SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A+' Grade

Bachelor of Science

(B.Sc.)

Environment Studies

Semester-I

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Paper Name: Environmental Studies

Course Outcomes:

Upon successful completion of this course, the student will be able to:

S. No.	Paper Outcomes (COs)	Cognitive Level
1.	**Recognize** key concepts ecology, environment and eco-sytem	Knowledge
2.	**Describe** the applications of alternative energy sources	Understand
3.	**Solve** the different types of environmental pollution problems	Apply
4.	**Categorize** current environmental issues	Analyze
5.	**Reframe** critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.	Evaluate

SYLLABUS

ENVIRONMENTAL STUDIES

UNIT I

INTRODUCTION TO ENVIRONMENTAL STUDIES

Introduction, meaning and definition, scope and importance, Relationship between Environmental Studies and other branches of science and social sciences, Need for Environmental awareness, Environmental education in present day, concept of Natural Resources and Challenges, Classification of resources, natural resources: Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources.

UNIT II

ECOSYSTEM AND BIODIVERSITY

Introduction, Concepts, Structure, Functions and Types, concept of Biodiversity and its conservation, Definition, genetic, species and ecosystem diversity, Bio geographically classification of India, Value of biodiversity, Bio diversity at global, National and local level, India as a mega-diversity nation, Hot-spot of biodiversity, Threats to biodiversity, Endangered, Threatened and endemic species of India, Conservation of biodiversity, Red Data Book.

UNIT III

ENVIRONMENTAL POLLUTION

Introduction, Definition, Causes, effects, control measures, Solid waste management, Role of an individual in prevention of pollution, Pollution case studies, Disaster management.

UNIT IV

ENVIRONMENT SUSTAINABILITY LAWS

Introduction, From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, water shed management, Resettlement and rehabilitation of people; its problems and concerns, Environmental ethics: Issues and possible solution, Climate change, global warming, acid rain ozone layer depletion, nuclear, accidents and holocaust, Waste land reclamation, Consumer is mand waste product, Sustainability acts, Issues involved in enforcement of environmental legislation, Public Awareness.

UNIT V

HUMAN POPULATION AND THE ENVIRONMENT

Introduction, Population growth, variation among nations, Population Explosion-Family Welfare Programme, Environment and Human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health.

UNIT I

INTRODUCTION TO ENVIRONMENTAL STUDIES

STRUCTURE

1.1 LEARNING OBJECTIVE

After completion of this unit, student get knowledge about:

- The concept of environmental studies.
- The multidisciplinary nature of environmental studies.
- Importance environmental studies for present day.
- The uses of resources.

1.2 INTRODUCTION

The word Environment came from the French Language which means the surroundings. The Environment is an interdisciplinary topic that includes the surroundings which cover the land, air, water, and their interrelationship and majorly their relationship with human beings and other organisms prevailing in the surroundings. Environment sciences not only deal in surroundings but it includes the processes in the land, water, and air which will even explain the pollutants that can harm and create pollution. When surrounding is not under control naturally then it can bring disasters. To manage these disasters, different committees, Acts, rules, and regulations are formed to maintain a clean, safe, and healthy ecosystem.

Douglas and Holland defined that "The term Environment is used to describe, in aggregate, all the external forces, influences, and conditions, which affect the life, nature, behavior and the growth, development, and maturity of living organisms"

1.3 MEANING

As residents on Earth, our actions can impact the planet and the rest of its inhabitants. Just as major environmental catastrophes, such as hurricanes, earthquakes, and volcanic eruptions, can affect us, our actions can have major impacts on the environment. Human activities, such as pollution released into the environment, cutting down forests, and damning rivers, have all created significant impacts for environmental health and society. Environmental studies are the field that examines this relationship between people and the environment.

Environmental studies are an interdisciplinary subject examining the interplay between the social, legal, management, and scientific aspects of environmental issues. Interdisciplinary means that issues are examined from multiple perspectives. Unlike environmental science, which focuses mainly on the scientific component of these environmental issues, environmental studies investigate the scientific and the humanitarian aspects. Students of environmental studies learn the causes, effects, and possible solutions to address important environmental problems.

1.4 SCOPE AND IMPORTANCE

The main source of environmental destruction in the world is the demand for natural resources generated by the consumption of the rich (whether they are rich nations or rich individuals and groups within nations).

Environmental movements of various countries have emerged due to the different reasons. This is basically due to the prevailing environmental quality of the locality. The environmental movements in the north are basically on the issue of quality of life. Whereas the environmental movements in the south arise due to some other reasons, such due to conflict for controlling natural resources.

The scope of Environmental Science is as follows:

Academics: Nowadays, it's mandatory to teach environmental science at every level and to make every child aware of the environment and to teach such subjects, teachers with specialized knowledge on these subjects are being appointed.

Industries: Many industries are using high technology which can impact our environment. On the other hand, the service sector industry is taking initiatives to use green marketing, green banking, green media techniques to save our environment.

Research and Development: Many experts are researching ecology and biodiversity. With the support of the researcher, we can save our environment to some extent. Some researchers have even worked in Governmental jobs to procure our environment.

NGOs: They are playing an important role to create awareness among the public by presenting different plays and conducting different programs with the support of national and international agencies. These agencies support NGOs financially.

Consultancies: Environmental Acts also have processes and procedures to accomplish to utilize the natural resources for any particular reason. To fulfill those procedures some expertise, knowledged person or Consultants need to be their guide Environment Impact Assessment is also being done in different industries, and to guide them, expert knowledge is always helpful.

Green Advocacy: Environment also has legal aspects. Many lawyers are making their career in environmental advocacy. There are many Environmental Acts and Public Interest Litigation that empowers human beings to fight against anti-environmental issues.

Importance of environment

Needs Global Attention: Any environmental issue is not a domestic issue to discuss instead it impacts the international level like the ozone layer. It will not only harm the Indian environment but the global environment.

Managing Natural Resources: It is also important to procure the natural resources available in our country. The exploitation of natural resources can bring disastrous effects on our country. Many researchers are continuously working on the procuring and effective utilization of resources. Everyone must conserve our ecology and biodiversity.

Growth of the Country: Growth and Development of any country impact the environment of that country. Technology and Urbanization have majorly impacted the environment negatively. Cleanliness and hygiene play an important role to play in the growth and development of any area.

Control Pollution: With the increase in population on the land, they need all the necessities for their growth and development, due to which they are cutting down the trees, using

electronic and electric gadgets which are impacting directly or indirectly the environment and create pollution.

Sustainable Development: It is required to utilize the environmental resources in a way so that the upcoming generations can also utilize the same resources for their betterment. Even we can say that we need to sustain the natural resources for our future generation.

Proper Planning and Development: Developing countries need proper planning to maintain ecology in the world. They should not exploit the natural resources for the development of their countries. It can affect sustainable development.

Environmental education: To Educate today's generation about environmental safety, the UN is also taking different initiatives like conducting conferences with UN countries. It is mandatory to aware the population about the pros and cons of utilizing the environmental resources extensively.

1.5 MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

Existence and behavior of living and non-living components of environment require inputs from physical, social and geological science. Human behavior and management of human societies are covered by social science, economics, psychology and political science. Regulations framed for environmental management and protection falls under jurisdiction of national legislation. Treaty reached regarding common problems faced by two or more countries comes under purview of international law and global governance. All the aspects of the environment and their respective disciplines of study are dealt with holistic approach.

Environmental science is an interdisciplinary academic field that integrates physical, biological and information sciences (including ecology, biology, physics, chemistry, plant science, zoology, mineralogy, oceanography, limnology, soil science, geology and physical geography, and atmospheric science) to the study of the environment, and the solution of environmental problems. Environmental science emerged from the fields of natural history and medicine during the Enlightenment. Today it provides an integrated, quantitative, and interdisciplinary approach to the study of environmental systems.

Environmental studies incorporate more of the social sciences for understanding human relationships, perceptions and policies towards the environment. Environmental engineering focuses on design and technology for improving environmental quality in every aspect.

Components of environment

The "solid" portion of" the earth, including water masses; the lithosphere plus the hydrosphere. Above the geosphere lies the **atmosphere** and at the interface between these two regions is found almost all of the biosphere or zone of life. The physical part of the earth is the **lithosphere.** The atmosphere is the blanket of air that surrounds the earth.

A hydrosphere (from the Greek word hydro, "water" and sphaira "sphere") in physical geography describes the combined mass of water found on, under, and over the surface of a planet.

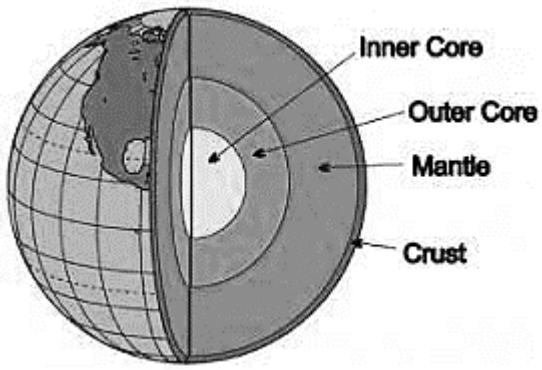
The term "biosphere" was coined by geologist Eduard Suess in 1875, which he defined as: "The place on the earth's surface where life dwells."

There are four types of components of environment:

1. **Geosphere**
2. **Hydrosphere**
3. **Biosphere**
4. **Atmosphere**

Geosphere

The solid part of the earth consisting of the crust and outer mantle. The physical elements of the Earth's surface crust, and interior. The term geosphere is often used to refer to the densest parts of Earth, which consist mostly of rock. The term originally applies to the lower nested geospheres identified with the states of terrestrial matter: solid (earth), liquid (water), gas (air), and plasma (fire). The nested geospheres then include the asthenosphere, atmosphere, lithosphere, hydrosphere, and the ionosphere or plasmasphere. The dense geosphere is also subdivided into the crust, mantle, and core.



The outer core is unusual in that it is considered to be a liquid, yet it is a part of Earth's interior.

Geosphere refers to the solid parts of the Earth and is used along with the atmosphere, hydrosphere, and biosphere to describe the systems of the Earth, sometimes the term "lithosphere" is used instead of the geosphere, however, the lithosphere only refers to the uppermost layers of the solid Earth (oceanic and continental crustal rocks and uppermost mantle).

The geosphere is considered that portion of the Earth system that includes the Earth's interior, rocks and minerals, landforms, and the processes that shape the Earth's surface.

The Earth's interior includes a thin, 5- to 70 km-thick layer of oceanic and continental crust overlying an additional 6,300 km of rock and metals. The crust varies in thickness and density, with oceanic crust consisting of a thin (around 5 km) layer of dense rock and continental crust consisting of less-dense, lighter-colored rock ranging between 30 and 70 km in thickness. Although the crust is comprised of many types of rocks and hundreds of minerals, these materials are assembled from a very small number of elements. A total of 98.7% of the crust (by weight) consists of just 8 elements, including oxygen (46.6%), silicon (27.72%), aluminum (8.13%), iron (5.00%), calcium (3.63%), sodium (2.83%),

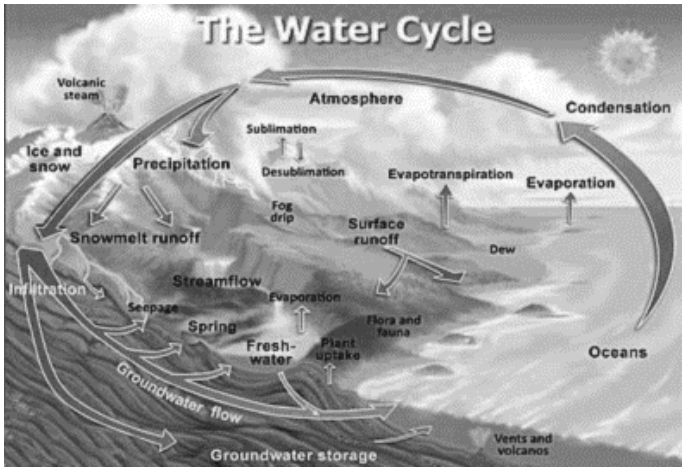
potassium (2.70%) and magnesium (2.09%). These elements form the building blocks of most of the inorganic materials we encounter in our daily lives such as glass (Si02), concrete (CaCO3), and steel. Oceanic crust is dominated by minerals consisting of silicon, oxygen, and magnesium and is thus called SIMA; the continental crust is made up of SIAL, in which silicon and aluminum dominate.

The Earth's interior is arranged somewhat like a layer cake, consisting of a series of layers that change in density, mineral composition, and thickness with depth. Directly below the crust is the mantle. It consists of two parts, an upper layer that is less dense and relatively brittle and a lower (much thicker) layer that is denser and plastic (it deforms without breaking). The crust and upper mantle combined form the brittle upper layers of the Earth's interior called the lithosphere. The upper mantle is also called the asthenosphere.

The mantle makes up the largest volume of the Earth's interior. The region beneath the mantle is called the core, and consists of two parts, a liquid outer core that is around 2250 km thick and a solid inner core 1220 km thick. The core is primarily made up of iron, with a small amount of nickel. The liquid iron in the outer core is particularly important in that it is the primary source of the Earth's magnetic field. Unlike a common magnet, though, the north and south ends of our "global magnet" are not exactly situated at Earth's poles. Instead, the magnetic north pole is situated in northern Canada, and the magnetic south pole resides north of Antarctica and south of Australia. Another interesting feature of the magnetic poles is that their precise location moves over time. Every few million years, even the polarity of the Earth's magnetic field reverses (called a geomagnetic reversal, where magnetic north and south "switch"). While scientists still do not fully understand why geomagnetic reversals occur, the presence of changing magnetic orientations preserved in rocks containing iron was a fundamental clue in unraveling the puzzle of Plate Tectonics. Almost all of our direct knowledge of the Earth's interior is from the upper 10 km. Our knowledge of the remaining 6,300 km is based largely on indirect evidence from seismology, laboratory studies of igneous and **metamorphic** rocks, computer models, and meteorites.

Hydrosphere

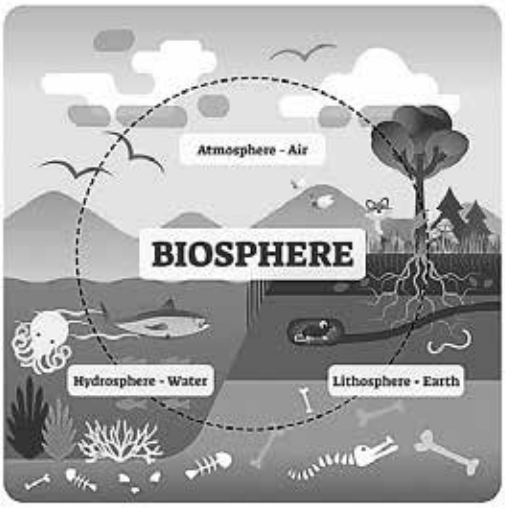
It refers to all the water on Earth. It mainly consists of the oceans but includes all water surfaces in the world, including inland seas, rivers, and lakes.



The outer layer of this hydrosphere is almost entirely ice, but current models predict that there is an ocean up to 100 km in depth underneath the ice. This ocean remains in a liquid form because of the tidal flexing of the moon in its orbit around Jupiter. The hydrosphere is composed of all of the water on or near the earth. This includes the oceans, rivers, lakes, and even the moisture in the air. Ninety-seven percent of the earth's water is in the oceans. The remaining three percent is freshwater; three-quarters of the freshwater is solid and exists in ice sheets.

Biosphere

The biosphere is the global sum of all ecosystems, it can also be called the zone of life on Earth. From the broadest physiological point of view, the biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, hydrosphere, and atmosphere. The biosphere is postulated to have evolved, beginning through a process of biogenesis at least some 3.5 billion years ago.

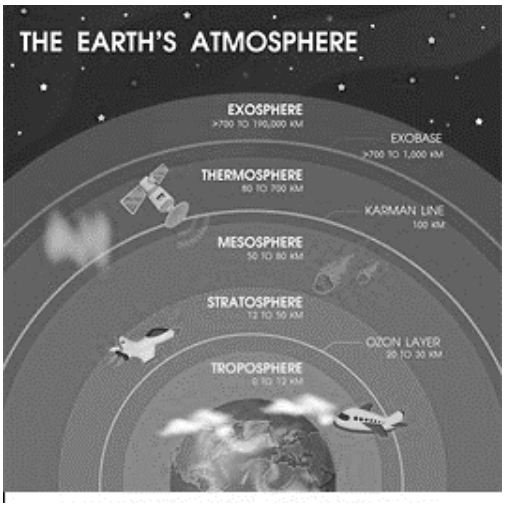


The actual thickness of the biosphere on earth is difficult to measure. Birds typically fly at altitudes of 650 to 1800 meters, and fish that live deep underwater can be found down to -8,372 meters in the Puerto Rico Trench. The biosphere is composed of all living organisms. Plants, animals, and one-celled organisms are all part of the biosphere. Most of the planet's life is found from three meters below the ground to thirty meters above it and in the lop 200 meters of the oceans and seas.

Atmosphere

Atmos means "air." The atmosphere includes all the gases surrounding the Earth. We often call the atmosphere "air." All planets have an atmosphere, but Earth is the only planet with the correct combination of gases to support life.

The atmosphere consists of five layers and is responsible for Earth's weather. Even though it seems like air is made of nothing, it consists of particles too small to be seen. All these particles have weight that push down on Earth. The weight of air above us is called air pressure.



The atmosphere surrounds the Earth in gaseous layers held in place by gravity. It is made up of about 78% nitrogen, 21% oxygen and1% carbon dioxide and other gases, including water vapor. The atmosphere blankets the Earth in layers. We live in the layer called the troposphere which reaches from the ground up 4-12 miles (6-20km) into the sky. This is where all weather happens from hurricanes to lightning. The next layer is the stratosphere where the air is much calmer. This is where commercial airplane fly. The next layer is the mesosphere. This layer stops most meteors as they fly toward Earth. All we see is the streak of light as they burn up. The thermosphere is next and is where the space shuttles orbited the Earth. The outer boundary of our atmosphere is the exosphere. It reaches about 6,200 miles (1,000 km) above the Earth. This is the level of the atmosphere where our satellites orbit the Earth.

History of environmentalism

In the early 1800s, In Europe, the concept of environmentalism came into picture through another ideology **Romanticism.** As the name suggests, Romanticism was not a movement which focus on love but on emotions. This movement Romanticism emphasises on love for nature, its motto was - people to appreciate the woods for their beauty, which challenged the scientific view which many people had towards nature at that period of time. And in Late1800s, the environmental movement had strongly emphasised in Britain as a response to the Industrial Revolution. As there were no environmental regulations which can stop this movement, the productions of the Industrial Revolution polluted air and water and expanded out into beautiful farmland. Quickly, the dark side of the Industrial revolution, factories with people calling for wild spaces to be protected. Early conservation groups, like 'the Society for the Protection of Birds (1889)' and 'the National Trust for Places of Historic Interest or Natural Beauty (1894),' began popping up all over England.

The environmental movement took shape in North America when John Muir, a great environmentalist, convinced the U.S. congress to create the Yosemite National Park to preserve the beautiful valley. Many other conservation efforts began to take place across the continent with people trying to protect the dwindling American bison population. And in 1916, President Woodrow Wilson founded the National Park Service, which deeply

supported the growing environmental movement. In the early 20th century, environmental laws and government agencies began to pop up all over the world but especially in Nazi Germany! Several of the high-ranking Nazis were environmentalists and wanted to protect the German forests. The environmental movement continued to grow in the 1950s, 60s, and 70s with many influential books being published, such as 'A Sand County Almanac (1949)' and 'Silent Spring (1962).' Silent Spring, written by American biologist Rachel Carson, is especially influential as it exposed the harmful and dangerous effects of the pesticide DDT. The book played very important role for the environmental movement that leads to the creation of the Environmental Protection Agency in 1970 and DDT was banned in 1972. The 1970s were greatly important for the green movement with many groups, like Greenpeace, forming in the 1970s. The first Earth Day and the UN's first environmental conference also happened in the 70s. Into the 1980s, a growing awareness on global warming brought the environmental movement even more into the mainstream. Unfortunately, the environmental movement's strength has declined somewhat since the late 2000s after it hit a high with the anger following the great recession.

Ecology

The term 'Ecology' is derived from Greek word 'Oekologue' which is composed of two words:

a. 'Oekos' means surrounding.

b. 'Logs' means study on a whole ecology means 'Study of surrounding'.

Ecology refers to the study of the organism in their natural habitat. Ecology .is concerned with the study of the organism in various habitats such as islands, oceans, freshwater, and air.

"The study of the structure and function of nature is known as ecology" As per, Odum

"It is a scientific study of the distribution and abundance of living organism and their interaction among organism and between organisms and their environment" Amdrewartha Ecology proceeds at three levels (i) The individual organism; (ii) The population; (iii) The community.

1.6 NEED FOR ENVIRONMENTAL AWARENESS

Since our environment is getting degraded due to human activities, we need to do something about it to sustain the quality. We often feel that government should take proper measuring steps. But all of us are equally responsible to protect our environment. Hence public awareness needs to be created. Both print media and electronic media can strongly influence public opinion. Politicians should respond positively to a strong publicly supported activity. NGOs can take active role in creating awareness from grass root levels to the top-most policy decision makers.

Environment is an integration of both living and non-living organisms. Water, air, soil, minerals, wild life, grass lands, forests, oceans, agriculture are all life supporting systems. Since these natural resources are limited, and human activities are the causative factors for environmental degradation, each one of us need to feel responsible to protect the environment.

The activities help in creating awareness among public are:

- Join a group to study nature such as WWF-I or BNHS or any other organization
- Read newspaper articles and periodicals like Down to earth, WWF-I newsletter, BNHS, Hornbill, Sanctuary magazine.
- Discuss environmental issues with friends and relatives.
- Join local movements that support activities like saving trees in your locality, reducing use of plastics, going for nature treks, practicing 3 Rs i.e., reduce, reuse, & recycle.
- Practice and promote good civic sense and hygiene such as enforcing no spitting or tobacco chewing, no throwing garbage on the road and no urinating in public places.
- Take part in events organized on World Environment Day, Wildlife week etc.
- Visit a national park or sanctuary or spend time in whatever natural habitat you have near your home.

World Environment Day: June 5th

1.7 ENVIRONMENTAL EDUCATION IN PRESENT DAY

Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions.

The components of environmental education are:

- Awareness and sensitivity to the environment and environmental challenges.
- Knowledge and understanding of the environment and environmental challenges.
- Attitudes of concern for the environment and motivation to improve or maintain environmental quality.
- Skills to identify and help resolve environmental challenges.
- Participation in activities that lead to the resolution of environmental challenges.

Environmental education does not advocate a particular viewpoint or course of action. Rather, environmental education teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decision-making skills.

Importance of environmental education

Environmental study is based upon a comprehensive view of various environmental systems. It aims to make the citizens competent to do scientific work and to find out practical solutions to current environmental problems. The citizens acquire the ability to analyze the environmental parameters like the aquatic, terrestrial and atmospheric systems and their interactions with the biosphere and astrosphere.

Importance

- World population is increasing at an alarming rate especially in developing countries.
- The natural resources endowment in the earth is limited.
- The methods and techniques of exploiting natural resources are advanced.
- The resources are over-exploited and there is no foresight of leaving the resources to the future generations.
- The unplanned exploitation of natural resources leads to pollution of all types and at all levels.
- The pollution and degraded environment seriously affect the health of all living things on earth, including man.
- The people should take a combined responsibility for the deteriorating environment and begin to take appropriate actions to save the earth.
- Education and training are needed to save the biodiversity and species extinction.
- The urban area, coupled with industries, is major sources of pollution.
- The number and area extinct under protected area should be increased so that the wild life is protected at least in these sites.
- The study enables the people to understand the complexities of the environment and need for the people to adapt appropriate activities and pursue sustainable development, which are harmonious with the environment.
- The study motivates students to get involved in community action, and to participate in various environment and management projects.
- It is a high time to reorient educational systems and curricula towards these needs.
- Environmental education takes a multidisciplinary approach to the study of human interactions with the natural environment.
- Environmental study is a key instrument for bringing about the changes in the knowledge, values, behaviors and lifestyles required to achieve sustainability and stability within and among countries.

Need for environmental education

The need to protect the environment hence the rationales for environmental education arise as a result of the following:

- Environment is the basis of all life and therefore deserves proper care and management.
- If the environment is threatened on a continuous basis, numerous problems which would constitute a danger to human existence could arise.
- The environment is part of our cultural heritage which should be handed down to prosperity.

- Some resources of the environment are not easily replaceable and should be managed on a sustainable basis, to prevent the extinction of certain components of the environment such as plants and animals.
- There is need to enhance the sanity and aesthetic quality of our environment in order to promote healthy living.
- The environment is part of nature and needs to be preserved for its own sake.

1.8 CONCEPT OF NATURAL RESOURCES

Substances that are required for survival comforts and prosperity. They are obtained directly from the environment resources can be materials, products, or waste that has potential value and can be used to process new useful products.

Any of the factors of production are used as inputs in the production process.

A supply of environmental benefits, like water, or sunlight, Substances that support life and fulfill human needs, including air, land, water, minerals, fossil fuels, forests, and sunlight.

The natural resources are of two kinds:

- **Renewable resources** are in exhaustive and can be regenerated within a given periodic. Forests, wildlife, wind energy, biomass. energy, tidal energy, hydropower, etc. Solar energy is also a renewable form of energy as it is an inexhaustible source of energy.
- **Non-renewable resources** that cannot be regenerated e.g., Fossil fuels like coal, petroleum, minerals, etc. Once we exhaust these reserves, the same cannot be replenished.

Even our renewable resources can become non-renewable if we exploit them to such an extent that their rate of consumption exceeds their rate of regeneration. For example, if a species is exploited so much that its population size-declines below the-threshold level-then it is not able to sustain itself and gradually the. species become endangered or extinct. It is very important to protect and conserve our natural resources and use them in an a-judicious manner so that we don't exhaust them. It does not mean that we should stop using most of the natural resources. Rather, we should use the resources in such a way that we always save enough of them for our future generations. In this unit we shall discuss the major natural resources:

- Forest resources
- Water resources
- Mineral resources
- Food resources
- Energy resources
- Land resources

FOREST RESOURCES

Forests are one of the most important natural resources on this earth. Covering the earth

like a green blanket these forests not only produce innumerable material goods but also provide several environmental services that are essential for life.

About 1 /3rd of the world's land area is forested which includes closed as well as open forests. Former USSR accounts for about a 5th of the world's forests, Brazil for about ra]7th and Canada and USA each for 6-7%. But it is a matter of concern that almost everywhere the cover of the natural forests has declined over the years. The greatest occurred in tropical Asia where one-third of the forest resources have.

Uses of forests

Commercial uses: Forests provide us a large number of commercial goods which include timber, firewood, pulpwood, food items, gum, resins, non-edible oils, rubber, fibers, lac, bamboo canes, fodder, medicine, drugs, and many more items, the total worth of which is estimated to be more than $300 billion per year.

Half of the timber cut each year is used as fuel for heating and cooking. One-third of the wood harvest is used for building materials like lumber, plywood and hardwood, particleboard, and chipboard. One-sixth of the wood harvest is converted into pulp and used for the paper industry. Many forest lands are used for mining, agriculture, grazing, and recreation, and the development of dams.

- **Ecological uses:** While a typical -tree produces commercial goods worth about $ 590 it provides environmental services worth nearly S 196, 250—"The ecological services provided by our forests may be summed up as follows:
- **Production of oxygen:** The trees produce oxygen by photosynthesis which is so vital for life on this earth. They are rightly the earth's lungs.
- **Reducing global warming:** The main greenhouse gas carbon dioxide (CO_2) is absorbed by the forests as a raw material -for photosynthesis. Thus, the forest canopy acts as a sink for CO_2 thereby reducing the problem of global warming caused by greenhouse gas CO_2.
- **Wildlife habitat:** Forests are the homes of millions, of wild animals and plants. About 7 million" species are found in the tropical forests along.
- **Regulation of hydrological cycle:** Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff, and slowly releasing the water for recharge of springs. About 50-80 %of the moisture in the air in tropical forests comes from their transpiration which helps in bringing rains.
- **Soil Conservation:** Forests bind the soil particles tightly in their roots and prevent soil erosion. They also act as the wind-
- **Pollution moderators:** Forests can absorb many toxic gases, and can help in keeping the air pure". They have also been reported to absorb noise and thus help in preventing air and noise pollution.

Over exploitation of forests

Since time immemorial, humans have depended heavily on forests for food, medicine, shelter, wood, and fuel. With a growing civilization, the demands for raw material like timber, pulp, minerals, fuelwood, etc. shot up resulting in large

NOTES

scale logging, mining, road-building and clearing of forests. Our forests contribute substantially to the national economy. The international timber trade alone is worth over the US $ 40 billion per year. Excessive use of fuelwood and charcoal, expansion of urban, agricultural and industrial areas and overgrazing have together led to over-exploitation of our forests leading to their rapid degradation.

WATER RESOURCES

Water is an indispensable natural resource on this earth on which all life depends. About 97% of the earth's surface is covered by water and most of the animals and plants have 60-65% water in their body.

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

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

  The water we use keeps on cycling endlessly through the environment, which we call the Hydrological Cycle. We have enormous resources of water on the earth amounting to about 1404 million Km^3. The water from various moist surfaces evaporates and falls again on the earth in the form of rain or snow and passes through living organisms and ultimately returns to the oceans. Every year about the 1.4-inch-thick layer of water evaporates from the oceans, more than 90% of which returns to the oceans through the hydrological cycle.

  Solar energy drives the water cycle by evaporating it from various water bodies, which subsequently return through rainfall or snow. Plants play a very important role by absorbing the groundwater from the soil and releasing it into the atmosphere by the process of transpiration. The global distribution of water resources is quite uneven depending upon several geographic factors. Tropical rain forest areas receive maximum rainfall while the major world deserts occur in zones of dry, descending air (20-40° N and S) and receive very little rainfall.

Water use and over-exploitation

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

Uptake of nutrients, their distribution in the body, regulation of temperature, and removal of wastes are all mediated through the water.

Human beings depend on water for almost every developmental activity; Water is used for drinking, irrigation, and transportation, washing, and waste disposal for industries and used as a coolant for thermal power plants. Water shapes the earth's surface and regulates our climate.

Water use by humans is of two types:
Water withdrawal: taking water from groundwater or surface water resource.

Water consumption: the water which is taken up but not returned for reuse.

With the increasing human population and rapid development, the world water withdrawal demands have increased in many folds and a large proportion of the water withdrawn is polluted due to anthropogenic activities. On a global average, 70 percent of the water withdrawn is used for agriculture. In India, we use93% of the water in the agricultural sector while in a country like Kuwait, which is water-poor, only 4% is used for watering the crops. About 25% of the water on the global average is used in industry, which again varies from a high of 70% in European countries to as low as 5% in less developed countries. Per capita use of water shows wide variations. In the USA, an average family of 4 consumes more than 1000 M^3 of water per year, which is many times more than that in most developing countries.

Water: a precious natural resource
Although water is very abundant on this earth, yet it is very precious. Out of the total water reserves of the world, about 97% is salty water (marine) and only 3% is freshwater. Even this small fraction of freshwater is not available to us as most of it is locked up in polar ice caps and just 0.003% is readily available to us in the form of groundwater and surface water.

Overuse of groundwater for drinking, irrigation, and domestic purposes has resulted in rapid depletion of groundwater in various regions leading to the lowering of water tables and drying of wells. Pollution of many of the groundwater aquifers has made many of these wells unfit for consumption.

Rivers and streams have long been used for discharging the wastes. Most of the civilizations have grown and flourished on the banks of rivers, but unfortunately, growth, in turn, has been responsible for the pollution of the rivers.

As per the United Nations estimates (2002), at least 101 billion people do not even have access to safe drinking water and 2.4 billion do not have adequate sanitation facilities. Increasing population and expanding development would further increase the demands for wastes. It is estimated that by 2024, two-thirds of the world population would be suffering from acute water shortage.

Groundwater
About 9.86% of the total freshwater resources are in the form of groundwater and it is about 35-50 times that of surface water supplies. Till some time, back groundwater was

considered to be very pure. However, of late, even groundwater aquifers are contaminated by leachates from sanitary landfills, etc.

A layer of sediment or rock that is highly permeable and contains water is called an aquifer. Layers of sand and gravel are good aquifers while clay and crystalline rocks (like granite) are not since they have low permeability.

Aquifers may be of two types:

- **Unconfined** aquifers are overlaid by permeable earth materials and they are recharged by water seeping down from above in the form of rainfall and snowmelt.
- **Confined** aquifers are sandwiched between two impermeable layers of rock or sediments and are recharged only in those areas where the aquifer intersects the land surface. Sometimes the recharged area is hundreds of kilometers away from the location of the well. Groundwater is not static, it moves, though at a very slow rate of about a meter or so in a year.

Effects of groundwater usage

- **Subsidence:** When groundwater withdrawal is more than its recharge rate, the sediments in the aquifer get compacted, a phenomenon known as ground subsidence. Huge economic losses may occur due to this phenomenon because it results in the sinking of the overlying land surface. The common problems associated with it include structural damage in buildings, fracture in pipes, reversing the flow of sewers and canals, and tidal flooding.
- **Lowering of water table:** Mining of groundwater is done extensively in arid and semi-arid regions for irrigating crop fields. However, it is not advisable to do excessive mining as it would cause a sharp decline in future agricultural production, due to the lowering of the water table.
- **Waterlogging:** When excessive irrigation is done with brackish water raises the water table gradually leading to water-logging and salinity problems.

Surface water

The water coming through precipitation (rainfall, snow) when does not percolate down into the ground or does not return to the atmosphere as evaporation or transpiration loss, assumes the form of streams, lakes, ponds, wetlands or artificial reservoirs known as surface water. The surface water is largely used for irrigation, industrial use, public water supply, navigation, etc. A country's economy is largely dependent on rivers.

Water-rich vs. Water poor countries

The top ten water-rich countries are Iceland, Surinam, Guyana, Papua New Guinea Gabon, Solomon Islands, Canada, Norway, Panama, and Brazil lying in the far north and have low evaporation losses.

The water poof countries include Kuwait, Egypt, United Arab Emirates, Malta, Jordan, Saudi Arabia, Singapore, Maldivian, Israel, and Oman, lying in the desert belt at about 15° to 25° Latitude and some of them like Malta and Singapore are densely populated areas resulting in a low per capita water.

Floods

In some countries like India and Bangladesh, rainfall does not occur throughout the year, rather, 90% of it is concentrated into a few months (June-September). Heavy rainfall often causes floods in the low-lying coastal areas. Prolonged downpours can also cause the over-flowing of $ lakes and rivers resulting in floods.

Deforestation, overgrazing, mining, rapid industrialization, global warming, etc. have also contributed largely to a sharp rise in the incidence of floods, which otherwise is a natural disaster.

Floods have been regular features of some parts of India and Bangladesh causing huge economic loss as well as the loss of life. People of Bangladesh are accustomed to moderate flooding during monsoon and they utilize the flood water for raising paddy. But, severe floods like that in 1970, 1988, and 1991 resulting from excessive Himalayan runoff and storms, had very disastrous consequences causing massive deaths and damages. In 1970, about one million people were drowned while 1,40,000 people died in 1991. Networking of rivers is being proposed at are national level to deal with the problems of floods.

Droughts

There are about 80 countries in the world, lying in the arid and semi-arid regions that experience frequent spells of droughts, very often extending up to year-long duration. When annual rainfall is below normal and less than evaporation, drought conditions are created.

Ironically, these drought-hit areas are often having a high population growth which leads to poor land use and makes the situation worse.

Anthropogenic causes: Drought is a meteorological phenomenon, but due to several anthropogenic causes like over-grazing, deforestation, mining, etc. there is spreading of the deserts tending to convert more areas to drought-affected areas. In the last twenty years, India has experienced more and more desertification, thereby increasing the vulnerability of larger parts of the country to droughts.

Erroneous and intensive cropping patterns and increased exploitation of scarce water resources through well or canal irrigation to get high productivity has converted drought-prone areas into decertified ones. In Maharashtra, there has been no recovery from drought for the last 30 years due to over-exploitation of water by sugarcane crop which has high water demands.

Remedial measures: Indigenous knowledge in control of drought and desertification can be very useful for dealing with the problem. Carefully selected mixed cropping helps optimize production and minimize the risks of crop failures. Social Forestry and Wasteland development can prove quite effective to fight the problem, but it should be based on a proper understanding of ecological requirements and natural process, otherwise, it may even boom rang. The Kolar district of Karnataka is one of the leaders in Social Forestry with World Bank Aid, but all its 11 talukas suffer from drought. It is because the tree used for plantation here was Eucalyptus which is now known to lower the water table because of its very high transpiration rate.

National and international conflicts over water

The indispensability of water and its unequal distribution has often led to inter-state or international disputes. Issues related to the sharing of river water have been largely affecting our farmers and also shaking our governments. Some major water conflicts are discussed here.

- **Water conflict in the Middle East:** Three river basins, namely the Jordan, the Tigris-Euphrates, and the Nile are the shared water resources for Middle East countries. Ethiopia controls the headwaters of 80% of Nile's flow arid plans to increase it.

  Sudan too is trying to divert more water. This would badly affect Egypt, which is a desert, except for a thin strip of irrigated cropland along the river Nile and its delta. The population of Egypt is likely to double in the next 20 years, thereby increasing its water crisis. Likewise, there is a fierce battle for water among Jordan, Syria, and Israel for the Jordan River water share.

  Turkey has abundant water and plans to build 22 dams on Tigris-Euphrates for Hydroelectric power generation. But it would drastically reduce the flow of water to Syria and Iraq, lying downstream. Turkey dreams to become the region's water Superpower. It plans to transport and sell water to starved Saudi Arabia, Kuwait, Syria, Israel, and Jordan. Probably, the next war in the Middle East would be fought over water and not oil.

- **The Indus Water Treaty:** The Indus, one of the mightiest rivers is dying a slow death due to dams and barrages that have been built higher up on the river. The Sukkur barrage (1932), Ghulam Mohamad Barrage at Kotri (1958), and Tarbela and Chasma Dams on Jhelum, a tributary of Indus has resulted in a severe shrinking of the Indus delta. In I960, the Indus water treaty was established vide which Indus, the Jhelum, and the Chenab were allocated to Pakistan, and the Satluj, the Ravi, and the Beas were allocated to India. Being the riparian state, India has a pre-emptive right to construct barrages across all these rivers in Indian territory. However, the treaty requires that the three rivers allocated to Pakistan may be used for non-consumptive purposes by India i.e., without changing its flow and quality. With improving political relations between the two countries, it is desirable to work out techno-economic details and go for integrated development of the river basin sustainably.

- **The Cauvery water dispute:** Out of India's 18 major rivers 17 are shared between different states. In all these cases, there are intense conflicts over these resources which hardly seem to resolve. The Cauvery River water is a bone of contention between Tamil Nadu and Karnataka and the fighting is almost a hundred years old. Tamil Nadu, occupying the downstream region of the river wants water-use regulated in the upstream Whereas, the upstream state Karnataka refuses to do so am claims its primacy over the river as an upstream user. The river water is almost fully utilized and both the states have increasing demands for agriculture and industry. The consumption is more in Tamil Nadu Chan Karnataka where the catchment is rockier. On June 2,1990, the Cauvery Water Dispute Tribunal was set up which through an interim award directed Karnataka to ensure that 205 TMCF of water was made available in Tamil Nadu's Mettur dam every year where the

settlement was reached. In 1991-92 due to good monsoon, there was no dispute due to good stock of water in Mettur, but in 1995, the situation turned into a crisis due to delayed rains and an Expert Committee was set up to look into the matter which found that there was a complex cropping pattern in Cauvery basin. Sambrapaddy in winter, Kurvaipaddy in summer, and some cash crops demanded intensive water, thus aggravating the water crisis. Proper selection of crop varieties, optimum use of water, better rationing, rational sharing patterns, and pricing of water is suggested as some measures to solve the problem.

- **The Satluj-Yamuna Link (SYL) canal dispute:** The issue of sharing the Ravi-Beas waters and the SYL issue between Punjab and Haryana is being discussed time and again and the case is in the Supreme Court. The Eradi Tribunal (1985) based on the allocation of water based on the time-inflow data of 20 years (1960-80), according to which 17.17 MAP (million-acre feet) water was available. However, now it is argued by Punjab that in the last 17 years there has been a consistent decline reducing the quantity to 14.34 MAP. The Supreme Court on January 15,2002, directed Punjab to complete and commission the SYL within a year, failing which the Center was told to complete it. However, two years have passed, but neither the SYL has been completed nor the conflict over sharing of Ravi- Beas's water is resolved.

  The conflict is that Punjab being the riparian state for Jhelum, Ravi and Satluj stakes its claim, Haryana has faced 'acute' shortage of water after it became a state in 1966 and has been trying to help it out by signing an MOU (Memorandum of understanding) with UP, Rajasthan, and Delhi for allocation of Yamuna waters. The Yamuna basin covers the state of Haryana while the Indus basin covers Punjab. The conflict revolving around the sharing of river water needs to be tackled with greater understanding and objectivity.

MINERAL RESOURCES

Minerals are naturally occurring, inorganic, crystalline solids having a definite chemical composition and characteristic physical properties. There are thousands of minerals occurring in different parts of the world. However, most of the rocks, we see every day are just composed of a few common minerals like quartz, feldspar, biotite, dolomite, calcite, laterite, etc. These minerals, in turn, are composed of some elements like silicon, oxygen, iron, magnesium, calcium, aluminum, etc.

Uses and exploitation

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

- Development of industrial plants and machinery.
- Generation of energy e.g., coal, lignite, uranium.
- Construction, housing, settlements.
- Defense equipment's-weapons, armaments.

- Transportation means.
- Communication- telephone wires, cables, electronic devices.
- Medicinal system- particularly in Ayurvedic System.
- Formation of alloys for various purposes (e.g., phosphorite).
- Agriculture-as fertilizers, seed dressings, and fungicides (e.g., zineb containing zinc, Maneb-containing Manganese, etc.).
- Jewelry - e.g., Gold, silver, platinum, diamond.

Based on their properties, minerals are basically of two types;

- Nonmetallic minerals e.g., graphite, diamond, quartz, feldspar.
- Metallic minerals e.g., Bauxite, laterite, hematite, etc.

The use of metals by human beings has been so extensive since the very beginning of human civilization that two of the major epochs of human history are named after them as Bronze Age and Iron Age. The reserves of metals and the technical know-how to extract them have been the key elements in determining the economy and political power of nations. Out of the various metals, the one used in maximum quantity is Iron and steel (740 million metric tons annually foil owed by manganese, copper, chromium, aluminum, and Nickel.

The CIS countries (The Commonwealth of Independent States i.e., 12 republics of former USSR), the United States of America, Canada, South Africa, and Australia are having the major world reserves of most of the metallic minerals. Due to huge mineral and energy resources, the USA became the richest and the most powerful nation in the world in even less than 200 years. Japan too needs a mention here, as there are virtually no metal reserves, coal, oil and timber resources in Japan and it is dependent on other countries for its resources. But it has developed energy-efficient technologies to upgrade these resources to high quality finished products to sustain its economy.

Minerals are sometimes classified as Critical and Strategic. Critical minerals are essential for the economy of a nation e.g., iron, aluminum, copper, gold, etc. Strategic minerals are those required for the defense of a country e.g., Manganese, cobalt, platinum, chromium, etc.

Some major minerals of India

- **Energy generating minerals:** Coal and lignite: West Bengal, Jharkhand, Orissa, M.P., A.P. Uranium (Pitchblende or Uranite ore): Jharkhand, Andhra Pradesh (Nellore, Nalgonda), Meghalaya, Rajasthan (Ajmer).
- **Other commercially used minerals:** Aluminum (Bauxite ore): Jharkhand, West Bengal, Maharashtra, M.P., Tamil Nadu.
- **Iron (hematite and magnetite ore):** Jharkhand, Orissa, M.P., A.P., Tamil Nadu, Karnataka, Maharashtra, and Goa.
- **Copper (Copper Pyrites**): Rajasthan (Khetri), Bihar, Jharkhand, Karnataka, M.P., West Bengal, Andhra Pradesh, and Uttaranchal.

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Environmental impacts of mineral extraction and use

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

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

- Jaduguda Uranium Mine, Jharkhand—exposing local people to radioactive hazards.
- Jharia coal mines, Jharkhand—underground fire leading to land subsidence and forced displacement of people.
- Sukinda chromite mines, Orissa—seeping of hexavalent chromium into river posing a serious health hazard, Cr^{6+} being highly toxic and carcinogenic.
- Kudremukh iron ore mine, Karnataka—causing riverpollution and a threat to biodiversity,
- East coast Bauxite mine, Orissa—Land encroachment and the issue of rehabilitation unsettled.
- North-Eastern Coal Fields, Assam—Very high Sulphur contamination of groundwater.

Impacts of mining

Mining is done to extract minerals (or fossil fuels) from deep deposits in soil by using mining or from shallow "deposits by surface mining. The former method is more destructive, dangerous, and expensive including risks of occupational hazards and accidents.

Surface mining can make use of any of the following three types:

- Open-pit mining in which machines dig holes and remove the ores (e.g., copper, iron, gravel, limestone, sandstone, marble, granite).
- Dredging in which chained buckets and draglines are used which scrap up the minerals from under-water mineral deposits.
- Strip mining which the ore is stripped off by using bulldozers, power shovels, and stripping wheels (e.g., phosphate rocks).

The environmental damage caused by mining activities are as follows:

- **De-vegetation and defacing of landscape:** The topsoil as well as the vegetation are removed from the mining area to get access to the deposit. While large-scale deforestation or de-vegetation leads to several ecological losses as already discussed in the previous section, the landscape also gets badly affected. The huge quantities of debris and tailings along with big scars and disruptions spoil the aesthetic value of the region and make it prone to soil erosion.
- **Subsidence of land:** This is mainly associated with underground mining. Subsidence of mining areas often results in tilting of buildings, cracks in houses, buckling of roads, bending of rail tracks, and leaking of gas from cracked pipelines leading to

serious disasters.

- **Ground-water contamination:** Mining disturbs the natural hydrological processes and also pollutes the groundwater. Sulphur, usually present as an impurity in many ores is known to get converted into sulphuric acid through microbial action, thereby making the water acidic. Some heavy metals also get leached into the groundwater and contaminate it posing health hazards.
- **Surface water pollution:** The acid mine drainage often causes the nearby streams and lakes. The acidic water is detrimental to many forms of aquatic life. Sometimes radioactive substances like uranium also contaminate the water bodies through mine wastes and kill aquatic animals. Heavy metal pollution of water bodies near the mining areas is a common feature creating health hazards.
- **Air pollution:** To separate and purify the metal from other impurities in the ore, smelting is done which emits enormous quantities of air pollutants damaging the vegetation nearby and has serious environmental health impacts. The suspended particulate matter (SPM), SOx, soot, arsenic particles, cadmium, lead, etc. shoot up in the atmosphere near the smelters and the public suffers from several health problems.
- **Occupational Health Hazards:** Most of the miners suffer from various respiratory and skin diseases due to constant exposure to the suspended particulate matter and toxic substances. Miners working in different types of mines suffer from asbestosis, silicosis stack lung disease, etc.

Remedial measures: Safety of mine workers is usually not a priority subject of industry, Statistical data show that, on average, there are 30 non-fatal but disabling accidents per ton of mineral produced and one death per 2.5 tons of mineral produced.

To minimize the adverse impacts of mining it is desirable to adopt eco-friendly mining technology. The low-grade ores can be better utilized by using the microbial-le aching technique. The bacterium Thermosulfidooxidans has been successfully and economically used for extracting gold embedded in iron sulphide ore. The ores are inoculated with the desired strains of bacteria, which remove the impurities (like Sulphur) and leave the pure mineral. This biological method is helpful for Economic as well as environmental point of view.

Restoration of mined areas by re-vegetating them with appropriate plant species, stabilization of the mined lands, the gradual restoration of flora, prevention of toxic drainage discharge, and conforming to the standards of air emissions are essential for minimizing environmental impacts of mining.

ENERGY RESOURCES

Energy consumption of a nation is usually considered as an index of its development. This is because almost all the developmental activities are directly or indirectly dependent upon energy. We find wide disparities in per capita energy use between the developed and the developing nations.

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The first form of energy technology probably was the fire, which produced heat and the early man used it for cooking and heating purposes. Wind and hydropower have also been in use for the last 10,000 years. The invention of steam engines replaced the burning of wood with coal and coal was later replaced to a great extent by oil. In the 1970s due to the Iranian revolution and Arab oil embargo, the prices of oil shot up. This ultimately led to the exploration and use of several alternative sources of energy.

Growing energy needs

Development in different sectors relies largely upon energy. Agriculture, industry, raining, transportation, lighting, cooling, and heating in buildings all need energy. With the demands of a growing population, the world is facing a further energy deficit. The fossil fuels like coal, oil, and natural gas which at present are supplying 95% of the commercial energy of the world's resources and are not going to last for many more years. Our lifestyle is changing very fast and from a simple way of life, we are shifting to a luxurious lifestyle. If you just look at the number of electric gadgets in your homes and the number of private cars and scooters in your locality you will realize that in the last few years, they have multiplied many folds and all of them consume energy.

Developed countries like the U.S.A. and Canada constitute about 5% of the world's population but consume one-fourth of global energy resources. An average person there consumes 300 GJ (Giga Joules, equal to 60 barrels of oils) per year. By contrast, an average man in a poor country like Bhutan, Nepal, or Ethiopia consumes less than 1 GJ in a year. So, a person in a rich country consumes almost as much energy in a single day as one person does in a whole year in a poor country. This clearly shows that our lifestyle and standard of living are closely related to energy needs. U.S.A., Norway, Switzerland, etc. with high GNP show high energy use while India, China, etc. have low GNP and low energy use. Bahrain and Quatar are oil-rich state (UAE) and hence their energy consumption and GNP are more, although their development is not that high.

Renewable energy resources

Solar energy: Sun is the ultimate source of energy, directly or indirectly for all other forms of energy. The nuclear fusion reactions occurring inside the sun release enormous quantities of energy in the form of heat and light. The solar energy received by the near-earth space is approximately 1.4kilojoules/second/m^2 known as solar constant.

Traditionally, we have been using solar energy for drying clothes and food-grains, preservation of eatables, and obtaining salt from sea-water. Now we have several techniques for harnessing solar energy. Some important solar energy harvesting devices are discussed here.

- **Solar heat collectors**: These can be passive or active. Passive solar heat collectors are natural materials like stones, bricks, etc., or material like glass which absorb heat during the day time and release it slowly at night. Active solar collectors pump a heat-absorbing medium (air or water) through a small collector which is normally placed on the top of the building.

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- **Solar cells**: They are also known as photovoltaic cells or PV cells. Solar cells are made of thin wafers of semiconductor materials like silicon and gallium. When solar radiations fall on them, a potential difference is produced which causes the flow of electrons and produces electricity. Silicon can be obtained from silica or sand, which is abundantly available and inexpensive. By using gallium arsenide, cadmium sulphide, or boron, the efficiency of the PV cells can be improved. The potential difference produced by a single PV cell of 4 cm^2 size is about 0.4-0.5 volts and produces a current of 60 milliamperes. A group of solar cells joined together in a definite pattern form a solar panel that can harness a large amount of solar energy and can produce electricity enough to run street-light, irrigation water pump, etc.
- Solar cells are widely used in calculators, electronic watches, street lighting, traffic signals, water pumps, etc. They are also used in artificial satellites for electricity generation. Solar cells are used for running radio and television also. They are more in use in remote areas where conventional electricity supply is a problem.
- **Solar cooker**: Solar cookers make use of solar heat by reflecting the solar radiation using a mirror directly onto a glass sheet that covers the black insulated box within which the raw food is kept. A new design of solar cooker is now available which involves a spherical reflector (concave or parabolic reflector) instead of a plane mirror that has more heating effect and hence greater efficiency.
- The food cooked in solar cookers is more nutritious due to slow heating. However, it has the limitation that it cannot be used at night or on cloudy days. Moreover, the direction of the cooker has to be adjusted according to the direction of the sun rays.
- **Solar water heater**: It consists of an insulated box painted black from inside and having a glass lid to receive and store solar heat. Inside the box, it has a black painted copper coil through which cold water is made to flow in, which gets heated and flows out into a storage tank. The hot water from the storage tank fitted on the rooftop is then supplied through pipes into buildings like hotels and hospitals.
- **Solar furnace**: Here thousands of small plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce as high a temperature as 3000°C.
- **Solar power plant**: Solar energy is harnessed on a large scale by using concave reflectors which cause boiling of water to produce steam. The steam turbine drives a generator to produce electricity. A solar power plant (50 K Watt capacity) has been installed at Gurgaon, Haryana.

Non-renewable energy resources

Coal

Coal was formed 255-350 million years ago in the hot, damp regions of the earth during the carboniferous age. The ancient plants along the banks of rivers and swamps were buried after death into the soil and due to the heat and pressure gradually got converted into peat and coal over millions of years. There are mainly three types of coal, namely

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anthracite (hard coal), bituminous (Soft coal), and lignite (brown coal). Anthracite coal has a maximum carbon (90%) and calorific value (8700 kcal/kg.) Bituminous, lignite, and peat contain 80, 70, and 60% carbon, respectively. Coal is the most abundant fossil fuel in the world. At the present rate of usage, the coal reserves are likely to last for about 200 years and if its use increases by 2% per year, then it will last for another 65 years.

India has about 5% of the world's coal and Indian coal is not very good in terms of heat capacity. Major coalfields in India are Raniganj, Jharia, Bokaro, Singrauli, and Godavari valley. The coal slates of India are Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh, and Maharashtra. Anthracite coal occurs only in J & K.

When coal is burnt it produces carbon dioxide, which is majorly a greenhouse gas responsible for causing enhanced global warming. Coal also contains impurities like sulphur and therefore as it burns the smoke contains-toxic gases like oxides of sulphur and nitrogen.

Petroleum

It is the lifeline of the global economy. There are ' 3 countries in the world having 67% of the petroleum reserve which together form the OPEC (Organization of petroleum exporting countries). About l/4th of the oil reserves are in Saudi Arabia.

At the present rate of usage, the world's crude oil reserves are estimated to get exhausted in just 40 years. Some optimists, however, believe that there are some yet undiscovered reserves. Even then the crude oil reserves will last for another 40 years or so. Crude petroleum is a complex mixture of alkane hydrocarbons. Hence it has to be purified and refined by the process of' fractional distillation, during which process different constituents separate at different temperatures. We get a large variety of products from this, namely, petroleum gas, kerosene, petrol, diesel, fuel oil, lubricating oil, paraffin wax, asphalt, plastic, etc.

Petroleum is a cleaner fuel as compared to coal as it burns completely and leaves no residue. It is also easier to transport and use. That is the reason why petroleum is preferred amongst all fossil fuels.

Liquefied petroleum gas (LPG): The main component of petroleum is butane, the other being propane and ethane. The petroleum gas is easily converted to liquid form under pressure as LPG. It is odorless, but the LPG in our domestic gas cylinders gives a foul smell. This is, in fact, due to ethyl mercaptan, a foul-smelling gas, added to LPG so that any leakage of LPG from the cylinder can be detected instantaneously.

Oil fields in India are located at Digboi (Assam), Gujarat Plains, and Bombay High, offshore areas in deltaic coasts of Godavari, Krishna, Kaveri, and Mahanadi.

Natural gas

It is mainly composed of methane (95%) with small amounts of propane and ethane. It is a fossil fuel. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. Natural gas is the cleanest fossil fuel. It can be easily transported through pipelines. It has a high calorific value of about 50KJ/G and burns without any smoke.

Currently, the number of natural gas deposits in the world are of the order of 80, 450 g nr^3. Russia has maximum reserves (40%), followed by Iran (14%) and the USA (7%). Natural

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gas reserves are found in association with all the oil fields in India. Some new gas fields have been found in Tripura, Jaisalmer, the Off-shore area of Mumbai, and the Krishna Godavari Delta.

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

Compressed natural gas (CNG): It is being used as an alternative to petrol and diesel for the transport of vehicles. Delhi has switched over to CNG where buses and auto-rickshaws run on this new fuel. CNG use has neatly reduced vehicular pollution in the city.

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

Biogas

Biogas is a mixture of methane, carbon dioxide, hydrogen, and hydrogen sulphide, the major constituent being methane. Biogas is produced by anaerobic degradation of animal wastes (sometimes plant wastes) in the presence of water. Anaerobic degradation means the breakdown of organic matter by bacteria in the absence of oxygen.

Biogas is a non-polluting, clean, and low-cost fuel that is very useful for rural areas where a lot of animal waste and agricultural waste are available. India has the largest cattle population in the world (240 million) and has tremendous potential for biogas production. From cattle dung alone, we can produce biogas of a magnitude of 22,500 Mm^3 annually. A sixty cubic feet gobar gas plant can serve the needs of one average family.

Biogas has the following main advantages: It is clean, non-polluting, and cheapest source. There is a direct supply of gas from the plant and there is no storage problem. The sludge left over is a rich fertilizer containing bacterial biomass with most of the nutrients preserved as such. Air-tight digestion/degradation of the animal wastes is safe as it eliminates health hazards which normally occur in case of direct use of dung due to direct exposure to faucal pathogens and parasites.

Biogas plants used in our country are basically of two types:

1. **Floating gas-holder type and 2. Fixed-dome type.**

- **Floating gas holder type biogas plant:** This type has a well-shaped fester tank that is placed under the ground and made up of bricks. In the digester tank, over the dung slurry, an inverted steel drum floats to hold the biogas produced. The gas holder can move which is controlled by a pipe and the gas outlet is regulated by a valve. The digester tank has a partition wall and one side of it receives the dung-water mixture through an inlet pipe while the other side discharges the spent slurry through the outlet pipe. Sometimes corrosion of steel gas-holder leads to leakage of biogas. The tank has to be painted time and again for maintenance which increases the cost.

- **Fixed dome type biogas plant:** The structure is almost similar to that of the previous type. However, instead of a steel gas-holder, there is a dome-shaped roof made of cement and bricks. Instead of partitioning, here there is a single unit in the main digester but it has inlet and outlet chambers.

  The Ministry of Non-Conventional Energy Source (MNES) has been promoting the Biogas Program in India. Out of the various models, the important ones used in the rural set-up are the KVIC Model (Floating drum type), Jama Model (Fixed dome type), Deenbandhu Model (Fixed dome type), Pragati Model (floating drum type), Ganesh Model (KVIC type but made of bamboo and polythene sheet) and Ferro-cerpent digester Model (KVIC type with Ferro-cement digester),

Biomass energy

Biomass is the organic matter produced by plants or animals which includes wood, crop residues, cattle dung, manure, sewage, agricultural wastes, etc. Biomass energy is of the following types:

- **Energy Plantations**: Solar energy is trapped by green plants through photosynthesis and converted into biomass energy. Fast growing trees like cottonwood, poplar, and Leucaena, non- oody herbaceous grasses, crop plants like sugarcane, sweet sorghum, and sugar beet, aquatic weeds like water hyacinth and sea-weeds and carbohydrate-rich potato, cereal, etc. are some of the important energy plantations. They may produce energy either by burning directly or by getting converted into burnable gas or may be converted into fuels by fermentation.
- **Petro-crops:** Certain latex-containing plants like Euphorbias and oil palms are rich in hydrocarbons and can yield an oil like sub stance under high temperature and pressure. This oily material may be burned in diesel engines directly or maybe refined to form gasoline. These plants are popularly known as petro-crops.
- **Agricultural and Urban Waste biomass**: Crop residues, bagasse (sugarcane residues), coconut shells, peanut hulls, cotton stalks, etc. are some of the common agricultural wastes which produce energy by burning. Animal dung, fishery and poultry waste, and even human refuse are examples of biomass energy. In Brazil, 30 % of electricity is obtained from burning bagasse. In rural India, animal dung cakes are burnt to produce heat. About 80 % of rural heat energy requirements are met by burning agricultural wastes, wood, and animal dung cakes.

  In rural areas, these forms of waste biomass are burned in open furnaces called 'Chulhas' which usually produce smoke and are not so efficient (efficiency is <8 %). Now improved Chulhas with tall chimney have been designed which have high efficiency and are smokeless.

  The burning of plant residues or animal wastes cause air pollution and produce a lot of ash as waste residue. The burning of dung destroys essential nutrients. It is, therefore, more useful to convert the biomass into biogas or biofuels

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The Jawaharlal Nehru National Solar Mission (JNNSM), or the National Solar Mission, is an initiative taken by Government of India and State Governments to promote solar power in India. It was inaugurated in January 2010, and has been revised twice and now boasts a target of 100 GW of solar PV by 2022.

The objective of this mission is that India is to lead globally in solar energy by creating the policy conditions for its deployment across the country. Each Phase of this mission is to support by differing key policies and targets.

Phase I (2010 – 2013)-

- Target for grid-connected PV (including rooftop) target: 1 000 MW
- Target for off-grid solar PV applications: 200 MW

Phase II (2014 – 2017):

- Cumulative target for grid-connected solar PV (including rooftop): 4 000 – 10 000 MW
- Target for off-grid solar PV applications: 1 000 MW
- Scheme for at least 25 solar parks (34 approved currently under Government) and the Ultra Mega Solar Power Projects to target 40 GW solar PV

Chipko movement

Control over natural resources is an important reason for the emergence of the environmental movement in India. Some good examples of these kinds of movements are Chipko and N B.A. In the first case, the reason for the conflict was control over the forest: whereas, in the second the reasons control over water. Let's have a look at the reasons behind the emergence of the Chipko movement in the Garwahal Himalayas.

The movement started in the Garhwal Himalaya in April 1973. Between 1973 and 1980, over a dozen instances were recorded where through an innovative technique of protest. Women and children threatened to hug forest threes rather than allow then lo he logged for export. Notably, the peasants were not interested in saying the trees per so, but in using their produce for agricultural and household requirements. In later years, however, the movement turned its attention to broader ecological concerns-such as the collective protection and management of forest, and the diffusion of renewable energy technologies.

The Chipko movement was the forerunner of and in some cases the direct inspiration for a series of popular movements in defense of community rights to natural resources. Sometimes these struggles are resolved around the forest and in other instances, around the control and use of pasture, water, and mineral or fish resources. Most of these conflicts have pitted rich against poor: Logging companies against hills villagers, dam builders against forest tribal communities, multinational corporations deploying trawlers against traditional fisherfolk in small boats. Here one part (e.g., loggers or trawlers) seeks to setup the pace of resource exploration to service an expanding commercial-industrial economy. A process which often involves the partial, or total dispossession of these communities who earlier had control over the resources in question, and whose own patterns of utilization were less destructive of the environment.

Uses of alternate energy sources

Wind energy

The high-speed winds have a lot of energy in them as kinetic energy due to their motion. The driving force of the winds is the sun. The wind energy is harnessed by making use of windmills. The blades of the windmill keep on rotating continuously due to the force of the striking wind. The rotational motion of the blades drives several machines like water pumps, flour mills, and electric generators. A large number of windmills are installed in clusters called wind farms, which feed power to the utility grid and produce a large amount of electricity. These farms are ideally located in coastal regions, open grasslands, or hilly regions, particularly mountain passes and ridges where the winds are strong and steady. The minimum wind speed required for the satisfactory working of a wind generator is 15 km/hr.

The wind power potential of our country is estimated to be about 20,000 MW, while at present we are generating about 1020 MW. The largest wind farm in our country is near Kanyakumari in Tamil Nadu generating 380 MW electricity.

Wind energy is very useful as it does not cause any air pollution. After the initial -installation cost, wind energy is very cheap. It is believed that by the middle of the century wind power would supply more than 10% of the world's electricity.

Hydropower

The water flowing in a river is collected by constructing a big dam where the water is stored and allowed to fall from a height. The blades of the turbine located at the bottom of the dam move with the fast-moving water which in turn rotates the generator and produces electricity. We can also construct mini or micro hydel power plants on the rivers in hilly regions for harnessing the hydro energy on a small scale, but the minimum height of the waterfalls should be 10 meters. The hydropower potential of India is estimated to be about 4×10^{11} KW-hours. Till now we have utilized only a little more than 11% of this potential.

Hydropower does not cause any pollution, it is renewable and normally the hydropower projects are multi-purpose projects helping in controlling floods, used for irrigation, navigation, etc. However, big dams are often associated with some environmental impacts which have already been discussed in the previous section.

Tidal energy

Ocean tides produced by gravitational forces of the sun and moon contain enormous amounts of energy. The 'high tide' and '**low tide**' refer to the rise and fall of water in the oceans. A difference of several meters is required between the height of high and low tide to spin the turbines. The tidal energy can be harnessed by constructing a tidal barrage. During high tide, the sea-water flows into the reservoir of the barrage and turns the turbine, which in turn produces electricity by rotating the generators. During low tide, when the sea-level is low, the seawater stored in the barrage reservoir flows out into the sea and again turns the turbines.

There are only a few sites in the world where tidal energy can be suitably harnessed. The bay of Fundy Canada having 17-18 m high tides has a potential of 5,000 MW of power

generation. The tidal mill at La Ranee, France is one of the first modern tidal power mills. In India Gulf of Cambay, the Gulf of Kutch and the Sunder bans deltas are the tidal power sites.

Geothermal energy

The energy harnessed from the hot rocks present inside the earth is called geothermal energy. High temperature, high-pressure steam fields exist below the earth's surface in many places. This heat comes from the fission of radioactive material naturally present in the rocks. In some places, the steam or the hot water comes out of the ground naturally through cracks in the form of natural geysers as in Manikaran, Kullu, and Sohana, Haryana. Sometimes the steam or boiling water underneath the earth does not find any place to come out. We can artificially drill a hole up to the hot rocks and by putting a pipe in it make the steam or hot water gush out through the pipe at high pressure which turns the turbine of a generator to produce electricity. In the USA and New Zealand, several geothermal plants are working successfully.

Biofuels

Biomass can be fermented to alcohols like ethanol and methanol which can be used as fuels. Ethanol can be easily produced from carbohydrate-rich substances like sugarcane. It burns clean and is non-polluting. However, as compared to petrol its calorific value is less and therefore, produces much less heat than petrol,

Gasohol is a common fuel used in Brazil and Zimbabwe for running cars and buses. In India too gasohol is planned to be used on a trial basis in some parts of the country, to start within Kanpur. Gasohol is a mixture of ethanol and gasoline.

Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Thus, the bulky radiator may be substituted by sleek designs in our cars. Methanol too is a clean, non-polluting fuel. Methanol can be easily obtained from woody plants and ethanol from gram-based or sugar-containing plants.

Hydrogen as a fuel

As hydrogen burns in air, it combines with oxygen to form water and a large amount of energy (150 kilojoules per gram) is released. Due to its high, rather the highest calorific value, hydrogen can serve as an excellent Moreover, it is non-polluting and can be easily produced. Production of Hydrogen is possible by thermal dissociation, photolysis or electrolysis of water:

- By thermal dissociation of water, (at 3000°K or above) hydrogen (H_2) is produced.
- Thermochemically, hydrogen is produced by chemical reaction of water with some other chemicals in 2-3 cycles so that you do not need the high temperatures as indirect thermal method and ultimately H_2 is produced.
- The electrolytic method dissociates water into hydrogen (H_2) and oxygen by making a current flow through it.
- Photolysis of water involves the breakdown of water in the presence of sunlight to release hydrogen. Green plants also have photolysis of water during photosynthesis.

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Efforts are underway to trap hydrogen molecule which is produced during photosynthesis.

However, hydrogen is highly inflammable and explosive. Hence, safe handling is required for using Hydrogen as fuel. Also, it is difficult to store and transport. And, being very light, it would have to be stored in bulk. Presently, H2 is used in the form of liquid hydrogen as a fuel in spaceships.

Living organism and their non-living environment are inseparably interrelated and interact with each other Any area of nature that includes living organisms and non-living substances interacting to produce and exchange material between them is an ecological system or ecosystem.

The term ecosystem was used by British Ecologist AG Tansley. According to him, the ecosystem consists of a biotic community and it's an abiotic component that is interrelated and interacts with each other.

CHECK YOUR PROGRESS

1. **What are four types of components of the environment?**
2. **What is the need for environmental awareness?**
3. **Discuss the major natural resources of our environment.**
4. **Water is characterized by certain unique features. Explain**
5. **Aquifers may be of two types. Explain them.**

FOOD RESOURCES

The main food resources are wheat, rice, maize, barley, pulses, cereals, potato, sugarcane, sorghum, millet, oats, cassava, fruits, vegetables, milk and sea food etc.

About 4 billion people in the staple food. Fish developing countries have wheat and rice as their quality protein and seafood contribute about 70 million metric tons of high to the world's diet. But we have harvests of already surpassed sustainable fish from most of the oceans.

World food problems

World grain production increased about three times during the last 50 But at the years. same time population growth in developing countries increased at such a rate that it out stripped food production. Every year about 50 million people die of malnutrition and starvation. India is the third largest producer of staple crops that is, wheat, maize, gram, rice yet about 300 million people are still undernourished (Table 5). They are receiving less than 90% of the minimum required calorie intake of 2500cals per day (as estimated by FAO of United Nations).

Impact of nutritional deficiency

Deficiency	Health effects	Deaths per year (in millions)
Proteins	Stunted growth, Kwashiorkor, marasmus	15 - 20

Iron	Anaemia, retardation of growth	0.75 - 1.00
Iodine, Vitamin A	Goitre, cretinism, night blindness	0.40 - 0.50

Food crisis is directly linked to population explosion. India has only 50% land compared to USA, but it has nearly three times population to feed. In some Third world countries, the food shortage is killing every year as many people as were killed by the dropping of atom bomb in Hiroshima during World War II in 1946. These startling statistical figures emphasize the need to increase our food production, its equitable distribution and control of population. The World Food Summit, 1996 has set the target to reduce the number of undernourished to just 50% by 2015.

Changes caused by overgrazing and agriculture

Beside natural factors like rainfall, climate and soil texture, crop production is also affected by overgrazing, traditional agriculture and modern agriculture.

a. **Impacts of Overgrazing**: Livestock wealth, maximum in India, plays a crucial role in the country. The huge population of livestock grazing on grassland or pasture surpass the carrying capacity. Carrying capacity of any system is the maximum population that can be supported by it on a sustainable basis. However, most often, the grazing pressure is so high that it carrying capacity is crossed and the sustainability of the grazing land fails.

   - **Land degradation:** Overgrazing degrades the land, removes vegetal cover, declines soil moisture and organic recycling. Due to trampling by cattle the soil loses infiltration capacity, soil structure, hydraulic conductivity, humus content and soil fertility. Loss of useful species. Overgrazing adversely affects the composition of plant population and their regeneration capacity. Several juicy fodder giving species like Panicum, Cenchrus, Dichanthium are replaced by unpalatable and poor-quality thorny plants such as Lantana, Argemone, Parthenium.
   - **Soil erosion:** Due to overgrazing by cattle, the cover of vegetation almost gets removed from the land. The soil becomes exposed and gets eroded by the action of strong wind and rainfall. The grass roots are very good binders of soil. When the grasses are removed, the soil becomes loose and prone to soil erosion.

b. **Impacts of Traditional Agriculture:** Traditional agriculture involves small fields, simple tools, rain water, organic fertilizers and a mix of crops. It results in low production. 1. Deforestation. Shifting cultivation (slash and burn) results in deforestation and soil erosion. 2. Depletion of nutrients. Slash and burn cultivation destroy the organic matter and makes the soil nutrients poor.

c. **Impacts of Modern Agriculture:** Modern agricultural techniques which are geared towards bumper crop production to meet the ever-growing demands of rapidly increasing population are exploring new agro-technologies to feed the masses. With the extensive use of high output techniques employing hybrid seeds of high yielding varieties (Green Revolution) and abundant irrigation water, fertilizers

and pesticides, the world is heading towards a complex array of environmental problems more severe than ever before. Although Green Revolution boosted the food production but its fallout become evident since 1990s as listed below:

1. **Fertilizers related problems**
   - Fertilizer enriched soil cannot support microbial flora. Hence there remains poor humus and less nutrients while the soil can readily become eroded by wind and water.
   - It is reported that there is a 30% decline in protein and carbohydrate content when corn, maize, gram and wheat crops were grown on sols fertilized with NPK fertilizers.
   - Potassium fertilizers in soil decreases the valuable nutrient ascorbic acid (vitamin C) and carotene in vegetables and fruits. Fertilized soil produces bigger sized vegetables and fruits which are more prone to pest, insects and diseases.
   - Phosphatic fertilizer like DAP (that of P20:) is considered detrimental to crop production. It may lead to Fe, Cu and Zn deficiency in plants.
   - Cereal crops like jawar, maize and pearl millet grown on alkaline soil absorb higher amounts of fluorides and responsible for the spread of fluorosis.
   - Excess use of fertilizers intensively reduces the ability of plants to fix nitrogen
   - Farmers use NPK fertilizers indiscriminately to boost up crop growth which cause micronutrient (Cu, Zn, Fe) imbalance.
2. **Eutrophication (Eu-more, Trophication-nutrition):** Agricultural run-off contains nitrogen and phosphorus fertilizers which reaches nearby water bodies. Excessive use of these fertilizers leads to over nourishment of these water bodies and gives rise to the phenomenon of eutrophication. Thus, the lake soon gets filled up with the extensive growth of algal bloom. Decomposition of algal bloom leads to oxygen depletion in water. Aquatic organisms begin to die and the lake becomes a dead pool of water.
3. **Nitrate pollution:** Excessive use of nitrogenous fertilizers, called the miracle drug of farming, lead to accumulation of nitrate in the soil which are transferred to man through plants. Nitrates, being highly soluble, go into drinking ground water and become toxic when its concentration exceeds 90 ppm. In human body these nitrates and nitrites are converted to nitroso and nitrosamines which are suspected as agents of stomach cancer.

   Nitrate in water causes cyanosis (blue jaundice) in children and methemoglobinemia or blue baby syndrome in infants where nitrite interferes with oxygen carrying capacity of blood.

   Nitrate poisoning in animals have been reported due to consumption of vegetation grown in nitrate rich soil. According to H.H. Koepf, an eminent sol

chemist, modern agriculture can honestly claim two notable crops-disease and pest but now a third factor (nitrate, nitrite fertilizers) can be frequently added to soil contaminants.

4. **Pesticide related problems:** Though some pesticides (DDT) are banned, they still show small doses in foods. Increased productivity of crops leads to greater dependency on agrochemicals creating new problems to be faced in future. [Also refer to Effects of Pesticides in Land Pollution]
5. **Inducing pest resistance species:** New generations of pests develop resistance to pesticides which survive even after pesticide spray. At present, about 30 pest species are known to be immune to all types of pesticides and are called super pests.
6. **Biological magnification or biological amplification:** Many pesticides are non-biodegradable so they persist in the food chain. For instance, concentration of DDT continuously increases in successive trophic level. Thus, DDT level builds up from 0.04 ppm in planktons, 0.94 ppm minnows, 5 ppm in fish to 75 ppm in geills. Man occupies the highest trophic level in the food chain, hence gets a high dose of pesticide. Organochlorine insecticides in des have the greatest magnification because they have a little affinity for lipids and are quite persistent Eco poisons.
7. **Impacts from high yielding varieties (HYV):** Applications of seeds of HYV produce monoculture that is, same species (genotype) grown over large areas. Such monoculture is vulnerable to attack b pathogen, which spreads quickly devastating the crops.
8. **Water logging:** Excessive irrigation of crop lands for good crop fertility leads to water logging, in absence of adequate drainage, excess water seeps into the underlying water table Soil gets fully drenched and roots of plants have insufficient air for respiration. Mechanical strength of the soil declines, plants get heavily lodged and crop yield falls. Punjab and Haryana have faced water logging problems as a result of extensive irrigation by canal water. Consequently, there is a sharp decline in crop fertility. Preventing excessive irrigation, sub-surface drainage technology and bio-drainage with trees like Eucalyptus are some of the remedial measures to prevent water logging.
9. **Salinity problems:** Over irrigation of crop lands gives rise to salinity which contains dissolved salts. Accumulation of salts such as NaCl, Na:SO4, CaCl2 and MgClk etc. in the soil profile causes the soil to become saline. Thousands of hectares of land in Punjab and Haryana have been affected by soil salinity. Salinity causes stunted plant growth and reduces crop yield. The best method of getting rid of salinity is to flush out by applying fresh water to such soils. Another method is laying underground network of perforated drainage pipes for flushing out the salts slowly. This system has been tried in CSSRI at Sampla, Haryana. The Central Soil Salinity Research Institute (CSSR) in Karnal, Haryana has successfully converted barren land to productive land.

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Case studies

Salinity in Haryana and Punjab. The first alarming report of salt affected wasteland formation related to irrigation practices came from Haryana and then Punjab in 1958. Several villages in Panipat, Rohtak and Delhi lying near western Yamuna canal were suffering from destructive saline efflorescence. The Reh Committee drew the attention of government on some vital points indicating the relationship between drainage and spread of usar and reh soils.

Water Logging in Punjab, Haryana and Rajasthan. In Punjab, the floods of 1950, 1952, 1956, 2010 resulted in aggravated water logging with severe drainage problems. Introduction of canal irrigation in Haryana have raised the water table followed by water logging and salinity in many irrigated areas causing huge economic losses as a result of fall in crop productivity. Rajasthan too has suffered badly from the biggest irrigation project -Indira Gandhi Canal Project. A vast area in Western Rajasthan has changed from water starved wasteland to that of water-soaked wasteland.

LAND RESOURCES

India has total area of about 329 million hectares. The utilization statistics available are for nearly 92.5% of the total area. About 162 million hectare of land is under agriculture cover. Nearly 5% of the land falls under fallow land. About 46 million hectares is under real forest as shown by satellites. A part of land is not in use. This waste land includes arid, rocky and sandy deserts. Cities and towns which use much land must grow vertically rather than horizontally. The land is also needed for industry, commerce, transport and recreation. Since total land is a fixed asset, we must take efforts for integrated land use planning.

Land Degradation

Land is an important component of the life support system. Unfortunately, land has been overused and even abused over the centuries. Due to exploding population land is used increasingly which poses threats to its productivity. Careless use damages soil that results into

- Reduction in quality of wood land, grassland, cropland
- Soil erosion
- Deforestation
- Degradation of water sheds and catchments
- Due to demographic pressures land is under stress. Also due to sprawl in agriculture, industry and urbanization, cropland is degraded and losing fast, fertile top soil.

Soil erosion

Soil erosion is a comprehensive natural process of detachment and removal of loosened soil materials by exogenic processes. It is generally regarded as creeping death of soil. Soil erosion is enhanced due to agricultural development, deforestation, flood, overgrazing, construction and strip-mining activities. There are numerous physical forces by which the fertile top layer is lost and wasted. This slow removal of top soil and disturbances in the soil

texture is called soil erosion or gravity erosion. Nearly 500 to 1000 years are required for the development of an inch of the top layer. But now the problem of erosion is increasing tremendously over the entire globe. The top soil which is thus lost is irreplaceable. Today about 25 x 109 tonnes of precious top soil flows into oceans as silt and sediments every year. India loses about 5300 million tonnes of soil every year. Of this enormous amount nearly 2000 million tonnes get deposited in streams and river beds, 480 million tonnes get lodged in dams and reservoirs and the rest is flushed into the sea. Most of the reservoirs in India are sitting up at faster rate. This has curtailed the life span of our multipurpose reservoirs drastically. About 30% of world's irrigated cropland is severely affected by salinity and water logging.

Types of soil erosion

- **Normal or Geologic Erosion:** This universal erosion is a natural process of denudation that tends to bring the soil to a uniform level. The first phase of this process is weathering which is essentially physio-chemical in nature. Weathering aided by certain biological influences causes disintegration of substances. The process leads to the development of complex soil bodies with definite physical, chemical and biological properties.
- **Accelerated Erosion:** It refers to the increased rate of erosion and extreme soil degradation by various land use changes induced by man. There is disequilibrium because of the formation and loss of soil. The fertile layer deteriorates much faster at which new soil forms. Accelerated soil erosion is mostly operative in humid climate regions where extensive forest clearance, grass land removal and trampling by livestock have been practiced at an alarming rate.
- **Transport Limited Erosion:** When the detachment of soil particles equals the transporting capacity of rainfall and run off, it is called transport Limited Erosion
- **Detachment Limited Erosion:** Here the rate of detachment of soil mass is less than the transport capacity of rainfall.

Agents of soil erosion

The agents which cause soil erosion are classified as follows:

a. **Climatic Agents**

Water and wind are the climatic agents of soil erosion:

1. **Water Induced Soil Erosion:** Water affects soil erosio1: in the form of torrential rains, rapid flow of water along slopes, run-off, wave act10n, melting and movement of snow. Water erodes soil chiefly in six ways:
   - **Sheet erosion.** When the soil is eroded and removed as a thin covering from large area, it is known as rain wash or sheet erosion.
   - **Rill erosion.** The run-off water as rain storms flows rapidly and cuts small stream-like structure in the form of well-defined finger shaped grooves.
   - **Gully erosion.** Several rills converge towards the slope and join to form wider and deeper channels of water called gullies.

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- **Slip erosion.** It occurs due to heavy rainfall on slopes of hills and mountains.
- **Stream bank erosion.** The rivers during floods splash their water against the banks and thus cut through them. Water strikes with great speed and the bank caves in alongside.
- **Rill and Ravine erosion.** It is the most effective form of soil erosion caused by riIls and gullies. The heavily gullied and ravinated land is known as Bad Land. It is estimated that owing to this erosion, 2.35 million cubic meters of agricultural land are lost every year from Jawa Block of Rewa District of Madhya Pradesh, India.

2. **Wind Erosion.** Wind erosion occurs in dry (arid) regions where soil is sandy and vegetation is extremely poor. Wind erosion is triggered by the damage of natural vegetation cover of soil by over g1·azing and over felling. Once the fertile top soil is laid bare to the fury of strong gales it gets blown off in the form of sand or dust.

   Storm and transported to far off places. These rolling particles rub the ground and due to abrasive action help in loosening the top soil. In India. wind erosion affects about 50 million hectares of land, most of which is in Rajasthan.

   Wind erosion is responsible for the following types of soil movements:

   - **Suspension:** Suspension erodes soil in the form of fine dust with the wind.
   - **Surface creep:** The heavier soil particles which are not easily thrown up by wind are simply pushed along the surface by wind.
   - **Saltation:** It occurs in arid regions where drainage is poor, rainfall is low and high temperatures prevail. Salt accumulation occurs around the oceans where water evaporates quickly leaving behind salts containing chlorides, sulphates, carbonates and nitrates of sodium, potassium, magnesium and calcium. The major part of such salty soil is carried away by wind in the form of small heaps.

b. **Biotic Agents:** Excessive grazing, deforestation and mining are the major biotic agents responsible for soil erosion. Due to these activities the top soil is rendered devoid of vegetation cover. So, the land is directly exposed to the action of various physical forces facilitating erosion. Overgrazing accounts for 35% of the world's soil erosion while deforestation is responsible for 30% of the earth's eroded lands. Unsustainable methods of farming cause 28% of soil erosion. Deforestation without reforestation, surface mining without land reclamation, soil compaction by agricultural machinery, excessive irrigation causing salination, water-logged soil, farming on land with unsuitable terrain and cattle trampling etc. make the top soil vulnerable to erosion

Factors affecting soil erosion

Food and Agriculture Organization (FAO) have considered the following factors responsible for soil erosion.

- **Climatic Factors**. For example, wind, temperature intensity, energy and rainfall pattern.
- **Physiographic Factors**. For example, length, steepness, curve of slope.
- **Soil Characteristics:** For example, aggregation, transportation, detachability and water holding capacity.
- **Cover of Vegetation:** Forests and cultivation etc. These factors of soil erosion are represented in the form of universal Soil Loss Equation as indicated below:

E = f (C, T, R, V, S, ... H)
Where,

- E is average annual soil/sediment loss
- f = function of C = cropping and management factor
- T = Topography
- R = Rock type
- V = Vegetation
- S = Soil character
- H= Human interference.

Detrimental effects of soil erosion

- Due to soil erosion Indian subcontinent has faced acute silting problems in Rihand, Bhakra and other dams. The life of Bhakra dam is feared to lessen by 250 years due to silt pollution at Govind Sagar Lake. Because of this alarming silt accumulation, it may not last for more than 150 years (constructed to last for 400 years).
- Soil erosion, salinization and water logging have resulted in a massive loss of 600 million hectares of potential farm lands.
- India has only 2.4% of the land area of the world while CIS has 9.8% and USA has 6. 7%. But the loss of fertile soil is maximum (18.5'%) m India of the total Soil loss over the entire planet.
- The eroded soil is deposited on lakes or river beds and leads to devastating floods.

Control measures of soil erosion

ln n primarily agricultural country like India land is by far the most precious asset. We have land about million times more than our all-industrial plants and power stations, yet we remain silent spectators to steady destruction of our most valuable resource. Control measures include following basic principles.

- Protection of soil from the impact of rain fall.
- To increase the infiltration of rain water.
- To prevent water from concentration.
- To encourage more water to enter the soil.

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- To increase the size of soil particles.
- To increase the soil resistance.
- Soil erosion can be controlled by reducing wind erosion and growing the strips of stubble or other plants. For example, some plants which yield hydrocarbons grow well in arid regions. These include Jojoba, a plant which produces sap like diesel oil and milky weed. Jodhpur Arid Zone Research Institute is conducting experiments with such varieties.
- In overgrazed land fodder trees should be grown like babul, which in irrigated land yield enough green fodder per acre to nourish six cows.
- Grazing animals should be kept in enclosures.
- By stubble mulching or trash farming-in which chopped crop residue is spread and ploughed into the soil to produce improved tilth in the surface soil.
- By growing intermittent vegetal shelter belts. Surface soil erosion and sand storms leading to sand casting of crop lands can be controlled by creating shelter belts which tend to break the wind and form barriers to check sand movement.
- By stabilizing sand dunes, i.e., to stabilize the soil in arid regions.

Soil conservation practices

- **Conservation till Farming:** Here special tillers break up and loosen the sub surface; without turning over the top soil. The tilling machines make slits in the unploughed soil and inject seeds, fertilizers, herbicides and a little water in the sht. Sec ds germinate and a crop grows without competition with weeds.
- **Mechanical Methods:** These methods include:
  a. Basin listing, i.e., to build small basins to retain water.
  b. Contour terracing, i.e., to construct a channel along the slope to intercept run off water. Terracing retains water for crops at all levels and cuts down erosion. In heavy rainfall areas, ditches are also provided behind the terrace to permit adequate drainage.
- **Biological Methods, i.e., by growing vegetation**
  a. **Agronomic practices:** It is the process by which soil erosion is reduced by growing vegetation under natural protection. These are:
     1. **Crop rotation**: Repeated cultivation of soil depletes the soil nutrients. It can be controlled by cultivating legumes after cereal crops.
     2. **Strip cropping:** Here strips of crops are alternated with strips of soil saving cover- crops like grasses or grass-legume mixture. Whatever run-off comes from the cropped soil is retained by the strip of cover-crop and tlus reduces soil erosion.
     3. **Contour farming:** Field is prepared with alternate furrows and ridges. Ridges of equal level are called contours. Water is caught and held in furrows (small dams) and prevent loss of soil.

b. **Dry land farming:** The aim of dry farming is to conserve all the moisture that falls on the land in the form of rain fall. The yields would be high enough to cover the cost of production and make the area self-sufficient. Some other methods such as fallowing of land, strip cropping and mulching etc. are also beneficial to check soil erosion.

c. **Agrostological Methods:** Grasses like cynodon dactylon which act as stabilizer are grown as erosion-resisting plants. These methods involve lay farming and retiring lands to grass.

Water logging

Farmers usually apply heavy irrigation to their farmlands to provide congenial moisture to the growing crops and to leach down salts deeper into the soil. The accumulated underground water forms a continuous column with the water table. This water-logged soil clogs the pore spaces between the soil particles affecting the crop growth due to inhibition of exchange of gases. Water logging is most often associated with salinity because the water used for irrigation contains salts and the soils get badly degraded due to erroneous irrigation practices. About 1.2 million hectares of land in Haryana has resulted in rise in water table by water logging due to introduction of canal irrigation. Indira Gandhi Canal Project of Rajasthan has changed a large area in Western Rajasthan into water logged waste land. It is a startling fact that the cost of development of irrigation projects is very high and in the long run they cause problems of water logging and salinity (loss of Rs. 10,000 million per annum) thereby reducing soil fertility.

Desertification

Desertification is the transformation of fertile, land into desert by natural or man-made activities. lt is caused by erosion of top soil, shifting of sand dunes by wind, mining and Over grazing. Desertification is characterized by DE vegetation and loss of vegetal cover, depletion of ground water, salinization and severe soil erosion. The UNEP estimates suggest that if we do not make sincere efforts, then very soon 63% of range lands, 60% of rain fed croplands and 30% of irrigated farmlands will suffer from decertification on a world-wide scale, adding 60000km2 of deserts every year.

1.9 ROLE OF AN INDIVIDUAL IN CONSERVATION OF RESOURCES

Conservation of resources means maintaining the ecological balance without depleting natural resources like water, forest, Soil, mineral and energy. An individual can play a vital role in facilitating conservation and regeneration, of resources by adopting following strategies:

- Do not keep water taps running while brushing, washing and bathing, Install water-saving toilets.
- Check for water leaks in pipes and repair them promptly. A small pin hole sized leak will lead to the wastage of 640litres of water in a month.
- Water the plants in the evening when evaporation. lo8Hea are minimum.

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- Use drip or sprinkling irrigation to improve irrigation efficiency.
- Install rain water harvesting system in houses which reduces the use of energy and cost for pumping water. One meter of water level saves 0.40 kwh assuming 10 hours of pumping per day for 365 days.

1.10 EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFE STYLE

There is a great variation in the population and utilization of natural resources among different countries. The more developed countries (MDC's) represent only 22% of world population but consume 88% of natural resources and about 80% of the global energy. MDC's include USA, Canada, Japan, CIS, Australia, New Zealand and Western European countries. The less developed countries (LDS's) on the other hand represent 78% of the world's population and use only 12% of natural resources and 20% of the global energy. The rich nations are contributing more to pollution and threatening the sustainability of life support systems on the earth. The poor nations are still struggling hard with their huge populations and poverty problems. The rich have grown richer while the poor have gone even poorer. This needs equal distribution of resources especially the basic requirements like drinking water, food and fuel etc. so that people in LDC's are at least able to sustain their life. The problems of LDC's like pollution, unhygienic conditions, diseases etc. can be brought under control only with the help of MDC's.

In order to achieve sustainable life styles, it is desirable to achieve a more balanced and equitable distribution of global resources and income to meet every one's basic needs. The rich nations will have to reduce their consumption levels and divert some resources to the poor nations. A fairer sharing of resources will narrow down the gap between the rich and the poor and will lead to sustainable development for all and not just for a privileged group.

1.11 CHAPTER SUMMARY

The word Environment came from the French Language which means the surroundings. The Environment is an interdisciplinary topic that includes the surroundings which cover the land, air, water, and their interrelationship and majorly their relationship with human beings and other organisms prevailing in the surroundings. Environment sciences not only deal in surroundings but it includes the processes in the land, water, and air which will even explain the pollutants that can harm and create pollution. When surrounding is not under control naturally then it can bring disasters. To manage these disasters, different committees, Acts, rules, and regulations are formed to maintain a clean, safe, and healthy ecosystem.

Environmental studies are an interdisciplinary subject examining the interplay between the social, legal, management, and scientific aspects of environmental issues. Interdisciplinary means that issues are examined from multiple perspectives. Unlike environmental science, which focuses mainly on the scientific component of these environmental issues, environmental studies investigate the scientific and the humanitarian aspects. Students of environmental studies learn the causes, effects, and possible solutions to address important environmental problems. Environmental movements of various countries have emerged

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due to the different reasons. This is basically due to the prevailing environmental quality of the locality. The environmental movements in the north are basically on the issue of quality of life. Whereas the environmental movements in the south arise due to some other reasons, such due to conflict for controlling natural resources. The first form of energy technology probably was the fire, which produced heat and the early man used it for cooking and heating purposes. Wind and hydropower have also been in use for the last 10,000 years.

1.12 REVIEW QUESTIONS

SHORT ANSWER TYPE QUESTIONS

1. **What are the components of the environment?**
2. **What is the scope of Environmental Studies?**
3. **Highlight the importance of Environment Science.**
4. **Define Environment.**

LONG ANSWER TYPE QUESTIONS

1. **Is there any scope of Environment Science in future? If Yes, Explain how.**
2. **Explain the concept of Ecosystem with its components.**
3. **Why a healthy environment is needed?**
4. **Describe the energy flow in an ecosystem.**
5. **Explain the concept of Community ecology.**

1.13 MULTIPLE CHOICE QUESTIONS

1. **Which of the following element is present in the large percentage in the biosphere?**
   a. Carbon
   b. Hydrogen
   c. Nitrogen
   d. Oxygen
2. **Which of them is fittest for survival of humans?**
   a. Lithosphere
   b. Hydrosphere
   c. Atmosphere
   d. Biosphere
3. **World environment day is celebrated on:**
   a. September 5
   b. July 5
   c. June 5
   d. May 5
4. **5th June is observed as _____.**

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a. World forest day
b. World environment day
c. World wildlife day
d. World population day

5. **21st March is observed as:**
a. World forest day
b. World environment day
c. World wildlife day
d. World population day

6. **The term "Environment" means _____.**
a. Sum total of all conditions that the life and development of all organisms on earth
b. A beautiful earth
c. Earth and water
d. A combination of plants and animals

7. **The term Environment is derived from an old French word "enviro" means:**
a. Outside
b. Surroundings
c. Inside
d. Biotic community

8. **Hydrosphere includes:**
a. Animals
b. Soil
c. Plants
d. Water bodies

9. **Most stable ecosystem is _____.**
a. Forest
b. Desert
c. Ocean
d. Mountain

10. **Zone consisting air, water and soil is known as _____.**
a. Hydrosphere
b. Atmosphere
c. Lithosphere
d. Biosphere

♦♦♦♦♦

UNIT II

ECOSYSTEM AND BIODIVERSITY

STRUCTURE

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2.1 LEARNING OBJECTIVE

After completion of this unit, student get knowledge about:

- Ecosystem and its types.
- Food chains, food webs.
- The concept of biodiversity and its threats and hot spots.
- The conservation of biodiversity.

2.2 INTRODUCTION

An ecosystem consists of the biological community that occurs in some locale, and the physical and chemical factors that make up its non-living or abiotic environment. There are many examples of ecosystems -- a pond, a forest, an estuary, a grassland. The boundaries are not fixed in any objective way, although sometimes they seem obvious, as with the shoreline of a small pond. Usually, the boundaries of an ecosystem are chosen for practical reasons having to do with the goals of the particular study.

The study of ecosystems mainly consists of the study of certain processes that link the living, or biotic, components to the non-living, or abiotic, components. The two main processes that ecosystem scientists' study are Energy transformations and biogeochemical cycling. As we learned earlier, ecology generally is defined as the interactions of organisms with one another and with the environment in which they occur. We can study ecology at the level of the individual, the population, the community, and the ecosystem.

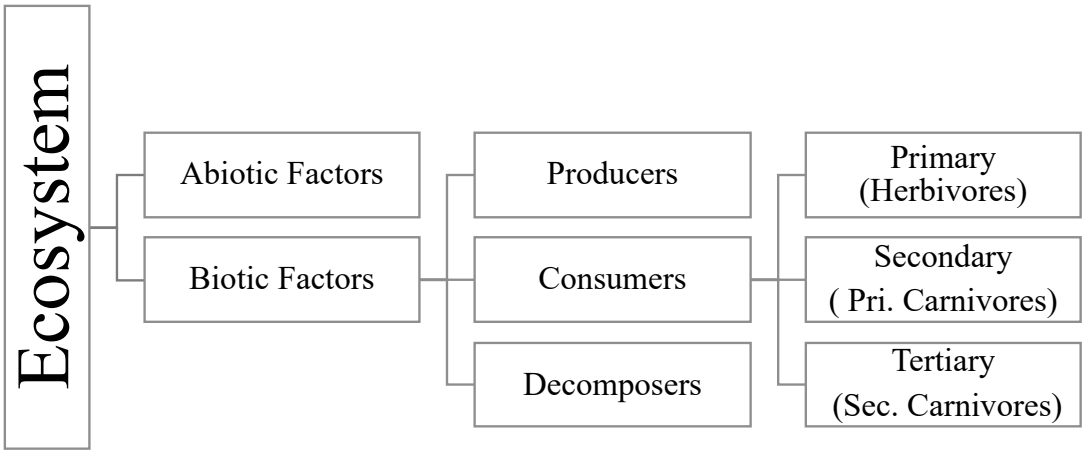
Studies of individuals are concerned mostly about physiology, reproduction, development or behavior, and studies of populations usually focus on the habitat and resource needs of particular species, their group behaviors, population growth, and what limits their abundance or causes extinction. Studies of communities examine how populations of many species interact with one another, such as predators and their prey, or competitors that share common needs or resources.

In ecosystem ecology we put all of this together and, insofar as we can, we try to understand how the system operates as a whole. This means that, rather than worrying mainly about particular species, we try to focus on major functional aspects of the system. These functional aspects include such things as the amount of energy that is produced by photosynthesis, how energy or materials flow along the many steps in a food chain, or what controls the rate of decomposition of materials or the rate at which nutrients (required for the production of new organic matter) are recycled in the system.

2.3 STRUCTURE OF ECOSYSTEM

The structure of an ecosystem is basically a description of the organisms and physical features of environment including the amount and distribution of nutrients in a particular habitat. It also provides information regarding the range of climatic conditions prevailing in the area.

From the structure point of view, all ecosystems consist of the following basic components:



1. **Abiotic Components:**

   Ecological relationships are manifested in physicochemical environment. Abiotic component of ecosystem includes basic inorganic elements and compounds, such as soil, water, oxygen, calcium carbonates, phosphates and a variety of organic compounds (by-products of organic activities or death).

   It also includes such physical factors and ingredients as moisture, wind currents and solar radiation. Radiant energy of sun is the only significant energy source for any ecosystem. The number of non-living components, such as carbon, phosphorus, nitrogen, etc. that are present at any given time is known as standing state or standing quantity.

2. **Biotic Components:**

   The biotic components include all living organisms present in the environmental system. From nutrition point of view, the biotic components can be grouped into two basic components:

   - Autotrophic components, and
   - Heterotrophic components

   The autotrophic components include all green plants which fix the radiant energy of sun and manufacture food from inorganic substances. The heterotrophic components include non-green plants and all animals which take food from autotrophs.

So biotic components of an ecosystem can be described under the following three heads:

1. Producers (Autotrophic components),
2. Consumers, and
3. Decomposers or reducers and transformers

The amount of biomass at any time in an ecosystem is known as standing crop which is usually expressed as fresh weight, dry weight or as free energy in terms of calories/meter.

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1. **Producers (Autotrophic elements)**

   The producers are the autotrophic elements—chiefly green plants. They use radiant energy of sun in photosynthetic process whereby carbon dioxide is assimilated and the light energy is converted into chemical energy. The chemical energy is actually locked up in the energy rich carbon compounds. Oxygen is evolved as by-product in the photosynthesis.

   This is used in respiration by all living things. Algae and other hydrophytes of a pond, grasses of the field, trees of the forests are examples of producers. Chemosynthetic bacteria and carotenoid bearing purple bacteria that also assimilate CO2 with the energy of sunlight but only in the presence of organic compounds also belong to this category.

   The term producer is misleading one because in an energy context, producers produce carbohydrate and not energy. Since they convert or transduce the radiant energy into chemical form, E.J. Kormondy suggests better alternative terms 'converters' or 'transducers'. Because of wide use the term producer is still retained.

2. **Consumers**

   Those living members of ecosystem which consume the food synthesized by producers are called consumers. Under this category are included all kinds of animals that are found in an ecosystem.

   There are different classes or categories of consumers, such as:

   - **Primary consumers**

     These are purely herbivorous animals that are dependent for their food on producers or green plants. Insects, rodents, rabbit, deer, cow, buffalo, goat are some of the common herbivores in the terrestrial ecosystem, and small crustaceans, molluscs, etc. in the aquatic habitat. Elton (1939) named herbivores of ecosystem as "key industry animals". The herbivores serve as the chief food source for carnivores.

   - **Secondary consumers:**

     These are carnivores and omnivores. Carnivores are flesh eating animals and the omnivores are the animals that are adapted to consume herbivores as well as plants as their food. Examples of secondary consumers are sparrow, crow, fox, wolves, dogs, cats, snakes, etc.

   - **Tertiary consumers:**

     These are the top carnivores which prey upon other carnivores, omnivores and herbivores. Lions, tigers, hawk, vulture, etc. are considered as tertiary or top consumers.

   - Besides different classes of consumers, **the parasites, scavengers and saprobes** are also included in the consumers. The parasitic plants and animals utilize the living tissues of different plants and animals. The scavengers and saprobes utilize dead remains of animals and plants as their food.

3. **Decomposers and transformers:**

Decomposers and transformers are the living components of the ecosystem and they are fungi and bacteria. Decomposers attack the dead remains of producers and consumers and degrade the complex organic substances into simpler compounds. The simple organic matters are then attacked by another kind of bacteria, the transformers which change these organic compounds into the inorganic forms that are suitable for reuse by producers or green plants. The decomposers and transformers play very important role in maintaining the dynamic nature of ecosystems.

2.4 FUNCTIONS OF ECOSYSTEMS

The functions of the ecosystem are as follows:

- It regulates the essential ecological processes, supports life systems and renders stability.
- It is also responsible for the cycling of nutrients between biotic and abiotic components.
- It maintains a balance among the various trophic levels in the ecosystem.
- It cycles the minerals through the biosphere.
- The abiotic components help in the synthesis of organic components that involves the exchange of energy.

So, the functional units of an ecosystem or functional components that work together in an ecosystem are:

- **Productivity** – It refers to the rate of biomass production.
- **Energy flow** – It is the sequential process through which energy flows from one trophic level to another. The energy captured from the sun flows from producers to consumers and then to decomposers and finally back to the environment.
- **Decomposition** – It is the process of breakdown of dead organic material. The top-soil is the major site for decomposition.
- **Nutrient cycling** – In ecosystem nutrients are consumed and recycled back in various forms for the utilization by various organisms.

Functions of ecosystem

- Physical Function is the function in which energy flow through food chain.
- Biological Function covers the food chains, food webs. Food chains are the flow of energy which passes from autotrophs to sequence of consumers in ecosystem. Multiple food chains are known as food webs.
- Ecological Succession is also known as ecosystem development. In this function of ecosystem, we try to sustain or try to develop the ecosystem for future and create sustainability.
- **Nutrient Cycling**: Biogeochemical Cycling process represents the biological, geological and chemical aspects of our ecosystem.

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2.5 ENERGY FLOW IN ECOSYSTEM

The functioning of ecosystem depends on the flow of energy through matter. The most important feature of energy flow is that it is unidirectional or one way flow the energy captured by autotrophs does not revert back to solar input. Unlike nutrients (like C, N, P) which move in a cyclic manner and are reused by the producers after flowing through the food chain, energy is not reused in the food chain. Also, the flow of energy follows the two laws of thermodynamics.

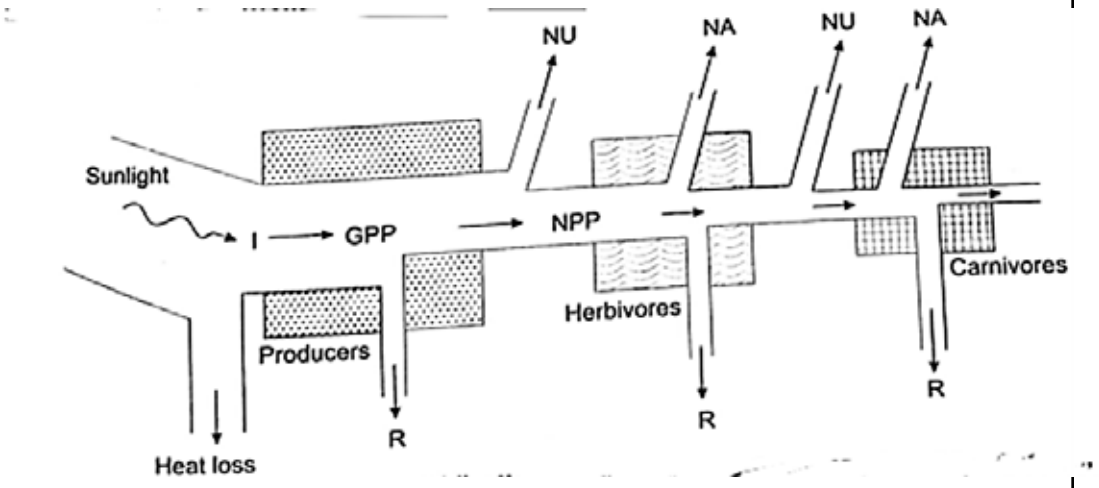
First law of thermodynamics states that energy can neither be created nor destroyed but it can be transformed from one form to another. The solar energy captured by the green plants (producers) gets converted into biochemical energy of plants and latter into that of consumers.

Second law of thermodynamics states that every transformation or transfer of energy is accompanied by its dispersion. As energy flows through the food chain, there occurs dissipation of energy at every trophic level. The loss of energy takes place through respiration or other metabolic activities. At every trophic level there is about 90% loss of energy and the energy transferred from one trophic level to the other is only 10%.

Energy flow models

The flow of energy through various trophic levels in an ecosystem can be explained with the help of various energy flow models.

1. **Single Channel Energy Flow Model:** The flow of energy takes place in a unidirectional manner through a single channel of green plants or producers to herbivores and carnivores. Figure below, depicts such a model and shows the gradual



decline in energy level due to loss of energy at each successive trophic level in a grazing food chain. Loss of energy is accounted largely by the energy dissipated as heat in metabolic activities and measured here as respiration coupled with unutilized energy. Thus, shorter the food chain, greater would be the available food energy as with increase in the length of food chain, there is corresponding energy as with an increase in loss of energy.

2. **Double Channel or Y-Shaped Energy Flow Model**: In nature both grazing food chain and detritus food chain operate in the same ecosystem but sometimes it is the grazing food chain which predominates. It occurs in marine ecosystem where primary production in the open sea is limited and a major portion of it is eaten by herbivorous marine animals. Thus, very little primary production is left to be passed on to the dead or detritus compartment. In a forest ecosystem, on the other hand, the huge amount of biomass produced cannot be completely consumed by herbivores. Rather, a large proportion of the biomass enters into detritus compartment in the form of litter. Hence here detritus food chain predominates. The Y-shaped or two channel model of energy flow shows the passage of energy through these two (grazing and detritus) foods chains which are separated in time and space.

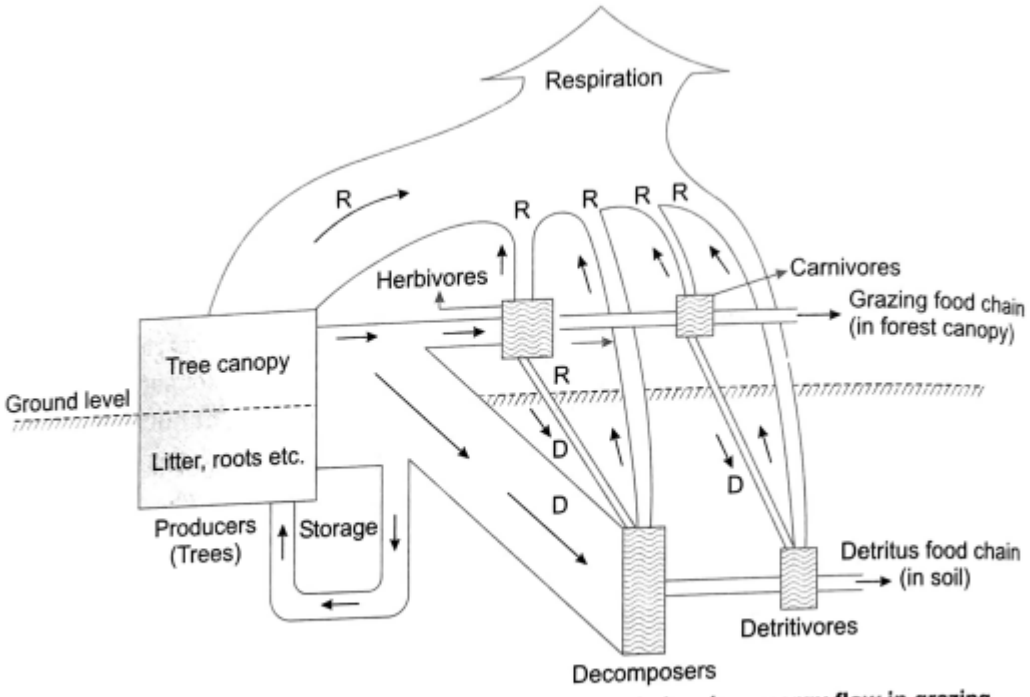


Fig. 10. Y-shaped or double channel energy flow model showing energy flow in grazing and detritus food chain (R = Respiration, D = Detritus or dead matter).

3. **Universal Energy Flow Model:** E.P. Odum explained energy flow through an ecosystem by the universal model (Fig.) applicable to living components like plant, animal, micro-organisms or a trophic group. Such a model may depict food chain like single channel and Y-shaped energy flow systems. As the flow of energy takes place, there is a gradual loss of energy every level, thereby resulting in less energy available at next trophic level as show" by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy is mainly the energy not utilized (NU). This is the energy lost respiration for maintenance or the energy lost in locomotion or excretion. Rest the energy is used for production.

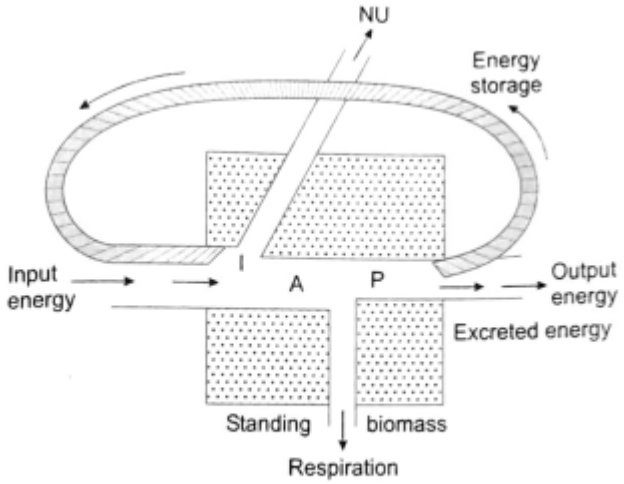


Fig. 11. Universal energy flow model (I = Input energy, A = Assimilated energy, NU = Energy not used, P = Production).

4. **Multi-channel Flow of Energy:** Multi-channel models indicate the basic pattern of energy flow in ecosystem. Under natural conditions, the organisms are inter-related in a way that several food chains become interlocked and this results into complex food web leading to multichannel flow of energy. In practice, under field conditions, we might face difficulties in measuring the energetics of ecosystem

Nutrient cycling

Nutrients like C, N, O, S, H, P etc., move in circular paths through biotic and abiotic components and so are called biogeochemical cycles. The nutrients too move through the food chain and ultimately reach the detritus compartment where various micro-organisms decompose organic nutrients of dead matter into inorganic substances that are readily used up by plants. Thus, the cycle starts afresh.

Productivity

The rate of organic matter or biomass production is called productivity. It is of two types.

a. **Primary Productivity** It is defined as the rate at which radiant energy is captured by producers for the synthesis of organic substances through photosynthesis or chemosynthesis. It is expressed as gm year for dry matter and kcal m year for energy. Primary productivity is further distinguished as:

- **Gross primary productivity** (GPP) is the rate of total production of organic matter/biomass by the producers per unit area and time.
- **Net primary productivity** (NPP) is the rate of organic matter stored by the producers after respiration (R) and maintenance per unit area and time.

$$NPP = GPP - R$$

Primary production of an ecosystem depends upon the solar radiation, availability of water, nutrients, type of the plants and their chlorophyll content. Productivity of tropical forests and estuaries (20,000 kcal m^{-2} yr^{-1}) are the highest. Deserts on the other hand have limited water supply, hence show low primary production (200 kcal m^{-2} yr^{-1}).

Agro-ecosystems get lots of energy subsidies in the form of irrigation water, good quality seeds, fertilizers and pesticides and show high productivity of 12,000 kcal m^2 yr^{-1}. Still, their productivity is less than that of tropical forests which are not receiving any artificial energy subsidies. Nature itself has designed its structure, species composition, rain fall, Warm temperature congenial for growth, abundant sunlight, energy capture and flow and a closed nutrient cycling system that ensures their high productivity.

b. **Secondary Productivity:** The energy stored of at consumer level (in excess of respiratory loss) for use by the next trophic level is known as secondary productivity.

2.6 ECOLOGICAL SUCCESSION AND FOOD CHAINS, FOOD WEBS, ECOLOGICAL PYRAMIDS

Ecological succession is the steady and gradual change in a species of a given area with respect to the changing environment. It is a predictable change and is an inevitable process of nature as all the biotic components have to keep up with the changes in our environment. The ultimate aim of this process is to reach equilibrium in the ecosystem. The community that achieves this aim is called a climax community. In an attempt to reach this equilibrium, some species increase in number while some other decrease.

In an area, the sequence of communities that undergo changes is called sere. Thus, each community that changes is called a seral stage or seral community. All the communities that we observe today around us have undergone succession over a period of time since their existence. Thus, we can say that evolution is a process that has taken place simultaneously along with that of ecological succession. Also, the initiation of life on earth can be considered to be a result of this succession process.

If we consider an area where life starts from scratch by the process of succession, it is known as primary succession. However, if life starts at a place after the area has lost all the life forms existing there, the process is called secondary succession. It is obvious that primary succession is a rather slow process as life has to start from nothing whereas secondary succession is faster because it starts at a place which had already supported life before. Moreover, the first species that comes into existence during primary succession is known as pioneer species.

These are the following types of ecological succession:

Primary Succession

Primary succession is the succession that starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life.

When the planet was first formed there was no soil on earth. The earth was only made up of rocks. These rocks were broken down by microorganisms and eroded to form soil. The soil then becomes the foundation of plant life. These plants help in the survival of different animals and progress from primary succession to the climax community.

If this primary ecosystem is destroyed, secondary succession takes place:

Secondary Succession

Secondary succession occurs when the primary ecosystem gets destroyed. For e.g., a climax community gets destroyed by fire. It gets recolonized after the destruction. This is known as secondary ecological succession. Small plants emerge first, followed by larger plants. The tall trees block the sunlight and change the structure of the organisms below the canopy. Finally, the climax community arrives.

Cyclic Succession

This is only the change in the structure of an ecosystem on a cyclic basis. Some plants remain dormant for the rest of the year and emerge all at once. This drastically changes the structure of an ecosystem.

Seral Community

"A seral community is an intermediate stage of ecological succession advancing towards the climax community."

A seral community is replaced by the subsequent community. It consists of simple food webs and food chains. It exhibits a very low degree of diversity. The individuals are less in number and the nutrients are also less.

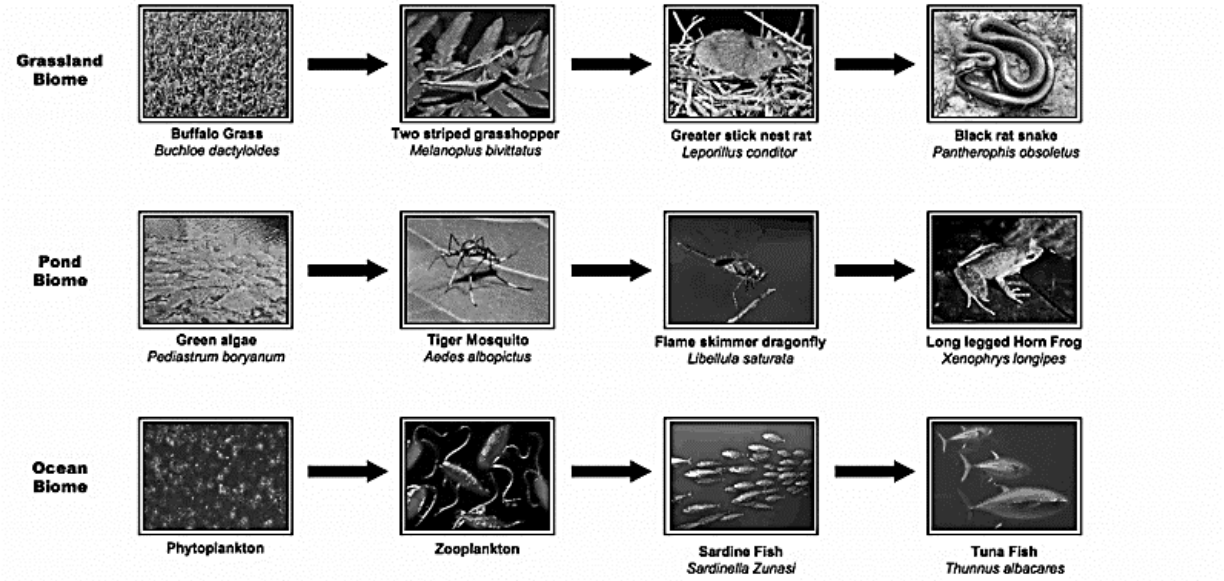
There are seven different types of seres:

Types of Seres	Explanation
Hydrosere	Succession in aquatic habitat.
Xerosere	Succession in dry habitat.
Lithosere	Succession on a bare rock surface.
Psammosere	Succession initiating on sandy areas.
Halosere	Succession starting in saline soil or water.
Senile	Succession of microorganism on dead matter.
Eosere	Development of vegetation in an era.

FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

Food Chain

- Plants are eaten by insects, which are eaten by frogs; these frogs are eaten by fish, which are eaten by human beings. This sequence is known as Food chain.
- Plant > insect > frog > fish > human.
- Each step in the food chain is called a "Trophic level" as in above food chain – 5 tropic levels.



Type of food Chain

- **Grazing:** Starts with green plants e.g., Grass > Grasshoppers > Birds > Snakes > Hawks
- **Parasitic:** Also starts with green plants but here smaller organisms depending on larger organism g. Grass > cow > lice
- **Detritus*/saprophytic:** Starts with dead plant/animal/ waste material > decomposers

*Detritus = dry leaves, dead plant, animal remains, dead skin cells, other organic waste (urine, excreta)

Trophic level

- Trophic level to which an organism belongs, indicates how far it is away from plants in the food chain
- Energy Flow in food chain is unidirectional, means energy flow can never be from carnivores to herbivores or herbivores to producers
- In grazing food chain, primary source of energy is living plant biomass while in detritus food chain, source of energy is dead organic matter or detritus

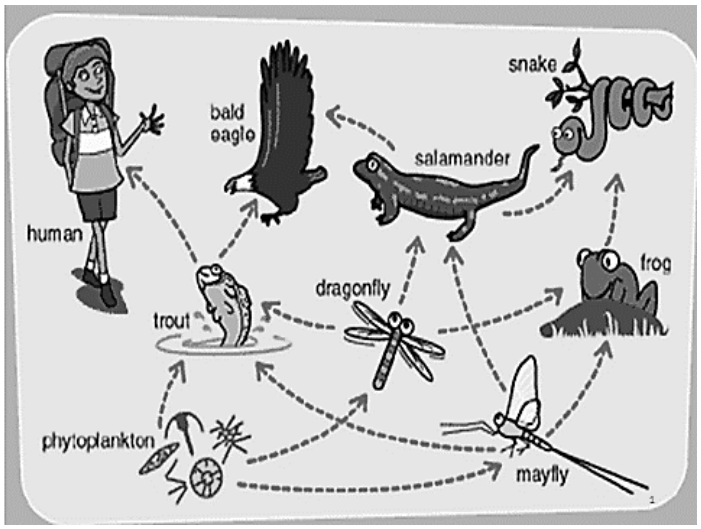
Trophic Level	Grassland Biome	Pond Biome	Ocean Biome
Primary Producer	grass	algae	phytoplankton
Primary Consumer	grasshopper	mosquito larva	zooplankton
Secondary Consumer	rat	dragonfly larva	fish
Tertiary Consumer	snake	fish	seal
Quaternary Consumer	hawk	raccoon	white shark

Energy Flow in the Ecosystem

- When energy is passed from one tropic level to next trophic level, some part of energy is wasted, so energy declines as we move up in the chain/ web / pyramid in:
- Body heat (Metabolism) + Respiration + Capturing the prey
- Remains trapped in skin, hair, bone and teeth of a prey, however this energy is later utilized when scavenger (hyena) comes into picture, as Hyena's stomach acid is so powerful, it can digest the skin, hair, bone, teeth and other remnants of a prey corpse
- Generally, only $1/10^{th}$ of the energy passes to next tropic level

Food Web

Food chain assumes the isolated linear line. But in real life, frog could be eating other insects apart from grasshopper. Fish could be eating smaller fishes apart from frog. So there exists an interconnected Network of (Food Chain + Food Chain + Food chain…). This interconnected network of food chains is known as food web.

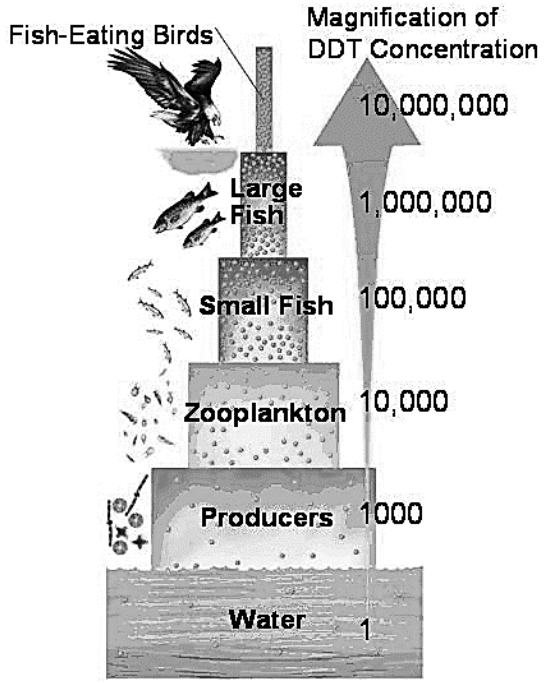


Bio-accumulation

- Refers how pollutant enters a food chain means concentration of pollutant from the environment to the first organism in a food chain.
- Occurs when an organism absorbs a toxic substance at a rate greater than that at which he can digest.

Bio-magnification

- Increase of toxic chemicals conc. Up the food chain.
- A man-induced process.
- Occurs with mobile & non-degradable chemicals / fat soluble pollutants only.
- DDT concentration.



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Biotic Potential

- Unlimited food + ideal environmental conditions → A species can produce offspring at maximum rate, known as Biotic potential.
- Can be high or low, depending on how many offspring can a species produce in ideal conditions.

Interspecies relations			
Interaction	**Species A**	**Species B**	**Example**
Mutualism	Enjoys	Enjoys	Bees and flowers (pollination)
Commensalism (Epiphytic)	Enjoys	Neutral	Orchid plant growing on a mango tree.
Predation	Enjoys	Harmed	Tiger eating deer.
Parasitism	Enjoys	Harmed	Tapeworm in human digestive tract.
Competition	Harmed	Harmed	Jungle Deer vs domestic goats grazing in same area.
Amensalism	Neutral	Harmed	Bread mold Penicillium secretes penicillin and it destroys other bacteria.

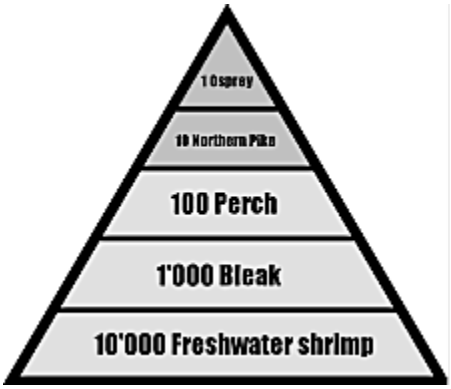
Ecological pyramids

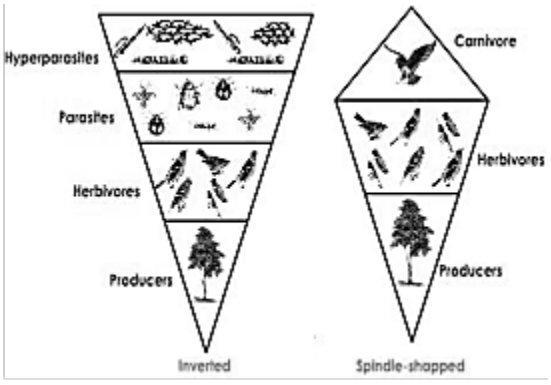
Ecological pyramids represent the trophic structure or trophic function of the ecosystem and is mainly of 3 types:

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

1. Pyramid of Number

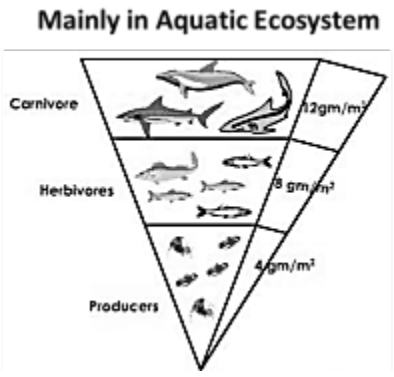
- Depicts the number of individual organisms at different trophic levels of food chain May be inverted or upright or spindle shaped.





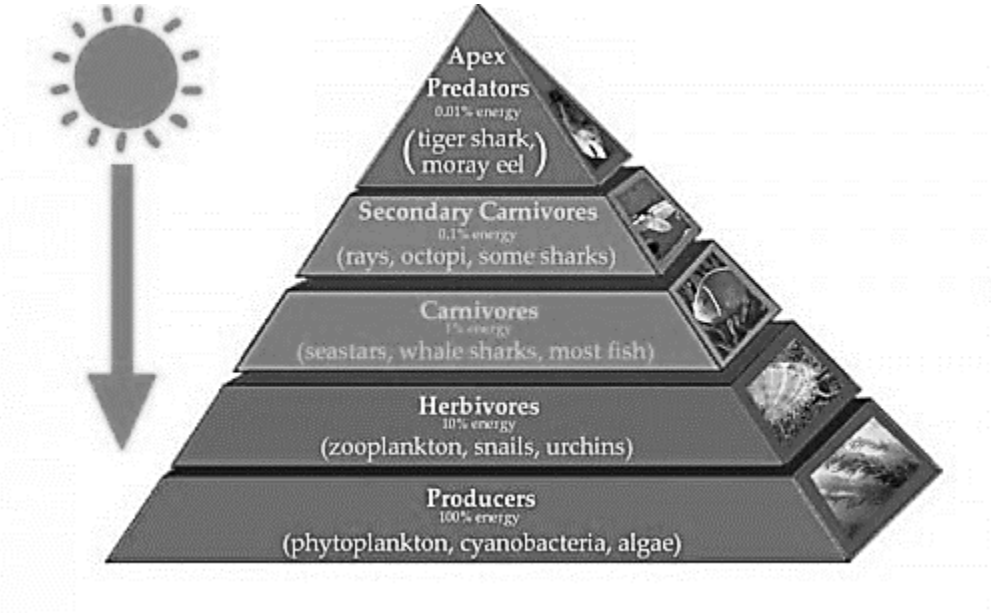
2. **Pyramid of Biomass**

- Depicts total dry weight of all organisms at each tropic level at a particular time, measured in g/m2 May be upright or inverted.



3. **Pyramid of Energy**

- A graphic representation of the amount of energy trapped per unit time and area in different trophic level of a food chain with producers forming the base and the top carnivores at the tip Always upright.



2.7 TYPES OF ECOSYSTEM

Types of Ecosystems

An ecosystem can be as small as an oasis in a desert, or as big as an ocean, spanning thousands of miles. **There are two types of ecosystems:**

- Terrestrial Ecosystem
- Aquatic Ecosystem

NOTES

TERRESTRIAL ECOSYSTEMS

Terrestrial ecosystems are exclusively land-based ecosystems. There are different types of terrestrial ecosystems distributed around various geological zones. They are as follows:

1. Forest Ecosystems
2. Grassland Ecosystems
3. Tundra Ecosystems
4. Desert Ecosystem

1. Forest Ecosystem

A forest ecosystem is a functional unit or a system which comprises of soil, trees, insects, animals, birds, and man as its interacting units. A forest is a large and complex ecosystem and hence has greater species diversity. Also, it is much more stable and resistant to the detrimental changes as compared to the small ecosystems such as wetlands and grasslands. A forest ecosystem, similar to any other ecosystem, also comprises of abiotic and biotic components. Abiotic components refer to inorganic materials like air, water, and soil. Biotic components include producers, consumers, and decomposers.

These components interact with each other in an ecosystem and thus, this interaction among them makes it self-sustainable.

Types of forest ecosystem

There are a few types of forest ecosystems listed below:

1. **Tropical Evergreen Rainforest:** Only a small percentage of tropical forests are rainforests where average rainfall is 80–400 inches in a year. This forest is characterised by deep and dense vegetation consisting of tall trees reaching different levels.
2. **Tropical Deciduous Rainforest:** The main characteristic of tropical deciduous rainforest are broad-leaved trees along with dense bushes, shrubs, etc. Two main seasons- summer and winter are distinctly visible there. This type of forest is found in many parts of the world. A large variety of flora and fauna are found here.
3. **Temperate Evergreen Forest:** Temperate evergreen forest is a type of forest that is characterised by a smaller number of trees but an adequate number of ferns and mosses.
4. **Temperate Deciduous Forest:** Temperate deciduous forest evolves in the moist temperate region with sufficient rainfall. Here also, winter and summer are well defined, and trees shed their leaves during winter. Dominant trees are maple, oak, peach, etc.
5. **Taiga/Boreal:** Situated just south of the Tundra, Taiga is characterised by evergreen conifers. The average temperature is below the freezing point for almost half of the year.

Characteristics of Forest Ecosystem

1. Forests are characterised by warm temperature and adequate rainfall, which make the generation of a number of ponds, lakes etc.,
2. The forest maintains climate and rainfall.
3. The forest supports many wild animals and protects biodiversity.
4. The soil is rich in organic matter and nutrients, which support the growth of trees.

Functions of Forest Ecosystem

1. **Goods Obtained from Forests:** There are various types of food products such as honey, wild meat, fruits, mushrooms, palm oil and wine, medicinal plants, etc., obtained from forests. Other than edible parts, we can obtain timber, wood biomass, cork, etc., from forests. The fuel can be extracted from old trees that are buried under the soil.
2. **Ecological Functions:** Forests play an important role in maintaining ecological factors such as climate, carbon storage, nutrient cycling and rainfall.
3. **Culture and Social Benefits:** The tribal people who live in the forests treat forests as nature goddesses. The traditional beliefs and spirituality save wild animals from hunters and cutting down of trees by urban people. Few modern people visit forests for recreation.

Structure of forest ecosystem

Abiotic components

These are the inorganic and organic substances present in the soil and atmosphere. In addition to the minerals, we find the dead organic debris-the litter accumulation. Climatic conditions (temperature, light, rainfall) are different due to complex stratification in the plant communities.

Biotic Components

The various biotic components, representatives from the three functional groups, of a forest ecosystem are:

1. **Producer Organisms:**
   - In a forest, the producers are mainly trees.
   - Trees are of different kinds depending upon the type of forest developed in that climate.
   - Apart from trees, climbers, epiphytes, shrubs and ground vegetation.
   - Dominant species of trees in major types of forest ecosystems are:
   - Tectona grandis, Acer, Beulah, Picea, Pine, Cedrus.
2. **Consumers:**

   In a forest, consumers are of three main types.

a. Primary Consumers:

- These are Herbivores which feed directly on producers.
- Ants, Beetles, Bugs, spiders etc. feeding on tree leaves.
- Larger animals such as Elephants, Deer, giraffe etc. grazing on shoots and/ or fruits of trees.

b. **Secondary Consumers:**

These are carnivores and feed on primary consumers.

E.g.: Birds, Lizards, Frogs, Snakes and Foxes.

c. Tertiary Consumers:

- These are secondary carnivores and feed on secondary consumers
- These include top carnivores like Lion, Tiger.

3. **Decomposers:**

- These include wide variety of saprotrophic micro- organism like;
- Bacteria (Bacillus Sp., Clostridium sp., pseudomonas.
- Fungi (Aspergillus sp., Ganoderma sp., Fusarium.
- Actinomycetes (Streptomyces).
- They attract the dead or decayed bodies of organisms & thus decomposition takes place.
- Therefore, nutrients are released for reuse.

2. **Grassland Ecosystem**

Grasslands are the areas that are dominated by a nearly continuous cover of grasses. It is one of the most widespread of all major vegetation in the world. They occupy about 20% of the land on the surface of the earth. Grasslands are found in both tropical and temperate regions where rainfall is not enough to support the growth of trees. They are also found in areas consisting of well-defined hot, dry, warm, and rainy seasons.

These are known by different names in different regions of the world like steppes in Europe and Asia, pampas in South America, Veldt in South Africa, and Downs in Australia. Grassland is found where rainfall is about 15-75 cm per year not enough to support a forest, but more than that of a true desert. Typical grasslands are vegetation formations that are generally found in temperate climates.

In India, they are found mainly high Himalayas. The rest of India's grasslands are mainly composed of the Steppes and Savana. Steppe formations occupy large areas of sandy and saline soils.

Functions of the Grassland Ecosystem

The primary function of an ecosystem is productivity. The producers fix the solar energy and produce the complex organic matter with the help of minerals. It provides forage for livestock, protection and conservation of soil and water

resources, furnishing a habitat for wildlife, both flora and fauna and (contribution to the attractiveness of the landscape. The functional aspects of the Grassland can be studied by two means:

1. **Food Chain in an ecosystem:** There is an important feature of the ecosystem that one level of an organism serves as food for another level of the organism. A series is formed which is known as Food Chain. In an ecosystem, the food chain does not follow the linear pattern, but an organism may feed upon more than one organism in the same food chain or upon organisms of different food chains. Thus, interconnected food chain system is formed known as a food web.
2. **Nutrient cycle in an ecosystem:** For any ecosystem to be successful, it is important that the constituent materials move in a cyclic manner. The producers (green plant) take up the mineral elements from the soil and air, convert them into organic form and after passing through the different trophic levels, are again returned to the soil and air.

Structure/Components of Grassland Ecosystem

The different structural components of the grassland ecosystem can be classified as abiotic and biotic components.

Biotic Components

a. **Producers** – In grassland, producers are mainly grasses; though, a few herbs & shrubs also contribute to the primary production of biomass.

b. **Consumers** – In a grassland, consumers are of three main types:

   1. **Primary Consumers** – The primary consumers are herbivores feeding directly on grasses. Herbivores such as grazing mammals (e.g., cows, sheep, deer, rabbit, buffaloes, etc.), insects (e.g., Dysdercus, Coccinella, Leptocorisa, etc.), some termites and millipedes are the primary consumers.
   2. **Secondary Consumers** – These are carnivores that feed on primary consumers (Herbivores). The animals like foxes, jackals, snakes, frogs, lizards, birds etc., are the carnivores feeding on the herbivores. These are the secondary consumers of the grassland ecosystem.
   3. **Tertiary Consumers** – These include hawks etc. which feed on secondary consumers.

c. **Decomposers** – These include bacteria of death and decay, moulds and fungi (e.g., Mucor, Penicillium, Aspergillus, Rhizopus, etc.). These bring the minerals back to the soil to be available to the producers again.

Abiotic Components

- These include the nutrients present in the soil and the aerial environment.
- The elements required by plants are hydrogen, oxygen, nitrogen, phosphorus and sulphur.

NOTES

- These are supplied by the soil and air in the form of CO2, water, nitrates, phosphates and sulphates.
- In addition to these, some trace elements are also present in the soil.

Types of Grassland Ecosystem

Grassland ecosystem contains five types of grasslands that are:

- Tropical Grasslands
- Temperate Grasslands
- Flooded Grasslands
- Montane Grasslands
- Desert Grassland
- **Tropical Grasslands**

  Tropical Grasslands are the ones which receive 50 cm to 130 cm rain. Furthermore, they have both rainy and dry days. As a result, they are warm all year round. Moreover, tropical grasslands are also called Savanna. These grasslands contain shrubs and small trees that are dry in nature.

  Also, the tropical grasslands contain quite short plants which makes it an excellent hunting ground. For instance, the African savanna is one of the tropical grasslands. In conclusion, the tropical grassland is a home for elephants, giraffes, lions, cheetahs, zebras, and other spectacular species.

- **Temperate Grasslands**

  Temperate grasslands receive rainfall of the range 25 cm and 75 cm. Furthermore, the climate in the temperate grasslands makes it both dormant and growing. Moreover, these grasslands suffer extreme climates. In the cold season, the temperature can reach up Flooded Grasslands to 0 degrees Fahrenheit.

  While in the summer season it reaches up to 90 degrees in some areas. The precipitation in these grasslands is mostly in the form of dew and snow. For instance, some vegetation that grows here are, cacti, sagebrush, perennial grasses, buffalo grass clovers, and wild indigos, etc.

- Flooded Grasslands

  The flooded grasslands are having water all year-round. Furthermore, these grasslands contain numerous vegetation that grows in water. Various water birds migrate to these areas while some are residents of it. Most Noteworthy the Everglades is the world's largest flooded grasslands. Furthermore, it features various types of birds, fish, mammals, reptiles, seed-bearing plants, amphibians, and butterflies, etc.

- **Montane Grasslands**

  Montane means 'high altitude' therefore these are the grasslands that are high altitude shrublands. These are called high altitude because they are above the tree line level of the ground.

Moreover, the plants found here have a rosette structure, abundant pilosity, and waxy surfaces. For instance, the northern Andes contain this type of habitat.

- **Desert Grasslands**

  The desert grasslands are the type of grasslands that separates the true desert of the lowlands and the montane grasslands. Furthermore, these grasslands receive very low precipitation. As a result, these are the hottest and the driest grasslands.

  These grasslands are mostly scattered as they are dependent on the areas of rainfall. Since the precipitation varies through regions. Therefore, the vegetation of the grasslands also varies. Moreover, various types of animals are present in these grasslands.

  For instance, reptiles like the prairie rattlesnake, western diamondback, gopher snake is present here. Furthermore, birds like Horned lark, Lark bunting, Meadowlarks, scaled quail are present here.

Characteristics of Grassland Ecosystem

If you want to understand the grassland ecosystem in a better way, then you need to know the characteristics of this ecosystem. These are the features that will better define the grassland ecosystem:

Precipitation (rain) in the grassland ecosystem

Grasslands ecosystem receives quite limited rainfall annually, and it covers almost 25% of the total land surface of the Earth. Limited rain causes no forest growth in this region.

Grassland ecosystem is also prone to drought and uncertain precipitation. Different grasslands have a different measurement of annual precipitation. For example – Savanna grassland experiences yearly rainfall up to 30-40 inches, whereas steppes in South-Eastern Europe or Siberia the annual rainfall ranges between 10-20 inches.

The temperature in the grassland ecosystem

If we talk about the temperate grassland ecosystem, the temperature varies a lot throughout the year. In summer season the temperature of temperate grasslands becomes too hot up to 38 degrees Celsius, whereas in winter seasons it reduces up to -40 degrees Celsius making it too cold.

On the other hand, the temperature of the savanna grasslands does not vary a lot. It ranges between 21-26 degrees Celsius. The climate of Savanna grassland is warm throughout the year.

Regular fire in the grassland ecosystem

Fires in grasslands are one of the important characteristics. Due to dry climate and flash lighting, the dry grass catches fire quite easily. Regular fire in grasslands increases the growth of grasses in fields, but it restricted the growth of trees, unfortunately; This is the reason; grassland ecosystem is lacking behind in terms of trees growth.

Poor vegetation in the grassland ecosystem

Poor vegetation is also a vital characteristic of the grassland ecosystem. This ecosystem is named grassland because of its huge area covered with grass fields. You will find very few numbers of trees in acres of grassland areas.

The dry climate and less rainfall are a major reason for poor vegetation in a grassland ecosystem. The grasses in the grassland ecosystem have adopted the climate of this region as compared to trees. As a result, you will find only grass fields in the grassland ecosystem.

The common species of grasses include purple needlegrass, foxtail, buffalo grass, wild oats, ryegrass, etc. These grasses have strong underground stems and roots that protect them from fires. It is excellent for grazing animals.

Key characteristics of the grassland ecosystem:

- Limited annual rainfall.
- The dry climate throughout the year.
- Lack of nutrients in the soil.
- Grasslands are prone to drought and uncertain precipitation.
- Frequent fire due to semi-arid climate and flash lighting.
- Poor vegetation growth dominated by grasses.
- Grasslands are home for a huge variety of animal species.

3. **Tundra Ecosystem**

A barren land characterized with black-messy soil permanently frozen dominated with vegetation of lichens, mosses, herbs & shrubs is known as tundra ecosystem.

In the tundra region, there are two distinct seasons – the long winter season and the short summer season. The long winter season may last up to 8 months in the tundra region. Tundra region experiences long nights during winter months and long days during summer months.

Types of tundra ecosystem

Before going into characteristics of tundra ecosystem, we will go through two types of tundra regions found on Earth – Arctic Tundra region and Alpine tundra region

- **Arctic Tundra Region**

  The Arctic tundra region is found between the North Pole and the taiga region (also known as coniferous forests). The main feature of Arctic tundra is extreme cold and frozen land throughout the year.

  The Arctic Tundra ecosystem mostly includes North America (Northern Alaska, Canada, Greenland), Northern Europe (Scandinavia), Northern Asia (Siberia), etc.

- **Alpine Tundra Region**

  Alpine tundra region can be found in high mountain tops above tree line any-

where across the globe. Unlike Arctic tundra, Alpine tundra is covered with snow for most of the year rather than frozen year-round.

The Alpine tundra ecosystem is commonly experienced in these regions – North America (Alaska, Canada, USA, Mexico), Northern Europe (Finland, Norway, Russia, Sweden), Asia (Southern Asia (Himalayan Mountain), Japan (Mountain Fuji), Africa (Mountain Kilimanjaro), South America (Andes Mountains), etc.

Characteristics of tundra ecosystem

Various characteristics of tundra ecosystem is given below in points:

1. **Extreme climatic conditions**
   - Tundra ecosystem experiences extreme cold almost throughout the year. During winter months, the average temperature of the Arctic Tundra region ranges from -25 degrees Fahrenheit to 40 degrees Fahrenheit.
   - On the other hand, the Alpine tundra region is a bit warmer as compared to the Arctic tundra region. The average temperature of Alpine tundra ranges from 0 degrees Fahrenheit to 54 degrees Fahrenheit.
   - During the summer season, the living organisms of the tundra ecosystem get a bit of relaxation due to a short period of slightly-warm temperatures.
   - During summer, the Alpine tundra region experiences a growing season of almost 180 days, whereas the Arctic tundra region experience 50-60 days approximately.
2. **Permafrost**
   - Permafrost can be considered as a characteristic that defines the tundra ecosystem efficiently. A long-lasting frozen layer of soil and other organic matter found in the tundra ecosystem is usually termed as permafrost.
   - Permafrost plays a vital role in the poor vegetation of the tundra ecosystem. This is the primary reason to explain why trees cannot survive in the tundra region.
   - In some places of the tundra ecosystem, the permafrost is spread up to hundreds or sometimes thousands of feet in depth under the Earth's crust. It is quite surprising, but it is an important characteristic of the tundra ecosystem. During the summer season, the permafrost partially melts, creating small ponds on the topmost layer of permafrost.
3. **Poor vegetation**
   - One of the major reasons for poor vegetation in the tundra ecosystem is permafrost. Due to permafrost, there is no deep-root system in the tundra region to support vegetation.
   - Apart from this, the other adverse climatic conditions like very low precipitation, extreme cold, etc. also acts as a barrier to the growth of vegetation in the tundra ecosystem.

- There are very few species of plants that can survive in the extreme weather conditions of the tundra region.
- Some of the commonly seen plants of the tundra ecosystem include lichen, sedges, shrubs, moss, liverworts, grass, various flowers, etc. These plants help to fulfill the food requirement of animal species that live in the tundra ecosystem.

4. **Land of Midnight Sun**
   - The midnight sun is a phenomenon commonly seen in the Arctic Tundra ecosystem. This phenomenon is caused when the sun does not disappear entirely below the horizon point.
   - The countries that witness the phenomenon of midnight sun include Finland, Greenland, Sweden, Canada, Norway, Iceland, Denmark, Russia, etc.
   - The midnight sun can be seen in the summer season in the Arctic region. Tundra region also experiences a period in the winter season when the sun does not rise above the horizon point at all. This phenomenon generates 24 hours of sunlight in the summer months and 24 hours darkness in winter months.
   - This phenomenon (24 hours darkness in winter and 24 hours sunlight in summer) is quite different as compared to the equatorial region of the Earth. The organisms living near Earth's equator experience almost equal schedule of day & night, i.e., 12 hours throughout the year.
5. **Meager precipitation**

   Extremely low precipitation and dry climate are some of the major characteristics of the tundra ecosystem. Tundra region experiences average precipitation less than 15 inches annually. Out of the total precipitation, only 2/3 falls in the form of rain.

4. **Desert Ecosystem**

Before going through the details about Desert Ecosystem let's understand what is ecosystem first:

An ecosystem is a community of all the living organism and non-living organisms interacting with each other in a specific area. Living organisms include all the organisms, plants and animals whereas non-living organisms include the physical environment that comprises air, water, sun, atmosphere, earth, climate etc.

In simple terms, an ecosystem is a setting where all the living and non-living components interact in a physical environment.

Coming to deserts…

When we hear the word 'desert' the very first thing that strikes our minds is a big barren, abandoned and dry land without plants covered with sand. A desert can be hot and cold both.

Desert is one of the most dried land areas on this planet that receives very little precipitation annually. It is a land with very less rainfall throughout the year measured less than 50 cm a year.

Desert ecosystem is the driest ecosystem of the earth and this is the reason it has less vegetation and less diversity of life. It is one of the parts of the terrestrial ecosystem. The plants and animals of the desert ecosystem have mastered the art of survival in harsh conditions. A desert ecosystem is basically devoid of any rainfall or precipitation.

In short desert ecosystem is the community of living and non-living organisms living together and interacting in an environment which seems to be abandoned. A Desert ecosystem is the interaction between both the Biotic and Abiotic components of the environment.

DESERT ECOSYSTEM CHARACTERISTICS

Here are some basic Desert ecosystem characteristics–

Aridity: It is the common characteristic of all the deserts on the earth. Aridity simply implies the deficiency of moistures or dryness. Desert experience very less rainfall and thus result in aridity.

Less rainfall/ precipitation: Less precipitation is one of the major features of deserts and also the reason behind the dryness. The rainfall in deserts is seasonal and occurs only for a limited duration. The annual rainfall that a desert receives every year is just 25-30 centimeters.

Extreme temperature: Desert ecosystems experience extreme temperatures during day and night. The days are very hot and the nights can be extremely cold. It is the sole characteristic of all the desert ecosystems either hot or cold all lacks moisture.

Velocity of wind: It tends to be very high in a desert ecosystem. This is the reason deserts experience sandstorms/ dust storms of high intensity resulting in the formation of huge sand dunes.

Scarcity of water: Due to less rainfall, there is a shortage of water in a desert ecosystem. Due to the scarcity of water deserts have to face the situation of drought half of the year.

Humidity: The humidity level in a desert ecosystem is very low in the daytime and relatively high at night.

The quality of the soil: In deserts is very low to grow vegetation. It is dry, rocky, thin, sandy, mainly grey in colour and has no organic contents like nitrogen, phosphorus etc which are essential for the growth of plants.

Biodiversity in a desert ecosystem: However, the survival in a desert ecosystem is very hard but despite the fact, deserts are home to various plants and animals. The plants and animals have adapted to survive in the harsh and extreme conditions of the desert.

The population density: Density Is very low in deserts and nearby areas as there is there a scarcity of water, food and climatic conditioner are too harsh.

Plants grow very slowly: In this ecosystem that includes basically vegetation's with spines like cacti that can easily survive in such conditions.

TYPES OF DESERT ECOSYSTEM

Desert ecosystems do not exist only in hot and dry areas of the earth. You can a find a desert ecosystem in a tropical, arid, and even in extremely cold locations.

Here we have shared information about all the types of Desert Ecosystem that exist on this earth.

- Hot and dry
- semi-arid
- coastal
- cold desert

Hot and Dry Desert Ecosystem: These kinds of the desert ecosystem have hot and dry climatic conditions through the air and have very low annual rainfall. The hot desert ecosystem is basically found in Central America, South Asia, North America, Africa, Australia etc. There are extreme variations in temperature and soil is rough and harsh.

Semi-arid desert ecosystem: This desert ecosystem is quite similar to the Hot and Dry desert ecosystem. This kind of ecosystem has hard rocks, stable ground, less sand dunes. Temperature is not as extreme as a hot and dry desert ecosystem. Great Basin is an example of Semi-arid desert ecosystem. It receives a lot of rain as compared to the normal desert's ecosystem.

Coastal desert ecosystem: The Atacama Desert in Chile and Namib in Africa are a good example of Coastal desert ecosystem. Such desert ecosystems are found near the coastal lines of big water bodies like oceans and seas and are generally affected by the ocean currents. Winter fogs are common here. They are more hospitable than other desert ecosystem and therefore they have a more flora and fauna than others.

Cold desert ecosystem: This desert ecosystem comprises of abundant rainfall throughout the winters and less in summers and generally has chilling winters with snowfall. The summers are short, moderately hot and moist here. These are usually covered with snow dunes. Such desert ecosystem can be found in Greenland, Antarctica, and Nearctic realm.

Structure and Function of desert ecosystem:

The different components of a desert ecosystem are:

a. **Abiotic Component:**

The abiotic component includes the nutrients present in the soil and the aerial environment. The characteristic feature of the abiotic component is lack of organic matter in the soil and scarcity of water.

b. **Biotic Component:**

The various biotic components representing three functional groups are:

1. Producer organisms:

The producers are mainly shrubs or bushes, some grasses and a few trees. Surprisingly, there are many species of plants that survive in the desert. Most of them are succulents, which mean they store water. Others have seeds that lay dormant until a rain awakens them. Regardless, these plants find a way to get water and protect themselves from the heat.

The most famous desert plant is the cactus. There are many species of cacti. The saguaro cactus is the tall, pole shaped cactus. The saguaro can grow up to 40 feet tall. It can hold several tons of water inside its soft tissue. Like all cacti, the saguaro has a thick, waxy layer that protects it from the Sun.

Other succulents include the desert rose and the living rock. This strange plant looks like a spiny rock. Its disguise protects it from predators. The welwitschia is a weird looking plant. It has two long leaves and a big root. This plant is actually a type of tree and it can live for thousands of years.

There are many other kinds of desert plants. Some of them have thorns others have beautiful flowers and deadly poisons. Even in the worst conditions, these plants continue to thrive.

2. **Consumers**

These include animals such as insects and reptiles. Besides them, some rodents, birds and some mammalian vertebrates are also found:

Desert Insects and Arachnids: There are plenty of insects in the desert. One of the most common and destructive pests is the locust. A locust is a special type of grasshopper. They travel from place to place, eating all the vegetation they find. Locusts can destroy many crops in a single day.

Not all desert insects are bad, though. The yucca moth is very important to the yucca plant, because it carries pollen from the flower to the stigma. The darkling beetle has a hard, white, wing case that reflects the Sun's energy. This allows the bug to look for food during the day.

There are also several species of ants in the desert. The harvester ants gather seeds and store them for use during the dry season. And the honey pot ants have a very weird habit. Some members of the colony eat large amounts of sugar, so much that their abdomens get too large for them to move. The rest of the colony feeds off this sugar.

There are also arachnids in the desert. Spiders are the most notable arachnids, but scorpions also belong in this group. Some species of scorpions have poison in their sharp tails. They sting their predators and their prey with the piercing tip.

Desert Reptiles: Reptiles are some of the most interesting creatures of the desert. Reptiles can withstand the extreme temperatures because they can

control their body temperatures very easily. You can put most of the desert reptiles into one of two categories: snakes and lizards.

Many species of rattlesnakes can be found in the desert. Rattlesnakes have a noisy rattle they use to warn enemies to stay away. If the predator isn't careful, the rattlesnake will strike, injecting venom with its sharp fangs. Other desert snakes include the cobra, king snake and the hognose.

Lizards make up the second category of desert reptiles. They are probably the most bizarre looking animals in the desert. While some change colors and have sharp scales for defense, others change their appearance to look more threatening.

One such creature is the frilled hazard. When enemies are near, the lizard opens its mouth, unveiling a wide frill. This makes the hazard look bigger and scarier. The shingle back has a tail with the same shape as its head. When a predator bites at the tail, the shingle back turns around and bites back. There are only two venomous lizards in the world, and one of them is the gila monster. It has a very painful bite.

Desert Birds: Like the other inhabitants of the desert, birds come up with interesting ways to survive in the harsh climate. The sand grouse has special feathers that soak up water. It can then carry the water to its young trapped in the nest.

Other birds, like the gila woodpecker, depend on the giant saguaro as its home. This woodpecker hollows out a hole in the cactus for a nest. The cool, damp inside is safe for the babies.

The roadrunner is probably the most well-known desert bird. Roadrunners are so named because they prefer to run rather than fly. Ostriches also prefer to use their feet. Even the young depend on walking to find food and water. The galah is one of the prettiest desert birds. It is one of the few species that return to the same nest year after year.

Galahs are interesting birds, in that the number of eggs they lay depends on the climate. If the desert is in a drought, they don't lay any. However, during more tolerable years, the galah may lay as many as five eggs.

Desert Mammals: There are several species of mammals in the desert. They range in size from a few inches to several feet in length. Like other desert wildlife, mammals have to find ways to stay cool and drink plenty of water. Many desert mammals are burrowers.

They dig holes in the ground and stay there during the hot days. They return to the surface at night to feed. Hamsters, rats and their relatives are all burrowers. Not only do the burrows keep the animals cool, they are also a great place to store food.

Of course, not all animals have in holes in the ground. The kangaroo and spiny anteater both live in the Australian desert region. Spiny anteaters are unusual mammals because they lay eggs.

The desert is also full of wild horses, foxes and jackals, which are part of the canine family. And we can't forget the cats. Lions are found all over the deserts of southern Africa. They get their water from the blood of their prey.

Camels – The Cars of the Desert: Camels could be included in the mammal section. Camels are the cars of the desert. Without them, people would have great difficulty crossing the hot terrain. There are two types of camels: Bactrian and dromedary. The main difference between the two is the number of humps. Dromedaries have one hump, and Bactrian have two. Both kinds are used by people, but only Bactrian's are found in the wild.

Camels are great for transportation because they use very little water. Camels can withstand very high temperatures without sweating. They also store fat in their humps for food. If a Bactrian camel travels a long distance without eating, its hump will actually get smaller.

3. **Decomposers:**

   Due to poor vegetation the amount of dead organic matter is very less. As a result, the decomposers are very few. The common decomposers are some bacteria and fungi, most of which are thermophile.

AQUATIC ECOSYSTEM

The aquatic ecosystem definition states it is a water-based environment, wherein, living organisms interact with both physical and chemical features of the environment. These living creatures whose food, shelter, reproduction, and other essential activities depend on a water-based environment are known as aquatic organisms.

Water plays a significant role in the management of world-scale ecosystem processes in aquatic systems, connecting the atmosphere, lithosphere, and biosphere by transferring material between them and allowing chemical reactions to occur. Water has unique physicochemical features that reflect the water body's quality. The physicochemical characteristics of an aquatic ecosystem determine how well it functions and how long it can support life forms. In the same way as sediments in terrestrial ecosystems provide substrate, nutrients, and a home for live aquatic resources, sediments in aquatic ecosystems are equivalent to the soil in terrestrial ecosystems. Sediments are significant catalysts in environmental food cycles and the two water quality dynamics.

The quality of sediment has a direct or indirect impact on the functioning of an aquatic ecosystem. The many physicochemical properties of sediment determine its quality. Similarly, the biotic mix of an aquatic environment determines how well it functions. In the aquatic environment, they serve as a trophic level and a source of energy. Fish have a significant ecological role in the whole food web at the trophic level.

Some of the most common aquatic organisms are – nekton, plankton, and benthos. Additionally, lakes, oceans, ponds, rivers, swamps, coral reefs, wetlands, etc. are a few popular aquatic ecosystem examples.

Types of Aquatic Ecosystem

In general, there are two types of aquatic ecosystems, namely marine ecosystems and freshwater ecosystems. Both marine and freshwater ecosystems are further divided under different aquatic ecosystems:

1. **Marine Water Ecosystem**

   This particular ecosystem is the largest aquatic ecosystem and covers over 70% of the earth's total surface. This ecosystem is relatively more concentrated in terms of salinity. Nonetheless, the body of aquatic organisms is well-adjusted to saline water, and they may find it challenging to survive in freshwater. The following categories comprise the marine ecosystem.

2. **Ocean Ecosystem**

   Pacific Ocean, Atlantic Ocean, Indian Ocean, Arctic Ocean, and the Southern Ocean are the five major oceans on earth. Notably, the Pacific Ocean is the largest and deepest of these five, while the Atlantic is the second largest in terms of size. Also, the Southern Ocean harbors the largest population of Krill among them. Other than that, the oceans serve as home to aquatic organisms like – turtles, crustaceans, plankton, corals, shellfish, blue whale, sharks, tube worms, reptiles, etc.

3. **Estuaries**

   Typically, it is the meeting point of a sea and rivers, which makes the water slightly more saline when compared to freshwater and more diluted when compared to the marine ecosystem. Biologically, estuaries are considered to be productive as they stimulate primary production and trap plant nutrients. Some examples of estuaries include – tidal marshes, river mouth, and coastal bays.

4. **Coral Reefs**

   These are fondly referred to as the Rain Forest of Oceans as they harbor a wide diversity of aquatic flora and fauna. A coral reef is an aquatic ecosystem made up of corals that form reefs. Coral polyps are held together by calcium carbonate in the formation of reefs. Stony corals, whose polyps cluster in groups, make up the majority of coral reefs.

   The animal phylum Cnidaria includes sea anemones and jellyfish, and coral is part of the class Anthozoa. Corals secrete hard carbonate exoskeletons that support and protect them, unlike sea anemones. Warm, shallow, clear, sunny, agitated water is ideal for most reefs. At the beginning of the Early Ordovician, 485 million years ago, coral reefs displaced the Cambrian's microbial and sponge reefs.

5. **Coastal Ecosystem**

   Coastal ecosystems are formed when land and water meet. The structure, variety, and energy flow of these ecosystems are all unique. The bottom of the coastal

environment is dominated by plants and algae. Insects, snails, fish, crabs, shrimp, lobsters, and other animals make up the fauna. It is one of the major aquatic ecosystems and is quite distinct in terms of structure and diversity. The coastal ecosystem is formed in the union of land and water. Coastal ecosystems harbor a variety of plants and algae and serve as a home to snails, shrimps, crabs, lobsters, and fish.

6. **Freshwater Ecosystem**

   This aquatic ecosystem covers less than 1% of the earth's surface and is broadly divided into – wetlands, lentic and lotic ecosystems.

7. **Swamps and Wetlands**

   These are marshy areas that are often covered in water and harbor a variety of flora and fauna. Wetlands are known to be a home of water lilies, marshes, swamps, Northern Pikes, dragonflies, Green Heron, etc.

8. **Lentic Ecosystems**

   It includes standing water bodies like ponds and lakes and is a home to both floating and rooted plants, algae, and invertebrates. All standing water habitats, such as lakes and ponds, are included in lentic ecosystems. Algae, rooted and floating-leaved plants, and crustaceans like crabs and shrimp live in these habitats. Frogs and salamanders, as well as reptiles like alligators and water snakes, can be found here. Salamanders, frogs, water snakes, and alligators are commonly found in lentic ecosystems.

9. **Lotic Ecosystems**

   These aquatic ecosystems are characterized by rapid flowing water moving in one direction. They are a hub of a wide variety of insects like beetles, mayflies, and stoneflies, among others. Also, it harbors species like river dolphins, beavers, otters, eel, minnow, and trout.

Functions of Aquatic Ecosystem

These pointers highlight the importance of aquatic ecosystem:

- Facilitates recycling of nutrients
- Helps to purify water
- Recharges groundwater
- Is a habitat for aquatic flora and flora
- Mitigates flood

Features of Aquatic Ecosystem

We can emphasize the following traits and features of aquatic ecosystems:

- They can be made of either freshwater or saltwater.
- They provide habitat for a variety of aquatic creatures.
- Algae and corals make up the majority of the flora.

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- They have a high level of biological diversity, making them the world's most productive and richest ecosystems.
- They play important roles in the planet's life, including assisting in the regulation of the hydrological cycle and acting as a pollution filter.

CHECK YOUR PROGRESS

1. **Define ecosystem?**
2. **State major components of an ecosystem?**
3. **Define trophic level and standing crop?**
4. **Name the biggest flower in the plant kingdom.**
5. **What are ecological pyramids?**

2.8 CONCEPT OF BIODIVERSITY AND ITS CONSERVATION

Bio-Diversity is composed of two words Bio + Diversity. Bio means life while diversity means variety. So, Bio-diversity means the variety and variability of all. Living organisms constitute the biological wealth of a nation. It is found in three levels.

1. **Genetic Biodiversity:** It means the variation of genes within a species. A species can have variety and each variety has its genes or genetic makeup. E.g., The number of different varieties found in a particular species such as humans, animals' flora. This diversity in genes within & species increases its ability to adapt to pollution, diseases, and other changes in the environment.
2. **Species-Level Biodiversity:** A variety within. regions are known as species biodiversity. The more species found in a. particular geographical region; the area is considered to be biologically wealthy. In India-the Himalaya range. Has flora and fauna. This makes the regions mere biologically wealthy.
3. **Eco-system Level Biodiversity:** It refers to a variety of ecosystems in a particular region or none. Various eco-system includes forests, wetlands, arid zones, deserts, etc. all eco-systems are rich in a variety of flora and fauna according to their environment. E.g., the Desert in India contains Babool. The Wetlands" of Assam has teak. Sal, Bamboo, while in the Himalayan range in pine, deodar, etc.

2.9 BIO GEOGRAPHICALLY CLASSIFICATION OF INDIA

Biodiversity in India

The total area is 32 million hectares. It is very rich in biological diversity. It is estimated that more than 40,000 species of the plant occur in India 4,000 mollusks, 6400 other invertebrates. 2000 fish 140 of amphibians and approx. 350 mammals.

The ecological sub regions

1. **Himalayan Mountain system**
   - Himalayan foothill. It is extended Kashmir to Assam.

     Flora- Sal, cotton, Giant Bamboo

     Fauna- Elephant, Samber, Deer, Rhino, wild buffalo

- Himalayan includes a higher attitude of Kashmir.

  Flora: Pine, dwarf bill bamboo

  Fauna: wild ass, goats, sheep, fox, cat

- Eastern Himalayans: It includes regions of Sikkim

  Flora: Oaks, pine, orchids, Moses

  Fauna: Red Panda, Goats, Antelopes

2. **Peninsular:** It is the region of high plateau land. U includes the Ganges River system and desert region of Rajasthan.

   Flora: Sal, Teak, Thorny trees

   Fauna: Elephants, deer, monkey, wild ass, desert cat, red fox, etc.

3. **Tropical Regional**: It is a region of heavy rainfall including north-eastern India and western ghats.

   Flora: Mosses, ferns, herbs

   Faun: Wild elephants, flying squirrel, mongoose, fish, small crabs, etc.

Biogeographic zones of India

The co,untry has 10 different biogeographic zones and 26 biotic provinces. The country has 10 different biogeographic zones and 26 biotic provinces.

S. No.	Biogeographic zones	Biotic provinces
1.	Trans-Himalaya	Ladakh mountains, Tibetan plateau
2.	Himalaya	Northwest, West, Central and East Himalayas
3.	Desert	Thar, Kutch
4.	Semi-arid	Punjab plains, Gujarat Rajputana
5.	Western Ghats	Malabar plains, Western Ghats
6.	Deccan Peninsula	Central highlands, Chotta-Nagpur, Eastern highlands, Central Plateau, Deccan South
7.	Gangetic plains	Upper and Lower Gangetic plains
8.	Coast	West and East coast, Lakshadweep
9.	North-East	Brahmaputra valley, Northeast hills
10.	Islands	Andaman and Nicobar

2.10 VALUE OF BIODIVERSITY

Values of biodiversity

A rich biodiversity is essential for the sustainable biosphere and bio-industrial development of a country. The multiple uses of biodiversity are listed below.

1. **Consumptive Use Value:** Biodiversity provides us valuable natural resources to satisfy the subtle needs of mankind. Our homes, livestock, fruits, vegetables, grains,

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grams etc. are all derived from the products of diverse and healthy ecosystems. Food, drugs, fibre, shelter and a host of other useful products are obtained from a variety of living organisms.

- **Food.** A large number of edible plant species are consumed by man as food. About 90% of the modern food crops have been domesticated from wild tropical plants. Even now agricultural scientists make use of the existing wild species of plants for developing better strains.
- **Drugs and Medicine**
  a. About 75% of the pharmaceutical lifesaving drugs are of plant origin. Reserpine (hypertension) is obtained from Rauwolfia serpentina, quinine (malaria) is derived from Cinchona ledgeriana, morphine (analgesic) is yielded by papaver somniferum, taxol (anticancer drug) is obtained from the bark of yew tree (Taxus baccata and Taxus brevifolia), vinblastine and vincristine drugs (containing anticancer alkaloid) are derived from Periwinkle (Catharanthus) plant.
  b. The wonder drug Penicillin used as antibiotic is derived from a Penicillium. Digitalin is obtained from foxglove (Digitalis) which is effective for heart ailments.
  c. Bee sting venom is used for treating arthritis. The Peepal tree leaves, Roots trunks are used for curing fever, cough, skin diseases etc. A plant found in west Africa called Katemfe (Thaumatococcus danielli), produces proteins that are 1600 times sweeter than sucrose. Several plant species, having other potent medicinal applications, are yet to be screened and intensively studied for their applications.

2. **Productive Use Value:** Many industries like textile industry, plywood industry, ivory industry, pulp and paper industry depend upon the productive value of biodiversity. Animal products such as tusks of elephants, musk from deer, silk from silk worm, woo from sheeps, fur and lac etc., are traded in the market. Developing countries Asia, Africa, Latin America are the richest biodiversity centers. Despite ban trade, wild life o products (fur, hide, horns, tusks, live specimens) are smuggled and marketed in large quantities to some rich western countries and also to China and Hong Kong where export of cat skins and snake skins fetches a booming business.
3. **Social Value:** Biodiversity has distinct social value related to our cultural, religious and ritual aspects. Plants and animals are considered as the symbols of national and cultural heritage. Many plants like Tulsi, Peepal, Mango, Lotus, Bael, khejri are regarded holy, sacred and worshipped in our country. The social life of sigmitice ribal people (their songs, dances, customs) are closely woven around the wild1ife in the forests. Many animals like cow, snake, bull, peacock, owl etc. have significant place in our psycho-spiritual arena and thus hold special social importance.
4. **Ethical Value (or Existence Value):** It involves ethical issues like all life must be preserved. It is based on the concept of Live and Let Live. If we want human race

to survive, then we must protect all biodiversity. Ethical value means that we may or may not use a species but its existence in nature gives as pleasure. We all feel sorry when we know that dodo or passenger pigeon is no more on this earth. We are not deriving anything direct from zebra, kangaroo or lion but we strongly feel that these species should survive in nature. This indicates the ethical value attached to each species.

5. **Aesthetic Value:** Eco-tourism, bird watching, wildlife, pet keeping, gardening etc. provide asthetic rewards of biodiversity. The willingness to pay concept on eco-tourism gives us even a monetary estimate for its aesthetic value. Eco-tourism is estimated generate about 12 billion dollars of revenue annually that roughly gives the aesthetic value of biodiversity. For instance,
   - A male lion can generate up to $515,000 due to its aesthetic value as paid by tourists, whereas if killed for the lion skin, a market price of $1000 can be fetched.
   - A Kenyan elephant can earn worth $1 million as tourist revenue. The mountain gorillas in Rwanda are fetching $4 million annually through eco-tourism.
   - Whale watching on Hervey Bay on Queensland coast earns $12 million per year.
   - Tourism to Great Barrier Reef in Australia earns $2 billion annually.
   - A typical tree provides $198,2150 worth of ecological services, whereas its value is only $600 if sold as timber.
6. **Option Value:** Option values include the potentials of biodiversity that are presently unknown and need to be explored. There is a possibility that we may have some potential cure for cancer or AIDS existing within the depth of a marine ecosystem or in a tropical rain forest. Thus, option value suggests that there are biological resources existing on this biosphere that may prove to be miracle species in future. Option value of biodiversity also includes areas where a variety of flora and fauna or specifically some endemic, rare or endangered species exist. Biodiversity is the precious gift of nature presented to us. We should not commit the folly of losing these gifts before unwrapping them.

2.11 BIO DIVERSITY AT GLOBAL LEVEL

Globally about 1.5 million species are known till date which is perhaps 2% of the actual number. We have roughly 17o,000 flowering plants, 30,000 vertebrates. about 250,000 other groups of species and the remaining species may range from 8 million to 100 million. Table illustrates the estimated number of some known living species (1,400,000) in different taxonomic groups

Table 2. Living species estimates (World Resource Institute. 1999)

Taxonomic group	Number of species	Taxonomic group	Number of species
Bacteria	5.000	Snail, clams. slugs	70,000

Protozoans	31,000	Insects	7,50,000
Algae	27,000	Miles, cockroaches, ticks	1,20,000
Fungi (Mushrooms, molds)	45,000	Fish and sharks	22,000
Higher plants	2,50,000	Amphibians	4,000
Sponges	5,000	Reptiles	5,000
Jelly fish, corals	10,000	Birds	9,000
Earthworms, flatworms	36,000	Mammals	4,000

Terrestrial biodiversity of earth is best described as biomes. Biomes are largest ecological units present in different geographic areas and are named the dominant vegetation, e.g., the tropical rain forests, savannas, forests, coniferous, deciduous desert, tundra etc. The tropical rain forests constitute 50% to 80% of about global biodiversity and are inhabited by teeming millions of plants, birds, species of insects, amphibians and mammals. They are the earth's house of largest store biodiversity. More than one-third of the world's extracted from therapeutic drugs are plants growing in tropical forest.

Out of the 3,000 plants identified by National Cancer Research sources of Institute as cancer fighting drugs 70% come from extract from one of tropical rain forests. Very recently, the creeping vines in the rain forest at Cameroon has effective in the proved inhibition of known replication of AIDS virus. The wonderful Neem tree for its medicinal properties in tropical India, has now come into lime even in the western light temperate countries. Euphorbia lathyrism (Grophar or gasoline tree), the most suitable energy plant, contains more than 5% oil and polymeric hydrocarbons. Tropical forests having 1,25,000 flowering plants are the treasure houses of food, medicine and commerce. Tropical deforestation alone is reducing the biodiversity by half a percent every year. Several extinct before species are becoming, they have been discovered. The Silent Valley in Kerala is the only place in India where tropical rain forests occur. Needless to say, we must protect our mainly precious forests. The case of Silent Valley Hydroelectric Project was abandoned because it had put to risk our forests have much less tropical rain forest biodiversity. Temperate forests have much less biodiversity but there is much better documentation of species.

Marine diversity is even much higher than terrestrial biodiversity and ironically, they are still less known. Estuaries, coastal waters and oceans biologically diverse and the diversity is just dazzling. Sea is the cradle of every known animal phylum. Out of the 35 existing phyla of multicellular animals, 34 are marine and 16 of these are exclusively marine. mapping the biodiversity has therefore, been rightly recognized as an emergency matter in order to plan its conservation and practical utilization in a judicious manner.

2.12 NATIONAL AND LOCAL LEVEL

NATIONAL BIODIVERSITY: India as a mega-diversity nation

India is one of the 12 mega-diversity countries in the world. It ranks 10th among the plant rich countries, 11th in terms of endemic species of higher vertebrates and 6th among

centers of diversity and origin of agricultural crops. The Ministry of Environment and Forests, Government of India currently recorded 47,000 species of plants and 81,000 species of animals which is about 7% and 6.5% of global flora and fauna.

Table 3. Distribution of species in major taxonomic groups of flora and fauna in India.

Plant's group	Number of species	Animal's group	Number of species
Bacteria	850	Molluscs	5042
Algae	2500	Arthropods	57525
Fungi	23000	Pisces (Fishes)	2545
Bryophytes	2564	Amphibia	204
Pteridophytes	1022	Reptiles	428
Gymnosperms	64	Birds	1228
Angiosperms	15000	Mammals	372

Note that:

- India is unique in having immense natural beauty in its different biomes and in possessing a diverse flora and fauna.
- Indian wildlife is incomparable in its variety. The tiger, lion, leopard, elephant, rhinoceros, snakes and minks are found here in abundance. India has more graceful deer's, peacocks and cats than any other country in the world.
- India includes more than 150 families of terrestrial vertebrates and more than 7,50,000 species of insects. The animals like black buck, Nilgiri tahr, pigmy hog, golden langur, lion-tailed macaque etc., are unique wild animals of India. India is gifted with a wide variety of deers such as musk deer (Kastura), barking deer, spotted deer (Cheetal), swawp deer (Bara singha), hog deer, mouse deer and dancing deer (Sambhar).
- The typical wild Indian birds include peafowl, jungle fowl, quail, duck, pigeon, sand grouse, eagle, pelican, hornbill etc.
- Indian reptiles include crocodiles, lizards, gharials and more than 125 varieties of snakes.

Many wild animals have disappeared due to natural and human activities. 100 to 600 species of animals and birds have become extinct because of climatic and geographic changes and also by over hunting by man for fo0d, fur, recreation and monetary benefits. endemism (species restricted only to a particular area). About 62% of amphibians and 50% of lizards are endemic to India. Western ghats exhibit the site maximum endemism.

Centre of origin

India has been the centre of origin of 5000 species of flowering plants, 166 species of crop plants and 320 species of wild varieties of cultivated crops, thereby providing a broad spectrum of diversity of traits for crop plants.

Marine diversity. In India, marine diversity is rich in molluscs, crustacean corals, polychaetes, mangrove plants and sea grasses. More than 350 species. corals of the world are found here. India has two hot spots of biodiversity (out of 25) in north-east region and western ghats. However, a large proportion of biodiversity (93 major wetlands, coral reefs and mangroves) is still to be full. explored.

LOCAL OR REGIONAL BIODIVERSITY

Biodiversity at regional level can be categorized into three types based upon their spatial distribution.

1. **Alpha Diversity:** Alpha diversity indicates diversity within the community. It refers to the diversity of organisms sharing the same community or habitat in a small homogeneous area. Alpha diversity is strongly correlated with physical environmental variables. For example, there are 100 species of tunicates in arctic waters, 400 species in temperate waters and 600 species in tropical seas Thus, temperature seems to be the most important factor affecting alpha richness of tunicates
2. **Beta Diversity:** Beta diversity indicates diversity between communities across different habitats and environmental gradients. Beta richness means that the cumulative number of species increases as more heterogeneous habitats are taken into consideration. For example, the ant species found in the local regions of north pole is merely 10. As we keep on moving towards the equator and add more and more habitats, the number of ant species reaches as high as 2000 on the equatorial region.
3. **Gamma Diversity:** Gamma diversity refers to the diversity of habitats over the total landscape gradients or geographical area. The diverse communities are functionally more productive and stable even under environmental stresses.

2.13 INDIA AS A MEGA-DIVERSITY NATION

India is one of the 12 mega biodiversity countries in the world. The country is divided into 10 biogeographic regions. The diverse physical features and climatic situations have formed ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems, which harbor and sustain immense biodiversity. Biogeographically, India is situated at the tri-junction of three realms - Afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore, has characteristic elements from each of them. This assemblage of three distinct realms makes the country rich and unique in biological diversity.

The country is also one of the 12 primary centres of origin of cultivated plants and domesticated animals. It is considered to be the homeland of 167 important plant species of cereals, millets, fruits, condiments, vegetables, pulses, fiber crops and oilseeds, and 114 breeds of domesticated animals. About 4,900 species of flowering plants are endemic to

the country. These are distributed among 141 genera belonging to 47 families. These are concentrated in the floristically rich areas of North-East India, the Western Ghats, North-West Himalayas and the Andaman and Nicobar Islands. These areas constitute two of the 18 hot spots identified in the world. It is estimated that 62 per cent of the known amphibian species are endemic to India of which a majority is found in Western Ghats. Approximately 65 per cent of the total geographical area has been surveyed so far. Based on this, over 46,000 species of plants and 81,000 species of animals have been described by the Botanical Survey of India (BSI) established in 1890 and Zoological Survey of India (ZSI) established in 1916, respectively. This list is being constantly upgraded, especially in lower plants and invertebrate animals.

The Forest Survey of India established in 1981 assesses the forest cover with a view to develop an accurate database for planning and monitoring purposes. Conservation and sustainable use of biological resources based on local knowledge systems and practices is ingrained in Indian ethos. The country has a number of alternative medicines, like Ayurveda, Unani, Siddha and Homeopathic systems which are predominantly based on plant based raw materials in most of their preparations and formulations. Herbal preparations for various purposes including pharmaceutical and cosmetic purposes form part of the traditional biodiversity uses in India.

The strategies for conservation and sustainable utilization of biodiversity have comprised providing special status and protection to biodiversity - rich areas by declaring them as national parks, wildlife sanctuaries, biosphere reserves, ecologically fragile and sensitive areas. Other strategies include offloading pressure from reserve forests by alternative measures of fuel wood and fodder need satisfaction by afforestation of degraded areas and wastelands and creation of ex-situ conservation facilities such as gene banks. For example, the Tura Range in Garo Hills of Meghalaya is a gene sanctuary for preserving the rich native diversity of wild citrus and musa species. Approximately, 4.2 per cent of the total geographical area of the country has been earmarked for extensive in-situ conservation of habitats and ecosystems. A protected area network of 85 national parks and 448 wildlife sanctuaries has been created. The results of this network have been significant in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles and elephants.

2.14 HOT-SPOT OF BIODIVERSITY

According to Conservation International, a region must fulfill the following two parameters to qualify as a hotspot:

1. The region should have at least 1500 species of vascular plants i.e., it should have a high degree of endemism.
2. It must contain 30% (or less) of its original habitat, i.e., it must be threatened.

The following regions which fulfill the criteria to be declared as Biodiversity Hotspot, these are major four biodiversity hotspots in India:

1. **The Himalayas:** are considered as the highest in the world, the Himalayas comprises of North-East India, Bhutan, Central and Eastern parts of Nepal. This region holds a record of having 163 endangered species which includes the Wild Asian Water

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Buffalo, One-horned Rhino, and as many as 10,000 plant species, of which 3160 are endemic. This mountain range covers nearly 750,000 km2. Eastern Himalayans hotspot comes under Indo Burma hotspot which covers about 2 million sq km Tropic Asia, east of India subcontinent. Apart from Neighboring countries, Indo Burman hotspot also covers Andaman and Nicobar Island in Indian Ocean.

2. **Indo – Burma Region:** The Indo-Burma Region is spread over a distance of 2,373,000 km². In the last 12 years, 6 large mammal species have been discovered in this region: The Large-antlered Muntjac, the Annamite Muntjac, the Grey-shanked Douc, the Annamite Striped Rabbit, the Leaf Deer, and the Saola. The region borders the Indian political boundary and extends into the north eastern states of Arunachal Pradesh, Assam and includes the Andaman Islands. This hotspot is also known for the endemic freshwater turtle species, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss. There are also 1,300 different bird species, including the threatened White-eared Night-heron, the Grey-crowned Coracias, and the Orange-necked Partridge.
3. **The Western Ghats:** The Western Ghats are present along the western edge of peninsular India and covers most of the deciduous forests and rain forests. This region consists of 6000 plant species of which 3000 are endemic. Originally, the vegetation in this region was spread over 190,000 km2 but has been now reduced to 43,000 km2. The region is also known for 450 species of birds, 140 mammals, 260 reptiles, and 175 amphibians. Western Ghats extend along a 16000km long strip of forest parallel to the western coast of Indian peninsula in Maharashtra, Karnataka, Tamil Nadu and Kerela and has 40% of endemic species of plants, 62% of amphibians and 50% of lizards.
4. **Sundaland:** The Sundaland hotspot lies in South-East Asia and covers Singapore, Thailand, Indonesia, Brunei, and Malaysia. In the year 2013, the Sundaland was declared as a World Biosphere Reserve by the United Nations. This region is famous for its rich terrestrial and marine ecosystem. Sundaland is one of the biologically richest hotspots in the world which comprises 25,000 species of vascular plants, of which 15,000 are found only in this region. The Sundarbans is a cluster of low-lying islands in the Bay of Bengal, spread across India and Bangladesh, famous for its unique mangrove forests. This active delta region is among the largest in the world, measuring about 40,000 sq km.

2.15 THREATS TO BIODIVERSITY

Threats to biodiversity

Biodiversity is disappearing on the earth, it's not about India but overall Earth is getting effected by the decline in biodiversity. Even a single species is important in our atmosphere. Every single species plays a very important role, if it gets disproportionate then ecological balance will get impacted.

Habitat loss and degradation

From last decade, we are observing destruction of habitat is the primary cause for the loss of biodiversity. The major factor for loss of biodiversity is the leading killing of the species.

As per IUCN, habitat loss is the major cause for species loss. 73% of the species loss is due to habitat destruction.

Following are the list of Human Activities that has hampered the biodiversity:

- Habitat Alteration-30%
- Commercial Hunting-21%
- Introduction to Alien and domestic Species-16%
- Hunting for sports-12%
- Pest and Predator Control-7%
- Hunting for food-6%
- Miscellaneous (Pollution, Superstition, Pet trading etc.)-8%

The greatest destruction to biological communities has occurred within last 150 years during which human population has increased tremendously.

Many migratory birds get affected by deforestation because of disturbance in their paths. Several migratory birds fail to find their old wetlands, which have been either filled or converted into human settlement. Some of the times, human cleanliness destroys the habitat of scavengers like vultures, kites etc.

Habitat fragmentation

Habitat Fragmentation refers to the dividing the habitat into smaller patches or pieces due to division of states, towns, districts, roads etc. The main causes of habitat fragmentation include geological **processes that slowly alter the layout of the physical environment.** Habitat Fragmentation can be done due to human impacts, natural disasters.

Poaching of wildlife

Poaching means illegal hunting, capturing and trading of endangered and rare species of animals, plants or we can say illegal trade of wildlife. It is a major threat to our wild life.

The causes of Poaching are:

- Medicinal Usage of wildlife
- Weak Regulation under wild life acts
- Great values of products manufactured by wildlife species
- Spiritual beliefs
- Food and Exotic dishes for the elite
- Human Population

Steps taken to stop Poaching

- Educate the General Public
- Hiring of Scouts
- Restricted Rules and Regulations
- Safe Habitat for Wild animals

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- More tracking and associations to support Wildlife

Man-wildlife conflicts

Population Explosion causes shrinkage of wildlife species habitat. As our earth has limited space to live. Man, and animals are always on conflict related to the living space and food. Due to which conservation of wild life is a challenging task. If the appropriate solution to this problem will not be able to achieved, then it will be difficult to conserve the wild life as human being are destroying the habitat of wildlife for their self-interest.

Causes of Man Wildlife Conflict

- Human Encroachment
- Insecurity among Weak and Injured animals
- Compensation against killing of Animals
- Safeguarding the Crops
- Animals enters the villages in search of food
- Development of Human Settlement

Endangered and endemic species of India

A plant, animal or microorganism that is in immediate risk of biological extinction is called endangered species or threatened species. In India, 450 plant species have been identified as endangered species. 100 mammals and 150 birds are estimated to be endangered. India's biodiversity is threatened primarily due to:

1. Habitat destruction
2. Degradation and
3. Over exploitation of resources

The RED-data book contains a list of endangered species of plants and animals. It contains a list of species of that are endangered but might become extinct in the near future if not protected.

Some of the rarest animals found in India are:

1. Asiatic cheetah
2. Asiatic Lion
3. Asiatic Wild Ass
4. Bengal Fox
5. Gaur
6. Indian Elephant
7. Indian Rhinoceros
8. Marbled Cat
9. Markhor

Extinct species is no longer found in the world. Endangered or threatened species is one whose number has been reduced to a critical number. Unless it is protected and conserved,

it is in immediate danger of extinction. Vulnerable species is one whose population is facing continuous decline due to habitat destruction or over exploitation. However, it is still abundant. Rare species is localized within a restricted area or is thinly scattered over an extensive area. Such species are not endangered or vulnerable.

Endemic species of India

Species that are found only in a particular region are known as endemic species. Almost 60% the endemic species in India are found in Himalayas and the Western Ghats. Endemic species are mainly concentrated in:

1. North-East India
2. North-West Himalayas
3. Western Ghats and
4. Andaman & Nicobar Islands

Examples of endemic Flora species are

1. Sapria Himalayan
2. Uvaria Lurida
3. Nepenthes Khasiana etc.

Endemic fauna of significance in the western ghats are:

1. Lion tailed macaque
2. Nilgiri langur
3. Brown palm civet and
4. Nilgiri tahr

Sacred grove

A sacred grove or sacred woods are any grove of trees that are of special religious importance to a particular culture.

The examples of sacred groves are Khasi and Jaintia Hills in Meghalaya and Aravalli Hills of Rajasthan. - India has a history of religious and cultural traditions that emphasized the protection of nature.

Sacred groves play a great role in maintaining the microclimate of the region. Conservation of these groves can conserve water and, prevent soil and nutrient loss. Sacred groves also help in preserving the religious and cultural heritage of Meitei culture.

Traditional water management system

In India, even today, there are several villages where water management is done not by the Irrigation Department, but by local managers. In south India, a **neerkatti** manages the traditional tanks very efficiently based on his/her knowledge of the terrain, drainage, and irrigation needs. They usually give preference to the tail end fields and decide per capita allocation of water based on the stock of available water in the tank and crop needs. In Maharashtra, the water managers are called havaldar's or jaghyas who manage and resolve

conflicts by overseeing the water channels from the main canal to the distributary canals. In Ladakh, the water manager is known as churpun who has got complete charge with full powers over allocation of available water. The major source of water is melting water from glaciers and snow supplementary by water from springs and marshes. The water is distributed to different fields through an intricate network of earthen channels.

In traditional water management, innovative arrangements ensure equitable distribution of water, which are democratically implemented. The 'gram-sabhas' approve these plans publicly. While water disputes between states and nations often assume battle like situations, our traditional water managers in villages prove to be quite effective.

Biological invasion with emphasis on Indian biodiversity

Biological invasions threaten biodiversity, economy and human livelihood in developing countries. Invasions from alien species such as grey squirrels threaten economies and livelihoods. They can transmit disease, choke river systems and wells, prevent cattle being able to graze and out-compete or eat native species. Increasing globalization, especially imports of pets and plants, has caused much of the biological invasions in the past. In the future air travel will be responsible for biological invasions of Africa and Asia. This will be exacerbated by climate change, and intensifying agriculture, which make it easier for invasive species to become established.

Rich nations are accustomed to the nuisance of invasive alien species, and are increasingly taking protective action. The study outlines how poorer economies are crucially reliant on international trade and have little power to regulate imports, so the introduction of highly dangerous species continues unchecked.

2.16 CONSERVATION OF BIODIVERSITY

- In-situ
- Ex-situ

In-situ: In Situ refers to preserve and protect the wildlife in their natural habitat. The main objective of starting with this strategy is to identifying the biodiversity rich areas to preserve and conserve the wildlife so that they can flourish and evolve. This strategy is very cheap and convenient to safeguard in natural environment. The cons of this strategy is that it is very difficult to identify the large areas as human population is increasing tremendously.

Ex-situ: Ex-situ is a strategy opposite to In-situ. Ex situ strategy refers to protect the wildlife outside their natural habitat. In this strategy, the endangered species are taken care under human care in either botanical garden, zoos, seedling, tissue culture etc.

2.17 RED DATA BOOK

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species (also known as the IUCN Red List or Red Data Book), established in 1948 with its headquarters in Switzerland. It was initiated to evaluate conservation status of species of plants and animals in 1964, is the world›s most comprehensive inventory of the global conservation status of biological species. It uses a set of criteria to evaluate the extinction risk of thousands of species and subspecies. These criteria are relevant to all

species and all regions of the world. With its strong scientific base, the IUCN Red List is recognized as the most authoritative guide to the status of biological diversity.

The IUCN aims to have the category of every species re-evaluated every five years if possible, or at least every ten years. This is done in a peer reviewed manner through IUCN Species Survival Commission Specialist Groups, which are Red List Authorities responsible for a species, group of species or specific geographic area, or in the case of Bird Life International, an entire class (Aves).This list also provides information to international agreements, such as Convention on Biological diversity, Convention on International Trade in Endangered species of Wild Fauna and Flora.

The number of species which have been assessed for the Red List has been increasing over time. As of 2019, of 105,000 species surveyed, 28,338 are considered at risk of extinction because of human activity, in particular overfishing, hunting and land development.

The objectives of Red List are as follows:

- Developing awareness about the importance if threatened biodiversity.
- Identification and documentation of endangered species
- Providing Global index of the decline of biodiversity
- Defining conservation priorities at the local level
- Guiding conservation action

2.18 CHAPTER SUMMARY

An ecosystem consists of the biological community that occurs in some locale, and the physical and chemical factors that make up its non-living or abiotic environment. There are many examples of ecosystems -- a pond, a forest, an estuary, a grassland. The boundaries are not fixed in any objective way, although sometimes they seem obvious, as with the shoreline of a small pond. Usually, the boundaries of an ecosystem are chosen for practical reasons having to do with the goals of the particular study.

The functioning of ecosystem depends on the flow of energy through matter. The most important feature of energy flow is that it is unidirectional or one way flow the energy captured by autotrophs does not revert back to solar input. Unlike nutrients (like C, N, P) which move in a cyclic manner and are reused by the producers after flowing through the food chain, energy is not reused in the food chain. Also, the flow of energy follows the two laws of thermodynamics.

Bio-Diversity is composed of two words Bio + Diversity. Bio means life while diversity means variety. So, Bio-diversity means the variety and variability of all. Living organisms constitute the biological wealth of a nation.

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species (also known as the IUCN Red List or Red Data Book), established in 1948 with its headquarters in Switzerland. It was initiated to evaluate conservation status of species of plants and animals in 1964, is the world›s most comprehensive inventory of the global conservation status of biological species. It uses a set of criteria to evaluate the

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extinction risk of thousands of species and subspecies. These criteria are relevant to all species and all regions of the world. With its strong scientific base, the IUCN Red List is recognized as the most authoritative guide to the status of biological diversity.

2.19 REVIEW QUESTIONS

SHORT ANSWER TYPE QUESTIONS

1. **What are the biotic and abiotic components of an ecosystem?**
2. **Discuss significance of food chains and food webs.**
3. **Explain the models of energy flow in an ecosystem.**
4. **How does the various ecosystem differ?**
5. **List major functional attributes of an ecosystem.**

LONG ANSWER TYPE QUESTIONS

1. **Discuss mechanism of ecological succession.**
2. **State salient features of an aquatic ecosystem.**
3. **How the double chain or Y-shaped model is more realistic working model than the single chain model?**
4. **Define productivity. Why are tropical wet forests and estuaries most productive?**
5. **Why some of the ecological pyramids are upright while others are inverted in different ecosystems?**

2.20 MULTIPLE CHOICE QUESTIONS

1. **The most stable ecosystem is _____.**
   a. Ocean
   b. Forest
   c. Desert
   d. Mountain
2. **An abiotic component of the ecosystem is _____.**
   a. Bacteria
   b. Humus
   c. Plants
   d. Fungi
3. **The food chain in which micro-organisms feed on dead producers is called _____.**
   a. Consumer food chain
   b. Predator food chain
   c. Detritus food chain
   d. Parasitic food chain
4. **The straight ecological pyramid is**
   a. Pyramid of energy
   b. Pyramid of biomass

c. Pyramid of numbers
d. All

5. **Food chains play very significant role in the ecosystem because _____.**
   a. Energy flow and nutrient cycling take place through them
   b. Of unique property of biological magnification
   c. They maintain ecological balance
   d. All

6. **Gross primary productivity is highest in _____.**
   a. Grass lands
   b. Wet tropical forests
   c. Agro ecosystem
   d. Open oceans

7. **The type of succession occurring on a bare rock is called _____.**
   a. Xerosere
   b. Hydrosere
   c. Halosere
   d. Mesosere

8. **A thick layer of ice found frozen under the soil surface throughout the year is called _____.**
   a. Ice berg
   b. Permafrost
   c. Pampas
   d. Steppers

9. **The ultimate stable and culminating community in hierarch and xerarch is _____.**
   a. Reed swamp
   b. Woodland
   c. Forest
   d. Lichen

10. **Estuaries have _____.**
    a. Fresh and salt-water
    b. Rich biodiversity
    c. High productivity
    d. All of these

♦♦♦♦♦

UNIT III

ENVIRONMENTAL POLLUTION

STRUCTURE

3.1 LEARNING OBJECTIVE

After completion of this unit, student will get knowledge about:

- Environmental pollutions and how to rectify them.
- How to manage solid waste.
- Different type of disaster management.

3.2 INTRODUCTION

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/ energies or naturally occurring contaminants.

Environmental pollution is one of the most serious problems facing humanity and other life forms on our planet today. "Environmental pollution is defined as "the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected." Pollutants can be naturally occurring substances or energies, but they are considered contaminants when in excess of natural levels. Any use of natural resources at a rate higher than nature's capacity to restore itself can result in pollution of air, water, and land.

Environmental pollution is of different types namely air, water, soil, noise and light-weight. These cause damage to the living system. How pollution interacts with public health, environmental medicine and the environment has undergone dramatic change.

3.3 CAUSES, EFFECTS AND CONTROL MEASURES OF VARIOUS POLLUTIONS

AIR POLLUTION

The atmosphere that surrounds us is a major constituent of the biosphere. It is nothing but the air mass and carries solids, liquids, and gases in it. These extraneous materials enter the air due to man-made and natural activities that degrade the quality of air. Before we can determine what enters the air as contamination it is necessary to know what air normally contains. The composition of clean, dry air is given in Table.

Gaseous composition of dry air

Constituent	Chemical symbol	Mole percent
Nitrogen	N_2	78.084
Oxygen	O_2	20.947
Argon	Ar	0.934
Carbon dioxide	CO_2	0.0350
Neon	Ne	0.001818
Helium	He	0.000524
Methane	CH_4	0.00017
Krypton	Kr	0.000114

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Hydrogen	H_2	0.000053
Nitrous oxide	N_2O	0.000031
Xenon	Xe	0.0000087
Ozone*	O_3	trace to 0.0008
Carbon monoxide	CO	trace to 0.000025
Sulfur dioxide	SO_2	trace to 0.00001
Nitrogen dioxide	NO_2	trace to 0.000002
Ammonia	NH_3	trace to 0.0000003

* Low concentrations in the troposphere; ozone maximum in the 30 to 40 km regime of the equatorial region.

Mackenzie, F.T., and J.A. Mackenzie (1995) **Our changing planet**. Prentice-Hall, Upper Saddle River, NJ, p 288-307. (After Warneck, 1988; Anderson, 1989; Wayne, 1991). As can be seen, the air is made up of several components that we recognize as pollutants and harmful. But when they are present in limited concentrations no harm is done to the biosphere. Only when their concentrations are above acceptable levels does the air get polluted.

Air pollution is defined thus; Air pollution means the presence of the toxic particles in the atmosphere of one or more contaminants such as dust, fumes, gas, mist, odor, smoke or vapor in quantities, and of duration, such as to be injurious to human, plant or animal, life, or which unreasonably interferes with the comfortable environment of life and property.

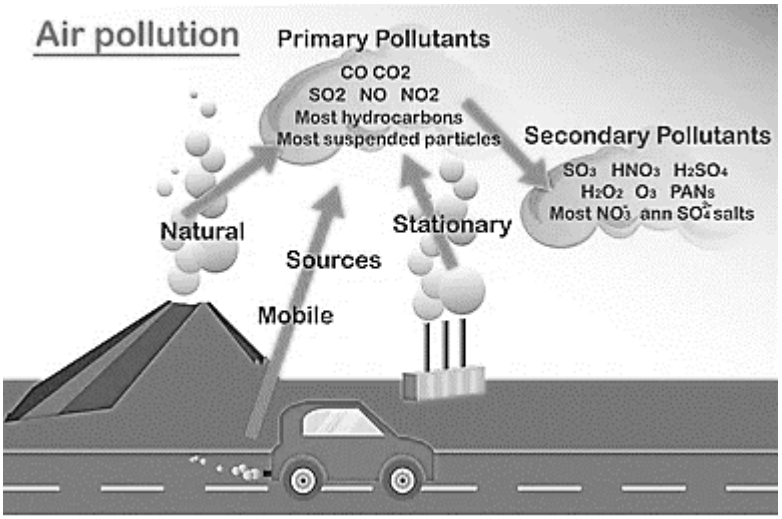
Types of Air Pollutants

A **pollutant** is a waste material or any unwanted material present in the air, water or soil. Broadly, we can classify these pollutants into two major categories.

There are two types of air pollutants:

1. Primary Air Pollutants
2. Secondary Air Pollutants

Primary Air Pollutants



The pollutants that directly cause air pollution are known as primary pollutants. They are the direct emissions from some identifiable source.

Example: Carbon monoxide, nitrogen oxides and sulphur oxides, fluorides, particulate matter, chlorofluorocarbon, hydrocarbons, etc.

Secondary Air Pollutants

The pollutants formed due to photochemical reactions in the atmosphere from primary pollutants are known as secondary pollutants. For example, Smog like Classical smog (London Smog), Photochemical smog (Los Angeles smog), Phenoxyacid Nitrate (PAN), acid rain, etc.

Causes of air pollution

Air pollution can be caused by both man-made and natural causes. There are many causes of air pollution. In fact, human activities contribute the most to environmental pollution.

Following are some of the important causes of air pollution:

1. **Agricultural Activities**: Spraying of insecticides, pesticides and fertilizers emit harmful chemicals into the atmosphere and contaminate the air.

2. **Factories and Industries:** The harmful smoke or gases emitted by factories contaminates the air since they are rich in carbon monoxide, organic compounds, hydrocarbons and chemicals.

3. **Burning of Fossil Fuels:** The combustion of fossil fuels emits a large amount of Sulphur dioxide, which pollutes the air.

4. **Automobiles:** The gases emitted from vehicles such as cars, trucks, jeeps, buses, lorries, etc., pollute the environment. These are the major source of greenhouse gases and result in harmful diseases for the people who inhale this air. Hydrocarbons, CO, CO2, Sulphur oxides are major constituents of automobile exhausts.

5. **Mining Activities:** The minerals below the Earth are extracted using large pipes in the mining process. The dust and chemicals released during the process pollute the air and destroy the health of the workers.

6. **Domestic Sources:** Painting of walls, using wooden sticks as fuel, burning cow dung, etc., are the basic usage in the home, leading to toxic smell in the air which causes health hazards.

Harmful Effects of Air Pollution

Air pollution can cause harmful health effects such as eye, nose, throat irritation, headache, and allergic reaction in the short term.

Following are the important effects of air pollution:

1. **Diseases**: Air pollution gives rise to several respiratory disorders and heart diseases. Lung cancer, pneumonia, and asthma have increased due to air pollution in the last few years.
2. **Acid Rain**: The Monument like Taj Mahal is affected due to acid rain. This acid rain is caused due to the burning of fossil fuels which releases harmful gases such as nitrogen oxide and sulphur dioxide into the air. The water droplets combine with this pollutant to become acidic and fall as acid rain, which affects the ecosystem.
3. **Ozone Layer Depletion:** The hole in the ozone layer is caused by air pollutants. Chemicals used as refrigerants such as chlorofluorocarbons, halons and hydrochlorofluorocarbons are the major cause of depletion of the ozone layer. This depletion allows harmful ultraviolet rays from the sun to enter the atmosphere and causes skin diseases and eye problems among normal people.
4. **Global Warming**: It is caused due to the emission of gases from automobiles. This creates an imbalance in the atmosphere, which leads to an increase in the temperature of the Earth.

Control measures

1. Air pollution can be prevented by less usage of automobiles.
2. A large number of fossil fuels are burnt to generate electricity. Therefore, we need to switch off the electrical appliances when not in use.
3. We should use solar cells, solar cookers, solar heaters, solar dryers, etc., to prevent air pollution.
4. The use of alternative energy source like wind energy, solar energy, etc., should be promoted.
5. We need to plant more and more trees and reduce deforestation to prevent air pollution.

Control of Vehicular Air Pollution

One of the major sources of air pollutants is automobile exhaust. Control of vehicular air pollution may lead to eventual control of air pollutants. The following steps should be followed or promoted in order to control vehicular air pollution:

1. Switching to public transport from personal vehicles.
2. Phasing out older vehicles.
3. Compulsory usage of unleaded petrol and, if possible, Compressed Natural Gas (CNG).

4. Use of catalytic converters in vehicles.

Plantation of Trees

Plants and trees reduce a large number of pollutants in the air. Ideally, planting trees in areas of high pollution levels will be extremely effective. **Saalumarada Thimmakka**, an Indian environmentalist from Karnataka, played a major role in planting trees and changing the environment through her contributions. So, we should thank her for this act as it has resulted in the reduction of air pollution.

WATER POLLUTION

Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers, and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly. If you poured a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water. The ink would still be there in the river, but in such a low concentration that you would not be able to see it. At such low levels, the chemicals in the ink probably would not present any real problem. However, if you poured gallons of ink into a river every few seconds through a pipe, the river would quickly turn black. The chemicals in the ink could very quickly have an effect on the quality of the water. This, in turn, could affect the health of all the plants, animals, and humans whose lives depend on the river.

Two-thirds of our planet is made up of water which is as big as 1 octillion liters. 70 percent of the human body is made up of water. It is a universal solvent. It is the only substance that exists in all 3 forms of matter on this planet. Today, the United Nations have recognized water as a basic human right, besides considering it as an economic commodity. Pollution is the introduction of contamination into the environment. Water pollution is the presence of extreme levels of pollutants (hazards) in a water body, such that it is no longer suitable for regular human usages such as bathing, cooking, or drinking.

What Are the Causes of Water Pollution?

Water is uniquely vulnerable to pollution. Known as a "universal solvent," water is able to dissolve more substances than any other liquid on earth. It's the reason we have Kool-Aid and brilliant blue waterfalls. It's also why water is so easily polluted. Toxic substances from farms, towns, and factories readily dissolve into and mix with it, causing water pollution.

Categories of Water Pollution

Groundwater

When rain falls and seeps deep into the earth, filling the cracks, crevices, and porous spaces of an aquifer (basically an underground storehouse of water), it becomes groundwater—one of our least visible but most important natural resources. Nearly 40 percent of Americans rely on groundwater, pumped to the earth's surface, for drinking water. For some folks in rural areas, it's their only freshwater source. Groundwater gets polluted when contaminants—from pesticides and fertilizers to waste leached from landfills and septic systems—make their way into an aquifer, rendering it unsafe for human use. Ridding groundwater of contaminants can be difficult to impossible, as well as costly. Once polluted,

an aquifer may be unusable for decades, or even thousands of years. Groundwater can also spread contamination far from the original polluting source as it seeps into streams, lakes, and oceans.

Surface water

Covering about 70 percent of the earth, surface water is what fills our oceans, lakes, rivers, and all those other blue bits on the world map. Surface water from freshwater sources (that is, from sources other than the ocean) accounts for more than 60 percent of the water delivered to American homes. But a significant pool of that water is in peril. According to the most recent surveys on national water quality from the U.S. Environmental Protection Agency, nearly half of our rivers and streams and more than one-third of our lakes are polluted and unfit for swimming, fishing, and drinking. Nutrient pollution, which includes nitrates and phosphates, is the leading type of contamination in these freshwater sources. While plants and animals need these nutrients to grow, they have become a major pollutant due to farm waste and fertilizer runoff. Municipal and industrial waste discharges contribute their fair share of toxins as well. There's also all the random junk that industry and individuals dump directly into waterways.

Ocean water

Eighty percent of ocean pollution (also called marine pollution) originates on land—whether along the coast or far inland. Contaminants such as chemicals, nutrients, and heavy metals are carried from farms, factories, and cities by streams and rivers into our bays and estuaries; from there they travel out to sea. Meanwhile, marine debris—particularly plastic—is blown in by the wind or washed in via storm drains and sewers. Our seas are also sometimes spoiled by oil spills and leaks—big and small—and are consistently soaking up carbon pollution from the air. The ocean absorbs as much as a quarter of man-made carbon emissions.

Point source

When contamination originates from a single source, it's called point source pollution. Examples include wastewater (also called effluent) discharged legally or illegally by a manufacturer, oil refinery, or wastewater treatment facility, as well as contamination from leaking septic systems, chemical and oil spills, and illegal dumping. The EPA regulates point source pollution by establishing limits on what can be discharged by a facility directly into a body of water. While point source pollution originates from a specific place, it can affect miles of waterways and ocean.

Nonpoint source

Nonpoint source pollution is contamination derived from diffuse sources. These may include agricultural or stormwater runoff or debris blown into waterways from land. **Nonpoint source pollution is** the leading cause of water pollution in U.S. waters, but it's difficult to regulate, since there's no single, identifiable culprit.

Transboundary

It goes without saying that water pollution can't be contained by a line on a map. Transboundary pollution is the result of contaminated water from one country spilling

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into the waters of another. Contamination can result from a disaster—like an oil spill—or the slow, downriver creep of industrial, agricultural, or municipal discharge.

The Most Common Types of Water Contamination

Agricultural

Not only is the agricultural sector the biggest consumer of global freshwater resources, with farming and livestock production using about 70 percent of the earth's surface water supplies, but it's also a serious water polluter. Around the world, agriculture is the leading cause of water degradation. In the United States, agricultural pollution is the top source of contamination in rivers and streams, the second-biggest source in wetlands, and the third main source in lakes. It's also a major contributor of contamination to estuaries and groundwater. Every time it rains, fertilizers, pesticides, and animal waste from farms and livestock operations wash nutrients and pathogens—such bacteria and viruses—into our waterways. Nutrient pollution, caused by excess nitrogen and phosphorus in water or air, is the number-one threat to water quality worldwide and can cause algal blooms, a toxic soup of blue-green algae that can be harmful to people and wildlife.

Sewage and wastewater

Used water is wastewater. It comes from our sinks, showers, and toilets (think sewage) and from commercial, industrial, and agricultural activities (think metals, solvents, and toxic sludge). The term also includes stormwater runoff, which occurs when rainfall carries road salts, oil, grease, chemicals, and debris from impermeable surfaces into our waterways.

More than 80 percent of the world's wastewater flows back into the environment without being treated or reused, according to the United Nations; in some least-developed countries, the figure tops 95 percent. In the United States, wastewater treatment facilities

process about 34 billion gallons of wastewater per day. These facilities reduce the number of pollutants such as pathogens, phosphorus, and nitrogen in sewage, as well as heavy metals and toxic chemicals in industrial waste, before discharging the treated waters back into waterways. That's when all goes well. But according to EPA estimates, our nation's aging and easily overwhelmed sewage treatment systems also release more than 850 billion gallons of untreated wastewater each year.

Oil pollution

Big spills may dominate headlines, but consumers account for the vast majority of oil pollution in our seas, including oil and gasoline that drips from millions of cars and trucks every day. Moreover, nearly half of the estimated 1 million tons of oil that makes its way into marine environments each year comes not from tanker spills but from land-based sources such as factories, farms, and cities. At sea, tanker spills account for about 10 percent of the oil in waters around the world, while regular operations of the shipping industry—through both legal and illegal discharges—contribute about one-third. Oil is also naturally released from under the ocean floor through fractures known as seeps.

Radioactive substances

Radioactive waste is any pollution that emits radiation beyond what is naturally released by the environment. It's generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that use radioactive materials for research and medicine. Radioactive waste can persist in the environment for thousands of years, making disposal a major challenge. Consider the decommissioned Hanford nuclear weapons production site in Washington, where the clean-up of 56 million gallons of radioactive waste is expected to cost more than $100 billion and last through 2060. Accidentally released or improperly disposed of contaminants threaten groundwater, surface water, and marine resources.

What Are the Effects of Water Pollution?

On human health

To put it bluntly: Water pollution kills. In fact, it caused 1.8 million deaths in 2015, according to a study published in The Lancet. Contaminated water can also make you ill. Every year, unsafe water sickens about 1 billion people. And low-income communities are disproportionately at risk because their homes are often closest to the most polluting industries.

Waterborne pathogens, in the form of disease-causing bacteria and viruses from human and animal waste, are a major cause of illness from contaminated drinking water. Diseases spread by unsafe water include cholera, giardia, and typhoid. Even in wealthy nations, accidental or illegal releases from sewage treatment facilities, as well as runoff from farms and urban areas, contribute harmful pathogens to waterways. Thousands of people across the United States are sickened every year by Legionnaires' disease (a severe form of pneumonia contracted from water sources like cooling towers and piped water), with cases cropping up from California's Disneyland to Manhattan's Upper East Side.

Meanwhile, the plight of residents in Flint, Michigan—where cost-cutting measures and aging water infrastructure created the recent lead contamination crisis—offers a stark look at how dangerous chemical and other industrial pollutants in our water can be. The problem goes far beyond Flint and involves much more than lead, as a wide range of chemical pollutants—from heavy metals such as arsenic and mercury to pesticides and nitrate fertilizers—are getting into our water supplies. Once they're ingested, these toxins can cause a host of health issues, from cancer to hormone disruption to altered brain function. Children and pregnant women are particularly at risk.

Even swimming can pose a risk. Every year, 3.5 million Americans contract health issues such as skin rashes, pinkeye, respiratory infections, and hepatitis from sewage-laden coastal waters, according to EPA estimates.

On the environment

In order to thrive, healthy ecosystems rely on a complex web of animals, plants, bacteria, and fungi—all of which interact, directly or indirectly, with each other. Harm to any of these organisms can create a chain effect, imperilling entire aquatic environments.

When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn reduces oxygen levels in the water. This dearth of oxygen, known as eutrophication, suffocates plants and animals and can create "dead zones," where waters are essentially devoid of life. In certain cases, these harmful algal blooms can also produce neurotoxins that affect wildlife, from whales to sea turtles.

Chemicals and heavy metals from industrial and municipal wastewater contaminate waterways as well. These contaminants are toxic to aquatic life—most often reducing an organism's life span and ability to reproduce—and make their way up the food chain as predator eats prey. That's how tuna and other big fish accumulate high quantities of toxins, such as mercury.

Marine ecosystems are also threatened by marine debris, which can strangle, suffocate, and starve animals. Much of this solid debris, such as plastic bags and soda cans, gets swept

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into sewers and storm drains and eventually out to sea, turning our oceans into trash soup and sometimes consolidating to form floating garbage patches. Discarded fishing gear and other types of debris are responsible for harming more than 200 different species of marine life.

Meanwhile, ocean acidification is making it tougher for shellfish and coral to survive. Though they absorb about a quarter of the carbon pollution created each year by burning fossil fuels, oceans are becoming more acidic. This process makes it harder for shellfish and other species to build shells and may impact the nervous systems of sharks, clownfish, and other marine life.

Control of Water Pollution:

Water pollution, to a larger extent, can be controlled by a variety of methods. Rather than releasing sewage waste into water bodies, it is better to treat them before discharge. Practicing

this can reduce the initial toxicity and the remaining substances can be degraded and rendered

harmless by the water body itself. If the secondary treatment of water has been carried out, then this can be reused in sanitary systems and agricultural fields.

A very special plant, the Water Hyacinth can absorb dissolved toxic chemicals such as cadmium and other such elements. Establishing these in regions prone to such kinds of pollutants will reduce the adverse effects to a large extent. Some chemical methods that help in the control of water pollution are precipitation, the ion exchange process, reverse, and coagulation. As an individual, reusing, reducing, and recycling wherever possible will advance a long way in overcoming the effects of water pollution.

SOIL POLLUTION

With the rise of concrete buildings and roads, one part of the Earth that we rarely see is the soil. It has many different names, such as dirt, mud, and ground. However, it is definitely very important to us. The plants that feed us grow in soil, and keeping it healthy is essential to maintaining a beautiful planet. However, like all other forms of nature, soil also suffers from pollution. The pollution of soil is a common thing these days, and it happens due to the presence of man-made elements.

According to Environmental Pollution Centers, soil pollution is, "The presence of toxic chemicals (pollutants or contaminants) in soil, in high enough concentrations to pose a risk to human health and/or the ecosystem. In the case of contaminants which occur naturally in soil, even when their levels are not high enough to pose a risk, soil pollution is still said to occur if the levels of the contaminants in soil exceed the levels that should naturally be present."

The main reason why the soil becomes contaminated is due to the presence of man-made waste. The waste produced from nature itself, such as dead plants, carcasses of animals and rotten fruits and vegetables only adds to the fertility of the soil. However, our waste products are full of chemicals that are not originally found in nature and lead to soil pollution.

Types of Soil Pollutants

- Heavy metals (such as lead and mercury, at excessively high amounts) in the soil can make it very poisonous to humans.
- PAHs (polycyclic aromatic hydrocarbons) are a class of organic chemicals where only carbon and hydrogen atoms are present.
- Coke (coal) production, automobile emissions, cigarette smoke, and shale oil extraction are all sources of PAHs in the soil.
- Industrial Waste Soil contamination can come from the dumping of industrial waste into soils.
- Pesticides are chemicals (or chemical mixes) that are used to kill or prevent pests from reproducing.

However, unintended pesticide dispersion into the environment (often referred to as "pesticide drift") raises a number of environmental issues, including water and soil degradation.

Causes of Soil Pollution

Soil pollution can be natural or due to human activity. However, it mostly boils down to the activities of the human that causes the majority of soil pollution such as heavy industries, or pesticides in agriculture.

Pesticides

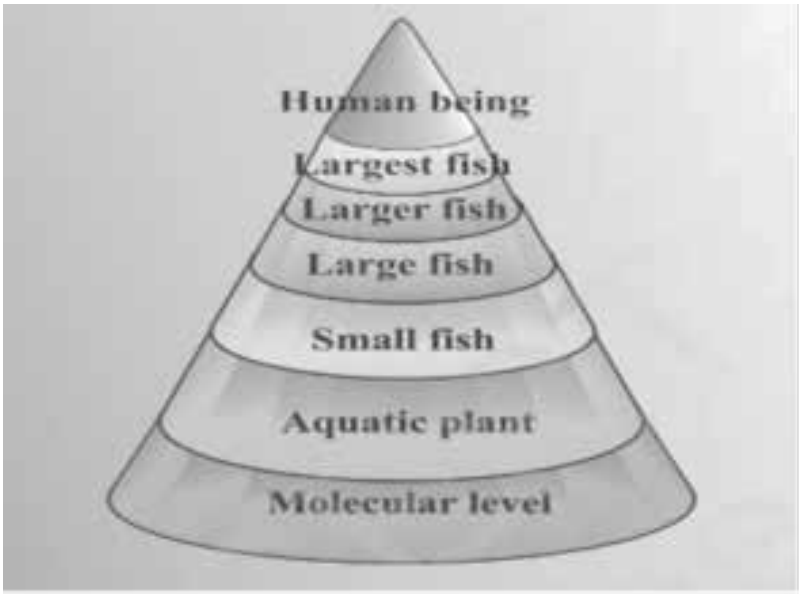
Before World War II, the chemical nicotine chemical present in the tobacco plants was used as the pest controlling substance in agricultural practices. However, DDT was found

to be extremely useful for malaria control and as pest control of many insects during World War II. Therefore, it was used for controlling many diseases.

Hence, post-war, people started using it as pest control in agriculture for killing rodents, weeds, insects, etc and avoiding the damages due to these pests. However, everyone gradually the adverse effects of this chemical which led to the ban of this chemical in many parts of the world including India.

Moreover, pests became resistance to DDT due to the chemicals regular use. Hence this led to the introduction of other harmful chemicals such as Aldrin and Dieldrin. Pesticides are synthetic toxic chemicals that definitely kill different types of pests and insects causing damage to agriculture but it has many ecological repercussions.

They are generally insoluble in water and non-biodegradable. Therefore, these chemicals will not gradually decompose and keep on accumulating in the soil. Therefore, the concentration of these chemicals will increase when the transfer of these chemicals take place from lower to higher trophic level via the food chain. Hence, it will cause many metabolic and physiological disorders in humans.



Chlorinated Organic toxins

The harmful effect of DDT and other chemicals led to the introduction of less persistent organic and more-biodegradable substance such as carbamates and organophosphates. However, these chemicals act as harmful toxins for nerves, hence they are more dangerous to humans. It led to pesticides related to the death of field workers in some agricultural fields.

Herbicides

Slowly, the industries began production of herbicides like sodium arsenite (Na_3AsO_3), sodium chlorate ($NaClO_3$), etc. Herbicides can decompose in a span of few months. However, even they affect the environment and are not environmentally friendly. Even though they are not as harmful as organo-chlorides but most of the herbicides are toxic. They are known to cause birth defects.

Furthermore, research suggests that spraying herbicides causes more insect attack and diseases of plants in comparison to manual weeding. One thing to note here is all the above factors occupy just a small portion of the causes. Majority of the causes is related to manufacturing activities in chemical and industrial processes that are released in nature or environment.

Inorganic Fertilizers

Excessive use of inorganic nitrogen fertilizers leads to acidification of soil and contaminate the agricultural soil. Also known as agrochemical pollution.

Industrial Pollution

The incorrect way of chemical waste disposal from different types of industries can cause contamination of soil. Human activities like this have led to acidification of soil and contamination due to the disposal of industrial waste, heavy metals, toxic chemicals, dumping oil and fuel, etc.

Inferior Irrigation Practices

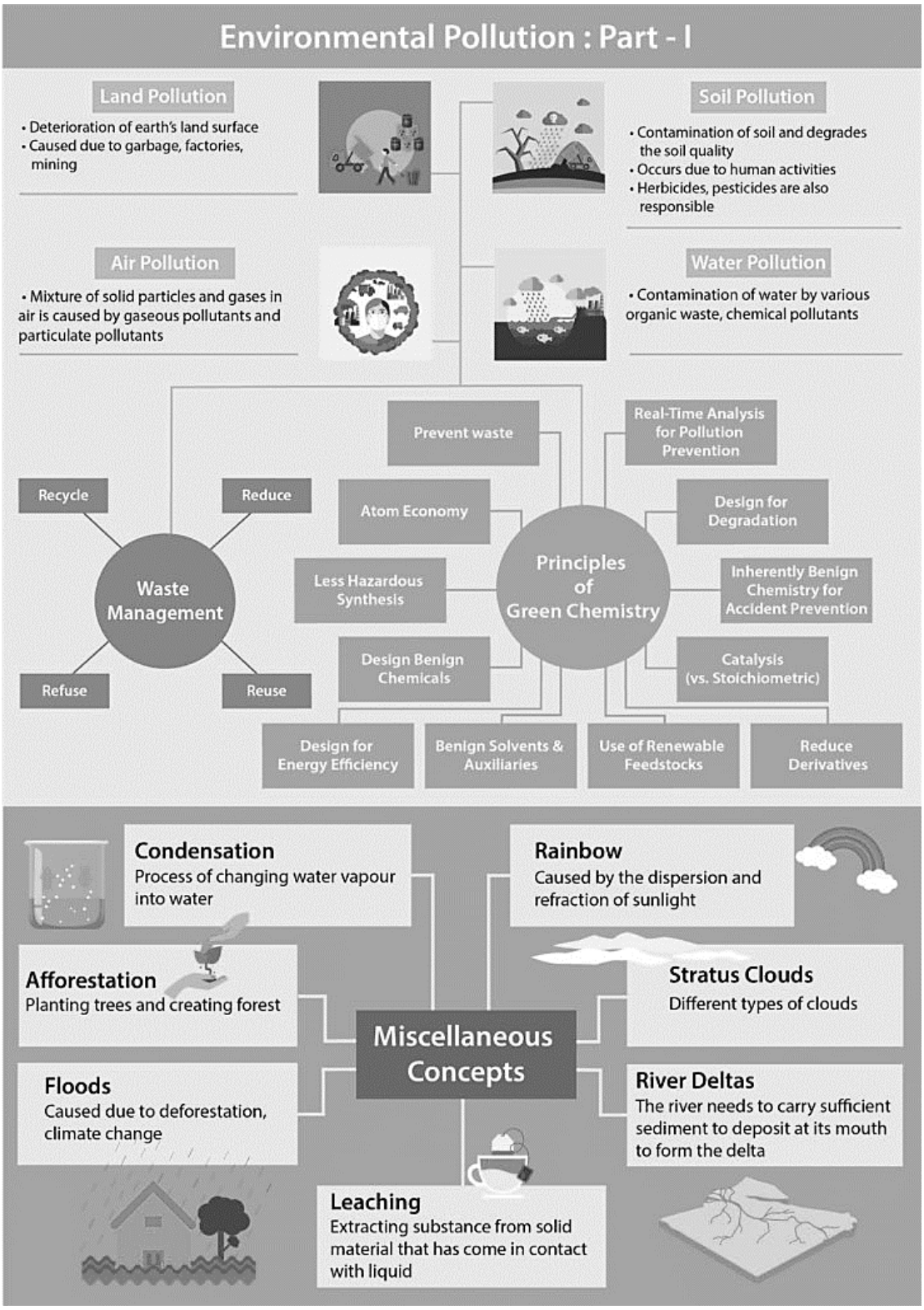
Poor irrigation methods increase the soil salinity. Moreover, excess watering, improper maintenance of canals and irrigation channels, lack of crop rotation and intensive farming gradually decreases the quality of soil over time and cause degradation of land.

Solid Waste

Disposal of plastics, cans, and other solid waste falls into the category of soil pollution. Disposal of electrical goods such as batteries causes an adverse effect on the soil due to the presence of harmful chemicals. For instance, lithium present in batteries can cause leaching of soil.

Urban Activities

Lack of proper waste disposal, regular constructions can cause excessive damage to the soil due to lack of proper drainage and surface run-off. This waste disposed of by humans contain chemical waste from residential areas. Moreover, leaking of sewerage system can also affect soil quality and cause soil pollution by changing the chemical composition of the soil.



Effects of Soil Pollution

Soil pollution is not only the problem in India but it is a global problem. It causes harmful effect on the soil and the environment at large. Contamination of soil will decrease the agricultural output of a land. Major soil pollution after effects are:

Inferior Crop Quality

It can decrease the quality of the crop. Regular use of chemical fertilizers, inorganic fertilizers, pesticides will decrease the fertility of the soil at a rapid rate and alter the structure of the soil. This will lead to decrease in soil quality and poor quality of crops. Over the time the soil will become less productive due to the accumulation of toxic chemicals in large quantity.

Harmful Effect on Human Health

It will increase the exposure to toxic and harmful chemicals thus increasing health threats to people living nearby and on the degraded land. Living, working or playing in the contaminated soil can lead to respiratory diseases, skin diseases, and other diseases. Moreover, it can cause other health problems.

Water Sources Contamination

The surface run-off after raining will carry the polluted soil and enter into different water resource. Thus, it can cause underground water contamination thereby causing water pollution. This water after contamination is not fit for human as well as animal use due to the presence of toxic chemicals.

Negative Impact on Ecosystem and Biodiversity

Soil pollution can cause an imbalance of the ecosystem of the soil. The soil is an important habitat and is the house of different type of microorganisms, animals, reptiles, mammals, birds, and insects. Thus, soil pollution can negatively impact the lives of the living organisms and can result in the gradual death of many organisms. It can cause health threats to animals grazing in the contaminated soil or microorganisms residing in the soil.

Therefore, human activities are responsible for the majority of the soil pollution. We as humans buy things that are harmful and not necessary, use agricultural chemicals (fertilizers, pesticides, herbicides, etc.), drop waste here and there. Without being aware we harm our own environment.

Therefore, it is very important to educate people around you the importance of environment if they are not aware. Prevention of soil erosion will help to cease soil pollution. Thus, it is our small steps and activities that can help us to achieve a healthier planet for us. Therefore, it is essential for industries, individuals and businesses to understand the importance of soil and prevent soil pollution and stop the devastation caused to plant and animal life.

The solution to reduce the soil pollution

- Use of correct farming techniques.
- Recycling of Waste before disposal, Recycle and Reuse Products.
- Use of organic fertilizers instead of chemical fertilizers and pesticides.
- Community education and awareness, Get the Locals Involved.
- Proper maintenance of sewage system, Proper disposal method of household and industrial waste.
- Reforestation and Afforestation Should be Promoted.

- Planting new trees and plants is afforestation. We live because plants live. If the plants die, all living things will also die. Thus, whenever trees are cut down new trees should be planted. Planting trees in hilly areas are most effective for conservation.

MARINE POLLUTION

Marine pollution refers to the contamination or presence of pollutants in oceans and seas. The word 'marine' comes from the Latin word for 'sea' and it is related to similar words, such as 'mariner'. Ocean pollution is become ever more of a problem in the present day.

Marine pollution can be defined as anything that contaminates the sea. Common marine pollutants include chemicals, small plastic beads in exfoliants and also toxic bio-matter (such as sewage). But, noise – due to excessive traffic around the ocean – can also be defined as pollution if it disrupts marine life.

Pollution can vary depending on the context and the purpose for which seawater is being used. For example, normal seawater has some small particles of plants or sand in, and when the sea is considered as the habitat of marine animals, one would not think of these particles as pollutants – whereas one would definitely define toxic chemicals as pollutants. However, if somebody wanted to use this brine for cooking in, they might see the sand and plants as polluting our cooking water.

Causes of marine pollution

1. **Toxic chemicals in water.**

   Chemical runoff from industry can really endanger marine life. Industrial waste pumped into the sea, household cleaners poured down the sink, and even chemicals in the atmosphere (for instance due to the discharge of industrial wastes through factory chimneys) that dissolve into the sea can pollute our oceans significantly.

2. **Oil spillages.**

   This is usually an accidental form of industrial dumping, whereby leaks in oil tankers cause vast quantities of oil to pour into the ocean. Accidental oil spills can devastate marine life.

3. **Small particles.**

   The tiny plastic beads in exfoliating creams and other small particles that we pour down the drain without thinking wind up polluting the ocean.

4. **Plastic, Litter, and human waste.**

   Plastic bags, aluminium cans, trash and other human waste constitute a major pollutant of the world's oceans. A huge 'island' of trash roughly the size of Texas was recently found in the Pacific Ocean for instance, demonstrating the vast scale of this problem.

5. **Sewage.**

   Whether or not it is treated with toxic chemicals, sewage pollutes the clear, clean water of the oceans. This is another type of industrial dumping. Sometimes, sewage is not pumped directly into the sea but into rivers, and then the untreated water of rivers carries it into the sea.

6. **The shipping industry.**

   Gases (which dissolve in the sea), chemicals and sewage from container ships are major pollutants.

7. **Dissolved greenhouse gases.**

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

Effects of Marine Pollution

1. **Oxygen depletion.**

   Seawater is full of dissolved oxygen, however decomposing sewage and other biomatter in oceans can result in a condition known as 'hypoxia' or oxygen depletion. This makes it hard for oxygen loving marine life – plants, fish and animals – to survive in the oceans.

2. **Higher acidity.**

   Toxic chemicals make our oceans more acidic. Again, this makes them poisonous to marine life and causes harm to fish and marine mammals as well as marine plants and corals.

3. **Choking marine life.**

   Small pieces of plastic and other litter are increasingly being found in the stomach of fish, turtles and other marine animals. These pieces of trash choke marine animals and hamper their digestion, with an often-fatal result.

4. **Spoiling birds' feathers.**

   Oil spills coat the feathers of marine birds and strip them of the natural oils that birds use to keep their feathers waterproof and to maintain their own body temperatures. As a result, marine birds can overheat or get too cold, and they find it hard to stay afloat as their feathers get soggy. They will also find it difficult to fly when their feathers are clogged with oil.

5. **Blocking out the sunlight.**

   Pollutants such as oil or litter can block out the sunlight from sea plants which need sunlight for photosynthesis.

6. **Dangers to human health.**

   Human swimmers and water sports lovers can become endangered by swimming in a polluted sea.

Control Measures for Marine Pollution

1. **Be careful with our chemicals.**

   Climate change and marine pollution are both results of excess human interference in the natural world. If we choose eco-friendly household cleaners and take measures to reduce the fumes we release into the air (for instance, by choosing public transport over cars) we can reduce the impact of our lives on the oceans.

   Further, careful site monitoring to prevent or stop any chemical or oil spills at all times will reduce the instances of oil spills.

2. **Don't flush or rinse away harmful particles.**

   If we do not flush plastics down the toilet, and if we do not pour oils and exfoliating beads down the faucet, we prevent these particles from reaching our oceans. Switch to exfoliants that use natural materials like seeds, sugar or sand instead – and recycle all plastics.

3. **Campaign.**

   Influence the decisions of policymakers and factory bosses to make them more eco-friendly by lobbying, writing letters, spreading the word on social media and campaigning. Motivating the shipping companies to use safe and environmentally friendly vessels are among the key measures that can be taken here.

4. **Volunteer at an oil spill site.**

   Volunteers are always needed at oil spill sites to save the lives of marine birds by washing the oil from their feathers and caring for them until they are ready to fly, swim and dive under water again. Intervention is always needed as soon as possible to ensure that these birds do not suffer any ill effects to their health.

5. **Volunteer at a beach cleanup – or organize one yourself.**

   Rid your local beach of litter by getting together with the rest of the community to pick up the trash left behind by careless picnickers, boat crews and more. Joining together as a community to care for the natural world is a wonderful way to remind everyone how intimately we are connected to nature, and how much we depend on it. Working together with other people also helps to keep us motivated and reminds us that we are not alone in our quest to care for the environment.

6. **Ensuring no debris is released into the ocean.**

   Recycling our plastics and other recyclable, and disposing of our waste responsibly is key here.

NOISE POLLUTION

Sound is main means of communication in many animals, including humans. A low sound is pleasant and harmless. A loud, unpleasant or unwanted sound is called as noise. A given sound can appear music to some and noise to others. It depends upon loudness, duration and mood of a person. Noise (La. nausea=seasickness) is physical form of pollution. It is not harmful to air, soil and water but affects the animals including humans. Noise is unwanted sound, that is unpleasant, loud and disruptive.

Humans have a hearing range called as audible range. Audible range depends upon frequency and loudness of sound. For a person with normal hearing, frequency ranges from 20 to 20,000 Hz and loudness ranges from 0 to 120 dB. Sound is measured in decibels (dB). A decibel value above 80 is considered to be noise pollution.

Sources of Noise Pollution

1. **Industrialization:** Most of the industries use big machines which are capable of producing noise. Apart from that, various equipment's like compressors, generators, exhaust fans, grinding mills also participate in producing noise.

2. **Poor Urban Planning**: In most of the developing countries, poor urban planning also plays a vital role. Congested houses, large families sharing small space, parking lots, street noise, honking, commercial zone leads to noise pollution which disrupts the environment of society.
3. **Social Events:** Noise is at its peak in most of the social events. Whether it is marriage, parties, pub, disc or place of worship, people normally defy rules set by the local administration and create nuisance in the area. People play songs on full volume and dance till midnight which makes the condition of people living nearby pretty worse.
4. **Transportation:** Large number of vehicles on roads, aero planes, trains produce heavy noise. The high noise leads to a situation wherein a normal person loses the ability to hear properly.
5. **Construction Activities:** Construction activities like mining, construction of bridges, dams, buildings, stations, roads, flyovers take place in almost every part of the world. These construction activities have to be continued to meet the demand of ever-increasing Population. It also creates noise pollution.
6. **Household Chores: We** people are surrounded by gadgets and use them extensively in our daily life. Gadgets like TV, mobile, mixer grinder, pressure cooker, vacuum cleaners, washing machine and dryer, cooler, air conditioners are also contributors to the amount of noise that is produced and but many times it affects the quality of life of our neighborhood.
7. **Fireworks:** Firework is a common thing during various fairs, festivals and cultural ceremonies. Apart from air pollution, the intensity of their sound creates noise pollution.
8. **Agricultural Machines:** Tractors, thrashers, harvesters, tube wells, powered tillers etc. have all made agriculture highly mechanical but at the same time highly noisy.
9. **Defence Equipment and launching of satellites:** A lot of noise pollution is added to the atmosphere by artillery, tanks, launching of rockets, explosions, exercising of military airplanes and shooting practices. Screams of jet engines and launching of satellite, sonic booms have a deafening impact on the ears.
10. **Miscellaneous Sources:** The automobile repair shops, market places, schools, colleges, bus stands, and railway stations etc. are other sources of noise pollution.

Effects of noise pollution

Human response to noise varies from man to man according to age and temperament. It may vary even in the same individual from time to time because of change in health, fatigue and other conditions. The effects of noise on human beings are as under: -

1. **Auditory effects:** It includes deafness or auditory fatigue.

   Deafness or impaired hearing: Prolonged exposures to noise lead to gradual deterioration of internal ear and subsequently hearing loss or deafness. It may occur due to continuous exposure to noise level of more than 90 dB. It may be temporary or permanent. Explosions or other high intensity sounds can also cause

immediate deafness by rupturing the ear drums or damaging the cochlea. Many times, hearing loss is attributed to occupation.

Auditory fatigue: It is defined as a temporary loss of hearing after exposure to sound. Continuous humming sound such as whistling and buzzing in the ears.

2. **Non auditory effects:** These are: -

   Irritation and annoyance: Noise, sometimes, leads to emotional disturbances and makes people lose their temper. It can interfere with proper rest and sleep. Annoyance seems to increase with the loudness of the sound.

   Work efficiency: It has been observed that noise reduces the efficiency of work.

   Physiological effects: It includes dilation of the pupils, paling of skin, tensing of voluntary muscles, diminishing of gastric secretions, increase in diastolic blood pressure and the sudden injection of adrenalins into blood stream which increases neuromuscular tension, nervousness, irritability and anxieties. It can adversely affect the development of unborn babies.

   Other health effects: Noise is also associated with headache, giddiness, sweating, nausea, fatigue, difficulty in breathing, disturbed sleep pattern, psychological stress.

   Trouble Communicating: High decibel noise can put trouble and may not allow people to communicate freely. Constant sharp noise can give you severe headache and disturb your emotional balance.

   Effect on Animals: Animals rely heavily on sounds to communicate, to find food, avoid predators etc. Pets react more aggressively due to exposure to constant noise. They become disoriented more easily and face many behavioral problems. Overexposure to high intensity of noise affects the hearing ability of many animals. Man-made noise affects mating calls and echolocation. This leads to reduction in survival and reproduction rates. At an ecosystem level, noise pollution could lead to migration of animals. Their migration can affect the crop production. Because many animals such as bats pollinate bananas, peaches, agave and other cash crops.

   Effect on non-living things: The noise booms cause cracks in walls of buildings as well as in hills. Sonic boom can break window panes and buildings.

Steps to Control Noise pollution

Noise pollution can be effectively controlled by taking the following measures:

1. **Control at receiver's end:** For people working in noisy installations, ear-protection aids like ear-plugs, ear-muffs, noise helmets, headphones etc. must be provided to reduce occupational exposure.
2. **Suppression of noise at source:** It can be achieved by following methods:
   a. Designing, fabricating and using quieter machines to replace the noisy ones.
   b. Proper lubrication and better maintenance of machines.
   c. Installing noisy machines in sound proof chambers.
   d. Covering noise-producing machine parts with sound-absorbing materials to check noise production.

e. Reducing the noise produced from a vibrating machine by vibration damping i.e., making a layer of damping material (rubber, neoprene, cork or plastic) beneath the machine.

f. Using silencers to control noise from automobiles, ducts, exhausts etc.

3. **Acoustic Zoning:** There should be silence zones near the residential areas, educational institutions and above all, near hospitals. Zoning of noisy industrial areas, bus terminals and railway stations, aerodromes etc. away from the residential areas i.e., increasing the distance between source and receiver.
4. **Sound Insulation at Construction Stages:** It reduces the chances of noise nuisance in future. Some of these measures could be:

   a. The space/cracks that get left between the door and the wall should be packed with sound absorbing material.

   b. Sound insulation can be done by constructing windows with double or triple panes of glass and filling the gaps with sound absorbing materials.

   c. Acoustical tiles, perforated plywood etc. can be fixed on walls, ceilings, floors etc. to reduce noise (especially for sound proof recording rooms etc.)
5. **Planting of Trees:** Green muffler scheme involves planting green trees and shrubs along roads, hospitals, educational institutions etc. to reduce noise to a considerable extent. Trees like Ashoka, Neem, Tamarind is good for this purpose.
6. **White noise: -** It is a special type of sound signal which is used to mask background sounds. White noise helps to mask out sounds which might otherwise prevent one from either falling asleep or waking up whilst asleep.
7. **Legislative Measures:** Strict legislative measures need to be enforced to curb the menace of noise pollution. Noise standards (Table) should be strictly followed. Minimum use of loudspeakers and amplifiers especially near silence zones. Banning pressure horns in automobiles. Albeit, noise has been considered as pollutant under Air act and the noise pollution (regulation and control) rules (2000) have been framed under Environment protection act. But still people need to be educated about harmful effects of noise.

THERMAL POLLUTION

Water pollution caused due to heat is defined as thermal pollution. When hot water from different sources released to different water bodies harms the aquatic life including animals and plants.

Sources of Thermal Pollution:

- Industries
- Nuclear Power plant
- Thermal Power Station
- Effects of Thermal Pollution
- Destroyed Aquatic Life

- Cellular Proteins loses its properties
- Affect Enzymes system and metabolic activities
- Quantity of dissolved oxygen reduced
- Algae population disappears
- Damage ecological balance

Control Thermal Pollution

Water should be cool down before it discharged to waterbodies. Tankers or reservors should be kept in industrial areas to retain water and cool down.

NUCLEAR HAZARDS

Today the vast and wonderful diversity of plant and animal kingdom that largely sustains the planet's ecological equilibrium is seriously endangered due to chronic radiation pollution. The main radiation hazard in the environment comes from ultraviolet, visible, cosmic rays and microwave radiations which produce genetic mutations in man. The biggest hazard comes from X-rays which account for 95% of our radiation exposure other than cosmic rays. Man has always been exposed to low levels of ionizing radiations from natural resources. But with the advent of nuclear weapons, exposure levels have increased enormously. The menace of radioactive pollution has raised extensively as a result of the discovery of artificial radioactivity, particularly due to the development of atoms bomb, hydrogen bomb and of techniques of harnessing nuclear energy. From neutron bombardment of atomic fuel, heavy radionuclides are produced which are extremely toxic. Once these radio-elements find access into the environment, they enter the Eco cycling processes and ultimately into food chain and metabolic pathways.

The main issue that Arises-Is there any virgin environment that has not been exploited by man? Every now and then we hear about a Chernobyl type of horrible disaster in the offing in our nuclear plants and the evils that amniocentesis has brought on the man. Nuclear science which has produced a host of beneficial peaceful applications, has also led to the piling up of nuclear arsenals capable of wiping out the entire humanity in a few seconds' time. Even then are we desirous to control our nuclear power.

Causes

Living organisms are continuously exposed to a variety of radiation sources which are categorized into natural and anthropogenic sources.

Natural causes of radiation

1. **Solar Rays:** Solar rays coming from the sun keep a steady drizzle of gamma rays, cosmic rays and heavy particles. Solar storms vastly intensify these showers, but the earth's atmosphere shields us from most celestial radiations.
2. **Electromagnetic Radiations:** These radiations are highly energetic and include the following rays:

- X-rays
- Ultra-violet rays

- Infrared rays
- Visible rays
- Gamma rays
- Radio waves

3. **Particulate Radiations:** Particulate radiations consist of proton, neutron, electron, alpha and beta particles. Cosmic rays become extremely intense at about 20 km above the earth. A Pilot receives 300 m rad per year of cosmic rays. People Travelling by jet lines get an extra exposure to cosmic rays.
4. **Environmental Radiations:** Radio-isotopes of naturally occurring radio release enormous number of radiations in the form of alpha, beta and gamma particles. Besides Radio-isotopes additional radiations emanate from air, soil, rocks and ground water. These radiations mix and interact with natural particulate materials in the atmosphere enhancing the extent of radioactive pollution.
5. **Radionuclides in Earth's Crust:** Radioactive elements, such as u.238 '. Th - 232, Ra-222 and K-40 which are widely distributed in earth's crust give rise to terrestrial radioactivity. The crops grown on such soil contain radioactive elements which are ingested in human body along with the food. All these natural sources continuously pour their radiations into the environment. After all man has originated and evolved in a world of natural low-level radiation. We cannot avoid living in a sea of radiations. Indeed, our entire ecosystem hums with low levels of natural radiation.

Anthropogenic causes of radiation

Recently manmade sources have begun to add large doses of radiation to the existing natural radioactive pollution to which our bodies have got accustomed with several ill effects. The major causes are:

1. **Medical X-rays:** Medical X-rays constitute about 18% of artificial radiations used in radiotherapy for diagnostic purposes. These rays are highly penetrating like the gamma rays. X-ray exposure is cumulative in the body and creates chronic defects in the internal organs.
2. **Radio-isotopes:** Indiscriminate use of radio-isotopes administered to patients during radiation therapy, their overdoses and improper handling are hazardous sources of nuclear pollution.
3. **Nuclear Tests**: During nuclear explosion test, a large quantity of long-lived radionuclides are released to the atmosphere, which get distributed ail over the world. Radionuclides formed in explosion test include hazardous fission fragments such as Sr-90, Cs-137, Ba-141, I-131 along with unused explosives and activation products.
4. **Nuclear Power Plants:** Nuclear power plants consist of nuclear reactors which utilize either plutonium or uranium as nuclear fuel to generate electricity by controlled chain reaction. In 2001, there were over 130 nuclear power plants in USA and more than 400 in rest of the world. The major constraint in the use of nuclear fission power is the yield of enormous quantities of radioactive fission waste products which remain lethal for thousands of years.

5. **Nuclear Reactors:** Nuclear reactors generate various wastes like:
   - Fission products remaining in both the primary and secondary fuels.
   - Extraneous activation products in the coolant.
   - Gaseous wastes of several nuclides comprising C-14, H-3, Xe-133, I-131, Kr-85, Ar-41
   - Liquid wastes containing H-3, C0-58, Fe-55, Co-59

   These nuclear wastes Constitute an ever- increasing source of nuclear pollution. However, pollution from such sources is bound to increase in future, as more nuclear reactors are installed to meet the rising energy demands. No one can guess its disastrous effects that what would happen in a nuclear accident if the reactor core melts down.
6. **Radioactive Ore-Processing:** Radioactive ores of uranium like pitch blend and uraninites as well as thorium are used in nuclear operations. Processes, i.e. mining, washing, refining, separation and milling etc. cause nuclear pollution in the atmosphere. All these treatments during ore processing result in the release of radioactive gases which subsequently adsorb on the particles, present in the atmosphere
7. **Industrial, Medical and Research use of Radioactive Materials:** Human activities have always resulted in some impacts on the environment, be these for agriculture, deforestation food, security, industrialization or technological developments Rapid industrialization of power plants have resulted in devastating the virgin atmosphere. Leakage of nuclear radiations from reactors, plants and nuclear research laboratories result in radiation pollution. Radionuclides administered to patients during medical diagnosis used in radiation therapy and scientific research laboratories have proved to be the main source of nuclear pollution.
8. **Radiation Pollution from Electric Fields:** Electrical gadgets and power transmission lines_ generate electric field causing environmental radiation hazard. Man is continuously exposed to such low frequency electric fields which are enough harmful.

Effects of nuclear hazards

Detrimental effects of radiation became known as 1895 when Wilhelm Roentgen put his hand between X-ray tube and) fluorescent screen. These rays penetrate deeply and the bones cast a deeper shadow than the flesh. In 1903, the French Physicist H. Becquerel discovered naturally ray emitting elements and shared the Nobel Prize with Madam Marie Curie. M. Curie discovered radium, which is 25000 times more lethal than arsenic. The potency of radiation toxicity was realized by the death of M. Curie when she died of leukemia. Radiation poses a wide range of symptoms and syndromes causing several adverse effects.

1. **Effects of Ionizing Radiations on Man:** Man is considered to be the final prey towards radiation effects and is at the end of all reactions and interactions. Ionizing radiation poses deadly cellular damage in man

NOTES

2. **Effects of Non-Ionizing Radiations**: Modern life and radiations seem to increase the risk of radioactive pollution. of all the non-ionizing radiations including infrared, radio waves, microwaves, radar etc., the action of ultraviolet (UV) radiation has been extensively studied.

   Effects of UV Radiations: UV radiations are thought to trigger two distinct immunological effects. One is confined to patches of skin that are actually irradiated while the other damage is caused to the immune system as a whole.

   - UV radiations cause leukemia and breast cancer, although the reasons are obscure. According to an estimate nearly 7000 people die of such cancers in USA every year.
   - UV rays can also be absorbed by lens and cornea in the eye leading to photokeratitis and cataracts. Since the radiation is not sensed by the visual receptors of eye, the damage is done without the individual knowing about it hazards.
   - UV radiations also affect drastically the micro-phytoplankton. Increased UV rays Will increase the mortality rate of zooplanktons in water. Enhanced radiation also impairs the fish productivity.
   - Plants absorb strongly the light near 280 nm. So, plant proteins are more susceptible to UV injury in plants 20% to 5O% chlorophyll reduction and harmful mutations are seen.

3. **Effects of Microwave Radiation**

   Microwaves between 10 to 30 cm can penetrate the epidermis and fat layer of the skin, while the waves longer than 30cm can penetrate deep tissues of dermis causing the skin hot. The eyes and other organs that cannot dissipate heat are most vulnerable to microwave radiations. Microwaves cause pearl chain effect where particles align in chain when subjected to an electric field. Radar Hazards. The radar hazards cause headache, nervousness and skin diseases.

4. **Biological Effects of Radiation**

   - Eye lens is vulnerable to high doses of radiation. It damages eye cells so that the eye lens becomes opaque forming cataract which impair sight.
   - Cumulative radiation sickness is marked by vomiting, bleeding of the gums and mouth ulcers in man.
   - High doses of radiation cause internal bleeding and blood vessels damage which become evident as red spots on the skin.
   - Acute nausea and vomiting begin within few hours after the gastro-intestinal tract is exposed.
   - Embryos get critically damaged. Unborn children are especially vulnerable to brain damage or mental retardation, if irradiation occurs during formation of central nervous system in early pregnancy.
   - Cumulative doses acutely damage the reproductive organs like ovaries and testes that may badly affect the victim's fertility as well as their off springs.

- High radiation doses cause damage to bone marrow: the body's blood factory. It is especially dangerous because it retards body's ability to fight against infection and hemorrhaging by harming the white blood corpuscles.
- The short-term damage may include anemia, fatigue, blood, kidney and liver disorders, epilation, skin changes including erythema, pigment discoloration and premature aging.

5. **Effects of Laser Radiation**

   Light amplification by stimulated emission of radiation (Laser) in gaseous systems was first reported in 1961 in a helium neon mixture. CO2, -laser and He-lasers are used in surgery. The latter is particularly useful for percutaneous myocardial revasculation (PMR). UV lasers cause photophobia, erythema, exfoliation of surface tissues. In case of IR laser radiation damage results from surface heating of cornea. Visible lasers (wavelengths of 0.4 to 0.75 nm) hit the epithelium of the retina. At extremely high-powered laser radiation (e.g., Q-switched pulses), depigmentation of skin, erythema, blistering and charring occurs. Important control principles to protect from exposure to laser systems include imparting awareness to people concerned regarding potential hazards, applying primary engineering and other controls, e.8., enclosure, beam stops, shutter, using shielding and safety goggles.

6. **Radiation Effects on Plants**

   Radiation effects are generally common to plants and animals. Small amounts of radionuclides may lead to an increase in the rate of mutation in plants also Radioactive elements accumulate in soil, sediments, air and water. Lethal doses or radioactive fallout materials (Sr-90 and Cs-137) reach man via., the food chain.

   Intense radiations kill plants but differently. Trees and shrubs vary 1n reactivity and sensitivity towards radioactive substances. This variation is mainly due to the difference in chromosome number and size. However, a chronic dose of 1 R per day continued for 10 years causes so much growth reduction in pines as an acute dose of 60 R.

   Studies revealed that after the disastrous Chernobyl accident the herbs, plants, soil and reindeer herds of Sweden and Norway were showered with radioactive rain for several days. 'Today the lichens-the people contaminated with radionuclides.

Control measures of nuclear hazards

With the present endeavors for improving the comforts and standards of living on one hand and for meeting growing demands of energy from natural resources, much longer-term impacts of radiations in the coming years are inevitable. So there. resources, is a dire need to look for source other than the conventional ones to control radiation hazards. Also, preventive measures from radiation should be double edged so as to curtail the effects of both natural and artificially produced occupational exposure. Following control measures should be adopted:

- Nuclear devices should never be exploded in air if the activities are extremely necessary then they should be exploded underground.

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- In nuclear reactors closed cycle coolant system with gaseous coolants of very high purity may be used to prevent extraneous activation products
- Containments may also be employed to decrease the radioactive emissions. It can be achieved by using tightly sealed boxes and closed cycle systems.
- Production of radionuclides should be minimized, as once produced they cannot be rendered harmless by any means except the passage of time.
- Fission reactions should be minimized as the rate of decay of rad10nuchdes and subsequent emission of radiations are unaltered by man.
- In nuclear and chemical industries, the use of radio-isotopes may be carried under a jet of soil or water instead of powder or gaseous forms.
- In nuclear mines, wet drilling may be employed along with underground drainage.
- Extreme care should be exercised in the disposal of industrial wastes contaminated with radionuclides.
- Using high chimneys and ventilators at the working place where radioactive contamination is high. It seems to be an effective way for dispersing radio-pollutants
- Nuclear medicines and radiation therapy should be applied when absolutely necessary with minimum doses.
- Protection from internal irradiation can be done by using regular protective clothing (overalls, cap, gloves, slippers) while performing experiments. While decontaminating glove boxes, use is made of respirator and plastic overalls etc.
- Collect the radioactive powder with wads wetted in mineral oil.
- Minimum number of nuclear installations should be commissioned as it is a fruitful measure to limit the emission of radio-pollutants.
- During nuclear installations, various efforts, including the process of site selection, its design, construction, commissioning, operation of decommissioning, its short- and long-term effects etc. should be seriously considered to control radiation.
- Environmental parameters such as micrometeorological data hydrological data. identification of critical group of population likely to be most exposed to radiation, foundation conditions and seismicity of the region should be undertaken before selecting and constructing a major nuclear industry.
- The pre-operational data so collected should be used to set the limits release of radioactive gases. The monitoring stations should carefully monitor the release of radio-isotopes during nuclear power installation.
- The recipient sectors of the environment with their safe capacities to accept the radio-toxins must be identified.
- Maximum efforts need to be put into making solar energy and fusion reactors feasible, not only to meet our energy requirements but also to minimize our dependence on present day fusion-fission based nuclear reactors.
- Main prophylactic measures include: The equipment, technological conditions, rational system of ventilation and disposal of radio-waste

Minimizing x-ray hazards

There is a general tendency among medical practitioners to stretch the use of X-rays as a diagnostic tool. The patient is X-rayed for the same investigation in more than one hospital. To minimize X-ray hazards, following steps need to be considered.

- A patient receives much larger dose during screening than while performing a radiographic procedure. Minimum screens should be taken to reduce the harm.
- X-ray screening can be replaced by radiography. In unavoidable cases, modern screening aids like image intensifiers could be used.
- Screening units should always be fitted with a fluoroscopic timer and should be strictly under radiological surveillance.
- Today numerous diagnostic modalities are available which do not involve an ionizing radiation and are harmless. Magnetic resonance imaging and ultrasonography are the recent diagnostic techniques that may yield more accurate information than the ionizing radiations.

3.4 SOLID WASTE MANAGEMENT

Any unwanted or discarded material from residential, commercial, industrial, mining and agricultural activities that causes environmental problem may be termed as solid wastes. Solid waste management comprises of systematic control of the generation, storage, collection, separation, treatment, processing, recycling., recovery and disposal of solid wastes.

Classification of Solid Wastes.

1. **Municipal Solid Wastes (MSW):** MSW include garbage and rubbish from households, hotels, offices, markets etc. Garbage denotes biodegradable food wastes while rubbish is used for non-biodegradable waste which may be combustible (e.g., paper, plastic, tyres) or non-combustible (e.g., glass, metals, used containers etc.)
2. **Industrial Solid Wastes**: These wastes are:
   - Process waste which depends upon the type of the products being manufactured such as tannery wastes, food processing wastes, plastic and rubber waste etc.
   - Non-process wastes like packing waste, cafeteria waste8 are common to all industries.
3. **Biomedical Solid Waste:** BMW includes pathological and surgical wastes.
4. **Agricultural Wastes:** These wastes result from farms, feed lots and livestock yards. Horticulture wastes consists of vegetable parts.
5. **Other Wastes:** Construction/demolition wastes include debris, rubbles, wood, concrete etc. Radioactive hazardous wastes are from nuclear power plants and laboratories etc. Electronic wastes originate from discarded electronic devices such as TV, computers. The annual solid waste production in India is: Domestic and trade (8.5%), industries (15.2%), thermal power stations (7.3%), mining (67%) and construction (2%).

Effects of solid wastes

Municipal solid wastes heap up on the roads due to improper disposal system. Open dumping allows biodegradable materials to decompose under unhygienic conditions. This produces foul odour and breeds disease vectors and infectious pathogens beside spoiling the aesthetics of the site. Industrial solid wastes are the sources of toxic metals and hazardous wastes which may leach or percolate to contaminate the ground water.

The hazardous wastes are mixed with garbage and other combustible waste. This makes segregation and disposal more difficult and riskier. Various types of wastes like cans, pesticides, solvents, radio-isotopes, plastics, etc. are mixed with paper, scraps and non-toxic materials which could be recycled. Burning of these waste produce furans, dioxins, poly chlorinated biphenyls which have the potential to cause several ailments including cancer

Management of solid wastes

Objectives. The aim of waste management is to collect, treat, utilize, control and dispose solid waste in an economic manner consistent with the protection of public health. Its major consideration apart from health is to adopt thro R's-reduce, reuse and recycle strategy.

- **Reduction in use of raw materials:** This will correspondingly decrease the production of waste. Reduced demand of any metallic product will decrease the mining of their metal and cause less production of waste. Etc.
- **Reuse of waste materials:** Reuse of paper, cardboard, glass, metal. plastic, discarded cycle tubes, auto parts of vehicles of generation. considerably reduces the waste of generation.
- **Recycling of materials:** Recycling is the reprocessing of materials discarded materials into new useful products. Examples include formation of new cans, bottles from broken aluminum cans and glass, fuel pellets from kitchen waste, cellulose from waste paper, ethanol from bagasse etc. Coal ash, the residue after coal left combustion for power generation, is an important source of ferrosilicon, silicon and aluminum.

  One tonne of solid waste processed by pyrolysis is believed to yield an energy equivalent to one barrel of oil. One tonne of combustible waste to 9 million BTU of produces energy equal heat or 65 gallons of fuel oil or 9000 cubic feet of natural gas.

Municipal solid waste treatment

Composition of MSW. The average composition of MSW is 30 to 40% organic matter, 30 to 40% fine materials, 5% paper, 1% glass, 1% metals and 1% plastic. Actual composition of MSW varies demographically. For discarding wastes, following treatment methods are adopted.

- **Sanitary Landfill:** In sanitary landfill operation, garbage is spread in thin layers compacted and covered with clay or plastic foam. In the modern landfills, the bottom is covered with an impermeable liner, usually several layers of clay, thick plastic and sand. The liner protects the ground water from being contaminated due to percolation of leachate. Leachate from bottom is pumped and sent for When treatment. landfill is full it is covered with clay, sand, gravel and top soil to prevent

seepage of water. Methane produced by anaerobic decomposition is collected and burnt to produce electricity or heat. Other methods of landfill treatment are sewage farming, spray irrigation, ridge and furrow and lagooning etc. In India, there exists 200 sewage farms covering 25000 hectares and using 650 million gallons of sewage per day. With increase in urbanization, planned sanitary landfill, backed by modern solid waste management, can provide the community with better environmental management.

- **Composting and Municipal Waste Composting Projects:** Composting the aerobic and thermophilic decomposition of organic waste to humus by micro-organisms like bacteria, fungi and worms. The process is conducted by a complete automatic system. (i) The crude refuse is dumped into a container or to a belt conveyor. (ii) Iron or metallic particles are removed by The wet material a magnetic separator. is then transferred to a rotatory cylinder which rotates on large tyres. Here aerobic microbes rapidly decompose pulverized wastes under aerobic conditions. The Government encourages feeding of wastes. compost plants by municipal Compost have been used by Indian Agricultural Research Institute to produce blue-green algae coated granulated compost.
- **Vermi Composting:** In vermiculture, earthworms feed on and degrade a variety of organic waste, eliminate noxious elements and convert the waste into high grade nutrient rich vermi-compost. It is very useful bio fertilizer and soil conditioner.

Incineration. Incineration involves burning of solid wastes at high temperature either on batch or continuous type incinerators. The modern municipal incinerators are of continuously burning type. These are equipped eh large storage bins, automatic feed hoppers, moving grates, ash discharging systems, pollution control devices like scrubbers and electrostatic precipitators. unit yields stable residue free from offensive odours. The waste heat of combustion can be utilized for supplementing electricity generation for domestic heating etc. However, the technique involves expensive equipment.

Industrial solid waste treatment.

- **High Temperature Incineration of Industrial Solid Waste:** It is a recent innovation where high temperature (1650°C) is attained using supplementary fuels. The non-combustible fractions of the refuse (metals, glass) can be melted and reused.
- **Pyrolysis:** The combustible constituents of the solid wastes are heated in a pyrolysis reactor at 1000°C in a low oxygen environment. Pyrolysis of the waste yields several components such as methanol, acetone, H2, CH4, CO2, carbon char and inert materials (glass, rock, metals). Advantage includes handling of hazardous plastics (PVC) in a safer way.
- **Vitrification:** The recent vitrification aims at converting glass, plastic, muck, mud and other wastes (except radio waste) into glass like solid.

Biomedical waste

Biomedical waste (BMW) is generated by hospitals, clinics, dispensaries and blood banks during diagnosis, treatment or immunization of human beings and animals. Considering the highly infectious and toxic nature of BMW, Government of India has passed Biomedical

Waste (Management and Handling) Act in 1998 which was amended in 2000. The Act emphasizes on the safe disposal methods to be strictly followed by the hospitals.

About 80% of BMW are comparable to domestic waste. The remaining 20% is hazardous. Improper disposal or dumping of BMW may cause pollution of air, water and soil. The hazards could be avoided if BMW is disposed properly.

Treatment Methods of BMW. Treatment methods include chemical disinfection, deep burial, thermal deactivation, radioactive irradiation, microwaving, autoclaving, incineration, electron beam sterilization and plasma pyrolysis etc.

Incineration of BMW. The common practice for handling BMW is the on-site incineration in a specially designed double chambered incinerator at 800°C and 1050°C. The thermos clave installed in the plant can treat 150 kg of waste per hour at high pressured steam and remove toxic dioxins, poly chlorinated biphenyls and HSO4 etc.

Biomedical waste from such hospitals which do not have facilities for incineration or pyrolysis are segregated, packed in coded and labelled containers and transported to a place where such facilities exist.

3.5 ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

It is aptly said, think globally act locally. Each individual should change his life Style in such a way so as to reduce environmental pollution. It can be done by following suggestions.

- LAY greater emphasis on pollution prevention than pollution control.
- Use ecofriendly products like degradable paper bags instead of polyethylene bags
- Promote 3R strategy of' reduction, reuse and recycling of wastes.
- Adopt renewable resources of energy.
- Save electricity by not wasting it when not required.
- Reduce dependence on fossil fuel especially coal or oil.
- Cut down the use of chloro fluoro carbons (CFCs) as they deplete the ozone layer.
- Use chemicals derived from poaches and plums to clean computer chips ant circuit boards instead of CPCs.
- Air pollution can be prevented by using solar powered hydrogen fuel.
- Use phosphate free or biodegradable detergent and shampoo. This will reduce eutrophication of water bodies.
- Do not put pesticides, paints, solvents, oils and chemicals into drain or ground water.
- Use bio fertilizers and organic manure instead of commercial fertilizers.
- Use less hazardous chemicals wherever their application can be afforded.
- Use rechargeable batteries which will reduce metal pollution.
- The solid waste generated during one manufacturing process can be used as a raw material for some other processes.

- Do not litter polythene bags.
- Plant more trees as trees can absorb many toxic gases and purify the air by releasing oxygen.
- Check population growth so that demand of materials is under control.

CHECK YOUR PROGRESS

1. **How indoor air pollution originates?**
2. **Name some equipment's in air pollution control.**
3. **Name some adsorbents or catalysts for SO_2 in flue gases.**
4. **Give various types of scrubbers used to remove SO_2.**
5. **State four sources of ground water pollution.**

3.6 POLLUTION CASE STUDIES

AIR POLLUTION EPISODES

A series of air pollution episodes have occurred from Meuse Valley, Belgium (1930) to Chernobyl nuclear disaster in USSK (1986).

Donora Alir Pollution Disaster

Donora Pennsylvania is a small mill town. It lies in a horse shoe shaped valley on Monogahela river, USA, south of Pitsburgh with steep hills on each side of the river. A four-day fog occurred in October 1948 due to pollutants (SO,) emitted by steel mills, zinc smelter and sulphuric acid plant. Owing to anticyclonic weather conditions, there was no air movement and temperature inversion had set in due to sea breeze conditions. About 40% people fell ill and some of them died.

TCDD Disaster at Seveso, Italy

In July 1976, a white cloud of poisonous gas consisting of 2, 3, 7, 8 tetrachlorobenzo-10-dioxin (TCDD) exploded in an herbicide (2, 4, 5-trichlorophenoxy acetate) manufacturing chemical plant. It engulfed the nearby town of Seveso and contaminated over buildings, grounds and soil. About 800 people were evacuated from the worst affected places by the Italian government. Nearly 200 people suffered from respiratory, eye, gastrointestinal and liver diseases. The worst victims were pregnant ladies who gave birth to deformed and premature babies. According to researchers, dioxin will continue to contaminate soil, air and water which will chronically pollute water resources and natural biological processes.

THE BHOPAL GAS TRAGEDY (THE CITY OF DEATH)

Venue. Bhopal, Madhya Pradesh, India. Industrial disaster date. December 3, 198 **Source.** Union Carbide Factory, manufacturer of Carabaryl (carbamate pesticide) using methyl isocyanate (MIC).

The Tragic Incident. December 3, 1984 was a chilly windy night of macabre death when a killer cloud of MIC gas converted the night at 11 p.m. into a night mare of misery, panic and sickness on Bhopal city with a population of 800.000 The safety valve remained open for two hours releasing over 50,000 lbs of MIC associated with COCl2 and HCN.

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Safety Devices and Violent Reaction: The two safety devices for neutralizing leaking MIC, viz., the vent gas scrubber and the flare tower were non-functional. Moreover, the refrigeration unit connected to MIC storage tanks, which keeps the liquid at 0°C, had been closed down since June, 1984. As a result, the gas was at 15°C. In a closed tank, the pressure due to reactions of MIC with He0 or catalyst can build up to the point that safety valves will open, venting both MIC and phosgene (COCl2) gas.

Misery, Panic and Death Drama: Between 12.30 and 1 a.m., people woke up coughing violently and with their eyes burning as if chili powder had been sprayed into them. The deadly poisonous gas spread over 40 sq. km. seriously affecting the people up to a distance of 5 to 8 km. An estimated 500,000 people fled that night, most on foot. Between 12.30 and 1 a.m., people woke in Jai Prakash Nagar everything was so quiet-thousands lay dead on the roads and in homes. Corpses with distended bellies were beginning to rot. More than 2000 people lay dying in Hamidia hospital. By 1 a.m. on December 4, 1984 the hospital was crowded by 25,000 patients. The death drama continued for four days. More than 100,000 injured people were treated with limited medical care. Many people sat in silence, blinded and mained by unknown enemy. Within a week about 10,000 people died while more than one lakh people continue to suffer from various disorders. By December 13, 1984 about 1 lakh people left the city.

Neutralization Drama-Operation Faith: The task of disposing off the balance MIC in the storage tanks was entrusted to the Director General of CSIR. It was decided to convert MIC into the final product carbaryl. On December 16, the factory was started to restore faith among people he operation ended on the seventh day and 24 tonnes of MIC had to be converted, 50% more than that was estimated.

The Aftermath: A medical survey held 100 days after the MIC exposure revealed that out of 250,000 people exposed, 65,000 were subjected to severe medical disability gastrointestinal, (respiratory, eye, neuromuscular, gastrointestinal), and 50,000 to mild disability. People suffering from breathlessness, digestion and sleeping problems are incapable of carrying on even light physical labor and unable to earn a living. Pregnant women were the worst victims.

Update about Bhopal Disaster: Recent reports indicate that about 28,000 gas victims have died so far while an estimated 10 to 15 people are dying every month from exposure related ailments. More than 1,20,000 survivors are said to be still suffering from a variety of chronic diseases including respiratory tract problems, lung diseases, hypertension, anxiety diminished vision, acute depression, muscular fatigue, recurrent fever gynecological disorders. The gas victims have not got proper medical care even after Rs. 250 crores have been spent for the purpose by the government. Thousands of people living in shanty towns near the factory complex are forced to drink toxic water because of the contamination of water table and soil. The State government even has not provided clean drinking water to the gas victims although Rs 70 crores have been spent for environment upgradation. The NGO Green peace described the factory site as a global toxic hot spot. Finally, the Supreme Court directed the Government (July 19, 2004) to release Rs. 1,500 crore of Union Carbide money to the victims of gas leak.

LOVE CANAL EPISODE

The Love Canal in Niagara Falls, New York was used to dump sealed steel drums of chemical waste by Hooker Chemicals and Plastics Corporation during 1930-1953. In 1953, the dump site was capped with clay and sold to the city Board of Education which built an elementary school. Houses were also built near the school. In 1976, the residents started complaining of foul smell and illness. The leachate penetrated in the area. In 1978, the state and federal official surveyed air samples in the basement of houses and identified some 26 toxic organic compounds. The President of USA declared Love Canal as an emergency disaster area and relocated the affected families. The clean-up of the canal and stabilization of the area costed over 40 million dollars. Love Canal episode is only the tip of an ice-berg and several other dump sites may exist in the third world countries.

Earthquakes

Earthquakes occur due to sudden movement of earth's crust, 'The earth's crust has several tectonic plates of solid rock which slowly move along their boundaries, when friction prevents these plates from slipping, stress build up and result in sudden fractures which can occur along the boundaries of the plates or fault lines (planes of weakness) within the plates, 'This results in earthquake, the violent short term vibrations in the earth. The point on a fault at which first movement occurs during an earthquake is known as epicenter, the seismic waves move away from the source of earthquake which can be recorded by seismometer. '"The severity of an earthquake is generally measured by its magnitude on Richter Scale devised by Charles Richter (1985).

Richter scale	Severity of earthquake	Richter scale	Severity of earthquake
Less than 4	Insignificant	6-6.9	Dostructive
4-4.9	Minor	7-7.9	Major
5-5.9	Damaging	More than 8	Disastrous

The largest earthquake ever recorded occurred on May 22, 1960 in Chile with the magnitude of 9.5 on Richter scale, affected 90,000 square miles and killed 6000 people.

A devastating earthquake hit Bhuj town in Gujarat on January 26, 2001. It caused massive damage and killed 26,000 people. It had an energy equivalent to 5.3 mega tonne hydrogen bomb.

Earthquake generated high seismic waves called tsunamis can severely affect coastal areas. These giant sea waves move at a speed upto 1000 km/hr or even faster. While approaching the sea shore they may often reach 15 m or upto 65 m in height and cause massive devastation.

In China tsunami killed 8,30,000 people in 1566 and 50,000 in 1976. Very recently, on March 11, 2011, the most devastating undersea earthquake (tsunami) occurred in Japan measuring 9 on Richter scale. It inundated coastal areas and caused explosion in nuclear reactor.

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3.7 DISASTER MANAGEMENT

Introduction to Natural Disasters

The term "Disaster" comes its origin in the French word "Disaster" which is a combination of two terms "Des" meaning bad or evil "aster" meaning star so when combined the expression is "Bad or evil star". In earlier days a disaster was considered to be a loss due to some unfavorable star.

Nowadays the concept has changed of the term "Disaster" is commonly used to denote any odd event be natural or manmade which brings about sudden & huge miseries (bad luck) to humanity.

Definition

According to the Oxford Dictionary

"An event man-made or natural, sudden or progressive the impact of which is that the affected community must respond through exceptional measures."

According to Webster Dictionary

"A sudden calamitous event producing great material damage, loss, and disasters."

"An event concentrated in time and space which threatens associate."

Disasters have been defined with the following factors:

1. Disruption to the normal pattern of life such disruption is usually severe & lay sudden unexpected & widespread.
2. The human effect, such as loss of life, live hood and property, injury and adverse effect on health.
3. Effect on social structure such as destruction of or damage to infrastructure buildings.

Factors responsible for Disaster:

1. Poverty
2. Lack of awareness
3. Increase in population
4. Transition in cultural activity
5. Wars

Some Definitions related to Disaster:

1. **Hazard:** - "Hazard" is an event that has the potential for causing injury to life or damage to property or the environment. The magnitude of the phenomenon, the probability of its occurrence the extent & severity of the impact can vary. In many cases, these effects can be anticipated and estimated".
2. **Risk:** "Risk" is a measure of the expected losses due to a hazard event of a particular magnitude occurring in a given area over a specific time ".
   - **The Event of Risk depends upon.**
   - The nature of the Hazard.

- The vulnerability of the elements which if affects.
- The economic value of those elements.
- Risk frequency means the number of occurrences per unit of time.

3. **The Vulnerability:** "The Vulnerability is defined is a degree of loss, which would suffer as a result of a specific hazard event". The nature of vulnerability & its assessment vary according to whether the element involves represents people and social structures, physical structures, or economic assets activities.
4. **An accident:** means an unexpected event that results in injury to a person and/or damage to property or the environment.
5. **Hazardous Material:** includes explosives compressed & liquefied gases, flammable & combustible materials, oxidizing materials, and organic peroxides, poisonous and infectious substances, radioactive material corrosives, and miscellaneous dangerous goods.
6. **Mitigation:** Mitigation means "reducing the actual or probable effects of extreme disaster on man & his environment".

Natural Disaster

Natural disasters are related to three factors:

- **Wind-Related:** storm cyclones, hurricane, storm surge, and tidal waves.
- **Water-Related:** flood, cloud burst, flash flood, excessive rain and drought.
- **Earth Related:** earthquake, tsunamis, avalanches, landslide, and volcanic eruption etc.

The common types of Natural disaster occurring in India are:

1. Earthquakes
2. Floods
3. Cyclone
4. Landslide

1. EARTHQUAKES

Earthquakes: sudden violent shaking of the ground as a result of movements within the earth's crust.

Casual Phenomenon: Slippages of crystal rocks & rebound too new;

General Features & Effects

Shaking of the earth caused by waves causing

- Surface faulting
- Shocks
- Vibration
- Landslides

NOTES

Predictability: Predictability of occurrence can be determined, but with no exact timing, forecasting is based on the monitoring of seismic activity &observation.

Factors Controlling Vulnerability

- Location of settlements in seismic areas structures that are not resistant to ground motion.
- Non-earthquake resistant buildings.
- Lack of information about earthquake risk.

Typical Adverse Effects

1. **Physical Damage:** Loss/ damage of structure, dam failure, landslides.
2. **Casualties:** Causing high causalities particularly highly populated areas or where buildings are not resistant.
3. **Public Health:** Fractures injuries are the most widespread problems flooding, contaminated water supply.
4. **Water Supply:** Water supply problems due to damage to the water system pollution of open wells & changes in the water table.

Possible Risk Reduction Measurement

- Hazard mapping
- Public Awareness
- Program Training
- Land use control
- Insurance

Typical Post Disaster Needs

- Search.
- Emergency medical & assistance.
- Damage needs & assessment surveys
- Relief assistance.
- Economic recovery.

Management for Earthquakes Effects

- Preparation of maps and location of fault zones so that their presence is considered while planning settlements and irrigation projects and when citing nuclear establishments.
- Earthquakes resistant design & constitution code.
- Education training & research.
- Laws
- Earthquakes insurance.

- Installation of seismological observation

2. **FLOODS**

Flood: An overflow of a large amount of water over dry land.

Problems of flood arise from the raising of the riverbed as a result of siltation in the streambeds. Further, the un-regulated surface runoff from the catchments, removal of vegetation cover accentuates the problems.

Casual Phenomenon

Naturally occurring flash, river & coastal flooding from intense rainfall! associated with seasonal weather patterns. Rising of riverbeds as a result of siltation in the streambed.

General Features:

1. **Flash Floods:** Flash floods occur due to heavy rain, accelerated run oft, dam failure.
2. **River Floods:** Inability of water to flow excessive rain due to seasonal slow flow of the river.
3. **Coastal Floods:** Coastal Floods are associated with typical cyclones and tidal waves etc.

Factors Causing Severity

Factors causing a sharp rise in the incidence of floods:

1. Depth of water body.
2. Duration.
3. Velocity
4. Rating rise of waves.
5. Frequency of occurrence
6. Seasonal

Predictability: Flood forecasting depends upon the seasonal pattern, capacity of the drainage basin, flood plain mapping, ariel, and terrestrial survey. Warning system in case of a storm, flash floods, etc.

Factors Contributing to Vulnerability

- Locations of settlements on flood plains.
- Lack of awareness of loading hazards.
- Reduction of absorption capacity of the land,
- Nonresistant buildings,
- High-risk infrastructure elements.
- In protected flood stocks, standing crop-livestock.
- Fishing boots & marine industries.

Typical adverse effects

1. **Physical Damage** structure damage by washing away, collapsing, the impact of floating debris, a landslide from saturated soil.
2. **Public Health** death, few serious injuries Malaria, Diarrhea & viral infection.
3. **Water Supplies** contamination of wells, groundwater, deficiency of clean water.
4. **Crops & Food Supplies** Harvested &food stock, animals form, seeds maybe lost.

Possible Risk Reduction Measures

By making channels, dams, vegetation cover for flood proofing:

Preparedness Measures

1. Flood detection, warning systems
2. Community participation and education.
3. Master plan and development for flood planning.

Post Disaster Needs

1. Search
2. Insurance
3. Medical Assistance
4. Disaster Assistance
5. Short term flood & water supplies
6. Water purification methods
7. Epidemiological survey

3. **LANDSLIDES**

Casual phenomenon landslides occur as a result of changes either sudden or gradual, in the composition, structure, hydrology, or vegetation on a slope.

General features

Landslides vary in type of movement, there may be falls slides, lateral spreads, flows & may be secondary effects of heavy storm volcanic eruption. Landslides are more widespread than any other geological events.

Predictability

Predictability is the means frequency of occurrence extent a consequence of landslides may be estimated and the area of high risk may be determined by use of information in geomorphology and climatology and vegetation.

The factor contributing to Vulnerability

1. Steep slope, softer soil, etc.
2. Settlements are based on steep slopes.
3. Lack of awareness.
4. Roads & communication lines in mountain areas.

5. Lack of understanding of landslide hazards.
6. Mining activities in the hilly areas.

Typical Adverse Effects

1. **Physical Effects:** Anything in the **path** of landslides will suffer damage block roads, and lines of communication.
2. **Indirect Effects:** Loss of productivity of agricultural, floods, reduces property value.

Possible Risk Reduction Measures

1. Hazard mapping.
2. Land-use regulation.
3. Insurance.
4. Community education.
5. Monitoring, warning deduction system

4. CYCLONES

Cyclones are violent tropical storms that develop in the Indian Ocean I which the strong winds more in a circular fashion. They can Havel 300-500 km in a day and often brings large amounts of rainfall when the storm approaches the coast, the sea level rises, creating what is called a storm surge.

The Indian Ocean is one of the sizes of major cyclone-prone regions of the world. India is exposed to tropical cyclones arising in the Bay of Bengal and the Arabian Sea. On average every 4 out of 5 cyclones is generated in the Bay of Bengal and has an impact on the eastern coast.

Siltation too plays a role in increasing storm surges and the resultant floods. The major rivers of India and Bangladesh including the Ganga, Yamuna, and Brahmaputra, flour into the Bay of Bengal. Due to deforestation and soil erosion, the rivers bring vast amounts of see when the silt is deposited in the Bay of Bengal, the area around the Gangetic Delta becomes shallower this creates ideal conditions for high tidal waves and storm surges. Infrastructure development of the coast prevents the seawater from receding thus aggravating floods.

The lakes are formed as mountain glaciers melt; a process that is probably being accelerated now by global warming. The water is kept in place by ice and piles of sediment called moraines that were deposited long ago. As the lakes grow, however, the moraines are beginning to collapse, and every monsoon season the risk of a disaster increases.

Factors affecting frequency and severity cyclones

Many scientists and environmentalists are certain that global warming is occurring and as a result natural disasters like cyclones are increasing in frequency and severity. We cannot as yet conclusively establish a connection between any individual weather event and global warming. However, there is considerable evidence to

make us believe that climatic change is having an overall impact on the pattern of extreme weather events.

From 1891-1988, the frequency of pre and post-monsoon cyclones has increased in the northern Indian ocean. On the other hand, cyclones have become less frequent during the summer monsoon.

Maximum summer temperatures in Orissa have shown a rise since the 1950s. at the same he winters and night temperatures have fallen. Another observed change is that the buffer zone between the warmer surface seawater and colder bottom water at the Bay of Bengal has cost. This might indicate that even small temperature changes affect the weather in the area very first.

India-a disaster-prone country

India's sizes geographical make it one of the most position behavior of the monsoon disaster-prone countries in the world.

The subcontinent is highly vulnerable to droughts, floods, cyclones, and earthquakes. Also, the Himalayan region experiences landslides, avalanches, and bush fires however, volcanoes are uncommon in India, with just two active ones in the Andaman's.

The number of people affected in earthquakes cyclones; floods is the highest followed by those affected by droughts the areas prone to different types of natural disasters are as follows: -

Cyclones: Eastern coastline and islands of Lakshadweep Andaman & Nicobar

Floods: The major river valleys such as those of Ganga and Brahmaputra

Earthquakes: 56% of land area

Droughts: 16% of the land area spread over 16 states

Landslides: The Himalayan region and western Ghats

Fires: Bihar, Orissa, West Bengal, and North East

3.8 CHAPTER SUMMARY

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/ energies or naturally occurring contaminants.

Environmental pollution is one of the most serious problems facing humanity and other life forms on our planet today. "Environmental pollution is defined as "the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected." Pollutants can be naturally occurring substances or energies, but they are considered contaminants when in excess of natural levels. Any use of natural resources at a rate higher than nature's capacity to restore itself can result in pollution of air, water, and land.

The atmosphere that surrounds us is a major constituent of the biosphere. It is nothing but the air mass and carries solids, liquids, and gases in it. Water pollution can be defined

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in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers, and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly. If you poured a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water.

Today the vast and wonderful diversity of plant and animal kingdom that largely sustains the planet's ecological equilibrium is seriously endangered due to chronic radiation pollution. The main radiation hazard in the environment comes from ultraviolet, visible, cosmic rays and microwave radiations which produce genetic mutations in man. The biggest hazard comes from X-rays which account for 95% of our radiation exposure other than cosmic rays. The role of every individual in preventing pollution is of paramount importance because a small effort made by him will have pronounced effect at the global level.

3.9 REVIEW QUESTIONS

SHORT ANSWER TYPE QUESTIONS

1. **What are the natural and manmade pollutants that cause air pollution?**
2. **Enumerate various methods for the control of particulate and gaseous pollutants**
3. **Discuss sources, adverse effects and control of water pollution.**
4. **How does soil pollution affect soil productivity? What measures can be taken to prevent soil pollution?**
5. **Explain various sources of marine pollution. How can you prevent pollution of our oceans?**

LONG ANSWER YPE QUESTIONS

1. **Discuss various effects and control measures of thermal pollution.**
2. **Mention sources of nuclear pollution. What type of damage non-ionizing radiation can cause?**
3. **Classify solid waste. How can the solid waste be managed?**
4. **How can you, as an individual, prevent environmental pollution? Why such effort is important?**
5. **Why do earthquakes and seaquakes occur? Explain the case of 2004 Asian Tsunami.**

3.10 MULTIPLE CHOICE QUESTIONS

1. **Lifesaving gas in the atmosphere is _____.**
   a. Ozone in the stratosphere
   b. Water vapor in the troposphere
   c. Oxygen charged in the mesosphere
   d. Nitric oxide in the ionosphere

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2. **Sinks of atmospheric gases are _____.**
   a. Ocean surface
   b. Soil
   c. Vegetation
   d. All

3. **Asphyxiation is caused by _____.**
   a. NOx
   b. HCN
   c. CHCL
   d. AsH3

4. **Pollutants emitted by jet planes are _____.**
   a. Aerosol
   b. Smoke
   c. Smog
   d. Fog

5. **The world's strictest provision for the control of air and water pollution is in _____.**
   a. China
   b. India
   c. Japan
   d. USA

6. **The killer in Bhopal disaster was _____.**
   a. Carbaryl
   b. Methyl isocyanate
   c. Aldrin
   d. Accidental fire

7. **The symptoms of polluted water are _____.**
   a. No external matter on the surface
   b. Foul smell, bad taste, oil and grease on the surface
   c. No change in physical appearance
   d. Less density

8. **Turbidity in water may be checked by coagulant such as _____.**
   a. Ferric chloride
   b. Ferric sulphate
   c. Ferric alum
   d. All

9. **Disease caused by eating fish contaminated with methyl mercury is _____.**
   a. Minamata disease
   b. Hashimoto disease
   c. Bright disease
   d. Osteosclerosis

10. **Treatment for drinking water supply requires _____.**
    a. Sedimentation
    b. Electrodialysis
    c. Disinfection by chlorination
    d. Filtration through sand bed

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UNIT IV

ENVIRONMENT SUSTAINABILITY LAWS

STRUCTURE

4.1 LEARNING OBJECTIVE

After completion of this unit, student will get some knowledge about:

- Environmental laws.
- Urban problems and their solutions.
- Resettlement and rehabilitation of people.

4.2 INTRODUCTION

'Environment' is a very comprehensive term. It includes within its ambit a wide variety of phenomenon. It is a dynamic term that may be used to describe a limited area on one hand, and the entire planet on the other. The term Environment may be perceived in different connotations. There numerous definitions of the term as provided by different National and International legal instruments. It includes the complex physical, chemical and biological factors surrounding an organism or an ecological community. Such factors act and interact with various species and organisms to affect their form, growth and survival. Any unfavorable alteration of this environment is called environmental pollution. Air, water, land, radiation and thermal are the common type of pollution.

Apart from international laws, every country has enacted laws regarding environment protection, pollution control etc. In India, there are several acts for environment protection that says protection of environment is the duty of government. The importance of environmental legislation is in that without adequate regulations and laws, environment conservation cannot be realized. Creating environmental awareness and promoting environmental education are the means to ensure that humans do not degrade environment but conserve it for the future.

4.3 FROM UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT

From Unsustainable to sustainable development

Sustainable development was brought into focus by 'Brundtland Commission' in 1987 on our common future. It is a concept. It may be defined as the development which is not at the cost of the environment and depletion of natural resources. Sustainable development underscores that the rate of consumption or use of natural resources should approximate the rate a: which' these resources can be substituted or replaced. To maintain a balance between environment and development it is necessary to strike sustainable development to meet the needs of the present generation. Without closing the option for the future generation.

Erlich Formula (I = P * A * T)

I = Impact on environment; P= Population; A= Affluence; T= Technological efficiency. With this formula, we can access the impact on the environment by various factors, and we can take necessary steps towards safeguarding the environment, not for ourselves but also, for our corning generation.

How to achieve Sustainable development: It is difficult to answer, how we can achieve sustainable-development because development is achieved at the cost of environmental

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damage or exploitation. If we take much care about the -environment then our development would be stagnated and the gap among-developed, underdeveloped and developing nations would get bigger and bigger. Yet we can't sit ideally, we must take certain steps to make our planet a beautiful place to live on and carrying our development.

Transformation of attitude: One of the best ways to achieve sustainable development is through the transformation of attitude. We must calculate the habit of sufficiency. We must leave our greed of having more and more. It requires transformation at the local national and global levels. We must consider it for the interest of future generations.

Principle of justice and equity: the principal emphasis that the injustice and inequality between developed and developing nations should be culminated or minimized. For these national leaders and international institutions should have responsibility for second development or economic and environment.

Population: May developing nations are overpopulated. Their economic development is quite low and is compelled to use low-grade fuel and low efficient devices. They keep on consuming more natural resources to keep them alive without caring for the depletion of the environment and natural resources. The government should take steps to curb the excessive population growth rate. In the case of the developed nation, they must not overexploit the resource though their population is very less as compared to that of developing and underdeveloped nations.

Poverty: To achieve sustainable development poverty in developing countries must be reduced nay how. The poor people being poor cause more environmental degradation. It is rightly said by idea Indira Gandhi at H.N Conference in 1972 at Stockholm that poverty and need on the greatest polluter".

Human Settlement issues: It includes providing shelters lo all, providing, infrastructures such as water, sewage, solid, waste, etc., and energy and transport. We must have landed us management so that we can. handle human settlement issues without damaging our environment.

Conservation: We should adopt various methods to conserve our natural resources as well as our environment. The various methods include:

- Afforestation.
- Recycling
- Repair and use
- Alternative for fossil fuel.
- Organic farming (using organic manure and pesticides)
- Rainwater harvesting.

Prevention- Degradation: We must prevent our natural resources from further degradation. We can prevent our air, water, soil, etc. through.

Water Shed Development: We can preserve the scarce resource of our potable water.

Treatment of affected area (Pollution): The affected area in terms **of water,** air, and soil

should be given proper treatment by discouraging those practices. It requires government initiatives.

Transfer of Technology: We can prevent further degradation by transfer of technology from low efficient to higher efficient devices. E.g., Using CNG vehicle in place diesel.

Biomass Utilization: Animal waste, domestic waste, sewage from which we can derive energy and manure is the best way of handling waste. It not only gives us clear fuel but also reduces the soil and waste from further depletion.

Remote sensing: It is done to survey the affected area with the help of remote sensing satellites have to help to have accurate information related to natural resources and can monitor the effect of the steps taken to restore the state of the environment.

Business & Industry: Business and industry play a very important role in sustainable development since they can change production process, they can invent new technology [hat can be more efficient they produce huge waste. BY inventing new technology, they can also minimize the harmful effect and can protect our environment.

Bio Diversity: Bio-diversity should be treated as a global resource or a common heritage of mankind. It does not belong to any individual nation but the entire world. If we have this thing in our mind then only, we can preserve the flora and fauna which are very important for our survival

4.4 URBAN PROBLEMS RELATED TO ENERGY

Urban Problem Related to Energy

Big cities and towns have always influenced education, religion, commerce, communication and politics, which have in turn influenced culture and society in various proportions. Initially only a very limited section of the society lived in cities and towns while the chief occupation of major population had been fishing, hunting, and agriculture and cattle rearing. However, Industrial Revolution leads to expansion of cities and town both in size and power. In developing nations, especially a large segment of society from villages moved to cities for occupational support (occupational migration).

This exactly was the cause of rapid expansion of cities and formation of metropolitans like Delhi, Bombay, Chennai, Bangalore, Calcutta and others. This ultimately brought into picture the concept of urbanization and industrializations, which provided many benefits to society, especially to the rich, but also introduced some evils in it. Here evils referred to were the increasing demand on energy resources; whose consumption in turn lead to multitude problems of pollution, resource shortage, diseases and waste disposal. Some of the major urban problems related to energy are as under:

Electricity:

Electricity from various sources is a major requirement of expanding cities, towns and villages. Each and every activity of man's life is now someway related to electricity consumption. Housing gadgets like mixer-grinder, T.V., computer, music systems, geysers, fans, lights, A.C.s, microwave, water lifting pump, warm blowers, coolers, etc. form the essential components of a house. This all together has led to an electricity energy crunch. It

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is well known that some part of electricity is lost in transmission and greater part is stolen.

The remainder is simply not enough to support the majority of people in the city and that's why the problem of electricity in cities is on the rise. The buildings are empowering the cities like anything but nowhere we see dams, supplying electrical units, increasing in number at the same pace. Therefore, what majority of the cities face today is a usual cut of electricity for a minimum of 6-8 hrs. This makes today's urban life handicapped. Resourceful enjoy the resource benefit from the rising generator and inverter culture, which in turn put pressure on resources and lead to pollution problems.

Fossil fuels (petroleum, natural gas and coal):

Fossil fuels have always been under a great threat from times immemorial. In the absence of technological advancements these have served mankind for several years. In this quest for energy the coal reserves have suffered a lot. With rise in technical know-how man started generating power from nuclear sources, hydroelectric power, wind power etc. But still, these contribute a little. We still depend on thermal power a lot.

a. **Petrol and Diesel:** Transport and communication has brought the petroleum reserves of the world under a great threat. The rise in number of vehicles per year is immense. To understand the gravity of the problem a glance of metropolitan roads and lanes is enough. Even the roads and lanes of big cities, small cities and towns are loaded with two wheelers.

b. **Natural Gas:** The common usage of natural gas is in the form of Liquid Petroleum Gas (LPG). There is a terrific rise in the usage of LPG driven household commodities with the expanding population. Earlier the LPG usage was only limited to kitchen for cooking. The advent of technology introduced a numerous household items making its use like gas geysers, gas heaters, gas fans, gas lanterns etc. In a way it is serving as a substitute of electricity, which is other reason for increasing pressure on oil wells/reserves.

c. **Coal:** The world population has extracted and used coal reserves thinking as if it is a never-ending commodity/resource. It has served:

1. Sustainable Development
2. Urban Problems
3. Water Conservation and Management
4. Resettlement and Rehabilitation of People
5. Environmental Ethics
6. Global Warning
7. Environment Protection Act
8. Issues involved in Enforcement of Environment Legislation

Millions throughout the ages. Earlier it was primarily used to support kitchens. People also utilized it for heating stoves/ heaters in colder regions of the world. Later, its usage in the railways became the chief cause of its rapid exhaustion. Coal reserves are a limited source of energy now. It should be used judiciously and economically.

Fuel wood: Fuel wood being used for the ignition of fire is chiefly responsible for the destruction of impoverished forestlands. Though fuel wood collection to support family daily chores is allowed in certain parts of the forest generally the outskirts but the greed and dearth compels women to penetrate deep into the forest. Generally, the big cities are characterized by the absence of forestland at the fringes. But whatever degraded forest is available serve as a source of fuel wood even in and around urban centres e.g., Dehradun is a well-developed city, but in its fringes, we can still see women and children carrying loads of fuel wood.

Water conservation:

Water conservation can be defined as:

1. Any beneficial reduction in water loss, use or waste as well as the preservation of water quality.
2. A reduction in water use accomplished by implementation of water conservation or water efficiency measures; or,
3. Improved water management practices that reduce or enhance the beneficial use of water. A water conservation measure is an action, behavioural change, device, technology, or improved design or process implemented to reduce water loss, waste, or use. Water efficiency is a tool of water conservation. That results in more efficient water use and thus reduces water demand. The value and cost-effectiveness of a water efficiency measure must be evaluated in relation to its effects on the use and cost of other natural resources (e.g., energy or chemicals).

The goals of water conservation efforts include as follows:

- **Sustainability:** To ensure availability for future generations, the withdrawal of fresh water from an ecosystem should not exceed its natural replacement rate.
- **Energy conservation:** Water pumping, delivery, and waste water treatment facilities consume a significant amount of energy. In some regions of the world over 15% of total electricity consumption is devoted to water management.
- **Habitat conservation:** Minimizing human water use helps to preserve fresh water habitats for local wildlife and migrating water flow, as well as reducing the need to build new dams and other water diversion infrastructure.

Rain water harvesting

Rain water harvesting is the accumulating and storing of rainwater for reuse before it reaches the aquifer. It has been used to provide drinking water, water for livestock, water for irrigation, as well as other typical uses. Rainwater collected from the roofs of houses and local institutions can make an important contribution to the availability of drinking water. It can supplement the subsoil water level and increase urban greenery. Water collected from the ground, sometimes from areas which are especially prepared for this purpose, is called Storm water harvesting. In some cases, rainwater may be the only available, or economical, water source. Rainwater harvesting systems can be simple to construct from inexpensive local materials, and are potentially successful in most habitable locations. Roof rainwater may not be potable and may require treatment before consumption. As rainwater rushes

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from your roof, it may carry pollutants, such as mercury from coal burning buildings, or bird faces. Although some rooftop materials may produce rainwater that would be harmful to human health as drinking water, it can be useful in flushing toilets, washing clothes, watering the garden and washing cars; these uses alone halve the amount of water used by a typical home. Household rainfall catchment systems are appropriate in areas with an average rainfall greater than 200 mm (7.9 in) per year, and no other accessible water sources (Skinner and Cotton, 1992). Overflow from rainwater harvesting tank systems can be used to refill aquifers in a process called groundwater recharge; though this is a related process, it must not be confused with rainwater harvesting.

There are several types of systems to harvest rainwater, ranging from very simple home systems to complex industrial systems. The rate at which water can be collected from either system is dependent on the plan area of the system, its efficiency, and the intensity of rainfall (i.e., annual precipitation (mm per annum) x square meter of catchment area = liters per annum yield ex, ... a 200 square meter roof catchment catching 1,000mm PA yields 200 KLPA.).

Watershed Management

Watershed management is the study of the relevant characteristics of a watershed aimed at the sustainable distribution of its resources and the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, and human communities within a watershed boundary. Features of a watershed that agencies seek to manage include water supply, water quality, drainage, storm water runoff, water rights, and the overall planning and utilization of watersheds. Landowners, land use agencies, storm water management experts, environmental specialists, water use purveyors and communities all play an integral part in the management of a watershed.

RESETTLEMENT AND REHABILITATION OF PEOPLE

It is a well-known fact that both natural and human made disasters force people to move out of their land. For example, Tsunami in South Asia in December 2004, Latur and Gujarat earthquake, the Orissa super-cyclone and scores of floods and droughts in other parts of our country have rendered thousands of people homeless and jobless. Disasters, like the Bhopal gas tragedy in Union carbide factory, derailment of trains, are examples of human made disaster.

Strategies for rehabilitation of thus displaced people are in the first place by way of preventive action. For instance, care is taken to build earthquake proof houses, gather advance information about cyclones and arrange for timely evacuation, build appropriate bunds in flood prone areas, maintain bridges that take regular up and down passing of trains/ road transport vehicles on them in order to avert likely disasters.

Secondly, advance preparation on the part of administration and local communities are made to face the consequences of sudden calamities. For both these remedial steps, the primary necessity is that of building awareness among the people in general and among administrative personnel in particular.

The scope for advance planning in the cases of natural and human made calamities is however quite limited and in comparison, we can certainly plan better in the cases of development projects which are planned in advance.

Development projects come into existence after a fairly long period of planning and awareness of displacement caused by such projects already exists among those who initiate the projects. The tragedy is that despite this prior knowledge of the extent of displacement, those in-charge of development projects pay little attention to the processes of resettlement and rehabilitation of displaced people.

Development projects instead focus on economic efficiency and not on those who stand to lose all that they have, their land, means of livelihood and stable patterns of social and cultural life. Those who give up substantial portions of their assets for the sake of development projects need to be recognized as stakeholders in development projects. They too need to be a part of development.

The strategies formulated for resettlement and rehabilitation of those displaced by development projects can of course be equally applied to those displaced by natural and human made calamities. As far as our country's preparation for coping with the impact of natural and human made calamities is concerned, we have begun to feel a little aware of negative impacts of such events because they are now occurring at frequent intervals.

As a result, there are some institutional measure have been taken by the government by way of constituting committees at various levels. They exist on paper and their immediate response to the actual events is yet to come in any significant manner.

But we can say that a beginning has been made and we need to further consolidate the initiatives already taken so that such measure can bring some relief to disaster victims by way of their resettlement and rehabilitation. At present, we find that ad hoc relief measures are adopted to cope with the gravity of problems caused by such disasters.

4.5 ENVIRONMENTAL ETHICS

Environmental ethics: issues and possible solutions

Environmental ethics deal with issues related to the rights of individuals that are fundamental to life and wellbeing.

- **Resource consumption patterns and the need for equitable utilization:** It deals with how we utilize and distribute resources. The disparity between haves and have-nots is widening. There is a disparity between the individuals, communities and countries in usage of resources. The well-to-do, educated urban dweller consumes much larger quantities of resources and energy than the traditional rural individual. This unequal distribution of wealth and access to land and its resources is a serious environmental concern. An equitable sharing of resources forms the basis of sustainable development for urban, rural and wilderness-dwelling communities.
- **Equity-disparity in the northern and southern countries:** It is concerned with who owns resources and how they are distributed. People living in the economically-advanced nations use greater amounts of resources and energy per individual

and also waste more resources. This is at the cost poor people who are resource-dependent and live in developing nations.

- **Urban-rural equity issues:** The common property of rural communities has increasingly been used to supply the needs of the urban and industrial sectors. As the rural sector supplies food and a part of the energy needs (mainly fuel wood) to most towns and cities in India, the common lands of the rural sector are being depleted of their resources.
- **The need for gender equity:** All over India, especially in the rural sector, women work longer hours than men. They are involved in collection and sale of fuel wood, collection of fodder, fruits, medicinal products, trekking several kilometers to fetch potable water, cooking meals in smoky unhealthy atmosphere etc. On an average they spend 10-12 hrs. a day of very hard work, every day of the year. Unfortunately, it is the men who play a decisive role in managing the village common and their resources while women have not been given an equal opportunity to develop and improve their status which is due to a lower access to education and health care than that of men. This has deep implications for the rate of utilization of natural resources and their conservation.
- **Preserving resources for future generations:** This ethical issue must be considered when we use resources unsustainably. If we overuse and misuse resources and energy from fossil fuels, our future generations will find survival very difficult.
- **The rights of animals:** The plants and animals that share the Earth with us to have a right to live and share the Earth's resources and living space. We have no right to push a species that has taken millions of years to evolve towards extinction. Cruelty to animals is a crime that must be regarded seriously and action must be taken against offenders.
- **The ethical basis of environment education and awareness:** The most important concern is related to creating an ethos that will support a sustainable lifestyle in society. The Supreme Court of our country has ordered that every young individual at school and college level be exposed to a course on environment. There are two aspects that are closely connected with ethical issues that are related to our environment. These are based on valuing nature as a resource and appreciating the beauty of nature and treasuring the magnificence of the wilderness.
- **The conservation ethic and traditional value systems of India:** During olden days, people have always valued mountains, rivers, forests, trees and several animals. Thus, much of nature was venerated and protected. Certain species of trees have been protected as they are valued for their fruit or flowers. Traditions held the animals/species as an important aspect of nature were the basis of local life-support systems and were integral to bring about a harmonious life.

Climate Change, Global Warming

Climate

It is the long-term statistical expression of short-term weather. Average long-term weather of an area is called 'climate'. Climate is determined by temperature and preparation. Changes in climate can be defined by the differences between average conditions at two separate

times. The global climate system is a consequence of and a link between the atmosphere, oceans, the ice sheets (cryosphere), living organisms (biosphere) and the soils, sediments and rocks (geosphere).

The earth is surrounded by the atmosphere, which is the body of air or gases that protects the planet and enables life. The air of our planet is 79% nitrogen and just under 21% oxygen; the small amount remaining is composed of carbon dioxide and other gases. There are five distinct layers of the earth.

- **Troposphere:** The layer of the atmosphere closest to the earth is the troposphere. This layer is where weather occurs. It begins at the surface of the earth and extends out to about 4-12 miles. The temperature of the troposphere decreases with height.
- **Stratosphere:** It extends to about 30-35 miles above the earth's surface. Temperature rises within the stratosphere but still remains well below freezing.
- **Mesosphere:** Temperature falls with increasing altitude. It lies about 35 to 50 miles above the surface of the earth.
- **Thermosphere:** It rises several hundred miles above the earth's surface, from 50 miles up to about 400 miles. Temperature increases with height. This layer is known as the upper atmosphere.
- **Exosphere:** Extending from the top of the thermosphere to 6200 miles above the earth is the exosphere.
- **Weather:** Troposphere has a particular set of physical properties, including temperature, pressure, humidity, precipitation, sunshine, cloud cover, wind direction and speed which are called weather.

Climate Change

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas.

Burning fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat and raising temperatures.

Global Warming

global warming is the phenomenon of increasing average air temperatures near the surface of Earth over the past one to two centuries. Climate scientists have since the mid-20th century collected detailed observations of different weather phenomena (such as temperatures, precipitation, and storms) and of related effects on climate (such as ocean currents and the atmosphere's chemical composition). These data indicate that Earth's climate has changed over almost all conceivable timescale since the beginning of geologic time and that the influence of human activities since at least the starting of the Industrial Revolution has been deeply woven into the very fabric of climate change.

Acid rain

It is the term used for pollution caused by SO2 and NO2 when they combine with atmospheric moisture. When coal, oil and natural gas burn, sulphur dioxide and nitrogen

dioxide are produced. These react with water in air and form sulphuric acid and nitric acid and return to the ground in the form of rain, fog or snow. Any precipitate or depositions having a pH lower than 5.6 as a result of contact with airborne particles having an adverse effect on flora & fauna on which it falls is called acid rain.

Causes of Acid Rain

Acid rain is caused by gases and smoke that are given off by factories and cars that run on fossil fuels. When these fuels are burned to produce energy, the sulfur that is present in the fuel combines with oxygen and becomes sulfur dioxide; some of the nitrogen in the air becomes nitrogen oxide. These pollutants go into the atmosphere, and become acid.

Sulfur dioxide and nitrogen oxide are produced especially when coal is burnt for fuel. Burning coal produces electricity, and the more electricity that people use, the more coal is burnt. Of course, nowadays people probably couldn't live without electricity, so coal will continue to be burnt; but electricity and energy are constantly being overused. Think of it this way: every time you turn on a light switch or the television set without really needing to, you're indirectly contributing to the acid rain problem. Automobiles produce nitrogen oxides (which cause acid rain), so every time you don't carpool when you can, you are helping to cause acid rain.

Acid rain is a big problem, but it is not unstoppable. If the amount of sulphur dioxides and nitrogen oxides in the air is reduced, then acid rain will be reduced. There are many helpful things that "normal" people (people who aren't part of a power company or the government) can do. First of all, conserve energy and pollute less! Use less electricity; and carpool, use public transportation, or walk when you can. This will help more than one might think. When less energy is used, less coal is burnt, and as a result, there is less acid rain. Experts say that if energy was used more carefully, we could cut the amount of fuel burned in half.

Also, if coal was cleaned before it was burnt; the dangerous pollutants that cause acid rain would be cleaned away. If coal is crushed and washed in water, the sulphur washes out. However, this is a very costly method, and many power companies and governments do not want to spend their money cleaning coal. It is also costly to bum low-sulphur coal (low-sulphur coal gives off less sulphur in the air as opposed to high-sulphur coal).

Ozone layer depletion

Ozone is formed by the action of sun light on oxygen. It is 20-50 kms above the surface of earth. It is a highly poisonous gas with a strong odour. It causes respiratory ailments like asthma and bronchitis, when it is at ground level. It causes harm to vegetation and leads to a deterioration of certain materials like plastic and rubber. When ozone in the upper atmosphere protects the earth from the sun's harmful UV radiation, as it absorbs. Chlorofluorocarbons (CFCs) used as refrigerants and aerosol spray propellants are indestructible until they reach stratosphere, where UV radiation breaks them down to release chlorine atoms.

When chlorine atoms react with ozone molecules, it leads to the depletion of ozone layer and releases oxygen molecules which do not absorb UV radiation. The destruction of

ozone layer causes increased incidence of skin cancer and cataracts. It also causes damage to certain crops and planktons, thus affecting natural food chains. This decreases in vegetation leads to an increase in carbon dioxide. Use of CFCs was to be banned by the year 2000 to recover ozone layer.

Changes in the ozone layer have serious implications for mankind:

- **Effects on human health:** Sunburn, cataract, aging of the skin and skin cancer are caused by increased UV radiation. It weakens the immune system by suppressing the body's resistance to certain infections like measles, chicken pox and other viral diseases that elicit rash and parasite diseases such as malaria introduced through the skin.
- **Food production:** UV radiation affects the ability of plants to capture light energy during the process of photosynthesis. This reduces the nutrient content and the growth of plants; this is especially seen in the case of legumes and cabbage.
- Plant and animal planktons are damaged by UV radiation. In zooplanktons (microscopic animals), the breeding period is shortened by changes in radiation. As planktons form the basis of the marine food chain, any change in their number and species composition influences fish and shellfish production.
- **Effect on materials:** Increased UV radiation damages paints and fabrics, causing them to fade faster.
- **Effect on climate:** Atmospheric changes induced by pollution contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like carbon dioxide, nitrogen oxides, methane and CFCs. Observations of the earth have shown beyond doubt that atmospheric constituents like water vapour, carbon dioxide, methane, nitrogen oxides and CFCs trap heat in the form of infrared (IR) radiation near the earth's surface.

  This is known as the 'Greenhouse effect'. The phenomenon is similar to what happens in a greenhouse. The glass in a greenhouse allows solar radiation to enter, which is absorbed by the objects inside. These objects radiate heat in the form of terrestrial radiation, which does not pass out through the glass. The heat is, therefore, trapped in the greenhouse increasing the temperature inside and ensuring the luxuriant growth of plants.

  1. There could be several negative effects of global warming.
  2. With a warmer earth, the polar ice caps will melt down causing a rise in ocean levels and flooding of coastal areas.
  3. In countries like Bangladesh or the Maldives this would be catastrophic. If the sea level rises by 3m, the Maldives will disappear completely beneath the waves.
  4. The rise in temperature will bring about a fall in agricultural produce.
  5. Changes in the distribution of solar energy can bring about changes in habitats. A previously productive agricultural area will suffer severe droughts, while rains will fall in locations that were once deserts. This could bring about changes in the species of natural plants, agricultural crops, insects, livestock, and micro-organisms.

6. In the polar regions, temperature rise caused by global warming would have disastrous effects. Vast quantities of methane are trapped beneath the frozen soil of Alaska. When the permafrost melts, the methane that will be released can accelerate the process of global warming.

Nuclear accidents and nuclear holocaust

Though nuclear energy is an alternate source of cheap and clean energy compared to fossil fuels; a single nuclear accident causes loss of life, long-term illness and destruction of property on a huge scale and for a long period of time. Radioactivity and its fall out result in cancer, genetic disorders and death in the affected area for decades after.

4.6 WASTE LAND RECLAMATION

Introduction

The productivity of waste lands is very low and people owning these lands are poor and are forced to earn a living from wage employment. Therefore, waste lands are regarded as a powerful tool and attacking the issues of poverty and backwardness.

Definitions

Land and water are of critical importance for Agriculture development. Loss of vegetation cover leads to loss of soil through erosion, which ultimately creates wasteland. Vast tracts of the land that are degraded and brought under plough with some efforts are known as waste lands.

A Technical Task Group was formed by the Planning Commission and National Wasteland Development Board (NWDB). This group has defined the wastelands as the land which is degraded and is presently lying unutilized except as current follows due to different constraints (CSIR 1990).

Depending upon the casual factors the waste lands may be grouped under:

1. Water-erosion
2. Wind-erosion and
3. Salinity and Alkalinity

The uncultured wastelands include barren rocky/stony waste areas, steep-sloping areas and snow-covered areas.

Types of wastelands

These are of three types: easily reclaimable, reclaimable with some difficulty, and reclaimable with extreme difficulty.

- **Reclaimable lands with some difficulty:** These waste lands are used for agro forestry. Integration of trees with agricultural crops and livestock management should be done.
- **Easily reclaimable lands:** These are used for agriculture. Salt content in this waste land can be reduced by leaching and flushing. Gypsum, urea, potash and compost should be used before planting

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- **Reclaimable lands with extreme difficulty:** These are meant for regenerating as forests. So far, 11.5% of prime forest land has become degraded.

Need for wasteland development

- Wasteland development provides a source of income for the rural poor.
- It ensures a constant supply of fuel, fodder and timber for local use.
- Makes the soil fertile by preventing soil erosion and conserving moisture.
- Helps maintain an ecological balance in the area.
- Increases the forest cover maintains the local climatic conditions.
- Trees help in holding moisture and reduce surface run-off rates.

Process of wasteland development

- Identify the problem at a micro-level-through district, village and plot level surveys.
- Plan based on community needs with the help of local government institutions such as the village panchayats, along with Block development officers (BDOs) and Revenue department.
- Identify the factors responsible for the formation of wastelands.
- Locale-specific strategies for reclaiming the wasteland must be worked out.
- Organize publicity campaigns, integrated with training farmers and frontline government and forest department staff on the various aspects of wasteland utilization.
- Suggest the necessary changes in cropping patterns for drought prone areas; selection of appropriate crops for fodder and trees; guidance on proper land management techniques; expertise for improving productivity; newer technologies advances in irrigation; guidelines to control water logging- should be provided.

CHECK YOUR PROGRESS

1. **Explain needs for wasteland development.**
2. **Discuss process of wasteland development.**
3. **Explain causes of acid rain.**
4. **What is rain water harvesting.**
5. **What are the types of wastelands?**

4.7 CONSUMERISM AND WASTE PRODUCT

- Consumerism is related to the constant purchasing of new goods, with little attention to their true need, durability, product origin, or the environmental consequences of their manufacture and disposal.
- Consumerism interferes with the sustainable use of resources in a society by replacing the normal common-sense desire for an adequate supply of life's necessities, with and insatiable quest for things that are purchased by larger and larger incomes to buy them.

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- Especially in developed countries, landfills are being rapidly filled with cheap discarded products that fail to work within short time and cannot be repaired.
- In many cases, consumer products are made psychologically obsolete by advertising industry long before they actually wear out.
- The inordinate amount of waste that is generated by consumer-oriented societies around the world is now a serious environmental issue.
- Most human activities are related to production and consumption cycle which produce excessive amounts of waste in the form of solid, liquid and gaseous waste products.
- With the advent of and industrial civilization, the highly complex technological processes for production of goods have rapidly increased problems due to inadequate waste disposal.
- With the rapid increase in population, the amount of waste in terms of quantity and quality has increased waste management pressure many-fold in recent years.
- Our health will be affected by dangerous industrial effluents, and be will be smothered by clouds of smoke and unhealthy gases. Therefore, the reuse of goods and waste utilization should become a part of the production-consumption cycle.
- For example, it is estimated that the per capita production of domestic waste is many times higher in a developed country hence compared to a developing country.
- Large quantities of solid, liquid and gaseous waste is produced by urban industrial communities in the form of plastic, paper, leather, tin cans, bottles, mineral refuse, and pathological waste from hospitals.
- Dead animals, agricultural wastes, fertilizer and pesticide overuse, and human and animal excreta are essentially rural concerns.
- This attitude towards waste has led to disastrous effects on the environment besides the overexploitation of natural resources.

4.8 SUSTAINABILITY ACTS

Wildlife Protection Act,1972

For over a century, Indian wildlife has received sporadic protection through numerous species-specific statues. The primary intent of most early statues was to pressure game animals for hunting. The Indian Forest Act of 1927 included provisions for hunting restrictions in reserved or protected forests and authorized the establishment of sanctuaries. In 1972 India adopted a comprehensive national law, the wildlife (protection) Act 1972 to prevent the fast decline of wild animals and birds. It extends to the whole of India except J & K. It is as follows:

This act provides certain regulations for the state wildlife advisory boards. These regulations are:

1. **Regulation for the hunting of wild animals & birds**
   - No person shall hunt any wild animal.

- A record should be maintained of wild animals that were killed or captured.
- Hunting of wild animals can be permitted in abstain cases like if a wild animal has become dangerous to human life if it has been killed in defense of oneself.

2. **Setting up of sanctuaries and national parks:** Declaration of sanctuary — Any area other than area comprised of any reserve forest or territorial waters can be declared as a sanctuary after notification by the state govt., if the govt. considers that such area is of adequate ecological, journal, Horal, natural or zoological significance to protect, propagate& developing wildlife or its environment.

   Declaration of National Park — any area within the sanctuary or not is a big reason of its ecological, journal, horal, geomorphological or zoological association needed to be contributed as a National Park to protect, propagate or developing wildlife were or its environment.

3. **Regulation for trade in wild animals:**

   - Energy wild animal, other than, vermin, which is hunted or bred in captivity or hunted on contravention: animal article, Hophy as meat from any wild animal; I very improved in India and an article made from such way; which vessel, weapon hap or fool that has been used for coming to an offense shall be the property of the green.
   - If any person obtains any govt. the property, he should report to the nearest police station or authorized officer with 48 his.
   - No person should transfer any person, sell, or destroy any govt. a property without permission.
   - No person should purchase, receive, or acquire any captive animal, wild animal other than vermin or any animal article, Hophy or meat therefore otherwise from a dealer or an authorized person.

4. **Judicially imposed penalties** for violating the act any person guilty of an offense shall on conviction & permissible with imprisonment for a term which may extend to 3 years or with fine which may extend to Rs. 25000/- or with both.

   When any person is convicted of an offense the court may direct that license or permit granted to the person shall be canceled and the final person shall not be eligible for a license. For 5 years from the date of correction.

   This Wildlife Protection Act provides 2-pronged conservation strategies: 1. Specified endangered specials are protected regardless of location; 2. All species are protected in designated areas called sanctuaries and national parks.

   An amendment to the actin 1982, introduced provisions permitting the capture and importation of wild animals for scientific management of animal populations. Comprehensive amendments to the parent act in 1991 envisaged the establishment of a central zoo authority to regulate the management and functioning of zoos. The boundaries of sanctuaries & national parks may not be altered except by the resolution of the state legislature. The new provisions also recognized the needs of tribal wild forest dwellers and introduce changes to advance their welfare.

Forest Conservation Act,1980

An Act to provide for the conservation of forests and for matters connected therewith or ancillary or incidental thereto. Be it enacted by Parliament in the Thirty-first year of the Republic of India as follows:

1. **Short title, extent and commencement**:
   - This Act may be called the Forest (Conservation) Act 1980.
   - It extends to the whole of India except the State of Jammu and Kashmir.
   - It shall be deemed to have come into force on the 25th day of October 1980. With a view to checking further deforestation, the Forest (Conservation) Ordinance, 1980 had been promulgated on 25th October, 1980. The present Act has replaced the said Ordinance and contains similar provisions. The Act extends to the whole of India except the State of Jammu and Kashmir and came into force on 25th October, 1980.
2. **Restriction on the de-reservation of forests or use of forest land for non-forest purpose:** Notwithstanding anything contained in any other law for the time being in force in a State, no State Government or other authority shall make, except with the prior approval of the Central Government, any order directing-
   - That any reserved forest (within the meaning of the expression "reserved forest" in any law for the time being in force in that State) or any portion thereof, shall cease to be reserved;
   - That any forest land or any portion thereof may be used for any non-forest purposes;
   - That any forest land or any portion thereof may be assigned by way of lease of otherwise to any private person or to any authority, corporation, agency or any other Organization not owned, managed or controlled by Government.
   - That any forest land or any portion thereof may be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for afforestation.

   [**Explanation:**- For the purpose of this section "non-forest purpose" means the breaking or clearing of any forest land or portion thereof for- (a) the cultivation of tea, coffee, species, rubber, palms, oil-bearing plants, horticultural crops of medicinal plants; (b) any purpose other than reafforestation, but does not include any work relating or ancillary to conservation, Development and management of forests and wildlife, namely, the establishment of check-posts, fire lines, wireless communications and Construction of fencing, bridges and culverts, dams, waterholes, trench marks, boundary marks, pipelines or other like purposes.]
3. **Constitution of Advisory Committee**: The Central Government may constitute a committee consisting of such number of persons as it in may deem fit to advise that Government with regard to-

- The grant of approval under section 2.
- Any other matter connected with the conservation of forests which may be referred to it by the central Government.

Environment Protection Act, 1986

The mission statement of this act is drawn from the decisions when at Stockholm conference in June 1972 expressing concerns about the decline in environmental quality, increasing, pollution, loss of vegetal cover and biological diversity, concentrations of harmful chemicals in the ambient atmosphere and increasing risks of environmental accidents.

According to this act, the environment includes water, air, and land and the inter-relationship which exists among their components.

Environment Pollution means the presence of any environmental pollutant in the environment.

Environment pollutant means any solid, liquid, or gaseous substances present in such concentration as may the injurious the environment.

Hazardous substance — means any substance which is liable to cause harm to human beings other living creatures or the environment.

According to this act, the central govt. shall have the power to take all such measures to protect & improve the quality of the environment and in preventing controlling and abating environmental pollution. These measures are —

- Planning and execution of the nationwide program for the prevention control of environmental pollution.
- Laying down standards for emission of environmental pollution from various sources.
- Laying down procedures and safeguards for the handling of hazardous substances.
- Laying down procedures & safeguards for the prevention of accidents, which may cause environmental pollution.
- Restriction of areas in which any industry, operation of the industry shall not be carved out or shall be caused out subject to certain safeguards.
- Examination of such manufacturing process, naturals, or substances as are likely to cause environmental pollution.
- Inspection of any premises, plant, equipment, machinery manufacturing, materials or substances for which the central govt. has empowered the central pollution control board.
- Establishment of environmental laboratories, institutes to carry out the functions interested in such laboratories or institutes.
- Collection of information in respect of matters relating to environmental pollution.
- Preparation of manuals, wide or guides relating to the prevention control of environment pollution.

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The ministry of environment and forests has taken several measures for the implementation of the provision of this act, including framing of rules, notification of standards and environmental laboratories identification of agencies for hazardous chemical wastes, and setting up of environmental protection council in the states.

Penalties

Whoever fails to comply with any of the provisions of this act shall be punishable with imprisonment for a term which may extend to five years or with five which may extend to one lac rupees or with both.

If the failure continues beyond a period of one year beyond the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to 7 yrs.

Some of the important features of the act are as follows:

1. It confers powers on the Central Government for (i) taking steps to protect the quality of the environment; (ii) planning and execution of countrywide programs for prevention, control, and abatement of pollution, (iii) prescribing standards for various emissions and effluents, (iv) laying down safeguards for the prevention of accidents and taking remedial measures, (v) establishing and recognizing analytical laboratories for pollution measurements, etc.
2. It confers powers on persons to complain to courts for any violation of provisions of the act.
3. It makes it obligatory for the person in charge to inform prescribed authorities of any accidental discharges.
4. It prescribes penalties for violation of provisions of the act without making a distinction between Government departments and private companies.

As per new problems and needs, additional rules have been framed from time to time such as in July 1989 a rule of a permit system to regulate handling and disposal of hazardous chemicals and wastes was framed. Rules for imports, exports, storage, and use of microorganisms and field trials of genetically engineered organisms were also framed in December 1989. An Approval Committee has been formed by the Ministry of Environment and forests for licensing experiments and field trials of genetically engineered organisms. In December 1989 standards were laid for the noise limits in day and night time in industrial, commercial, residential areas and 'silence zones' up to 100 meters around educational institutions, hospitals, and courts where the use of even vehicular horns, loudspeakers, and bursting of crackers and banned.

Rosenkranz et al (1991) have listed 18 of India's International treaty obligations as per the Register of International Treaties and Other Agreements in the Field of Environment (1989) of the United Nations Environmental Programme (UNEP). India is a contracting party (CP) in some and signatory (S) in some others.

The most important ones are:

1. Convention on Wetlands of International Importance (Ramsar 1971 Convention) (C.P.)

2. The Antarctic Treaty 1959 (S)
3. Treaty banning nuclear weapons tests in the atmosphere, outer space, and underwater (Moscow 1963) (S).
4. Convention concerning the protection of World Cultural and Natural Heritage (Paris 1972) (C.P.)
5. Convention International Trade in Endangered species of wild fauna and flora (Washington DC 1973) C.P.

Rosenkranz et al (1991) have also given India's different acts and rules, their implications, legal cases on different aspects, and court judgments on them in critical detail. They have also defined various technical and legal terms, penalties for violating different rules, and technical short-comings allowing sometimes the offenders to escape punishments.

Almost all countries have taken up seriously the growing damage to the environment and resource degradations and have enacted legislation to protect the environment and natural resources against pollution and overexploitation. Due to more and more facts on environmental disasters coming to light, governments have expanded the scope of existing laws and have brought up new legislations.

The ten most urgent steps for environment management are:

- Arresting erosion of 02cms shield (Most real protocol).
- Reducing the production of greenhouse effect such as CNG buses in Delhi.
- Checking Acid rains.
- Availability of safe drinking water.
- Protection of trees and forest.
- Dumping of toxic chemicals.
- Radio levels and nuclear power plant.
- Checking Acid Newson and habitat degradation.
- Conserving fast disappearing of biodiversity.

Air (Prevention & Control of Pollution) Act, 1981

The Act represents an implementation of the decisions made at the UN conference on the Human Environment held in Stockholm in June 1972, in which India participated. It states decisions to take appropriate steps for the preservation of the quality and control of pollution.

The central govt. used article 253 to enact this law and made it applicable throughout India Article 258(3) requires the central govt. to compensate the states for the cost of carrying out these delegated functions.

The act defines air pollution as "any solid, liquid or gaseous substance present in the atmosphere in such concentration as may be or hind to be injuries to human beings or other living animals or plants, property or environment."

The central and state government shall constitute a central or state board for the prevention

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and control of air pollution under the Air act, all the industries operating within designated air pollution control areas must obtain cement from the state boards. The states are required the prescribe emission standards for industry and automobiles after consulting the central board and noting ambient are quality standards. The central and state government is interested in the implementation of the provisions of the act.

Functions of the Central Pollution Control Board:

- To advise the central govt. On any matter concerning the improvement of the quality of care and prevention, control or abatement of air pollution.
- To plan and execute a nationwide program for the pollution, control, and abatement of air pollution.
- To coordinate the activities of state pollution control boards (spcb's)
- To provide technical assistance & guidance to spcb's to collect, compile and publish technical and statistical data relating to air pollution and measures desired for its effective prevention, control, or abatement and prepare manuals, wides, or guides relating to the prevention, control, or abatement of are pollutions.
- To prepare standards for quality of air.

Functions of the State Pollution Control Board:

- Impart instruction for ensuring standards for emission from automobiles
- It can declare any area within the state boundaries as are pollution control area and can prohibit the use of certain fuels or equipment in the control ones.
- To restrict the emission of any air pollution over the standards laid down.
- May approach court for preventing persons from causing air pollution.
- Can obtain related information from polluting units and take samples of air emissions.
- It can direct the closure or prohibition of any industry operation or the stoppage or regulation of supply of electricity or water or any other service.
- An inspect any control equipment, industrial plant as manufacturing process and to give directions to persons as it may consider necessary to take appropriate measures for the prevention, control or abatement of air pollution.
- To give consent to the polluting industries before their establishment and continuing their operations.

The act was amended through mild court administered penalties on violators. The 1987 amendment strengthened the enforcement machinery and introduced stiffer penalties. Now the boards may close down a defaulting industrial plant or may step its supply of electricity or water. A board may also apply to a count to reteam emission that exceeds prescribed standards. Notably, the 1987 amendment introduced a citizens' initiative provision into the Air act and extend the act to include noise pollution.

Certain punishable acts —

- Obstruction of any person acting under the orders of SPCB's

- Failure to inform the occurrence of the air pollutants over standards laid down
- Supplying incorrect information for obtaining consent to operate

Penalties

Whoever fails to comply with the provisions of directions shall be punishable with imprisonment for a term which may extend to 3 months with a fine which may exceed Rs. 10000/- or both.

Role of judiciary: Ministry of Environment and forest is the apex body of the central govt. to frame and or implement several legislations enacted by the parliament to protect the environment and ecology of the country. The ministry through its regulations agencies like CPCB, SPCB, and other organizations focus on prevention, control, and abatement of pollution, promotion of Clean and low waste generation technologies, materials, recycling, waste reduction, environmental quailing, natural resource accounting environment management system (EMS) standards, and human resource development. The Supreme Court has also given several directions to the central government to design, monitor, and enforce environmental programs.

Environmental pollution may arise from both point source and non-point source like automobiles. The regulatory bodies have fixed emissions and effluent standards point sources. Indirect measures for pollution control such as catalytic converters in automobiles, lead-free petrol, low sulphur diesel oil, and timely inspection of vehicles are other measures to be adopted. The pollution control bodies have also laid down standards for water and air pollution and are being regularly monitored with the help of SPCBs.

There are three types of standards for effluents. The standards for effluent discharge include more than 50 parameters like color and odor, suspended solids, dissolved solids, pH, BOD, COD, Iron, Zn, Mercury, lead, coliform counts, heavy metals, arsenic, and other toxic substances. The effluent standards for wastewater generation are notified for more than ten industries have been covered concerning the maintenance of standards for emission or discharge of environmental pollutants. These are; cosmetic soda industry, manmade fibers, oil refinery sugar industry, thermal power plants, cotton textile industry, cement, and electroplating industries.

It would take several years to lay down standards for many other industries and to revive the existing standards. Due to rapid advances in science and technology, it has become mandatory to monitor the standards continuously and to frame standards for industries and processes which hitherto were not known to pose any problem for environmental pollution Moreover, we do not have modern and fully equipped laboratories to conduct tests and carry out researches.

The State Governments and the SPCB can adopt tighter standards taking into consideration the carrying capacity of the local environment. The central pollution control Board can prohibit the operations of industries in certain areas. According to the Environment protections Act 1986 rule (5), the following points may be taken into consideration (i) maximum allowable limits for various pollutants (ii) discharge of pollutants from industries (iii) topographic and climatic features of the area (iv) biological diversity (v)

environmentally compatible land use (vi) net advance environmental impact likely to occur (vii) proximity to protected areas like ancient movement, sanctuary, national park, game reserve, the closed area under wildlife protection act and proximity to human settlement.

The supreme court of India experienced one of its most creative periods after the emergency which evolved an atmosphere of freedom and dialogue. During this era, the boundaries of the fundamental right to life and individual liberty guaranteed in article 21 of the constitution were expanded to include environmental protection. The first indication of the right to a wholesome environment may be traced to the Doon valley mining operations case. In July 1983, representatives of the rural litigations and Entitlement Kendra appealed to the Supreme Court alleging that illegal mining in the Mussoorie Dehradun region was devastating the fragile ecosystem of the area. On July 14, the court directed its registry to treat the letter as a writ petition under Article 32 of the constitution with notice to the Uttar Pradesh Government. However, the court held that closure would cause hardship to the affected parties, but it was the price that had to be paid for protecting improving, and safeguarding the rights of the people to live in a healthy environment with minimal damage to the ecology of the area.

Eight years after the blasting of the Doon valley case, the Supreme Court revealed the basis of its jurisdiction to entertain environmental cases. In Subhash Kumar Vs State of Bihar, the court held that the right to life includes the right to enjoy clean water and air. If anything endangers or disturbs the quality of life in contrary to law, a citizen has a right to move the Supreme Court under article 32 of the constitution. Elaborating the theme of this article in a town planning case, Virendra Gaur Vs State of Haryana, the court observed.

Article 21 protects the right to life as a fundamental right. Enjoyment of life including (the right to live) with human dignity encompasses within its ambit, the protection and preservation of environmental, ecological balance free from pollution of air and water, sanitation, without which life cannot be enjoyed. Any contracts or actions would cause environmental pollution. Environment, ecological, air, water pollution, etc. should be regarded as amounting to a violation of article 21. Therefore, a hygienic environment is an integral facet of the right to a healthy life and it would be impossible to live with human dignity without a human and healthy environment.

Biological diversity act, 2002

India saw a transformation of its closed economy into an open economy, post-1990. Biopiracy thereafter, stood unguarded with no stringent legislation protecting the overexploitation and piracy of resources. This further saw the formation of a civil society group appointed to formulate a National Biodiversity strategy and plan. However, this wasn't accepted and the government itself articulated a legal framework and draft known as the Biodiversity Bill, 2000, based on which this Act was passed by the Lok Sabha on 2nd December 2002 and Rajya Sabha on 11th December 2002. It had finally received the Presidential assent on 5th February 2003.

The Biological Diversity, as federal legislation, was a mere attempt of India to uphold the objectives put forth by the United Nations Convention on Biological Diversity (CBD) 1992, giving immense importance to the rights of a state over its resources.

This Act broadly sets forth to protect and conserve the biological diversity, control the utilization of resources, and maintain equality in the distribution of its resources and benefits arising from it. Section 8, sub-Section (1) and (3) of this Act, puts forth the provision of establishing a National Biodiversity Authority in Chennai.

Objective

The Act in general aims in conserving the Biological Diversity, maintaining and controlling the proper use of its components, ensuring equitable distribution of benefits derived from such utilization. The mentioned objectives of the Act provide for a safeguard of traditional knowledge, prevent biopiracy, prohibit people from claiming patents without the government's permission, etc.

The facets of the objective of aiming to conserve Biological diversity is showcased by Chapter IX of this Act, especially with Sections 36, 37 and 38 which relates to developing national plans and programmes for the conservation of biodiversity, powers given to state government to notify and preserve areas of biodiversity, and with the authority of the Central Government to notify species that are dangerously endangered, on the verge of extinction, threatened species, prohibiting their collection and so on. While sustainable use of its component would indicate towards regularising the use of natural resources and not exhausting it.

Section 21 of the Act determines the provision of benefit sharing. It aims to acquire equitable sharing of benefits emanating from the accessed biological resources, its by-products, knowledge, and practice related to it as per the set terms and conditions between the person applying for acquiring such benefits and the local bodies involved.

Important Provisions

The Biological Diversity Act puts forth definitions, principles, appointed authorities, procedures, mechanisms for conservation, access benefits, etc, all related to biodiversity. It also mentions an institutional structure to be established for the same purpose.

Conservation Provisions

Section 36 talks about the role of the Central government in developing national strategies and plans for conservation purposes. The Central government has responsibilities such as:

1. It is duty-bound for formulating national strategies, plans and programmes to conserve and uphold the sustainable use of biological diversity.
2. If any area rich in biological diversity or such resources seems to be facing threats then it is the central government's responsibility of notifying the respective state government and asking them to take appropriate steps to prevent it.
3. Composing sectoral and cross-sectoral plans and policies, which are practicable in the notified environment on the foundation of integration of conservation and the sustainable use of biological diversity.
4. The central government has to take measures for assessing the harmful effects of upcoming projects on biodiversity and to either prevent it or come up with techniques of diminishing such effects.

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5. The central government must aspire to protect the traditional knowledge holders and their knowledge with methods including registration of such knowledge at the local, state or national levels, and other measures necessary for protection and so on.

Section 37 of the Act involves the declaration of Biodiversity Heritage Sites with regard to which the state government is required to notify about the areas of biodiversity heritage in the Official Gazette under this Act. It proceeds to protect the area rich with biodiversity in its natural surroundings. The biodiversity-rich landscape and ecosystems brought under already legally protected areas such as National Parks and Wildlife Sanctuaries in a method similar to that of the declaration of Eco-sensitive areas as per the Environment Protection Act (1986) The Section also puts the responsibility on the state government to compensate people or sections of people economically affected by such declaration.

Without any sort of prejudice, Section 38 of the Act requires the Central Government, in deliberation with the concerned State Government, notifying from time to time about species that are on the verge of extinction or threatened species and prohibit its collection thereof for any trade purpose and put to action appropriate steps for the preservation of such species. Whereas Section 39 empowers the Central Government to designate repositories for biological material to be kept in safe custody.

But again, under Section 40 of the act, the Central Government with regard to the National Biodiversity Authority by notification in the Official Gazette can make declarations of the Act not applying to particular items, including biological resources normally the commodities.

In the case of *Environment Support Group v. National Biodiversity Authority*, an appeal was made to declare Section 40 of the Biological Diversity Act, 2002 illegal and unconstitutional as serious prejudice was likely to be caused which could cause jeopardy to the national interest and biodiversity of certain species. It wanted to draw the attention of authorities towards public agricultural universities indulging in criminal biopiracy of local varieties of eggplant.

The petitioners also highlighted that they had got 18 critically endangered plants among its 190 plants as normally traded communities. The petition also argued that Section 40 of the Biodiversity Act, 2002 deemed to allow arbitrary and unfettered trade of India's biological wealth leading to extensive bio-piracy. Although the National Biodiversity Board and Karnataka Biodiversity Board had filed a criminal complaint of biopiracy before the High Court of Karnataka, the petition filed for criminal proceedings in a relevant ruling of the High Court of Karnataka dismissed petitions and quashed criminal prosecution of the respondents who had been accused serious criminal acts of biopiracy by the National Biodiversity Authority and Karnataka State Biodiversity Board.

The biodiversity authorities at the national and state levels

Section 8 lays down the provision of the establishment of the National Biodiversity Authority at the national level whereas Section 22 does the same for state biodiversity boards at the state level. Further Section 22(2) does not allow the State Biodiversity Board to be constituted for a Union territory. The National Biodiversity Authority shall exercise

the powers and perform the functions of a State Biodiversity Board for that Union territory: Provided that in relation to any Union territory, the National Biodiversity Authority may delegate all or any of its powers or functions under this sub-Section to such person or group of persons as specified by the Central Government.

The chairperson of the National Biodiversity Authority presides over the meetings and all questions are decided by the votes of all members present and voting. As per Section 13, the National Biodiversity Authority can form a number of committees as required for the effective and efficient discharge of its duties and functions under the Act. Such a committee should also choose people who are not the members of the National Biodiversity Authority, as they might have the right to attend the meetings of the committee and take part in the proceedings but shall not have the right to vote.

Section 19 of the Act puts forth that any person wanting to obtain any biological resource originating in India or information relating to it, for research or for commercial purposes or transfer the results of such research related to biological resources occurring or obtained from India, are required to make an application and payment of prescribed fees. Also, as per 19(2) any person applying for patent or intellectual property protection whether in India or outside India based on any invention, research, knowledge, or study originating in India have to make an application to the biodiversity authority and wait for its approval.

In the case of *Akb Jagannath Nag v. Union of India & Ors,* it was appealed that the petitioner had intellectual property rights in terms of Section 6 and Section 19(2) of the Biological Diversity Act, 2002 and concerned Rules which were in his favour. Therefore, such approval by the concerned Authority under the Biological Diversity Act would clearly come in the way of the order criticised before the learned Single Judge. The order passed by the Controllers and Patents and Designs as per Section 15 of the Patents (Amendment) Act, 2005 was appealable in terms of Section 117A of the Patents Act, 1970 as amended in 2005. If there was an exercise of wrong jurisdiction, excessive authority during passing such order, the same could be challenged before the Appellate Authority.

Based on this the appellant had interfered with the order passed by the Controllers of Patents and Designs as well as the learned Single Judge. If the present approval under Section 6 of the Biological Diversity Act seemed to change the entire scenario, then it had to be brought under the notice of the single learned judge by the way of review. Therefore, it was held that it would not be just to point out faults with either the order of the Controllers of Patents and Designs or the order of the learned Single Judge. This appeal was disposed of with an application for stay given to the appellant with the choice of option for approaching the learned Single Judge for review of the order of the Appellate Authority as indicated.

Functions

Some of whose functions are:

1. Prohibiting a person claiming a patent over biodiversity or related knowledge, study, or research without prior approval and permission of the Indian Government.
2. The State Biodiversity Board advises the State Government, according to any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components, and benefit-sharing.

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3. The State Biodiversity Board performs functions as required by the Act or prescribed by the State government.
4. Conservation of sustainable use of biological resources including habitat and species protection (EIP) of projects, integration of biodiversity, formulating plans, and policies of various Departments and Sectors.
5. The National Biodiversity Authority has to regulate activities in accordance with Sections 3, 4, and 6 of the Act.
6. The National Biodiversity Authority, on behalf of the Central Government, could take steps for opposing granting of intellectual property rights in any country outside India related to any biological resource obtained from India or knowledge about such biological resource which is derived from India.

Offences and penalties

Put forth by Section 58, offences under this Act are cognizable and non-bailable. Except for the Central Government or any authority authorized by the government or any benefit claimant with his intention to make a complaint, no court shall take cognizance of any offence under this Act or rules as per Section 61 of the Act. No suit, prosecution or other legal proceedings shall lie against the Central Government or any officer of the Central Government or the State Government or any member, officer or employee of the National Biodiversity Authority or the State Biodiversity Board with regard to an action done in good faith as per Section 54 of the Act. Provisions of this Act even being inconsistent with any other law in force shall yet have effect and put to work as laid under Section 59.

Offences punishable with imprisonment for a term which may extend to five years or fine which may extend to ten lakh rupees or both:

1. In contravention to the provisions of Section 3, if a non-Indian, an Indian or corporate body with foreign participation initiates biodiversity-related activities without prior approval of the National Biodiversity Authority.
2. In contravention to the provisions of Section 4, any person whether a citizen or not, delivers results of any research related to any biological resources for monetary gain to a non-Indian.
3. In contravention to the provisions of Section 6, any person making an application for an Intellectual Property Right of an invention based on any research on a biological resource obtained from India without previous approval of the National Biodiversity Authority.

Offences punishable with imprisonment for a term which may extend to three years, or with fine which may extend to five lakh rupees or both:

1. Contravening Section 7 of the Act, if any citizen of India excluding Vaids and Hakims who are practising indigenous medicines, acquires any biological resource for commercial utilization or bio survey without giving prior notification to the State Biodiversity Board.
2. Contravening Section 24 sub-Section (1), if any citizen of India or a corporate organization registered in India, aims to undertake any activity of obtaining

biological resources for commercial work and does not give prior intimation as is prescribed by the State Government to the State Biodiversity Board.

A person going against any direction given by the Central Government, the State Government, the National Biodiversity Authority or the State Biodiversity Board for which no punishment has been specified under the Act, then he/she shall be punished with a fine which may extend to one lakh rupees, in case of a subsequent offence extending to two lakh rupees which with continuous contravention incur an additional fine two lakh rupees everyday laid by Section 56 of the Act.

ISSUES INVOLVED IN ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

Environmental legislation is evolved to protect our environment as a whole, our health, and the Earth's resources. The presence of a legislation to protect air, water, soil etc., does not necessarily mean that the problem is addressed. Once legislation is made at the global, national or state level, it has to be implemented.

There are several NGOs in the country such as WWF-1, BEAG and the BNHS, which take these matters to court in the interest of conservation. Anyone can request them to help in such matters. There are also legal experts such as MC Mehta who have successfully fought cases in the courts to support environmental causes.

PUBLIC AWARENESS

Environmental sensitivity in our country can only grow through a major public awareness campaign.

This has several tools:

1. The electronic media, The press.
2. School and college education, adult education.
3. Orienting the media to protect pro-environmental issues is an important aspect.
4. Several advertising campaigns frequently have messages that are negative to environmental preservation.

4.9 CHAPTER SUMMARY

Sustainable development was brought into focus by 'Brundtland Commission' in 1987 on our common future. It is a concept. It may be defined as the development which is not at the cost of the environment and depletion of natural resources. Sustainable development underscores that the rate of consumption or use of natural resources should approximate the rate a: which' these resources can be substituted or replaced. To maintain a balance between environment and development it is necessary to strike sustainable development to meet the needs of the present generation. Without closing the option for the future generation.

Big cities and towns have always influenced education, religion, commerce, communication and politics, which have in turn influenced culture and society in various proportions. Initially only a very limited section of the society lived in cities and towns while the chief occupation of major population had been fishing, hunting, and agriculture and cattle rearing. However, Industrial Revolution leads to expansion of cities and town both in size

and power. In developing nations, especially a large segment of society from villages moved to cities for occupational support (occupational migration).

Rain water harvesting is the accumulating and storing of rainwater for reuse before it reaches the aquifer. It has been used to provide drinking water, water for livestock, water for irrigation, as well as other typical uses. Rainwater collected from the roofs of houses and local institutions can make an important contribution to the availability of drinking water. It can supplement the subsoil water level and increase urban greenery. Water collected from the ground, sometimes from areas which are especially prepared for this purpose, is called Storm water harvesting. In some cases, rainwater may be the only available, or economical, water source. Rainwater harvesting systems can be simple to construct from inexpensive local materials, and are potentially successful in most habitable locations. For over a century, Indian wildlife has received sporadic protection through numerous species-specific statues. The primary intent of most early statues was to pressure game animals for hunting. The Indian Forest Act of 1927 included provisions for hunting restrictions in reserved or protected forests and authorized the establishment of sanctuaries.

4.10 REVIEW QUESTIONS

SHORT ANSWER TYPE QUESTIONS

1. **What are environmental laws?**
2. **Explain unstable development.**
3. **What is global warming?**
4. **Explain types of wetlands.**
5. **What is waste land reclamation?**

LONG ANSWER TYPE QUESTIONS

1. **Write a brief note on biological diversity act, 2002.**
2. **Write a brief note on environmental protection act.**
3. **Wild life protection act. Explain.**
4. **Write brief notes on:**
   - **Air (prevention and control of pollution) act.**
   - **Forest conservation act.**
5. **Explain environmental ethics.**

4.11 MULTIPLE CHOICE QUESTIONS

1. **Biological diversity act, _____.**
   a. 2001
   b. 2002
   c. 2003
   d. 2004

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2. _____ (Prevention & Control of Pollution) Act, 1981
   a. Air
   b. Water
   c. Fire
   d. None of the above

3. Wildlife protection act extends to the whole of India except _____.
   a. Himachal
   b. J & K
   c. Chhattisgarh
   d. Uttar Pradesh

4. There are _____ type of wetlands.
   a. 1
   b. 2
   c. 3
   d. 4

5. Acid rain is caused by _____.
   a. Acid
   b. Gases and smoke
   c. Dirty water
   d. None of the above

6. Average long-term weather of an area is called _____.
   a. Climate
   b. Rain
   c. Acid rain
   d. Weather

7. Ozone is formed by the action of _____ on oxygen.
   a. Air
   b. Water
   c. Sun light
   d. Hydrogen

8. Ozone is _____ kms above the surface of earth.
   a. 10-20
   b. 20-30
   c. 20-40
   d. 20-50

9. Ozone is the _____ atmosphere protects the earth from the sun's harmful UV radiation.
   a. Upper
   b. Lower
   c. Middle
   d. None of the above

10. The common usage of natural gas is in the form of _____.

a. CNG
b. LPG
c. Bio gas
d. None of the above

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UNIT V

HUMAN POPULATION AND THE ENVIRONMENT

STRUCTURE

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5.1 LEARNING OBJECTIVE

After completion of this unit, student will knowledge about:

- Population growth and majors taken by government.
- Human rights which play an important role in human life.
- some value education.
- Disease HIV/AIDS causes and symptoms.
- Welfares for women and child.

5.2 INTRODUCTION

The population is referred to as the total of the human individual in a particular geographical boundary. It usually comprises of male and female. As per July 2004 estimation, the Indian population is 1,065,070,607 which is increased to 100 crores approximately by 2007.

Population density is around 324 people per square kilometer. Population Growth in respect to India is classified into four groups.

1. 1901-1921	Stagnated Population Growth
2. 1921-1951	Steady growth in population
3. 1951-1981	Rapid population Growth
4. 1981-2001	High growth rate with definite slowing down.

Growth Rate = No. of Births in a year- No. of deaths in a year. 1000/ Total Population.

During 1991-2001, the population of India increased by 180.6 million. The percentage declined from 23.86 percentages for 1981-1991 to 21.34 percentages from 1991-2001, a decline of 2.52 percentages is observed.

5.3 POPULATION GROWTH

Causes of population growth:

1. Illiteracy
2. Medical Facility (Death rate and infant mortally rate is decreasing)
3. Poverty
4. Migration
5. A desire for a male child

Population and Pollution

The relationship between population and pollution is different in developed nations and developing nations. In developing nations, there is a direct relationship between population and pollution. In developing nations people do not have high purchasing power, they are technically backward, so, they use natural resources irrationally causing more pollution. They cannot even take steps to control pollution. While in the developed nation the equation is entirely different. There is an inverse relationship between population and pollution. They have high purchasing power. They use all the natural resources in bulk

causing more pollution than that of the developing nations. In developing nations, there is a struggle to gain sufficiently in all aspects from agriculture to technological environments. For this, they use the bulk of pesticides, insecticides, etc. that ultimately degrade our natural resources both flora and fauna and physical environment. S, we can conclude that the population contributes largely to the pollution, though it does not depend on the number it depends on the consumption pattern and attitude.

Population explosion

It is a condition when the population increases suddenly at a rapid speed beyond control. The population explosion gives birth to overpopulation. Overpopulation is a condition of having more people than can live on the earth in comfort, happiness, and health and still leave the world a fit place for the future generation.

It took the entire history of mankind for the population to reach 1 billion around 1810, it doubled to 2 billion in 1930, then 4 billion in 1975. It is estimated that this population could be doubled to nearly 11 billion in less than one year. The population explosion causes a lot of problems such as illiteracy, poor public services, poverty, the problem of infrastructure, unemployment.

Actions and strategies that can be developed to solve these problems

There is controversy over whether population growth is good or bad. Over-population and continuing population growth are making substantial contributions to the destruction of Earth's life support systems. In the past, human populations have rarely been subject to explosion. The powerful long-term momentum that is built into the human age structure means that the effects of fertility changes become apparent only in the future. For these reasons, it is now conventional practice to use the technology of population projection as a means of better understanding the implications of trends.

Action plans and strategies can be developed to increase public understanding of how rapid population growth limits chances for meeting basic needs. The spirit of open communication and empowerment of individual women and men will be key to a successful solution to many population problems. Collective vision about health care, family planning, and women's education at the community level build a basis for action. The creation of action plans helps to meet challenges to find cooperative solutions. Free and equal access to health care, family planning, and education are desirable in their own right and will also help reduce unwanted fertility.

Individual choice, human rights, and collective responsibility are keys to allowing families to plan the size and spacing of their children. It is essential to achieve a balance between population and the available resources. Teachers, parents, community, workers, and other stakeholders should extend the range of choices about available resources to individuals especially women, and by equalizing opportunities between the genders from birth onwards. Teachers, students, parents, and other stakeholders can look for trends in the population explosion. They can hold community meetings at school to discuss how this issue presents, challenges to the big picture of the human population on the planet "Earth".

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Poverty

Poverty can be defined as a situation when people are unable to satisfy the basic needs of life. As per the planning commission of India poverty line is drawn with an intake of 2400 calories in rural areas and 2100 calories in urban areas. If they fail to get that much minimum level of calories, they are considered below the poverty line. An estimated 250 million people are below the poverty line and approximately 75 percentage populations are from a rural area.

Causes:

1. The high population growth rate.
2. High illiteracy rate (around 30%).
3. Unemployment.
4. Lack of infrastructure (lack of schools, vocational college).
5. High level of dependency on primitive methods of agriculture.
6. Regional inequalities – In politics from there are so many areas that are neglected by our politicians and policymakers. They failed to generate employment or they have floured on the state to the others.
7. Before 1991 high foreign investment was prevented.
8. Political corruption: Political parties use the funds for their self-use which is a means for poor people. Rajiv Gandhi said that out of 100 paise only 14 paisa reach them.

5.4 ENVIRONMENT AND HUMAN HEALTH

Introduction

Changes in environment had an influence on health patterns. Environmental Health (WHO) comprises those aspects of human health, including the quality of life, that are determined by physical, chemical, biological, social and psycho-social factors in the environment. It refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that adversely affect the health of present and future generations.

The cloudy atmosphere keeps out the sunshine, deprives people of sun-made vitamin D, thus accounting for the disease rickets. Both chronic bronchitis and carcinoma of the lung in Europe are due to atmospheric conditions, which hold down the smoke and turn mist into smog. But in strong sunshine fair skins with little pigmentation have an added liability to skin cancer. Rheumatism has been related to dampness and cold. Lack of trace elements in the soil causes diseases in ruminant animals. Temperature and humidity effect the vectors of disease. The mosquitoes carry malaria, yellow fever, dengue, encephalitis, filariasis etc.

Types of diseases

The main diseases suffered by the people are classified as follows:

- **Deficiency diseases:** they are the disorders caused by lack of specific essential

substances such as vitamins, minerals, or amino acids in the diet taken by a person. E.g.: Avitaminosis A, Anemia, rickets and Osteomalacia, Teeth & gum diseases. Arthropodal and Helminthic diseases: disease caused by infestation with arthropod parasites

E.g.: Malaria, filariasis, Helminthic diseases.

- **Communicable diseases:** are also known as infectious disease. They spread from one person to the other, that is, a healthy person can catch it from a patient.

  E.g.: Dysentery & diarrhea, Gastroenteritis, enteric fever, infectious hepatitis, whooping cough, tuberculosis, measles, veneral diseases, leprosy.

- **Non-communicable diseases:** Cancer, cardio-vascular diseases.
- **Water related diseases:** Poor and erratic water supply and sanitation services and inadequate sanitation in public places such as schools, hotels, hospitals, health centers etc. are the main problems for spreading of diseases. Providing access to sufficient quantities of safe water, facilities for the sanitary disposal of excreta, and introducing sound hygiene-related behavior can reduce the morbidity and mortality caused by these risk factors.

There are 3 major types of water-related diseases:

- **Water –borne diseases:** These are caused by dirty water contaminated by human and animal wastes, especially from urban sewage or by chemical wastes from industry and agriculture. E.g.: Diarrhea, dysentery, polio, meningitis and hepatitis A and E. Excessive levels of nitrates cause blood disorders and pesticides in drinking water cause cancer, neurological diseases and infertility.
- **Water-based diseases:** Aquatic organisms that live a part of their life cycle in water and another part as a parasite in man, lead to several diseases. E.g.: Guinea worm affecting feet and round worm affecting the small intestine. Water-related vector diseases: Breeding of insects like mosquitoes in stagnant water cause malaria and filariasis.
- **Water-scarcity diseases:** Poor sanitation and poor water supply leads to tuberculosis, leprosy, tetanus etc. Arsenic in drinking water is a serious hazard to human health. Drinking water that is rich is arsenic leads to arsenic poisoning or arsenicosis.

  Water with high concentrations of arsenic results in problems such as color changes on the skin, hard patches on the palms and soles, skin cancer, cancers of the bladder, kidney and lung, and diseases of blood vessels of the legs and feet. It may lead to diabetes, high blood pressure and reproductive disorders.

Risks due to chemicals in food

Food contamination may occur through environmental pollution of the air, water and soil. Infections associated with beef, pork, chicken, fish etc. and unpasteurized fruit juice, lettuce, sprouts, cheese curd etc. led to various diseases like abortions, still births, cholera, bloody diarrhoea, acute renal failure, blood poisoning and liver cancer.

Cancer and the environment: Cancer are caused by the uncontrolled growth and spread of abnormal cells that affect any tissue of the body. Types of cancer include lung, colon,

rectal, stomach, oral, pharyngeal, breast and cervical. Cancer is preventable by smoking, providing healthy food and avoiding exposure to carcinogens. Most of the cancers are curable by a combination of surgery, chemotherapy (drugs) and radiotherapy (x-rays).

5.5 HUMAN RIGHTS

Human rights are those conditions that are considered indispensable for a person's all – round development and welfare. These rights can be divided into two groups: legal rights and moral rights. Legal rights come from the law. For example, people have a legal right to vote in India once they are 18 years old. A person's wife or child has got a moral right to be taken care of by him.

Several environmental issues are closely linked to human rights. These include the equitable distribution of environmental resources, the utilization of resources and intellectual property rights (IPRS), conflicts between people and wildlife especially around PAs, resettlement issues around development projects such as dams and mines, and access to health to prevent environment-related diseases. Indigenous people's products and uses are protected by 'Community Bio-diversity Registers' (CBRs).

Equity

- One of the primary concerns in environmental issues is how wealth, resources and energy must be distributed in a community. We can think of the global and regional community issues, national, family and individual concerns. While economic disparities remain a fact of life, we as citizens of community must appreciate that a widening gap between the rich and poor, between men and women, or between the present and future generations must be manipulated if social justice is to be achieved.
- Rights to land, water, food and housing are all a part of the environment that we all share. However, while some live unsustainable lifestyles with high consumption patterns; many others live well below the poverty line. Even in a developing country such as ours, there are enormous economic inequalities. This requires an ethic in which an equitable distribution becomes a part of everyone's thinking.
- The right to the use of natural resources that the environment holds is an essential component of human rights. It is related to disparities in the number of resources available to different sectors of society. People who live in wilderness communities are referred to as 'ecosystem people'. They collect food, fuel wood, and NTFP's catch fish in aquatic ecosystems, or hunt for food in forests and grasslands.
- When land use patterns change from natural ecosystems to more intensively used farmland and pastureland the rights of these indigenous people are usually sacrificed. Take the case of the subsidies given to the pulp and paper industry for bamboo, which makes it several times cheaper for the industry than for a rural individual who uses it to build his home.
- There are serious conflicts between the rights of rural communities for even basic resources, such as water, and the industrial sector that requires large amounts of water for sustaining its productivity. The right to land or common property resources of tribal people is infringed upon by large development projects such

as dams and mining. Movements to protect the rights of indigenous peoples are growing worldwide.

Nutrition, health and human rights

1. There are links between the environment, nutrition and health that must be seen from a human rights perspective. Proper nutrition and health are fundamental human rights. The right to life is a fundamental right in our constitution. As a deteriorating environment shortens life-spans, this effect has an impact on our fundamental constitutional right.
2. Poverty, hunger, malnutrition and poorly-managed environments together affect health and weaken the socioeconomic development of a country. Nearly 30 % of humanity, especially those in developing countries are affected by this problem. A human rights approach is needed to appreciate and support millions of people left behind in the 20th century's health revolution.
3. Poverty, hunger, malnutrition and poorly-managed environments together affect health and weaken the socioeconomic development of a country. Nearly 30 % of humanity, especially those in developing countries are affected by this problem. A human rights approach is needed to appreciate and support millions of people left behind in the 20th century's health revolution.

Intellectual property rights (IPRS) and community biodiversity registers (CBRS)

1. Traditional people, especially tribal's living in forest, have used local plants and animals for generations. This storehouse of knowledge leads to many new discoveries for modern pharmaceutical products. The revenue generated from such finds goes to the pharmaceutical industry that has done the research and patented the product. This leaves the original tribal user with nothing, while the industry could earn billions of rupees. To protect the rights of indigenous people who have used these products, a possible tool is to create a CBR of local products and their use so that their exploitation by the pharmaceutical industry would result in a royalty to the local community.
2. **Traditional medicine:** traditional medicine refers to health practices, approaches, knowledge and beliefs that incorporate plan-animals and mineral – based medicines, frequently of local or regional origin. It may be linked to spiritual therapies, manual techniques and exercises. These may be used singly or in combination to treat, diagnose and prevent illnesses or maintain well-being. Traditional medicine is often handed down through the generations or may be known to a special caste or tribal group.
3. In India, some of our primary health-care needs are taken care of entirely by traditional medicine, while in Africa; up to 80% of the population uses it for primary health care. In industrialized countries, adaptation of traditional medicine is termed 'complementary' or Alternative' medicine (CAM).
4. While there are advantages to traditional medicine as it is cheap and locally available, there are also diseases which it cannot treat effectively. This is a risk, as patients who use these alternative medicinal practices may rely on ineffective measures. The consequences could be a serious delay in diagnosis and effective

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treatment of a treatable condition. There is need to carefully research the claims of traditional practices to ensure that they are effective.

5. 25% of modern medicines are made from plants first used traditionally. Yoga is known to reduce asthma attacks. Traditional medicine has been found to be effective against several infectious diseases.

CHECK YOUR PROGRESS

1. **What is population explosion?**
2. **Explain causes of poverty.**
3. **Explain nutrition, health and human rights.**
4. **What is risk due to chemicals in food?**
5. **Explain human health.**

5.6 VALUE EDUCATION

Value education is expected to bring about a new sustainable way life. Education, both through formal and non-formal processes, must address understanding environmental, natural and cultural values, social justice, human heritage, equitable use of resources, managing common property resources and the causes of ecological degradation. Values deal with one's own principles and standards from which we judge what is right and wrong behaviour. Values are a set of principles or standards of behaviour that are regarded desirable, important & held in high esteem by society.

Types of value education

1. **Environmental values:** Every human being has a great variety of feelings for different aspects of his or her surroundings. True environmental values go beyond valuing a river for its water, a forest for its timber and NTFPs, or the sea for its fish. Environmental values are inherent in feelings that bring about sensitivity for preserving nature as a whole. This is a more spiritual, Eastern, traditional value. There are several writings and sayings in Indian thought that support the concept of the oneness of all creation, of respecting and valuing all the different components of nature. Value system has been altered with time and circumstances. With enormous numbers of people throwing away large quantities of non-degradable waste, it is damaging to the environment and value system must prevent all this through a strong environmental value education system. Pro-environmental actions must begin to move from the domain of individuals to that of a community. Environmental values must stress on the importance of preserving ancient structures. The characteristic architecture, sculpture, artworks and crafts of ancient cultures are invaluable environmental assets.
2. **Valuing nature:** We must learn to value and respect diverse human cultures. We have a great responsibility to protect life in all its glorious forms and must therefore respect the wilderness with all its living creatures. On one hand, we need to protect natural ecosystems; while on the other hand, we must protect the rights of local people. We must also attempt to restore degraded areas to their former natural ecological state.

3. **Valuing cultures:** Every culture has a right to exist. Tribal people are frequently linked closely with nature and we have no right to disturb and disrupt their life. We need to appreciate that many ancient and tribal cultures have a wisdom and knowledge of their own environments that is based on a deep sense of respect for nature. Tribal have produced unique art forms, such as painting, sculpture and crafts, which are beautiful and can enrich living experiences for everyone. The world will be culturally impoverished if we lose this traditional knowledge.
4. **Human heritage:** The earth itself is a heritage left to us by our ancestors. Heritage preservation is now a growing environmental concern, because we have undervalued much of this heritage during the last several decades and is vanishing at an astonishing pace. Though we admire and value the Ajanta and Ellora Caves, Taj Mahal and environmentally-friendly colonial buildings, we have done little to actively preserve them. As environmentally-conscious individuals, we need to lobby for the protection of the wilderness and our glorious architectural heritage.
5. **Equitable use of resources:** The equitable use of resources is seen as an essential aspect of human well-being and must become a shared point of view among all socially and environmentally-conscious individuals. In spite of the great number of people in the more populous developing countries, the smaller number of people in the developed countries uses more resources and energy than those in the developing world. Similarly, the small number of rich people in poor countries whose per capita use of energy and resources, and the generation of waste based on the one-time use of disposable products leads to great pressures on the environment. We need to discourage this kind of consumption and need more sustainable lifestyles.
6. **Common property resources:** There are several commonly-owned resources that all of us use as a community. The water that nature recycles, the air that we all breathe, the forests and grasslands which maintain our climate and soil, are all common property resources. Managing local forests through village-level FPCs has shown that if people know that they can benefit from the forests, they will begin to protect them. This essentially means sharing the power to control forests between the Forest Department and the local people.
7. **Ecological degradation:** In many situations, valuable ecological assets are turned into serious environmental problems. The changes in land use from natural ecosystems to more intensive utilization or marginal lands into intensive agricultural patterns or changes into urban or industrial land carry an ecological price. Wetlands provide usable resources and a variety of services, when destroyed to provide additional farmland, produce lower returns. A natural forest provides valuable NTFPs, whose economic returns are high that provided by felling the forest for timber. These values must form a part of a new conservation ethic.
8. **Social justice:** We need to respect and value the diverse aspects of the societies. If poor are not respected as they are lacking the best things in life, they will rebel, anarchy and terrorism will spread. The developing world will face a crisis than the developed countries, unless we protect the rights of poor people.

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5.7 HIV/AIDS

The AIDS (acquired immune deficiency syndrome) due to Human immuno deficiency virus (HIV) has caused a worldwide epidemic, called as pandemic as it continues to spread all over the world. The disease is spread through direct transfer of body fluids containing the virus into the bloodstream of another person. Sharing of contaminated needles among intravenous drug users and sexual contact are the most likely methods of passage. This is a problem with homosexual community in US. WHO estimated that 42 million adults and children are living with HIV/AIDS. Nearly 4 million are affected in India. The distribution of the virus is lowest in the economically developed countries and highest in less developed countries. Sub-Saharan Africa has been hit hardest by this disease. The economic burden on these countries is tremendous. Those with AIDS symptoms are unable to work and need medical care. Because of poverty there is often little medical care available.

Human immunodeficiency virus (HIV) is a lentivirus (a member of the retrovirus family) that causes acquired immunodeficiency syndrome (AIDS), a condition in humans which the immune system begins to fail, leading to life-threatening opportunistic infections. Infection with HIV occurs by the transfer of blood, semen, vaginal fluid, pre-ejaculate, or breast milk. Within these bodily fluids, HIV is present as both free virus particles and virus within infected immune cells. The four major routes of transmission are unsafe sex, contaminated needles, breast milk, and transmission from an infected mother to her baby at birth (Vertical transmission). Screening of blood products for HIV has largely eliminated transmission through blood transfusions or infected blood products in the developed world.

HIV primarily infects vital cells in the human immune system such as helper T cells (specifically CD4+ T cells), macrophages, and dendritic cells. HIV infection leads to low levels of CD4+ T cells through three main mechanisms: firstly, direct viral killing of infected cells; secondly, increased rates of apoptosis in infected cells; and thirdly, killing of infected CD4+ T cells by CD8 cytotoxic lymphocytes that recognize infected cells. When CD4+ T cell numbers decline below a critical level, cell-mediated immunity is lost, and the body becomes progressively more susceptible to opportunistic infections.

HIV/AIDS Transmission

HIV is transmitted when the virus enters the body, usually by injecting infected cells or semen. There are several possible ways in which the virus can enter.

- Most commonly, HIV infection is spread by having sex with an infected partner. The virus can enter the body through the lining of the vagina, vulva, penis, rectum, or mouth during sex.
- HIV frequently spreads among injection-drug users who share needles or syringes that are contaminated with blood from an infected person.
- Women can transmit HIV to their babies during pregnancy or birth, when infected maternal cells enter the baby's circulation.
- HIV can be spread in health-care settings through accidental needle sticks or contact with contaminated fluids.

- Very rarely, HIV spreads through transfusion of contaminated blood or blood components. Blood products are now tested to minimize this risk. If tissues or organs from an infected person are transplanted, the recipient may acquire HIV. Donors are now tested for HIV to minimize this risk.
- People who already have a sexually transmitted disease, such as syphilis, genital herpes, chlamydial infection, gonorrhea, or bacterial vaginosis, are more likely to acquire HIV infection during sex with an infected partner.
- The virus does not spread through casual contact such as preparing food, sharing towels and bedding, or via swimming pools, telephones, or toilet seats. The virus is also unlikely to be spread by contact with saliva, unless it is contaminated with blood.

HIV/AIDS Symptoms

Many people with HIV do not know they are infected. Many people do not develop symptoms after they first get infected with HIV. Others have a flu-like illness within several days to weeks after exposure to the virus. They complain of fever, headache, tiredness, and enlarged lymph nodes in the neck. These symptoms usually disappear on their own within a few weeks. After that, the person feels normal and has no symptoms. This asymptomatic phase often lasts for years.

The progression of disease varies widely among individuals. This state may last from a few months to more than 10 years:

- During this period, the virus continues to multiply actively and infects and kills the cells of the immune system.
- The virus destroys the cells that are the primary infection fighters, called CD4 cells.
- Even though the person has no symptoms, he or she is contagious and can pass HIV to others through the routes listed above.

AIDS is the later stage of HIV infection, when the body begins losing its ability to fight infections. Once the CD4 cell count falls low enough, an infected person is said to have AIDS.

Sometimes, the diagnosis of AIDS is made because the person has unusual infections or cancers that show how weak the immune system is:

1. The infections that happen with AIDS are called opportunistic infections because they take advantage of the opportunity to infect a weakened host.
2. Pneumonia caused by Pneumocystis, which causes wheezing.
3. Brain infection with toxoplasmosis which can cause trouble thinking or symptoms that mimic a stroke,
4. Widespread infection with a bacteria called MAC (mycobacterium avium complex) which can cause fever and weight loss,
5. Yeast infection of the swallowing tube (esophagus) which causes pain with swallowing, and

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6. Widespread diseases with certain fungi like histoplasmosis, which can cause fever, cough, anaemia, and other problems.

A weakened immune system can also lead to other unusual conditions:

1. Lymphoma in the brain, which can cause fever and trouble thinking; or
2. A cancer of the tissues called Kaposi's sarcoma, which causes brown, reddish, or purple spots that develop on the skin or in the mouth.

5.8 WOMEN AND CHILD WELFARE

Since India gained Independence in 1947, the government has been focusing on the welfare and progress of women. All the five-year development plans of India included a special section on women, children, and their development.

From an initial plan outlay of Rs. 4 Cr. To Rs. 70000 Cr. The government has made efforts to bring up the status of women socially, economically, and politically on par with that of men.

The problem faced by women

1. Female Early marriage
2. Early motherhood
3. dowry death
4. Inequalities
5. Physical assault

Among many policies launched by the government of India related to the improvement of the status of women in India are:

1. **Child marriage Restraint Act:** below 18 years' girl's marriage is illegal.
2. **Maternity Benefits Act:** It focuses on mother and child health care.
3. **Dowry Prohibition Act:**
4. The family court is targeted towards providing legal aid and settling family-related issues.
5. The government of India has set up forums and developed action plans as:
   - The National Plan of action for girl child ensures the survival, protection, and development of girl child.
   - The National Nutritional Policy
   - Shram Shakti reports has recommended areas, related to improving employment opportunities, training, and development of skills for women.
6. A large number of voluntary organization (NGO's) such as SEVA, SAHELI, ASMITA, LOK SHAKTI, SPANDHANA, national center for providing basic health care services, to provide food and shelter for destitute, supports them in findings unemployment and organize training program. Some of them help in spreading awareness of the disease like leprosy, tuberculosis, AIDS, etc.

Child welfare

Children constitute principal assets of any country. Children's Development is as important as the development of material resources and the best way to develop national human resources is to take care of children. India has the largest child population in the world. All-out efforts are being made by India for the development and welfare of children. Significant progress has been made in many fields it assuring children their basic rights.

However, much remains to be done. The country renews its commitment and determination to give the highest priority to the basic needs and rights of all children. Children are the most vulnerable to exploitation and abuse. A lot more has to be done for the health, nutrition, and education of children. It is unfortunate that girls in particular face debilitation discrimination at all stages. Therefore, specific concentration is being given to the efforts to improve their lives and opportunities of the Girl Child.

According to Article 39 of the Directive Principles of State Policy, the constitution of India pledges that the State will direct its policy towards children, to provide them the opportunities and facilities to grow healthily, in conditions of freedom and dignity, and to protect them from exploitation.

India is a signatory to the World Declaration on the Survival, Protection, and Development of Children. In pursuance of its commitment, the Department of Women and Child Development, has formulated the National Plan of Action for Children. The areas addressed by the plan include health, nutrition, education, water, sanitation, and the environment.

5.9 ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH

Information Technology plays an important role in the environment and human health. The invention of the computer in the history of mankind is one of the great developments. Information technology is based on a computer. Computer, Internet, Remote Sensing, and GIS (Geographic Information System) are the various component of Information technology.

Remote Sensing

Remote sensing is the science of acquiring information about an object or a surface future, without coming in physical contact with the object or feature of interest. Remote sensing technology involves electromagnetic energy, acoustic waves, and force fields to gain information about an object.

Force Fields

Gravity and magnetism are frequently used by geologists, geophysicists, and astronomers for various purposes.

Acoustical Waves

Very often-acoustical waves are used for examining the ocean floor. An acoustic echo sounder releases short pulses of audible sound in a selected direction and the returning signals are collected to gain information about the seafloor.

Electromagnetic Energy
It is the most commonly used medium-for remote sensing.

Applications of remote sensing in Environmental Sciences:
From an environmental point of view, remote sensing is used in the following areas:

1. Weather analysis and forecasting.
2. Global climatologically studies.
3. Hydrological studies.
4. Soils and landforms studies.
5. Rocks and mineral resources' studies.
6. Ecology, conservation and resource management.
7. Land use and crop production.
8. Built environment studies.
9. Hazards and disasters prediction and monitoring.

5.10 CHAPTER SUMMARY

The relationship between population and pollution is different in developed nations and developing nations. In developing nations, there is a direct relationship between population and pollution. In developing nations people do not have high purchasing power, they are technically backward, so, they use natural resources irrationally causing more pollution. They cannot even take steps to control pollution. While in the developed nation the equation is entirely different. There is an inverse relationship between population and pollution. They have high purchasing power.

There is controversy over whether population growth is good or bad. Over-population and continuing population growth are making substantial contributions to the destruction of Earth's life support systems. In the past, human populations have rarely been subject to explosion. The powerful long-term momentum that is built into the human age structure means that the effects of fertility changes become apparent only in the future. For these reasons, it is now conventional practice to use the technology of population projection as a means of better understanding the implications of trends.

Changes in environment had an influence on health patterns. Environmental Health (WHO) comprises those aspects of human health, including the quality of life, that are determined by physical, chemical, biological, social and psycho-social factors in the environment. It refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that adversely affect the health of present and future generations.

The AIDS (acquired immune deficiency syndrome) due to Human immuno deficiency virus (HIV) has caused a worldwide epidemic, called as pandemic as it continues to spread all over the world. The disease is spread through direct transfer of body fluids containing the virus into the bloodstream of another person. Sharing of contaminated needles among

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intravenous drug users and sexual contact are the most likely methods of passage. This is a problem with homosexual community in US.

5.11 REVIEW QUESTIONS

SHORT ANSWER TYPE QUESTION

1. **Discuss the problems faced by women.**
2. **What is HIV/AIDS?**
3. **What is value education?**
4. **What are human rights?**
5. **Describe the types of diseases.**

LONG ANSEWR TYPE QUESTIONS

1. **Write a brief note on role of information technology in environment.**
2. **Explain transmission of HIV/AIDS. Symptoms also.**
3. **Discuss human rights equity and intellectual property rights.**
4. **Applications of remote sensing in Environmental Sciences. Explain.**
5. **Explain poverty in brief and its causes.**

5.12 MULTIPLE CHOICE QUESTIONS

1. **The population is referred to as the total of the human individual in a particular geographical boundary.**
   a. Biological
   b. Geographical
   c. Ecological
   d. None of the above
2. **There are _____ causes of population growth.**
   a. 5
   b. 4
   c. 3
   d. 2
3. **The population explosion gives birth to overpopulation.**
   a. Children
   b. Overpopulation
   c. Universe
   d. None of the above
4. **There are _____ major types of water-related diseases.**
   a. **4**
   b. **3**
   c. **2**
   d. **1**

5. **Water related disease include:**
   a. Water –borne diseases
   b. Water-based diseases
   c. Water-scarcity diseases
   d. All of the above

6. **Arthropodal and _____ diseases: disease caused by infestation with arthropod parasites.**
   a. Rickets
   b. Osteomalacia
   c. Helminthic
   d. None of the above

7. **Primary infection fighter cells are:**
   a. CD3
   b. CD4
   c. CD5
   d. CD6

8. **Maternity Benefits Act: It focuses on _____ health care.**
   a. Parents of the child
   b. Father and child
   c. Mother and child
   d. None of the above

9. **Computer, Internet, Remote Sensing, and GIS (Geographic Information System) are the various component of_____.**
   a. Information Technology
   b. Production Technology
   c. Supply chain management
   d. None of the above

10. **The problem faced by women does not include:**
    a. Female Early marriage
    b. Early motherhood
    c. dowry death
    d. Equalities

♦♦♦♦♦

ANSWER KEY

UNIT I

QUES.	ANSWERS	QUES.	ANSWERS
1.	d.	6.	a.
2.	d.	7.	b.
3.	c.	8.	d.
4.	b.	9.	c.
5.	a.	10.	a.

UNIT II

QUES.	ANSWERS	QUES.	ANSWERS
1.	a.	6.	b.
2.	b.	7.	a.
3.	c.	8.	b.
4.	a.	9.	c.
5.	d.	10.	d.

UNIT III

QUES.	ANSWERS	QUES.	ANSWERS
1.	a.	6.	b.
2.	d.	7.	b.
3.	b.	8.	d.
4.	a.	9.	a.
5.	c.	10.	c.

UNIT IV

QUES.	ANSWERS	QUES.	ANSWERS
1.	b.	6.	a.
2.	a.	7.	c.
3.	b.	8.	d.
4.	c.	9.	a.
5.	b.	10.	b.

UNIT V

QUES.	ANSWERS	QUES.	ANSWERS
1.	b.	6.	c.
2.	a.	7.	b.
3.	b.	8.	c.
4.	a.	9.	a.
5.	d.	10.	d.