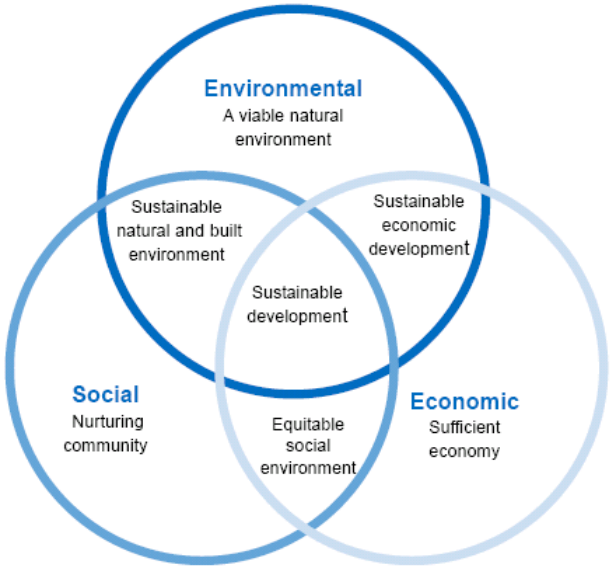


Figure 6.1: A model for integrating Human needs, ecosystem health and sustainable economic growth

6.3 Water conservation

Water is most essential and significantnatural resource. It covers approximately 71% of earth's surface. Out of total, about 97% is saline water whereas the rest is fresh water. It supports in maintaining the earth's climate. It also weakens the environment pollutants, makes 50-97% of our total body weight. Still it is one of the greatest poorly managed resource on the earth. The fresh water which is absolutely pure is present below the earth asunderground water.

Several approaches can be accepted for water conservation:

1. We can increase the surface water availability by decreasingsiltation and rain run-offwater.
2. We can save water through improved agricultural practices such as tillage mulching, animal residue spreading on land etc. These methods help in reducing run off water by allowing more time for water to infiltrate in the earth.
3. Use of improved irrigation methods such as sprinkler and drip irrigation rather than flooding.
4. Contour farming on small furrows and ridges across the slope traps rain water and permits more time for infiltration.
5. Trace and wad leaks in water pipe lines.
6. Make use of small capacity flush in toilets.
7. Do not waste water by keeping the taps running when not in use.
8. Collection of rain water in reservoirs, tanks and ponds. The best technique of water conservation is rain water harvesting.
9. Storageofwater also takesplaceinthesoilrootzoneinhumidregionswhensoilis reached tofield capacity. By leaving the soil fallow for one season, water can be made available for cropsgrown in next season.
10. Recyclingofindustrialwaste water through waste treatment plants and sewage water through sewage treatment plant is a best method for reusing that water.
11. Water storage structures, like farm ponds, dugout etc. builtbyindividual farmers,can bebeneficialprocedures for water conserving.

6.3.1 Rain water harvesting

Underground H_2O is the only fresh H_2Osource. But day by day, surface water sources likelakes, rivers and ponds are getting polluted due to constantly increasing industries. We completely depend upon the underground H_2O, whose water level is alsobecoming lower day by day. Rain water harvesting is a very good technique in preserving the underground H_2O.

Rain water harvesting is the method through which rain H_2O is seized from building roof and kept in reservoir or tanks or loading it underground for later use.rainwater harvesting not only upsurge the water availability, it also manages the decreasing of water table. It is an eco-friendly approach and recharges the ground water table.

Dropping of ground water level is mainly due to:

(i) Wastage and over exploitation of ground H_2O.

(ii) Non availability of other fresh water sources.

This results into extreme fall in ground water level, weakening in ground water quality and drying up of wells. That's why rain water harvesting is an effective process to recover ground water level.

Main objectives of rain water harvesting are as follows:

1. To reduce fresh rain water loss
2. To store excess water when it is available and use itat subsequent time.
3. To encounter increasing demand of H_2O for growing population.
4. To decrease soil erosion from rain run-off water.
5. Todiminish H_2Opollution.
6. To maintain ground watertable level.

There were two main techniques for harvesting the rain water:

1. **Traditional method**
2. **Modern method**

1. **Traditional method of rain water harvesting:** House roof top method is the most ancient method. In this technique we can capture and recharge approximately 65,000 litres of rain water in Delhi, only from an area of 100 sq. metre size roof top and meetthe domestic and drinking waterneeds ofa family of four person for 160 days. Now a day's roof top method is the finest technique for water conservation and rain water harvesting. It is a successful way and cheapest method to recharge the ground water. Here, rain water is collected from the house roof top. It is diverted to earth storage tank. This water later used for domestic purpose.

Some other traditional methods are also used for rain water harvesting:

1. Harvesting rain run-off water in the catchment area by constructing dykes, check dams and sub surface.
2. Collecting rain water by constructing pond and Percolation Lake in villages.
3. Conservation by accumulating rain water in embankment type water storage.

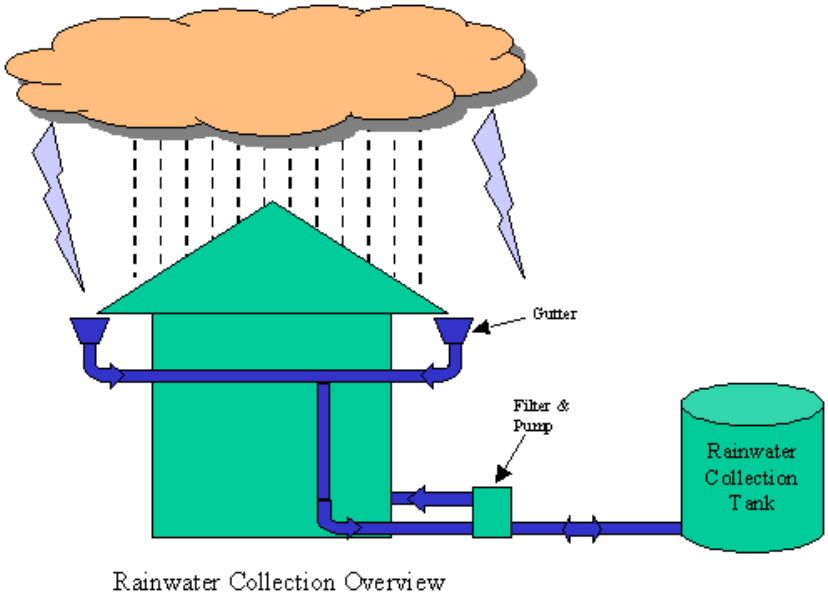


Figure 6.2: Rainwater harvesting system

2. Modern technique of rain water harvesting: Watershed and small dams formed on ponds in villages and made of materials like stones androcks they are constructed for harvesting rain water from huge catchment area.

6.3.2 Watershed management

Watershed is adraining area to drain rainwater into a stream. Itis a small catchment area from which rainfall, precipitation, as well as snow fall drift into stream. Size of watershed can be ranged from a few square kilometres to few thousand square kilometres. The watershed includes complex interaction of land, soil, water vegetation and land use activities.

The main aim of the watershed management is balancedconsumption of water and land resources for optimal production by causingleastharm to environment and natural resources.The most importantpurposes of watershed management are:

(i) Conserving water and soil.

(ii) Refining the capability of land to hold water.

(iii)Growing trees, herbs and shrubs.

(iv)Rain water harvesting and ground water recharging.

(v) Availability of fresh water in non-rainy season.

(vi)Checking soil erosion.

Watershed Management Practices

There are various types of watershed management techniques which can be used for natural resources' conservation. Some are given below:

6.4 Climate change

Climate is defined as the average weather of a specific area. It includes seasonal variations, overall weather conditions, and immoderations of weather in a region. Such conditions which average at least 30 years is known as climate.

In 1990 and 1992 the Inter-governmental Panel on Climate Change (IPCC) published topexisting evidence about past climate change, the greenhouse effect and recent changes in global temperature. It is observed that earth temperature has alteredhugely during the geological times. It has experienced numerous glacial and inter-glacial periods. Although, during the past 1000 years of the current interglacial period the mean average temperature has fluctuated by 0.5-1°C. Even small changes in climatic conditions may interrupt agriculture that would be responsiblefor migration of animals including humans.

Man,activities are disturbing the subtle balance between numerous components of the environment. Increase in amount of greenhouse gases in the atmosphere is main factor to increase in global temperature. Enhancement in temperature upset hydrological cycle and result in increase in sea level, drought and flood which indirectly affect agriculture productivity.

The temperature change is not equal throughout the world,it differs from place to place. At higher altitude region temperature increases during late autumn and winter. Poles experience 2-3 times more temperature than the global average. The pole warmings reduce thermal gradient between high altitude and equator. It will also disturb the global ocean and wind pattern, distribution and timing of rain fall.Human societies are also extremely affected by climate change. Climate change is a major fear for human health. Human health depends on sufficient food, pure drinking water, secure shelter, and good environmental conditions. All these factors are related and significantly affected by climate change. The risk of infectious diseases such as diarrhoeal will increase with climate change. Food production is decreasing in susceptible regions directly and through an increase in pests and plant or animal diseases.

6.5 Global warming

Approximately 75% of the solar radiationsare absorbed byearth'ssurface, which rises its temperature. The remaining radiations are radiated back to the atmosphere. Some of the radiations are stuck by greenhouse gases, mainly carbon dioxide which causes global warming. As carbon dioxide is released by different human activities, it is responsible for global warming.The average temperature of the earth surface is about 15°C. Without greenhouse gases Earth's surface would be ice-covered with a mean air temperature of -18°C. Human activities during the last few decades of industrialisation and population growth have polluted the atmosphere to the extent that it has begun to seriously affect the climate. Carbon dioxide in the

atmosphere has increased by 31% since pre-industrial times, causing more heat to be trapped in the lower atmosphere. Last few decades of industrialisation and human population growth, induced adverse impact on the atmosphere and begun to seriously affect the climate. Under the United Nations Convention on Climate Change, several nations signed a convention to reduce the emission of greenhouse gases.

The main greenhouse gases are CO_2 and water vapour, which are controlled by global carbon and hydrological cycle. Some other greenhouse gases whose level increases by human activities are nitrous oxide, methane and chlorofluorocarbons. Deforestation further enhanced the level of CO_2 due to non-removal of carbon dioxide by photosynthesis. These gases are known as major greenhouse gases because they behave like a blanket and cover earth's surface to and maintain earth temperature. Significant greenhouses gases are:

- CO_2
- Water vapour
- Nitrous oxide
- CFCs
- Methane

Even in small quantity these gases play an essential role in maintaining temperature. CO_2 individually contributes about 60% of total warming whereas, methane, nitrous oxide and CFCs contribute 20%, 6% and 14% respectively.

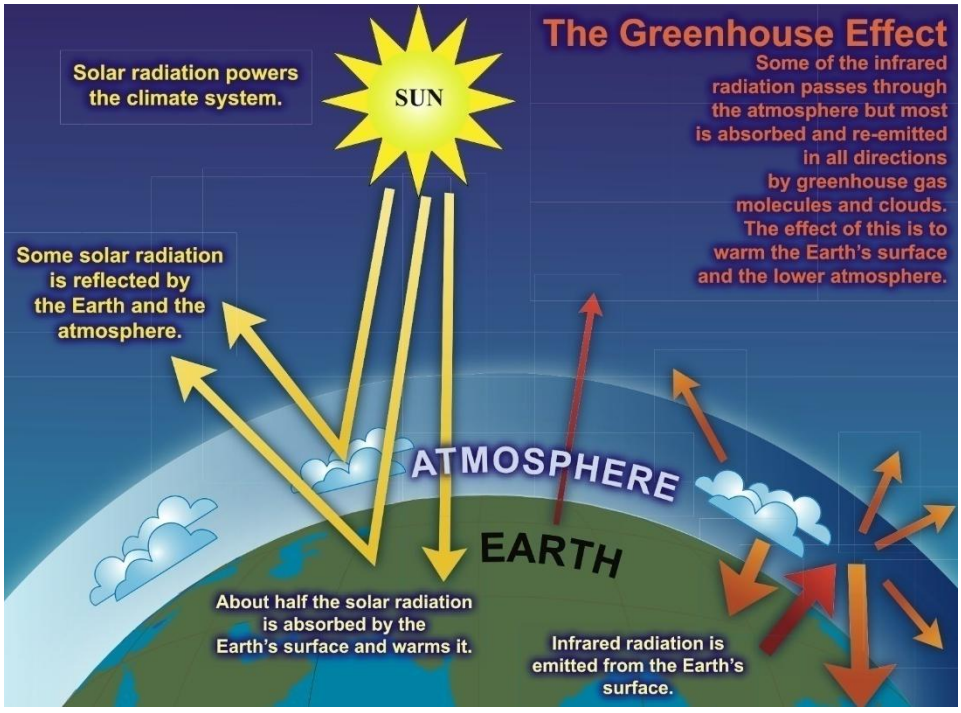


Figure 6.3: Complete process of global warming.

6.5.1 Increase in concentration of greenhouse gases

Human activity and modernisation have been enhancing the global warming by increasing the amount of greenhouse gases in atmosphere during the past 250 years. This has resulted in significant increases in positive radiative forcing, which has a warming effect on the climate. In last 100 years, carbon dioxide level has increased from 280 ppm in 1750 to over 407 ppm today. This means it is approximately 40% higher than pre-industrial time. The first increased in atmospheric carbon dioxide start in 1957 at South pole and 1958 at Mauna Loa, Hawaii. At that time, concentration in Mauna Loa was 315 ppm and was growing at 1 ppm per year. In1979, National Oceanic and Atmospheric Administration (NOAA) began assembling data from a network of sites to determine a global average value. In 1990, global average value was noticed as 354 ppm which growing at rate of 1.6 ppm/year. In 2006, it reached upto 380 ppm and increased at rate of 2 ppm/year.

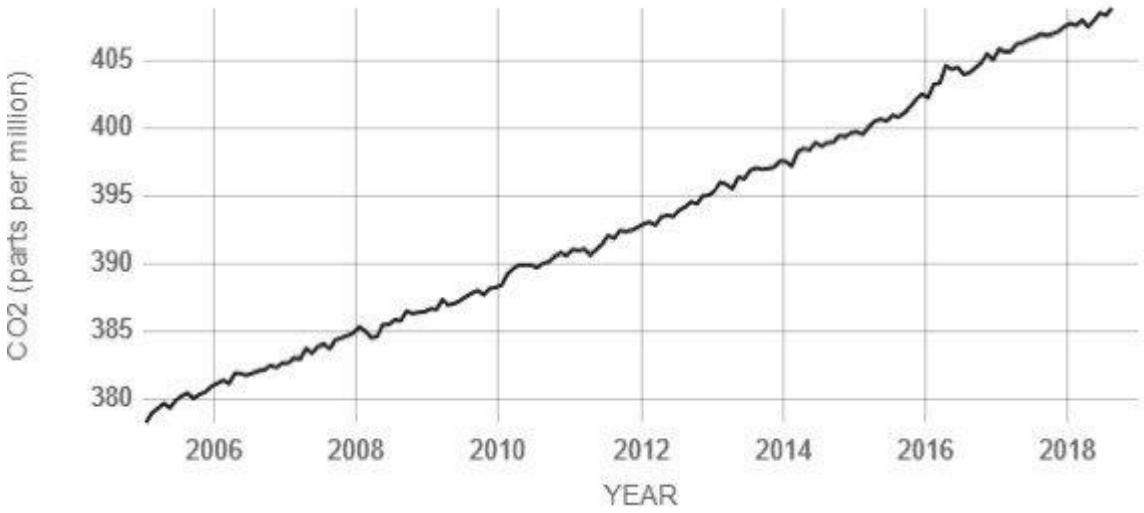


Figure 6.4: Carbon dioxide concentration in the atmosphere 2006-2018.

6.5.2 Impact of greenhouse effect

The enhanced greenhouse effect is not only responsible for global warming but also effect different climatic and natural process:

Increase in temperature: it is predictable that the earth's mean temperature will increase from 1.5 to 5.5°C by 2050 if gases input continues with same rate.

Effect on sea level: Sea levels are expected to rise between 10 and 32 inches or higher by the end of the century. Global warming induces polar ice and glaciers melting which results in a rise in sea level.

Human health: Rain distribution and falling pattern is distributed by global warming, thus vector borne diseases like elephantiasis, malaria and filariasis will likely to be spread. Higher humidity and temperature will increase the chances of skin and respiratory diseases.

Food and farming: Changes in rainfall patterns, flooding, drought, frequent heat wavesand extreme weather create difficulties for farmers which result in a fall in, falling food accessibility and make it costly to purchase.

Coral bleaching: Increasing temperatures and ocean acidity is contributing to dangerous coral bleaching.

6.5.3 Measure to control global warming: The following steps are significant to control the global warming:

- Use non-renewable and renewable resources more efficiently
- Cut down the rate of use of fossil fuel and CFCs sources.
- Shift from non-renewable to renewable resources.
- Efficiently decreasing the CO_2 content in atmosphere.
- By using nuclear power plant for electricity production.
- Accept sustainable development.
- Plant more trees.

6.5.4 Responding to climate change

Climate change is a complex issue faced by society. It involves different areas: economics, science, society, moral, political and ethical questions both at local and global level.Responding to climate change involves two approaches:

1. **Mitigation** involves reducing the emission and flow of greenhouse gases into atmosphere, either by decreasing sources of these gases or enhancing the sinks that store these gases such as forest, ocean and soil.
2. **Adaptation** involves adjusting expected and actual future climate change. The goal is to decreases our susceptibility to the harmful effect of climate change. It also includes making the most of any potential beneficial opportunities associated with climate change.

6.5.5 Earth summit

The United Nations Conference on Environment and Development (UNCED), also known as the Rio de Janerio Earth Summit, Rio Summit or Rio Conference on Earth Summit, was an important United Nations Conference held in Rio de Janerio from 3 to 14 June 1992. The focus of conference was on the global environment and relationship between science, environment and economics. Representatives of 105 countries assembled to validate their agenda

of sustainable development. All the participant nations present recognized the Rio declaration without any change a non-binding statement of extensive principles for environmental policy. Formal and informal international networks were set up to convey and oversee application of the agreements.

The UNCED has various outcomes for sustainable development articulated in the conference outcome document, Agenda 21. It states that sustainable development should become a priority item on the agenda of the international community and also focused on national economic, social and sustainable development strategies.

6.5.6 Rio conventions

Three main documents agreed upon at the Earth Summit are as follows: The Convention on Biological Diversity (CBD), The United Nations Framework Convention on Climate Change (UNFCCC), or Global Warming Convention, the Kyoto Protocol (1997), and The United Nations Convention to Combat Desertification (UNCCD). Each convention structures a basic framework for sustainable development in the context of their respective themes of biodiversity, climate change and land degradation. In 2002, the world summit on sustainable development (WSSD) which is known as Rio+10, held at Johannesburg to track and review progress in implementing the outcomes from Earth Summit. WSSD also established a strategy for implementation for the actions set out in agenda 21, known as the Johannesburg plan. A brief description of this Rio convention is here under:

6.5.7 Convention of Biological Diversity (CBD)

The Convention on Biological Diversity is the international legal instrument for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" that has been ratified by 196 nations. In other words, its other objective is to make national plans for the conservation and sustainable use of biological diversity. It is often seen as the key document regarding sustainable development.

6.5.8 United Nations Framework Convention on Climate Change (UNFCCC)

The convention was accepted in 1992. Its main objective is the stabilization of concentration of greenhouse gases in the atmosphere at a level that would prevent human interference with climate change. This convention came into force in 1994. In 1997, the UNFCCC adopted the Kyoto protocol.

6.5.9 United Nations Convention to Combat Desertification (UNCCD)

This international agreement made a link environment, sustainable development and land management. The convention addresses mainly the arid, semi-arid and dry areas, where some

vulnerable ecosystem and people can be found. In 2007, the UNCCD adopted 10-year strategies (2008-2018) with some specified goals: global partnership to prevent desertification and land degradation, mitigate the drought effect in affected area.

6.5.10 Kyoto protocol

The Kyoto Protocol is an international agreement which linked to the United Nations Framework Convention on Climate Change (UNFCCC). This protocol commits that state parties focus on decreasing man-made greenhouse gas emissions. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and came into force on 16 February 2005. There are currently 192 parties. The Kyoto Protocol is a legally binding treaty under which industrialized and developed countries will diminish their collective emissions of greenhouse gases by 5.2% compared to the year 1990. The goal is to lower overall emissions from six greenhouse gases - carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, HFCs, and PFCs - calculated as an average over the five-year period of 2008-12. National targets range from 8% reductions for the European Union and some others, 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.

6.6 Acid rain

Acid rain is made up of rain droplets that are remarkably acidic due to excessive amounts of nitrogen and sulphur released by industrial processes. Acid rain is also known as acid deposition. Acid deposition mainly occurs in two different ways: dry and wet. Dry deposition means different polluting gases and particles stick to the earth via smoke and dirt in the absence of rain. Wet deposition occurs in any form of precipitation that eliminates acids from the air and credits them on Earth's surface. Acidity of rainwater is 5.3-6.0 but pH of acid rain is below that range.

6.6.1 Causes of acid rain:

- Acid rain is caused by Sulphur and Nitrogen components which mixed with the rain water. Sulphur and Nitrogen particles produced by two ways either human activity likefrom industries or by natural reasons like thundering and volcanic eruptions. The major sources of SO_2 and NOX in the atmosphere are:
- Fossil fuels burnedto produce electricity. Approximately two thirds of SO_2 and one fourth of NOX in the air come from electric power generators.
- Heavy equipment's and vehicles.
- Manufacturing, oil refineries and other industries.

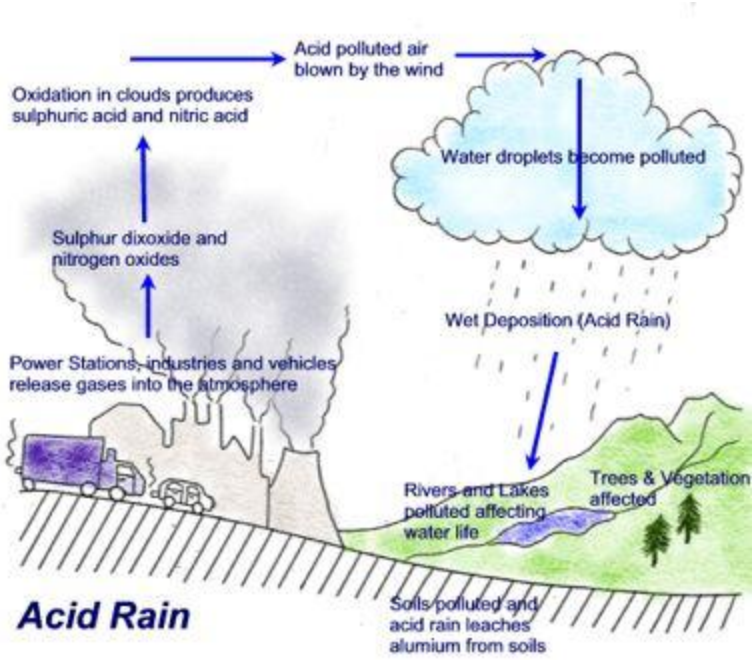


Figure 6.5: Acid rain

6.6.2 Effect of acid rain

- When acidic rain falls down and flows into the lakes, rivers and ponds it disturbs the aquatic system. It changes the synthetic arrangement of the water, to a form which is really destructive to the marine ecosystem to endure and causes water contamination.
- It causes different types of respiratory diseases in animals and humans.
- Acid rain is harmful for animals, man, agriculture and plants. Itwashes all nutrients away from top layer of soil which are mandatory for the survival and yield of plants.
- Acid rain also causes the corrosion of water pipes. Which further results in leakage of heavy metals such as iron, lead and copper into drinking water.
- It harms the landmarks and monuments made up of stones and metals.

6.6.3 Control of acid rain

- Liming of soil and lakes should be done to prevent the harmful effect of acid rain.
- Emission of SO_2 and NO_2 from power plants and industries should be decreased.
- Interior of drinking water pipelines should be coated by protective layer of inert polymer.

6.7 Ozone layer depletion

In the course of recent years people have gained knowledge in stopping injury to the ozone layer by reducing the usage of certain chemicals. But more remains to be done to defend and re-establish the climaticprotection that sits in the stratosphere about 15 to 30 kilometres above the Earth's surface.

Stratospheric ozone absorbs UV radiation, predominantlydamaging UV- Btype rays. Exposure to UV rays is connected with increased danger of cataracts and skin cancer, as well as injury to marine and plantsecosystems. Atmospheric ozone is sometimes named as the "good" ozone, due to its defending role, and shouldn't be mistaken with tropospheric, or ground-level, "bad" ozone, a key segment of air contamination that is connected with respiratory disease.

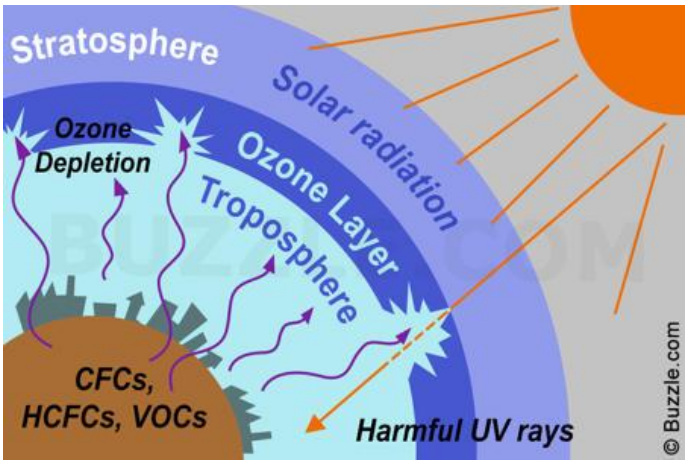


Figure 6.6: Ozone layer depletion in stratosphere

6.7.1 Causes of ozone layer depletion

The ozone layer depletion is a chief concern and is related with a number of factors. The important causes accountable for the depletion of the ozone layer are listed below:

- **Chlorofluorocarbons:** Chlorofluorocarbons are the chief reason of ozone depletion. These are mainly released by solvents, aerosols, soaps, spray refrigerators, air-conditioners, *etc*.In the stratosphere chlorofluorocarbons are fragmented by the UV radiations and release chlorine atoms. These atoms react and destroy ozone layer.
- **Nitrogenous compounds:** The nitrogenous compounds such as NO_2, NO, N_2O are highly responsible for the depletion of the ozone layer.
- **Natural causes:** The ozone layer has been depleted by some natural procedures such as stratospheric winds and sun-spots. But it does not cause more than 1-2% of the ozone layer depletion.
- The volcanic eruptions are also responsible for the depletion of ozone layer.

6.7.2 Effects ofozone layer depletion

The ozone layer depletion has damaging effects on the environment. Some major effects of ozone layer depletion are:

- **Effects on the Environment:** Strong UV rays may lead to negligible growth, also inhibit flowering and photosynthesis in plants. The forests also have to bear the damaging effects of the ultraviolet rays.
- **Effects on Human Health:** The human are beings directly exposed to the ultraviolet radiations due to the depletion ozone layer depletion. This might result in serious health issues such as cancer, skin diseases, cataract, sunburns, quick ageing and weekend immune system.
- **Effects on Animals:** Direct exposure to ultraviolet radiations leads to eye and skin disorders, and cancer in animals.
- **Effects on Marine Life:** Phyto-planktons are significantly affected by the exposure to ultraviolet rays. These are higher in the aquatic food chain. If the planktons are devastated the organisms present in the lower food chain are also affected.

6.7.3 Controlof ozone layer depletion

The ozone layer depletion is a serious matter and numerous programmes had been launched by the administration of manynations to control it. Several steps should be taken at the individual level to prevent the depletion of ozone layer.Following are some of the points that would help in preventing this problem at a global level:

Minimise vehicles use: Vehicles emit a hugequantity of greenhouse gases that lead to ozone depletion and global warming. Therefore, the use of vehicles should be minimised as much as possible.

Avoid using pesticides: Natural methods should be applied to get rid of weeds and pests instead of using compounds. Eco-friendly chemicals should be used to remove the pests or remove the weeds manually.

The use of nitrous oxide should be prohibited: The government should take actions against the use of harmful nitrous oxide that is badly affecting the ozone layer. The people should be made aware of the harmful effects of nitrous oxide and the products emitting the gas so their its use is minimised at the individual level as well.

6.8 Nuclear accidents and holocaust

A nuclear accident is defined by the International Atomic agency as an “happening that has led to important consequences to people, environment or the facility”. Nuclear energy is generated by using different radioactive substances. Nuclear fission of radioactive substances generates huge amount of heat which is controlled in nuclear reactor. But there is always a risk

of nuclear accident during nuclear fuel cycle. The accident occurs due to malfunctioning of safety measures.

Due to nuclear accident or explosion global warming phenomenon would not take placed. This is known as nuclear winter. It may responsible for loweringdown the global temperature even during summer also. It will severely affect the crop yield and productivity.

6.8.1 Causes of nuclear accident

There were several factors which cause to nuclear accidents:

1. Design fault in reactor
2. A violation of reactor functioning
3. Lack of a 'Safety Culture' in the power plant

6.8.2 Effect of the Accidents

1. **Environmental consequences**: The radioactive fallout produces damaging effect approximately up to 10 km radius and the radioactive material deposit itself over the areas and produce lethal effect in small mammals and coniferous trees.
2. **Health hazards:**There has been an increase in psychological disorders and different types of diseases such as depression, anxiety, helplessness, cancersand other disorders which lead to mental stress.
3. **Economic, political and social consequences:**The highly contaminated areas would besocially, economicallyand politically deteriorated as the natality ratewoulddecrease and emigration wouldsignificantly rise which wouldcause a shortage in labour force. These areas could not evolve industrially or agriculturally because of strict rules about the areas that are too contaminated.

Exercise

Short Answer Type Questions

1. What is environment?
2. Define the term of sustainable development.
3. What do you understand by rain harvesting?
4. What are greenhouse gases?
5. Define the term wasteland.
6. What is ozone layer?
7. What do you mean by environmental ethics?
8. What is consumerism?
9. What is holocaust?

10. What is wasteland reclamation?
11. What is the range of UV-B radiation?
12. What is water conservation?

Long Answer Type Questions

1. What is global warming? Describe the causes and harmful effect of global warming.
2. Write a critical note on rain water harvesting.
3. Describe the importance of water conservation.
4. What is a watershed? Discuss watershed objectives and practices of watershed management.
5. Why urban energy requirement is more than rural requirement?
6. What is the major implication of enhanced global warming?
7. What are the significant imitations to successful implementation of our environmental legislation?
8. Describe the problems and concerns of rehabilitation and resettlement of people as a result of development projects.
9. What is ozone layer? Mention its significance and its causes.
10. Write a critical note on nuclear accident.
11. Discuss the measures to conserve water.

CHAPTER 7 | Human Population

7.1 Population and environment

Population, environment and natural resources are three main and crucial pillars of human society. Out of these, population enjoys the important and central place. Human population grows exponentially. Growing human population possess some harmful effects on environment.

7.2 Population growth

Increase in the number of individuals in a given population is known as population growth. This is measured in term of growth rate per unit of time. Growth rate of population depend upon several factors like natality, mortality, migration and biotic potential of a population *etc*.

The ratio between mortality and natality in percentage is known as vital index.

Vital index= Natality/ mortality x 100

Human growth can be measured by growth curve. Growth curve may be S- shaped or j shaped. Growth curve depends on whether growth is logistics or exponential.

7.2.1 S-shaped growth curve

It the logistic curveinitially, population grow slowly then it increases with high rate and finally it stabilizes near carrying capacity of environment (represented by K). Carrying capacity is not fixed, it differs over space and time with the availability of limited resources. It is determined by different factors including competition, climate change and predation. Logistic growth curve produces a sigmoid (S-shaped) growth curve. In sigmoid growth curve, the population increases slowly at first, then rapidly, but after that it slows down gradually as the environmental resistance increases, until equilibrium is maintained.

$dN/dt=rN (K-N)/K$

where,

N= Population size

dN/dt= rate of change in population size

k= carrying capacity

r= intrinsic rate of increase.

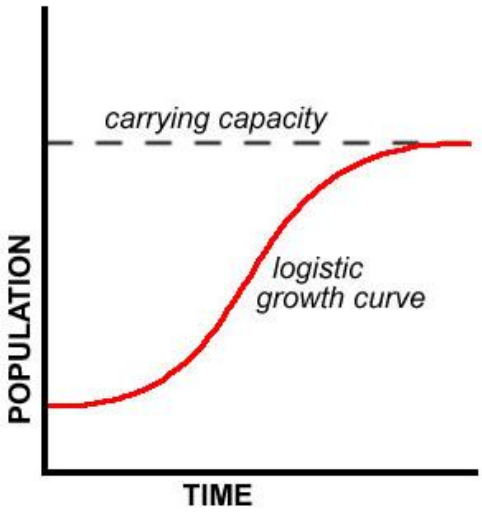


Figure 7.1: Sigmoidal population growth curve

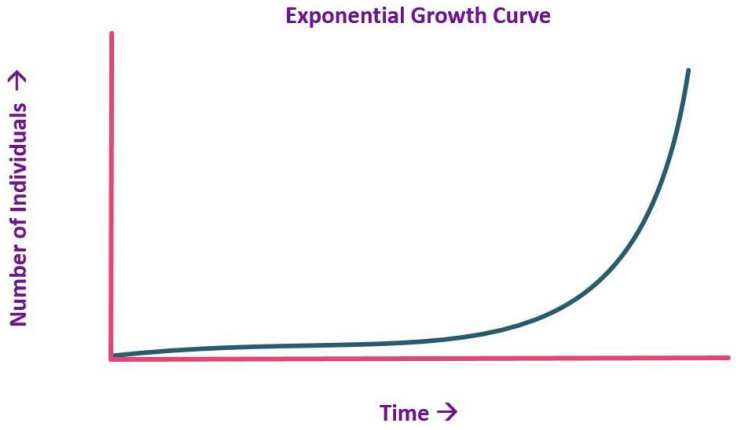
7.2.2 J-shaped growth curve

It is exponential curve in which population grow suddenly and exceed carrying capacity of environment which is followed by rapid decline phase. Growth pattern that increases at a constant amount per unit of time (i.e. 1,2,3,4) is called arithmetic growth. The exponential form of growth may be showed by simple model based on exponential equation:

$$dN/dt=rN$$

where, N is the population size and r are the intrinsic rate of increase.

During exponential growth under an ideal unlimited environment, per capita rate of increase is maximum and is known as intrinsic rate of increase. The maximum value of r is used to expression biotic potential.



7.3 Dispersion

It is the spatial distribution of individuals in a population relative to one another. There are three basic patterns that commonly found:

Regular dispersion: It is also known as uniform and even distribution, the individuals are more or less spaced at an equal distance from one another.Individuals are evenly spaced from expected by chance.

Random dispersion: The position of one individual is unrelated to the position of other individuals. Environmental condition is very uniform and there is no tendency to aggregate. It is very rare in nature.

Clumped dispersion: Individuals are aggregate into groups. Population generally exhibit this type of dispersion. It results from uneven distribution of resources.

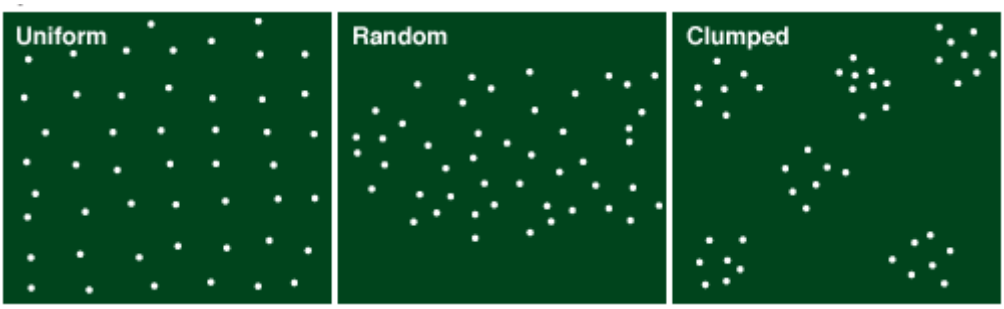


Figure 7.2: Diagrammatic representation of the spatial pattern of distribution of individual within a population

7.4 Age structure and age distribution

The relative abundance of the organisms of various age groups in the population is called as age distribution of population. Geometrically, the proportion of different age group population of an organism is called age pyramid. Age pyramid is mainly based upon people belonging to different age classes like pre-reproductive (0-14 years), reproductive (15-44) and post reproductive (above 45). Three main kinds of age pyramids are found in nature. These are:

Pyramidal shaped

In this type, young population is more, and make broad base. Most of individuals are in pre-reproductive phase, will soon enter into reproductive age. It will result in an increase in population. On the other hand, very few people at post reproductive stage, shows less loss of individuals due to death.

Bell shaped

This pyramid shows a stable population, in which young population declines, due to equal number of individuals in 0-35 age group. Therefore, in next year same number of individuals will enter into reproductive stage.

Urn shaped

It indicates a little percentage of young individuals and also shows a decreasing population. urn-shaped pyramid is obtained when the natality rate is extremely reduced and the pre-reproductive group declines in proportion to the other age groups of the population.

The age structure, total fertility rate, replacement level and infant mortality are essential parameters which determines the population growth. But the population is still growing when all couples have two children.

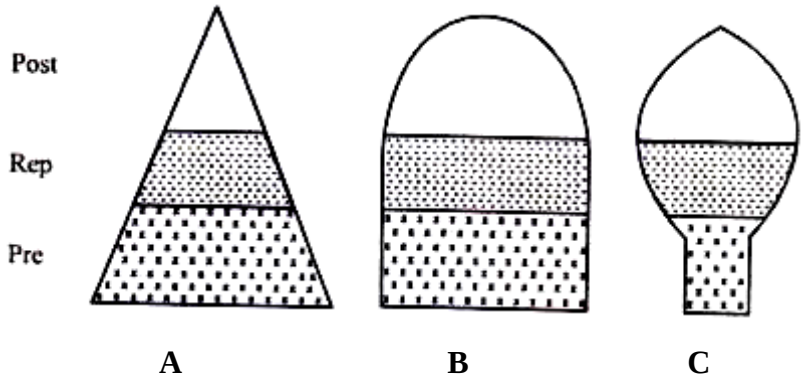


Figure 7.3: Age Pyramids of a population

Zero population growth

Zero population growth (ZPG) occurs when there is no any change in the number of people in a given time. Population maintain at a constant level by birth rate is equal to death rate.

7.5 Sex -ratio

The ratio of male to female in a population. In most sexually reproducing species, the ratio tends to be 1:1. The sex ratio should be fairly balanced in a society to flourish. Although, due to gender-based abortion and female feticide, the sex ratio has been distressed in many countries including India.

7.6 Demographic transition

Demographic transition, involves a series of phases that a country goes through when transitioning from non-industrial to industrial. The theory of the demographic transition denotes to the shift in from high birth rates and high infant death rates in societies due to less education and economic development, to demographics of low birth rates and low death rates with education, technology and economic development.

7.7 Population explosion: family welfare programme

The massiveenhance in population, due to low death rate and high birth rate is known as population explosion. Human population is not increasing at a uniform rate throughout the world.

Between 1950-1990, the population reached at 5 billion level with addition of 92 million every year. In the 2000-year, world population reached at 63 billion. This unprecedent growth of population at an alarming rate is referred as population explosion.

7.7.1 The Indian scenario

India is the second populous country of the world after china with 1 billion population. If this growth rate will continue, population will reach 1.63 billion by 2050 and India will become the most populous country suppressing China.

Therefore, India is facing serious ramification of the population explosion problems. This population explosions enhance environment degradation and resources depletion. Our natural resources like water, land, minerals, fossil fuel etc. are limited. Due to huge exploitation, these resources are getting diminished. Even some of the renewable resources like grassland, forests etc, are also under stress.

At the same time ecological life supporting system also getting jeopardized. There is a violent argument on the population. As to whether we should instantly reduce fertility rate to stabilize the population growth or whether human being will advise to search for new technology for alternate resources, so that the problems crossing carrying capacity of the environment will never actually come.

7.7.2 Family welfare programmes

Population explosion is very much similar to time bomb that must be diffused in time. We need a programme which must be helpful to keep population below carrying capacity. It is not accurately known as to how long we continue our exponential growth in population and use resources without suffering overshoot. We get many alarming signals that if not maintained, the overgrowth of population is going to diminished all-natural resources. The united nation projections are about population stabilization of developing and developed countries; this ratio is derived by dividing birth rate by crude death rate. In developing countries, population stabilization is achieved only by family welfare programmes.

7.8 Human health and environment

In general, a physical fit human not suffering from any illness is known as a healthy person. However, there are some other dimensions also connected with the state of being health. According to WHO health is a state of completely mental, physical and social fit and not merely the absence of diseases. Human well-being is also affected by several other factors like biological, chemical, nutritional and psychological factorsas per United nation environment programme (UNEP) 1992, it was stated that all components of the environment of earth

ultimately exert effect on human well- being and health. The sense of this declaration is becoming louder and more applicable every day. Polluted air, chemical loaded food, water deficiency, are the main components of present-day polluted environment. This polluted environment cannot make a man healthy. So, there is a direct and indirect interaction between human and environment. If the one is disturbed, the other would be affected automatically.

7.9 Human rights

Human rights are a set of rights which every human is entitled to. All human being are inherited with these rights no matter what creed, caste, gender and the economic status they belong to. Human rights are very significant for ensure that all humans get treated equally. They are in fact essential for a good standard of living in the world. The universal declaration of Human Right was adopted by the general assembly of United Nationin 1948. In this declaration total 30 articles were included to describe the human right concept.

The link between environment and human rights are very much obvious. Even they are not completely documented,in 1972, the UN conference on Human environment decided that both parameters of man's environment, the man made and natural are important for well-being and for enjoyment of basic human rights. Direct linkage between human rights and environment has become clearer in recent years. Damaging of climate and environment is mainly linked with abuse of human rights. Right to land, freedom of expression, right to have clean environment and natural resources are main success points of human rights and environment movements.

Man has basic right of equality, freedom and suitable condition of life in a good environment that allows a life of dignity and well-being. He bears a solemn responsibility to improve and protect environment for present and future population. Human rights and human injustice are often imposed in the name of development. For example, to stabilize population the right of every woman to resolve her fertility rate should not be hardened with. It causes disturbance in psychological and social environment.

Therefore, efforts should be made to integrate the movement theoretically and practically to manage and move towards an ideal society with sustainable development.

7.10 Value education

The purpose and function of education is the development of a well-balanced and all-round personality of the students, and also to develop all scopes of the human intelligence so that children can help make our country more cohesivesocially responsible, culturally rich and intellectually competitive nation. But, in these days, stress is excessively laid on knowledge-based and information-oriented education which takes care of only the intellectual development of the child.

Universal values related to our behaviour and attitude must be our foundation as they teach us beyond our identity and ego. These will helpful us in enjoying a profound, rich and prosperous life. This education system automatically makes friendlier environment for sustainable development. This will ensure a good and healthy social and physical environment. The lust for materialistic life is a main driving force behind environment pollution. If our education can address to that, then we can be assured of a sustainable environment for future generation.

7.11 HIV/AIDS

HIV (Human immunodeficiency virus) is a virus that mainly attacks human immune cells called CD4 cells, which are a type of T cell. HIV is an enduring infection. HIV belongs to retero-virus group. The virus weakens the immune system. HIV do not kill the person directly but the infection which rarely affect and reach at severe level. AIDS (Acquired Immuno Deficiency Syndrome) is the most advanced stage of HIV infection. Once HIV infection develops into AIDS, infections and cancer pose a greater risk. Without treatment, HIV infection is likely to develop into AIDS as the immune system gradually weaken down. The incubation period from HIV infection and appearance of symptoms of AIDS vary from person to person. It may extend upto 10-15 years.

Transmission of HIV is mainly through body fluid like vaginal secretion, semen, blood and breast milk, the infection is transmitted only if these fluids are transmitted from infected person to normal person.

Mode of transmission

1. **Unprotected sex:** unprotected sex with an infected partner without any protection can transmit HIV. Vaginal fluids, blood, seminal fluid, semen and breast milk can contain and transmit HIV. The virus can enter into the body through the lining of the vagina, vulva, penis, rectum, or mouth during sex.
2. **Sharing syringes/needles:** HIV virus can survive in syringes and needles for a month. Therefore, already used needle by a person should be avoided.
3. Through blood transfusion
4. From infected mother to her new born child.

AIDS is a common disease like any other disease. It cannot transfer through direct contact, hand shaking, hug, eating together *etc*. There should be no discrimination against infected person. We need to spread awareness in society about AIDS. Awareness is the best tool and prevention against AIDS.

Position in world and India:

Different protection and awareness programmes on HIV/AIDS are launched inter naturally and it is estimated that there are approximately33.4million people infected with AIDS. About 1,400,000 to 1,600,000 people infected with HIV/AIDS reside in India. India ranks third in gross HIV/AIDS population after Nigeria and South Africa. This position in India is shocking due to unawareness in sex education, unprotected sex, drug abuse, transportation and migration. Several government bodies and NGO's are trying to spread alertness about HIV and protection measures.

Protection from HIV:

- Use condom during sex and practice safe and protected measures use every time having sex.
- Certain ointments, creams and gels are known as microtricidesmay be used before sex because they kill HIV causing virus.
- Never use already used needles and syringes always use sterilized equipment's.
- Before the blood transfusion ensure that whether the blood is taken from non-infected person.

Although no HIV treatment is available till now, but some drugs are being used to prevent AIDS from rejuvenating damage to immune system. This may enhance the life expectancy. These drugs are:

- Protease inhibitor drugs are: indavir, lopinovir and atazanavir.
- Reverse transcriptase inhibitors: Zudovudine, Didanosine, Abacavir
- Fusion inhibitors: Enfuvirtide.
- These drugs are commonly prescribed along with a regime which is known as highly active antiretroviral therapy (HAART).

Effect of HIV on population:

The joint United Nation programme estimated that approximately 33.4 million people are HIV positive. AIDS decreases the life expectancy. Due to this, population growth decline than expected in African countries. Stopping AIDS will require public, government and NGOs honest efforts at large levels.

7.12 Woman and child welfare

Family is a basic and fundamental social group comprising one or two parents and their children and form basic unit of social structure. Society development depends upon on the individual development. Children and woman are basic components of a family. Special care and

protection must be taken for their complete development. The department of woman and child development was established in 1985 to act as a main agency for enacting, making policy and plans. This programme must ensure that women are empowered both socially and economically.

Various schemes for woman development are:

1. Manjhi Kanya Bhagyashree Scheme
2. Hostel for working woman
3. Indira Mahila Yojana- launched in 1995.
4. BetiBachaoBetiPadhao Scheme
5. Counselling Centre for Women
6. SavitribaiPhule Multipurpose Women's Centre for victims of atrocities
7. Kishori Shakti Yojana
8. Women State Homes for Destitute Women, Teenage Mothers, Women who are victims of atrocities (Age Group of 16 to 60 years)
9. Welfare Scheme for Devdasis
10. Financial Help for Marriage of Girls in Orphanages, Women Reception Centers and Protection Homes
11. RashtriyaMahilaKosh
12. Support to Training and Employment Programme for Woman (STEP 1987)
13. Shubh Mangal SamuhikVivah Scheme
14. Eradicating Child Prostitution
15. Employment and Income Generation-Cum Production Units (NORAI).
16. Haryana Integrated Woman's Empowerment and Development Project.
17. Devi Rupak Yojana by Haryana Govt.
18. Rural Woman's Development and Empowerment Project (RWDEP).

All the above mentioned and some other initiatives by the government and NGOs are being run to empower the woman, educationally, socially, economically and technically.

7.13 Child welfare

Child labouris banned by law but some instances of employment of child labour go ignored. Children are thought to the assets of society but approximately around 20 million children in India are thought to be working as child labour. National policy for children was initiated on 22 August, 1974. This policy describes children of country as a extremely important asset. National Children Board was initiated in December, 1974 headed by Prime Minister. The

UN general assembly in 1959 accepted the declaration of rights of a child. After the UN convention on rights of child, it became international law in the year 1990.

Following are some of the programmes taken by Indian government for children welfare.

1. **Integrated Child Development Services (ICDS):** It is a centrally sponsored scheme started in 1975. Its objectives are:
    - Reduction in mortality, malnutrition, morbidity incidents and school dropouts.
    - Improving health and nutritional status of children.
2. **Balwadi Nutrition Programme:**It was initiated in 1970-71 with an objective to provide entertainment, nutritional facilities and school for providing early education.
3. **Legislative Measures:**The child labour Act, 1986.
4. **Child Labour Eradication Scheme:**This scheme initiated in1994 with an objective of shifting child labour from dangerous factories to school.

7.14 Environment protection act

It is an Act to provide for the protection and improvement of environment, it came in force on 19th November, 1986. This Act is also called the Environment (Protection) Act, 1986.It extends to whole of India.The decision of implementation of act made at U.N. conference on Human environment held in June, 1972 at Stockholm.The main objectives of this act is to co-ordinate all the actions of various regulatory agencies under the current laws and to develop a regulatory body for environmental protection.

Exercise

Short type question answer

1. Define population.
2. Describe two main causes of population explosion in India.
3. What is full form of AIDS?
4. Name the species to which human beings belongs.
5. What is zero population growth?
6. Define ecoinformatics.
7. What is value education?
8. What is vital index.
9. Define biotic potential.
10. What is immigration?
11. What do you mean by exponential growth?
12. What is the sex-ratio?

13. What is logistic growth?
14. What is age structure?
15. What is distribution?

Long type question answer

1. Discuss population variation among nations.
2. What do you understand by Declaration of Human Right Environment?
3. Describe S-shaped growth curve diagrammatically.
4. Discuss the salient features of draft declaration of Human right and environment.
5. Discuss the family planning welfare and family planning movement in India.
6. How can age structure pyramids serve as important tools for predicting population growth trends of a nation?
7. Discuss the objectives and guiding principles of environmental education with India reference.
8. What is meant by population explosion? Discuss the Indian-scenario.
9. Describe the different issue and measures for woman and child welfare.
10. Discus the effect of environment on human health.
11. Discuss various measurement for woman and child welfare at international and national issue.
12. What is birth control and explain various methods involved in birth control?
13. Discuss about HIV/AIDS, mode of spread and its effect on health.
14. Discuss the influence of environmental parameters and pollution on human health.

Glossary

Acid rain	:	Toxic gases like NOx and Sox dissolve in rain water to form nitic and sulphuric acid.
Abiotic	:	Non-living
Age-structure	:	% of men and women in the adult, young and old stage in a population.
Air pollution	:	Toxic chemicals, excess noise and heat in the atmosphere in concentration that is harmful for humans, plants and animals.
Aerobic	:	Organism that needs oxygen for respiration.
Anaerobic	:	Organism that not needs oxygen for respiration.
Altitude	:	Height above sea-level.
Allergens	:	Substances causing allergy.
Annual	:	Occurring in a year.
Aquifer	:	A highly permeable layer of sediment or rock containing water.
Ambient air	:	The air surrounding us.
Atmosphere	:	The mass of air surrounding the earth.
Aerosol	:	Minute droplets and particles suspended in air.
Anthropogenic	:	Caused by humans.
Arid	:	Dry
Autotroph	:	Organism synthesizes their own food like green plants.
Biodiversity	:	Total variability among species of animals, plants and microorganisms.
Biodegradable	:	Substances that can be broken down by microbes.
Bioaccumulation	:	Non-biodegradable substances accumulated in the body.
Biomagnification	:	Increases in concentration of some stable compounds at successive trophic level in a food chain.
Biogeochemical cycles	:	Cycling of nutrients among different living organisms, water, air and soil.
Biomass	:	Organic matter produced by living organisms.
Biogeographical area	:	A region with specific climatic, ecological and environmental condition.

Biome	:	A broad, regional type of ecosystem with distinct soil, climate, flora and fauna.
Biotic	:	Living
Beta diversity	:	Variation in species composition across different habitats.
Biosphere	:	Zone of earth where life is found.
Bog	:	Water -logging soil usually containing peat.
Boreal forests	:	Mixed deciduous and coniferous trees.
Cell	:	The smallest and function unit of living organism.
Cancer	:	Cell divide uncontrollably and invade in surrounding tissue.
Carcinogen	:	Any agent which promotes cancer.
Chemosynthesis	:	Conversion of inorganic substances into organic compounds in the absence of sunlight.
Climate	:	Long term pattern of weather in a specific area.
Carnivore	:	Organism that feeds on other animals.
Carrying capacity	:	Maximum population size that a given system can support over a given period of time.
Chlorofluorocarbon (CFCs)	:	Carbon compound with one or more chlorine and fluorine atoms.
Chlorophyll	:	Green coloured pigment found in green plants.
Closed Canopy	:	Forest where tree crowns are spread over 20% of the ground.
Climax community	:	The final stable community formed during succession.
Commensalism	:	A mutual relationship in which one organism is benefited while the other is neither benefited nor harmed.
Conifers	:	Needle bearing trees producing cones like pines.
Consumer	:	Organism who cannot synthesize its own food.
Compost	:	A nutrient rich soil produced by biological degradation of organic materials.
Consumerism	:	Use of resources.
Consumption overpopulation	:	When resources use at very high rate resulting in large- scale waste generation and environmental degradation.
Coral reefs	:	Massive colonies formed by billions of small coral animals.
Core	:	Inner zone of earth.
Crust	:	Solid outer zone of earth.

Cyanobacteria	:	Blue green algae.
Contraceptives	:	Physical and chemical methods used for family planning.
Deciduous	:	Trees that shed their leaves at the end of the growing season.
Delta	:	Fan-shaped sediment deposit found at the river mouth.
Desert	:	A biome where evaporation more than precipitation.
Desertification	:	Degradation of fertile land into desert like land.
Decomposers	:	Microorganism that degrades complex organic matter into simpler molecule.
DDT	:	Dichlorodiphenyl trichloroethane, a pesticide.
Demography	:	Study of human population.
Demographic transition	:	A pattern of falling death and birth rates in response to improve living condition due to industrialization.
Detritivore	:	Organism that consume debris, dung and organic litter.
Drought	:	Condition in which an area does not get enough rainfall.
Detritus	:	Dead organic matter.
Doubling time	:	Time taken by population to double itself.
Drip irrigation	:	Perforated tubes used that gives out water dropwise to each plant.
Ecology	:	Study of interaction of living organism with their biotic and abiotic environment.
Earth quake	:	Shaking of earth due to movement of tectonic and oceanic plates.
Ecological services	:	Materials and processes provided by ecosystem like water, air and nutrients.
Ecological succession	:	The process by which one community is naturally replaced by another one over a period of time.
Ecosystem	:	A biological community and its physical environment exchanging energy and matter.
Endemism	:	Restriction of a species to a particular area.
Ethics	:	Moral values and principal to guide us.
Environmental impact assessment	:	A systematic analysis of the effects of a major development project.
Environmental studies	:	A systematic study of our environment as well as our role in it.

Estuary	:	Partially enclosed coastal area at the mouth of a river where fresh and salt water meet.
Epiphyte	:	Plants grow on other plants.
Eutrophication	:	Over-nourishment of water bodies due to excessive use of phosphates and nitrates.
Extinction	:	Loss of species from earth.
Exponential growth	:	Growth at a constant rate of increase per unit of time.
Fauna	:	All the animals present in a given region.
Family planning	:	Planning the timing, spacing and number of offspring.
Feedback mechanism	:	A mechanism to sense, evaluate and react to environmental changes as a result of information feedback into the system.
Famine	:	Acute food shortage.
Flood plains	:	Low land along river banks.
Fertilizer	:	Substance that adds organic and inorganic nutrients to the soil to enhance yield.
Food chain	:	A feeding series in an ecosystem.
Food web	:	A complex interlocking series of food chains.
Flora	:	All plants present in a given region.
Fungi	:	Achlorophyllous plants like molds, mushrooms, yeast etc.
Fossil fuels	:	Fossilization of plants and animals produce fuels.
Fungicides	:	Chemicals that kill fungi.
Gene	:	A unit of heredity.
Gamma rays	:	Very short wavelength ionizing rays with high energy.
Gasohol	:	A fuel that is a mixture of alcohol and gasoline.
Glacier	:	A flowing body of ice.
Greenhouse effect	:	Trapping of heat by earth atmosphere due to greenhouses gases.
Ground water	:	Water held in aquifers below the earth surface.
Half life	:	Time required by substances to decay by half.
Habitat	:	Place where organism lives.
Humus	:	A dark amorphous substance that is partially degraded and serves as a major source of nutrients for plants.
Heterotrophs	:	Organism that cannot synthesize their own food.

Homeostasis	:	An inherent property of living organism and environment to resist change and remain stable.
Hurricanes	:	Cyclonic storms with heavy rains and wind with speed more than 119 km/h.
Human rights	:	Right that a human being must enjoy on this earth.
HIV	:	Human immunodeficiency virus- a virus causing dreaded diseases AIDS.
Insolation	:	Incoming solar radiation.
Industrial smog	:	Air pollution due to mixture of SO2 suspended sulphur particles.
Infiltration	:	Percolation of rain water into soil.
Isotopes	:	Two or more form of an element that have same number of proton but different mass number.
Ion	:	Atom with positive or negative charge.
Infant mortality rate	:	Number of infants per 1000 birth that die before their first birthday.
Leaching	:	It is a process in which different chemical form upper soil layer are dissolve and passes into lower layer.
Latitude	:	Distance from equator.
Lithosphere	:	Outer shell of the earth composed of crust and rigid part of mantle.
Landslides	:	Mass movement of rock or soil downhill.
Life expectancy	:	Average number of years a new born baby survive.
Lethal dose	:	The amount of substance per unit of body weight that kills all the tested animals.
Mass number	:	Sum of number of proton and neutron in the nucleus.
Malnutrition	:	Diet with deficiency of nutrients.
Matter	:	Anything that has mass.
Mycorrhiza	:	Mutual beneficial interaction between plant root and fungi.
Mutation	:	A sudden heritable change.
Marsh	:	A wetland without trees.
Mutualism	:	An association between two organisms so that both of them benefited.
Mulch	:	A protective cover of ground may be dried leaves.
Natural hazards	:	Hazards that destroy or damage wild life habitats, property and human settlements.

Natural gas	:	Underground deposits of gases containing mainly methane, propane and butane.
Niche	:	A functional position and role of a species in an ecosystem.
Neutron	:	Elementary particle in the nuclei of all atoms having no electric charge.
Nitrogen fixation	:	Conversion of atmospheric nitrogen gas into ammonia by nitrogen fixing bacteria.
Nuclear fusion	:	Two nuclei of isotopes of lighter element fuse to form a heavier nucleus releasing large amount of energy.
Nuclear fission	:	Nuclei of certain isotopes with large mass number are split apart into lighter nuclei and release huge amount of energy.
Ore	:	A metal yielding material.
Open sea	:	Part of ocean beyond the continental shelf.
Outsees	:	Native people rooted out of their land.
Omnivores	:	Organism that eat both animals and plants.
Open canopy	:	A forest where tree crown cover less than 20% of the ground.
Organic farming	:	Farming involves organic fertilizers and natural pest control, no use of inorganic fertilizers and pesticides.
Part per million (ppm)	:	Number of parts of a chemical found in one million.
Particulate matter	:	Solid particles or liquid droplets suspended in air.
Pathogen	:	Organism that causes diseases.
Peat	:	Semi-decayed organic matter.
Perennial species	:	Plants that grow for more than two years.
pH	:	Numeric value that indicates the relative acidity and alkalinity.
Photosynthesis	:	Synthesis of food by green plants in the presence of sunlight by using water and carbon dioxide.
Photovoltaic cell	:	Solar cell converts solar energy into electricity.
Phytoplankton	:	Small plants like bacteria, algae found floating on water surface.
Poaching	:	Illegal commercial hunting or fishing.
Pioneer species	:	The species which colonize the bare land.
Point source	:	A single specific source that discharge pollutants into the environment.

Population	:	Group of individual organisms of a species living with in a particular area.
Population explosion	:	Exponential growth of population to a size that exceeds the carrying capacity.
Predator	:	Organism that feeds directly on another organism to survive.
Primary pollutant	:	Pollutant released directly inti the air.
Runoff	:	The excess of precipitation that does not infiltrate and evaporate.
Radioactive substance	:	The substance that spontaneously emits one or more types of radiation like alpha, beta and gamma radiation.
Rangelands	:	Grasslands.
Residence time	:	The length of time for which a chemical stay in environment.
Rehabilitation	:	Re-settlement the outsees.
Remediation	:	Cleaning up chemical contamination from polluted area.
Sanitary landfill	:	Waste disposal site on land in which waste is spread in thin layers.
Salinity	:	Amount of soluble salts in water or soil.
Sludge	:	Settled solids removed from wastewater.
Secondary pollutant	:	Pollutant formed by the reaction of two and more primary pollutants in the air.
Smelting	:	Process of separation of desired metal from ore.
Stress	:	Factors that causes a strain.
Species	:	All the organism genetically similar, breeding freely and produce fertile offspring.
Sustainable development	:	Increases in standards of life that can be maintained over a long time without degrading environment.
Synergism	:	When the effect of two factors together is more than the sum of exposure to each factor individually.
Stratosphere	:	Second layer in the atmosphere which possess ozone layer.
Tectonic plates	:	Huge blocks of earth crust that slide along slowly.
Tailing	:	Mining waste.
Teratogens	:	Chemicals and other agent that causes abnormalities during embryonic development.
Toxins	:	Poisonous chemicals harmful even in small concentration.
Transpiration	:	Loss of water through plant surface.

Tundra	:	Treeless arctic and alpine biome.
Troposphere	:	The layer of air nearest to earth surface.
Thermodynamics	:	A branch that deals with energy transfer and conversion.
Terracing	:	Shaping the land to create level shelves on hill slopes.
Urbanization	:	Increases population in cities.
Upwelling	:	Movement of nutrients from bottom to surface of water bodies.
Unconfined aquifer	:	Ground water above a layer of earth material with low permeability.
Volcano	:	Emission of magma from a fissure in earth surface.
Vertebrates	:	Animal with backbones.
Watershed	:	The land area from which water drains under gravity to a common drainage channel.
Water logging	:	Saturation of soil with irrigation water or excessive precipitation.
Weather	:	Physical condition of atmosphere.
Wetland	:	Ecosystem with standing water and having rooted vegetation.
Wildlife	:	Undomesticated life forms.
X-ray	:	Short wavelength rays, useful in medical diagnosis.
Zero population growth	:	When births rate and immigration in a population just equal to deaths and emigration rate.
Zooplankton	:	Small floating animals on water surface feeding of phytoplankton.

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Environmental Science

ISBN: 978-93-88901-15-4

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Published By:
Bhumi Publishing, India

ISBN 978-93-88901-15-4
9 789388 901154