# Chapter 1

## Introduction to Environmental Studies And its Multidisciplinary Nature of

The word ‘Environment’ is derived from the French word ‘Environner’ which means to encircle, around or surround. The biologist Jacob Van Uerkal (1864-1944) introduced the term ‘environment’ in Ecology. Ecology is the study of the interactions between an organism of some kind and its environment. As given by Environment Protection Act 1986, Environment is the sum total of land, water, air, interrelationships among themselves and also with the human beings and other living organisms. It studies the sources, reactions, transport, effect and fate of a biological species in the air, water and soil and the effect of and from human activity upon these. Environmental Science deals with the study of processes in soil, water, air and organisms which lead to pollution or environmental damages and the scientific basis for the establishment of a standard which can be considered acceptably clean, safe and healthy for human beings and natural ecosystems.

The word environment is derived from the French word '**environ**' meaning surroundings. Hence, everything surrounding us is called "ENVIRONMENT".

The **Oxford Advanced Learners Dictionary** defines environment as the natural world in which people, animals and plants live.

According to Boring, ‘A person’s environment consists of the sum total of the stimulation which he receives from his conception until his death.’ Indicating that environment comprises various types of forces such as physical, intellectual, mental, economical, political, cultural, social, moral and emotional.

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, behaviour and the growth, development and maturity of living organisms.

**Ecology** is the science that studies the relationships between living things and the environment. It is also considered to be a discipline of biology.

**Environment Science** is the systematic and scientific study of the environment and our role in it.

**Environmental Studies** can be defined as the branch of the study concerned with environmental issues.

**Environmental studies** is an multidisciplinary academic field which systematically studies human interaction with the environment in the interests of solving complex problems. Environmental studies bring together the principles of the physical sciences, commerce/economics and social sciences so as to solve contemporary environmental problems. The environment consists of **four segments** of the earth namely atmosphere, hydrosphere, lithosphere and biosphere:

1. **Atmosphere**: The Atmosphere forms a distinctive protective layer about 100 km thick around the earth. A blanket of gases called the atmosphere surrounds the earth and protects the surface of earth from the Sun's harmful, ultraviolet rays. It sustains life on the earth. It also regulates temperature, preventing the earth from becoming too hot or too cold. It saves it from the hostile environment of outer space. The atmosphere is composed of nitrogen and oxygen besides, argon, carbon dioxide and trace gases.

The atmosphere has a marked effect on the energy balance at the surface of the Earth. It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun. It transmits only ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultra-violate waves below about 300 nm.

2. **Hydrosphere**: The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reservoirs, polar icecaps, glaciers, and ground water. Oceans represent 97% of the earth's water and about 2% of the water resources is locked in the polar icecaps and glaciers. Only about 1% is available as fresh water as surface water in rivers, lakes, streams, and as ground water for human use.

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

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

**Elements of Environment**

Environment is constituted by the interacting systems of physical, biological and cultural elements inter-related in various ways, individually as well as collectively. These elements are:

(1) **Physical Elements**

Physical elements are space, landforms, water bodies, climate, soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.

(2) **Biological Elements**

Biological elements such as plants, animals, microorganisms and men constitute the biosphere.

(3) **Cultural Elements**

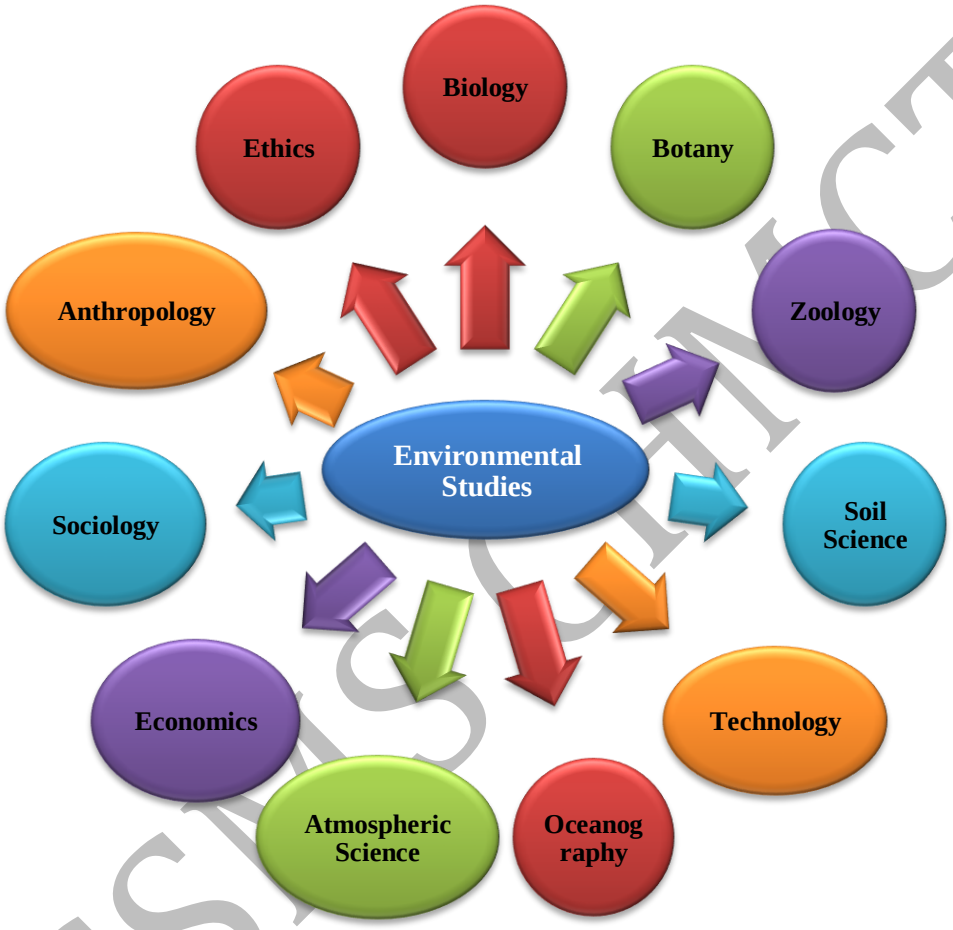
Cultural elements such as economical, social and political elements are essentially man- made features, which make the cultural background.

**MULTIDISCIPLINARY NATURE OF ENVIRONMENT STUDIES**

Environment studies is a multidisciplinary subject where different aspects are dealt with in a holistic approach. The science of Environment studies comprises various branches of studies like chemistry, physics, life science, medical science, agriculture, public health, sanitary engineering, geography, geology, atmospheric science, etc. It is the science of physical phenomena in the environment.

The complex relationship that exist in our natural environment among people, animals, others organisms, water soil, air tree, ocean, and so on. The interconnections are numerous and

involve many different disciplines. We need inputs from diverse disciplines such as biology, botany, zoology, soil science, technology oceanography, atmospheric science, economics, sociology, anthropology and ethics. Environmental studies involve educating the people for preserving the quality of environment.




**SCOPE OF ENVIRONMENTAL STUDIES**

The scope of environmental studies is very wide and it deals with many areas like i) Conservation of natural resources, ii) ecological aspects, iii) pollution of the surrounding natural resources, iv) controlling the pollution, v) social issues connected to it, and vi) impacts of human population on the environment.

1. Developing an awareness and sensitivity to the total environment and its related problems.
2. Motivating people for active participation in environmental protection and improvement.
3. Developing skills for active identification and development of solutions to environmental problems.
4. Imbibe and inculcate the necessity for conservation of natural resources.

5. Evaluation of environmental programmes in terms of social, economic, ecological and aesthetic factors.

**IMPORTANCE OF ENVIRONMENTAL STUDIES**

The environment studies make us aware about the importance of protection and conservation of our mother earth and about the destruction due to the release of pollution into the environment. The increase in human and animal population, industries and other issues make the survival cumbersome. A great number of environment issues have grown in size and make the system more complex day by day, threatening the survival of mankind on earth. Environment studies have become significant for the following reasons:

**Environment Issues are being of Global**:

It has been well recognized that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence require international efforts and cooperation to solve them.

**Development and Environment**:

Development leads to Urbanization, Industrial Growth, Telecommunication and Transportation Systems, Hi-tech Agriculture and Housing etc. However, it has become phased out in the developed world. The North intentionally moves their dirty factories to South to cleanse their own environment. When the West developed, it did so perhaps in ignorance of the environmental impact of its activities. Development of the rich countries of the world has undesirable effects on the environment of the entire world.

**Explosive Increase in Pollution**

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

**Need for an Alternative Solution**

- It is essential, especially for developing countries to find alternative paths to an alternative goal. We need a goal as under:
- A true goal of development with an environmentally sound and sustainable development.
- A goal common to all citizens of our planet earth.
- A goal distant from the developing world in the manner it is from the over-consuming wasteful societies of the "developed" world.

It is utmost important for us to save the humanity from extinction because of our activities constricting the environment and depleting the biosphere, in the name of development.

**Need for Wise Planning of Development**

Our survival and sustenance depend on resources availability. Hence Resources withdraw, processing and use of the products have all to be synchronized with the ecological cycle. In any plan of development our actions should be planned ecologically for the sustenance of the environment and development.

**NEED FOR PUBLIC AWARENESS**

The need of the hour is to make the public aware of the consequences of the environmental degradation, if not corrected and reformative measures undertaken, would result in the extinction of life. In today's world because of industrialization and increasing population, the natural resources has been rapidly utilized and our environment is being increasingly degraded by human activities, so we need to protect the environment. It is not only the duty of government but also the people to take active role for protecting the environment, so protecting our environment is economically more viable than cleaning it up once, it is damaged.

The role of mass media such as newspapers, radio, television, etc is also very important to make people aware regarding environment. There are various institutions, which are playing positive role towards environment to make people aware regarding environment like BSI (Botanical Survey of India, 1890), ZSI (Zoological Survey of India, 1916), WII (Wild Life Institute of India, 1982) etc.

It is also necessary to face the various environmental challenges and to act accordingly to make the acts eco-friendly. The major challenges ahead are the following:

**Population**: A population of over thousands of millions is growing at 2.11 per cent every year. Over 17 million people are added each year. India accounts for 16 % of the world population, but with only 2.4 per cent of the land area. This makes considerable pressure on the natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although the population control does automatically lead to development, yet the development leads to a decrease in population growth rates. For this development to be happened, knowledge of the women is essential. The future population growth has to be linked to the resource base in order to have sustainable development.

**Poverty Alleviation:** India has often been described a rich land with poor people. The poverty and environmental degradation are inter-dependent. The vast majority of our people are directly dependent on the natural resources of the country for their basic needs of food, fuel, fodder and shelter. About 65 % of Indians are poor and about 40% of our people are still below the poverty line. Environment degradation has adversely affected the poor who depend upon the natural resources of their immediate surroundings. Thus, the challenge of poverty and the challenge of environment degradation are two facets of the same challenge. The population growth is essentially a function of poverty.

**Agricultural Growth:**The people must be acquainted with the methods to sustain and increase agricultural growth without damaging the environment. Fertilizers and pesticides are causing major threats to the environment in the form of soil and water pollution. It is evident that it is very difficult that these chemicals will be kept out of soil, water and food chain if they are extensively and continuously used in crop production. Highly intensive agriculture has caused soil salinity and damage to the physical structure of soil.

**Protecting Ground Water from pollution:** Because of intensive agriculture, increase in number of industries, rapid urbanization and population growth, the need for water is growing at a faster rate. This leads to the fast depletion of groundwater table. It is very essential of rationalizing the use of groundwater now. Factors like community

wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected the quality of groundwater also. The need of the hour is to restore the water quality of our rivers and other water bodies as lakes and to avoid the groundwater pollution. Finding suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean which are difficult challenges ahead. Rain water harvesting and water management can help to an extent in this regard.

**Development and Forests:** Forests provide raw materials for construction of houses and for industries like paper and pulp manufacturing, packaging, fire wood and fodder for people etc. Forests serve as catchments for the rivers. With increasing demand of water, huge dams were constructed in independent India leading to submergence of large forest areas; displace local people and damage flora and fauna. As such, the dams on the river Narmada, Bhagirathi and elsewhere have become areas of political conflicts and scientific debate. Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas of forests in many states are now converted as agricultural lands for growing hilly vegetables and plantation crops and mining. These areas are to be brought back under forest cover. The tribal communities inhabiting forests respects the trees and birds and animal that gives them sustenance. We must recognize the role of these people in restoring and conserving forests. The modern knowledge and skills of the forest department should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests by the government officials and tribal people should be evolved in a well-planned way to implement afforestation.

**Degradation of Land:** At present out of the total 329 mha of land, only 266 mha possess any potential for production. Of this, 143 mha is agricultural land and 85 mha suffers from varying degrees of soil degradation. Of the remaining 123 mha, 40 mha are completely unproductive. The remaining 83 mha is classified as forest land, of which over half is denuded to various degrees. Nearly 406 million head of livestock have to be supported on 13 mha, or less than 4 per cent of the land classified as pasture land, most of which is overgrazed. Thus, out of 226 mha, about 175 mha or 66 per cent is degraded to varying degrees. Water and wind erosion cause further degradation of almost 150 mha This degradation is to be avoided.

**Reduction of Genetic Diversity:** Immediate measures to conserve genetic diversity need to be taken at the earliest. At present most wild genetic stocks have been disappearing from nature. The protected areas network like sanctuaries, national parks, biosphere reserves are isolating populations. Remedial steps are to be taken to check decreasing genetic diversity.

**Evil Consequences of Urbanization:** Nearly 27 per cent Indians live in urban areas. Urbanization and Industrialization has given birth to a great number of environmental problems that need urgent attention. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

**Air and water Pollution:** Majority of our industrial plants are using outdated treatment technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas that have been identified as the worst in terms of air and water pollution. Acts are enforced in the country, but their implementation is not so easy. The reason is their implementation needs great resources, technical expertise, political and social will. Again, the people are to be made aware of these rules. Their support is indispensable to implement these rules.

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

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## Ecosystem : Structure and function

Organisms interact with each other and also with the physical conditions that are present in their habitats. 'The organisms and the physical features of the habitat form an ecosystem' - **Clarke** (1954). The concept of ecosystem was first put forth by **A.G.Tansley**(1935). Ecosystem is the major ecological unit. It has both structure and function. The structure is related to species diversity.

According to **E.P.Odum**, the ecosystem is the basic functional unit of organism and their environment interacting with each other. The function of ecosystem is related to the energy flow, decomposition, nutrient cycling and major biomes.

Structure

Generally ecosystems consist of two basic components.

1. Abiotic component.

2. Biotic component.

## 1. Abiotic components

It includes basic in-organic (soil, water, oxygen, calcium carbonates, phosphates etc.) and organic compounds. It also includes physical factors such as moisture, wind currents and solar radiation. Radiant energy of sun is the only significant energy source for any ecosystem.

## 2. Biotic components

Include producers, consumers and decomposers.

**i)Producer :** These are the autotrophic, chlorophyll-bearing organisms, which produce their own food.

**ii)Consumers :** A consumer which gets nutrition by eating plants is called **Primary consumers** (herbivore) (eg) Rabbit, deer and cow.

**The Secondary Consumer:** (carnivores) is an animal that eats the flesh of herbivores (eg) cats and dogs.

**Tertiary Consumers:** are the type of carnivores, which prey upon other carnivores. (eg) Lion, tiger and vulture.

### iii)Decomposers

Decomposers attack the dead remains of producers and consumers and degrade the complex organic substances into simpler compounds to derive their nutrients. The decomposers play very important role in maintaining the dynamic nature of ecosystem.

## Functions of Ecosystem

An ecosystem is a functional and life sustaining environmental system. The environmental system consists of biotic and abiotic components. Biotic components include living organisms and abiotic components includes inorganic matter and energy.

The functions of the ecosystem are as follows:

1.
    1. It regulates the essential ecological processes, supports life systems and renders stability.
    2. It is also responsible for the cycling of nutrients between biotic and abiotic components.
    3. It maintains a balance among the various trophic levels in the ecosystem.

4. It cycles the minerals through the biosphere.
5. The abiotic components help in the synthesis of organic components that involves the exchange of energy.

What is a food chain?

A food chain refers to the order of events in an ecosystem, where one living organism eats another organism, and later that organism is consumed by another larger organism. The flow of nutrients and energy from one organism to another at different trophic levels forms a food chain.

The food chain also explains the feeding pattern or relationship between living organisms. Trophic level refers to the sequential stages in a food chain, starting with producers at the bottom, followed by primary, secondary and tertiary consumers. Every level in a food chain is known as a trophic level.

The food chain consists of four major parts, namely:

The Sun: The sun is the initial source of energy, which provides energy for everything on the planet.

Producers: The producers in a food chain include all autotrophs such as phytoplankton, cyanobacteria, algae, green plants. This is the first stage in a food chain. The producers make up the first level of a food chain. The producers utilise the energy from the sun to make food. Producers are also known as autotrophs as they make their own food. Producers are any plant or other organisms that produce their own nutrients through photosynthesis. For example, green plants, phytoplankton and algae are some examples of producers in a food chain.

Consumers: Consumers are all organisms that are dependent on plants or other organisms for food. This is the largest part of a food web, as it contains almost all living organisms. It includes herbivores which are animals that eat plants, carnivores which are animals that eat other animals, parasites are those organisms that live on other organisms by harming them and lastly the scavengers, which are animals that eat dead animals' carcasses.

Here, herbivores are known as primary consumers and carnivores are secondary consumers. The second trophic level includes organisms that eat producers. Therefore, primary consumers or herbivores are organisms in the second trophic level.

**Decomposers:** Decomposers are organisms that get energy from dead or waste organic material. This is the last stage in a food chain. Decomposers are an integral part of a food chain, as they convert organic waste materials into inorganic materials like nutrient-rich soil or land.

Decomposers complete a life cycle. They help in recycling the nutrients as they provide nutrients to soil or oceans, that can be utilised by autotrophs or producers. Thus, starting a whole new food chain.

**Types of Food Chain**

There are two types of food chains, namely detritus food chain and grazing food chain.

**Detritus food chain:** The detritus food chain includes different species of organisms and plants like algae, bacteria, fungi, protozoa, mites, insects, worms and so on. The detritus food chain begins with dead organic material. The food energy passes into decomposers and detritivores, which are further eaten by smaller organisms like carnivores. Carnivores, like maggots, become a meal for bigger

carnivores like frogs, snakes and so on. Primary consumers like fungi, bacteria, protozoans, and so on are detritivores which feed on detritus.

**Grazing food chain:** The grazing food chain is a type of food chain that starts with green plants, passes through herbivores and then to carnivores. In a grazing food chain, energy in the lowest trophic level is acquired from photosynthesis.

In this type of food chain, the first energy transfer is from plants to herbivores. This type of food chain depends on the flow of energy from autotrophs to herbivores. As autotrophs are the base for all ecosystems on Earth, the majority of ecosystems in the environment follow this kind of food chain.

Some common food chains are mentioned below:

Plants → Deer → Lion

Plants → Worm→ Bird → Cat

Plants→ Grasshopper→ Frog→ Snake→ Hawk

Algae→ Small→ animal → Sma

**Food Web:**

Several interconnected food chains form a food web. A food web is similar to a food chain but the food web is comparatively larger than a food chain. Occasionally, a single organism is consumed by many predators or it consumes several other organisms. Due to this, many trophic levels get interconnected. The food chain fails to showcase the flow of energy in the right way. But, the food web is able to show the proper representation of energy flow, as it displays the interactions between different organisms.

When there are more cross interactions between different food chains, the food web gets more complex. This complexity in a food web leads to a more sustainable ecosystem.

Conclusion

Understanding food chains is vital, as they explain the intimate relationships in an ecosystem. A food chain shows us how every living organism is dependent on other organisms for survival. The food chain explains the path of energy flow inside an ecosystem.

## WASTE LAND RECLAMATION

The pressure on land is growing owing to population explosion. The erosion of soil by man's activities and unsustainable practices is called barren land or wasteland. Different people and organisations define wasteland in different way. Let us consider some of them.

### Important Definitions

1. **According to National Remote Sensing Agency,** "Wasteland is the land which is laying without use or which has no capacity of production."

2. **According to National Wasteland Develoopment Board,** "Wasteland or barren land is the land which has no capacity of production because of one or other reasons."

3. **According to Wasteland Survey and Reclamation committee,** "Waste land is the land which is either not available for agriculture or impossible to do agriculture on it for some reasons."

### Causes of wasteland expansion

1. Misuse of soil
2. Industrial waste
3. Cutting of forests
4. Farming forcibly on wasterland
5. Jhoom farming
6. Excessive grazing on grassland

7. Faulty water management
8. Irrigation by polluted water
9. Excessive use of fertilizers
10. Overlooking techniques of soil preservation

Depletion of soil is continued in India. 1.5 hectare land is becoming waste per year in India. The Vohra Commission told in seventies that a policy must be made to control the problem of wasteland. A survy reveals that 1295.82 lakh hectare land is waste in India. The government has constituted National Wasteland development Board. The main aims of the Board are following:

(i) Checking soil erosion
(ii) Managment of water
(iii) Production of fuel wood
(iv) Co-operation of government agencies and non-government agencies
(v) Stress on afforestation
(vi) Reform of soil quality

**Measures to Reclamate Wasteland**

One the suggestions of Hanumant Rao Committee, a number of pgorammes have been started to develop waste land.

**(1) Drought prone areas programme (DPAP):** The government in 1973-74 started this programme in arid areas. This programme includes 155 districts and 947 divisions of 13 states. This programme was based on water shed plan. In this programme the aim was to work with the co-operation of community. With the development of watershed, soil erosion could be controlled. Humidity of land increased adn programme of tree plantation gained boom.

**(2) Integrated Wastelent Development Programme (IWDP):** The programme was started in the year 1989-90. It was submerged in the National Wasteland Development Board in 1992. In this programme, wasteland development programmes are run with the help of villagers. The main aims of the programme are the following:

(i) Preservation of soil and humidity with the help of various techniques.
(ii) Conservation of natural resources and enhancing the natural productivity.
(iii) Encouragement of agro-forestry and gardening.
(iv) Working with the help of people.
(v) Forestation and grazing ground development.

## Carbon cycle

Carbon cycle shows the movement of carbon in elemental and combined states on earth. Diamond and graphite are the elemental forms of carbon.***carbon cycle is the process where carbon compounds are interchanged among the biosphere, geosphere, pedosphere, hydrosphere, and atmosphere of the earth.***

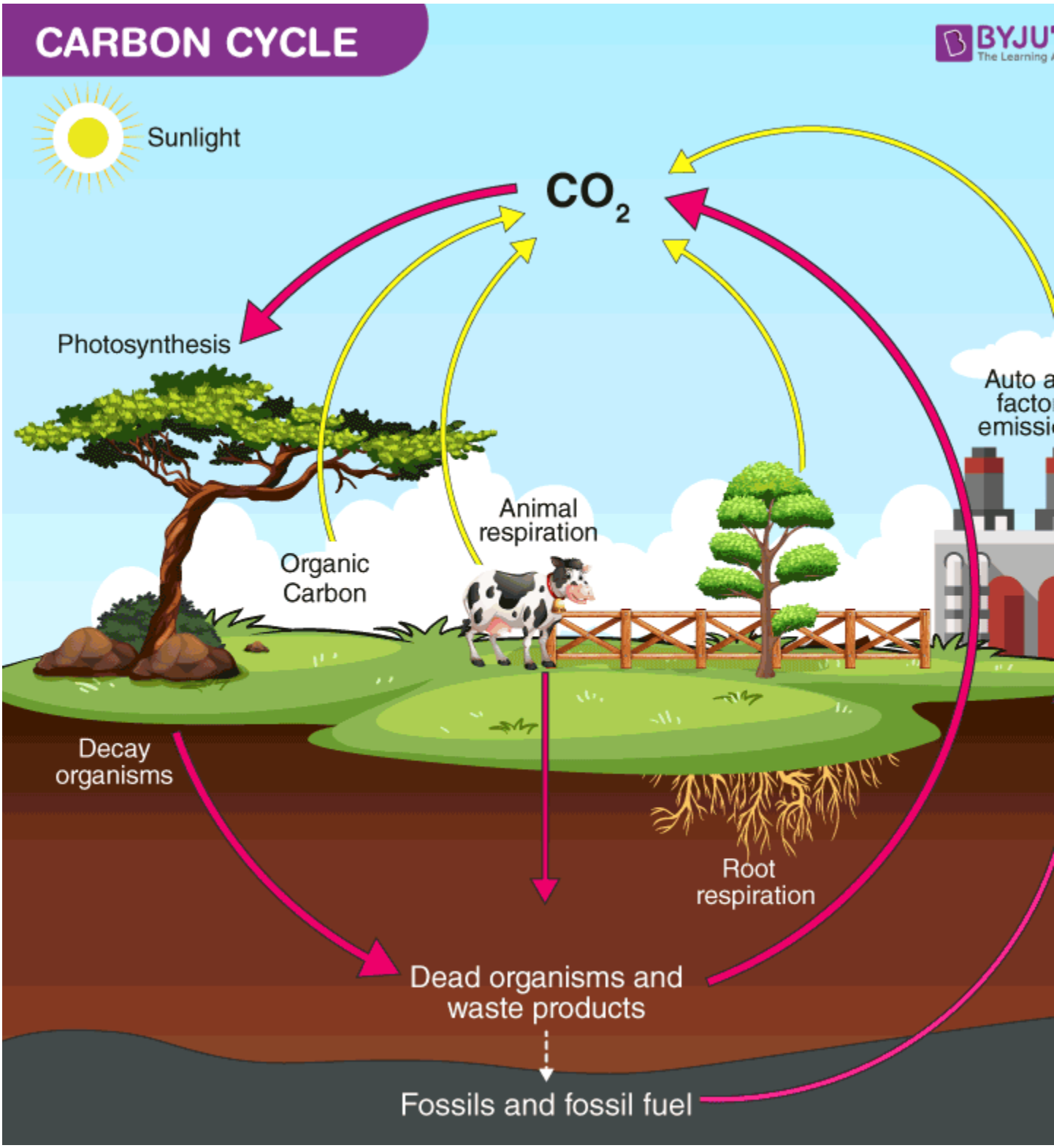
# Carbon cycle steps:

Following are the major steps involved in the process of the carbon cycle:

1. Carbon present in the atmosphere is absorbed by plants for photosynthesis.
2. These plants are then consumed by animals, and carbon gets bioaccumulated into their bodies.
3. These animals and plants eventually die, and upon decomposing, carbon is released back into the atmosphere.
4. Some of the carbon that is not released back into the atmosphere eventually become fossil fuels.
5. These fossil fuels are then used for man-made activities, which pumps more carbon back into the atmosphere.

# Carbon cycle diagram:

The carbon cycle diagram below elaborates the flow of carbon along different paths.




Carbon Cycle diagram showing the flow of carbon, its sources and paths.

## Carbon Cycle on Land

Carbon in the atmosphere is present in the form of carbon dioxide. Carbon enters the atmosphere through natural processes such as respiration and industrial applications such as burning fossil fuels. The process of photosynthesis involves the absorption of $CO_2$ by plants to produce carbohydrates. The equation is as follows:

$CO_2 + H_2O + \text{energy} \rightarrow (CH_2O)_n + O_2$

Carbon compounds are passed along the food chain from the producers to consumers. The majority of the carbon exists in the body in the form of carbon dioxide through respiration. The role of decomposers is to eat the dead organism and return the carbon from their body back into the atmosphere. The equation for this process is:

$(CH_2O)_n + O_2 \rightarrow CO_2 + H_2O$

## Oceanic Carbon Cycle

This is essentially a carbon cycle but in the sea. Ecologically, oceans take in more carbon than it gives out. Hence, it is called a "carbon sink." Marine animals convert carbon to calcium carbonate and this forms the raw building materials require to create hard shells, similar to the ones found in clams and oysters.

When organisms with calcium carbonate shells die, their body decomposes, leaving behind their hard shells. These accumulate on the seafloor and are eventually broken down by the waves and compacted under enormous pressure, forming limestone.

When these limestone rocks are exposed to air, they get weathered and the carbon is released back into the atmosphere as carbon dioxide.

## Importance of Carbon Cycle

Even though carbon dioxide is found in small traces in the atmosphere, it plays a vital role in balancing the energy and traps the long-wave radiations from the sun. Therefore, it acts like a blanket over the planet. If the carbon cycle is disturbed it will result in serious consequences such as climatic changes and global warming.

Carbon is an integral component of every life form on earth. From proteins and lipids to even our DNA. Furthermore, all known life on earth is based on carbon. Hence, the carbon cycle, along with the nitrogen cycle and oxygen cycle, plays a vital role in the existence of life on earth.

## Key Points on Carbon Cycle

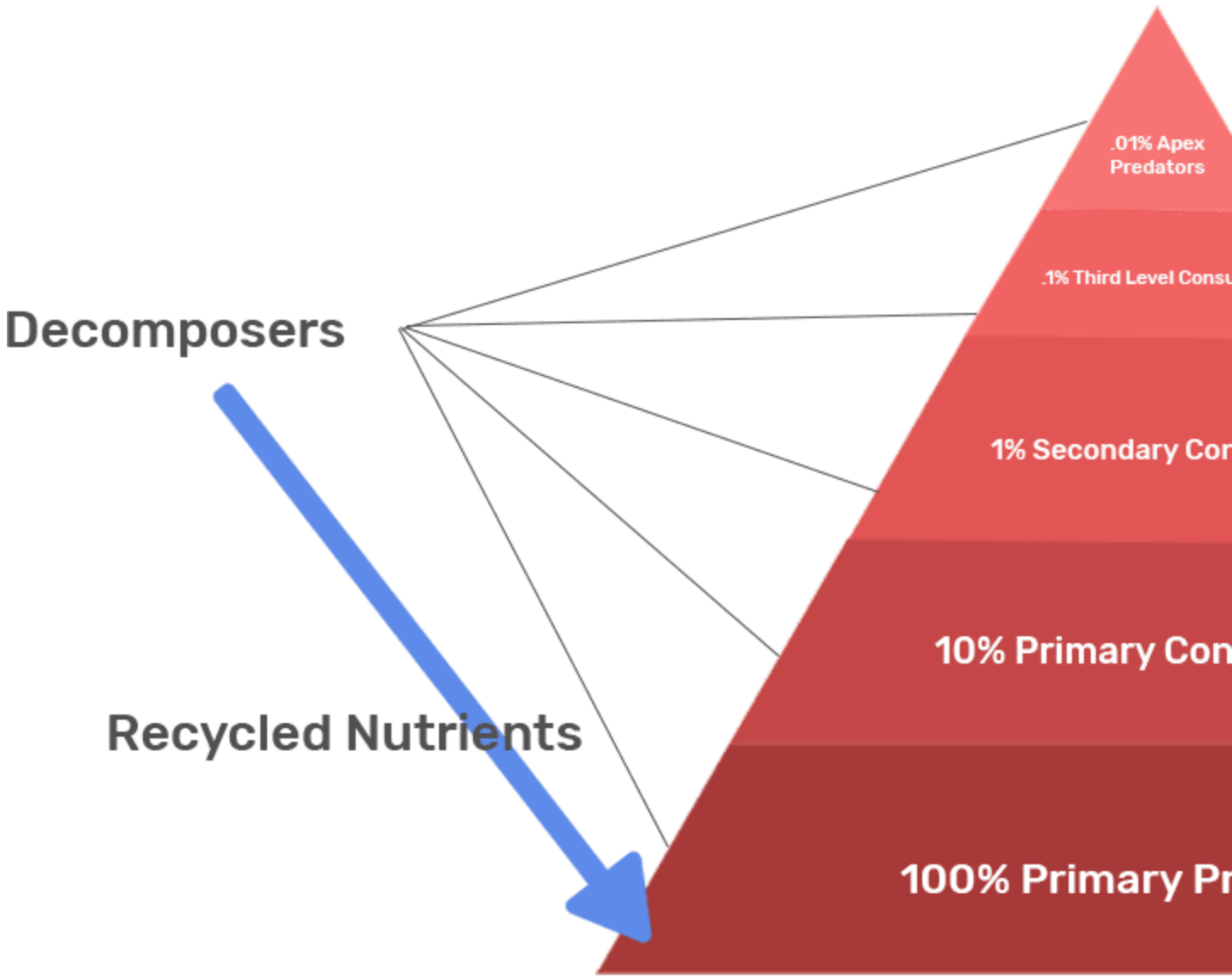
- Carbon cycle explains the movement of carbon between the earth's biosphere, geosphere, hydrosphere and atmosphere.
- Carbon is an important element of life.

- Carbon dioxide in the atmosphere is taken up by the green plants and other photosynthetic organisms and is converted into organic molecules that travel through the food chain. Carbon atoms are then released as carbon dioxide when organisms respire.
- The formation of fossil fuels and sedimentary rocks contribute to the carbon cycle for very long periods.
- The carbon cycle is associated with the availability of other compounds as well.

The graphical representation of the relationship between various living beings at various trophic levels within a food chain is called an ecological pyramid. The pyramid is formed on the basis of the number of organisms, energy and biomass, and just like the name suggests, these are shaped in the form of a pyramid.

The concept of ecological pyramid was developed by Charles Elton(1927). The ecological pyramid is also often known as the energy pyramid.

# ENERGY PYRAMID



The bottom of the pyramid, which is also the broadest part is occupied by the ones at the first trophic level, that is the producers. The next level of the pyramid is occupied by primary consumers. This is followed by the next level in the pyramid, belonging to the secondary and tertiary consumers.

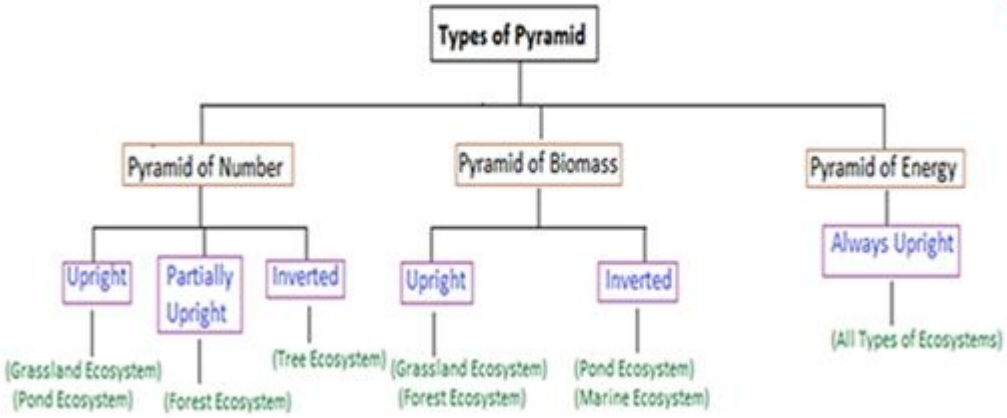
The ecological pyramid is also used to explain how various organisms in an ecosystem are related to one another. The pyramid ideally shows who is consumed by whom, while also showing the order in which the energy flows.

Types of Ecological Pyramids

The ecological pyramids can be categorized into three types based on ecological parameters. These are described as follows:

An overview of Different types of Pyramids in the Ecosystem

Fig: An overview of Different types of Pyramids in the Ecosystem




1. **Pyramid of Numbers:** This graphical presentation of pyramids deals with the relationship between the producers and consumers at sequential trophic levels in terms of their numbers. The pyramid of numbers may be upright or inverted depending upon the comparative numbers of producers and consumers in an ecosystem.

**a. Upright Pyramid of Number:** In the upright pyramid of numbers, there is a gradual decrease in the number of individuals while moving from producers (lower trophic level) to consumers (higher trophic

level). This pyramid is found in the grassland ecosystem or cropland ecosystem and pond ecosystem.

i. In the grassland ecosystem, the grasses (producers) are in abundance. These occupy the broad base of a pyramid.

ii. Next comes the primary consumers (herbivores), such as grasshoppers that are less than that of grasses.

iii. Further comes the secondary consumers (primary carnivores), such as rats showing comparatively less population than grasshoppers.

iv. Rats are consumed by tertiary carnivores (secondary consumers), such as snakes that are larger in size but smaller in the population than rats.

v. The hawks are the top carnivore that is least in number and occupy the tapering apex of the pyramid.

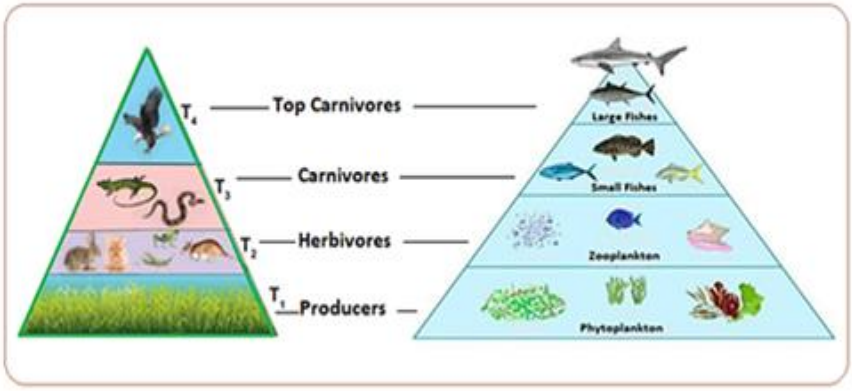



Fig: Upright Pyramid of Number in Grassland and Pond Ecosystem

**b. Inverted Pyramid of Numbe**r: The tree ecosystem and parasitic food chain show an inverted pyramid of numbers. The producers in the tree ecosystem are the least in numbers, and the population of consumers gradually increases at each trophic level.

i. The producers (trees) are positioned at the narrow part of the pyramid since they are the least in numbers.

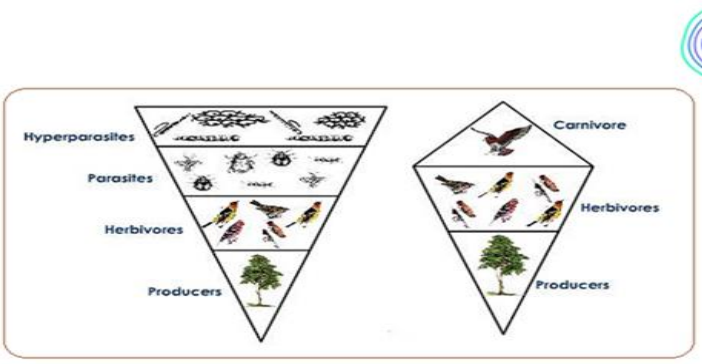
ii. Birds and other herbivores that feed on tree products are comparatively high in number.

iii. Lice and bugs are parasites of birds and have a greater population than birds.
iv. The number of hyperparasites (fleas, microbes) in the tree ecosystem drastically increases and occupies the broad end of the pyramid.

**c. Spindle-shaped Pyramid of Number:** It is also known as a partially upright pyramid because there is neither sequential increase (upright) or sequential decrease (inverted) in the number of individuals in an ecosystem.
It can be summed up that there is an increase in the number while moving forward from producers to herbivores (primary consumers). It is further followed by a decrease in the number of carnivores (secondary consumers) while moving to the tertiary trophic level and above. Hence this graphical representation exhibits a phenomenon of Decrease → Increase → Decrease, designing a partially-upright or spindle-shaped pyramid. This type of pyramid of numbers is found in the forest ecosystem without parasites.

i. The producers exhibit a moderate population size that is neither least nor maximum; hence are not positioned at the broad base or tapering apex of the pyramid.
ii. The herbivores are comparatively more in number that feeds upon forest products and are placed almost in the middle part of the pyramid.
iii. The herbivores are being eaten up by carnivores (eagles) that are least in numbers and occupy the top end of the pyramid.

Fig: Inverted and Spindle-shaped (partially inverted) Pyramid of Number in Tree and Forest Ecosystem



2. **Pyramid of Biomass:** Biomass refers to the dry weight of living organisms. The total amount of living (organic) matter in an ecosystem at a specific time is called standing crop. A typical pyramid of biomass is more fundamental as it shows the quantitative relationship of the standing crop.

This pyramid deals with the relationship between the dry weight of primary producers and consumers at different trophic levels in an ecosystem. It is easier to estimate the dry weight in an ecosystem than the number of individuals and the rate of energy flow at each trophic level. The pyramid of biomass may be upright or inverted in different ecosystems.

a. **Upright Pyramid of Biomass:** The straight or upright pyramid of biomass is found in grassland and forest ecosystems, where the gradual decrease in the biomass of organisms has been observed at successive trophic levels.

b. **Inverted Pyramid of Biomass:** The pyramid of biomass is inverted in the pond or marine ecosystem.

i. The biomass of phytoplankton will be smaller than that of zooplankton.

ii. The biomass of zooplankton will be lesser than that of primary carnivores (small fishes).

iv. The secondary carnivores (large fishes) have the maximum biomass.

v. The phytoplankton, therefore, occupies the narrow tapering end of the pyramid, and the large fishes occupy the broad base of the pyramid.

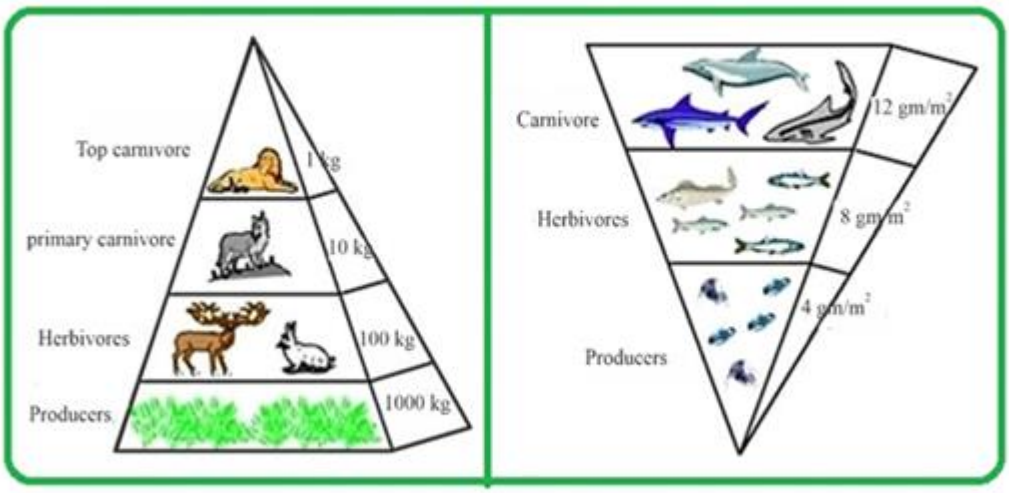



Fig: Upright Pyramid of Biomass & Inverted Pyramid of Biomass

3. **Pyramid of Energy:** It is the graphical representation of the amount of energy per unit area accumulated at different trophic levels in an ecosystem. It is also called the pyramid of productivity.

The pyramid of energy is based on the concept of the flow of energy in a food chain proposed by Lindemann. According to Lindemann's energy flow model, "only 10% of the total energy is transferred to the successive trophic levels and creating the biomass". Remaining is utilized in respiration, hunting, and other activities or is lost to the surroundings in the form of heat. Hence the energy available at each trophic level is 10% of the previous level. It is called the ten percent law of energy. This leads to the formation of an upright pyramid of energy that is invariably formed in each ecosystem. The energy is highest at the producer level and gradually decreases as it moves to the subsequent levels, including herbivores (primary consumer), carnivores (secondary, tertiary consumers). In other words, it can be said that the pyramid of energy depicts the energy as a minimum at the highest trophic level and as a maximum at the lowest trophic level. An example of the pyramid of energy can be explained by assuming a certain numerical value of energy.

i. Suppose 2000 joules of solar energy are incident on the green vegetation. The plants can trap only 1% of the total solar energy. It

means only 20 joules of solar energy will be converted into chemical energy by photosynthesis.

ii. The herbivores feed upon producers get only 10% of the energy stored in plants, that is 2 joules. The remaining 18 joules were lost to the environment.

iii. Carnivores feeding on herbivores would be able to store only 0.2 joules of energy as flesh.

# Topic- Ecological succession

## ecological Succession Definition

Ecological succession is a term developed by botanists to describe the change in structure of a community of different species, or *ecosystem*. The concept of ecological succession arose from a desire to understand how large and complex ecosystems like forests can exist in places known to be recently formed, such as volcanic islands. The different types of ecological succession exists during different phases of an ecosystem, and depend on how developed that ecosystem is. In the concept of ecological succession, ecosystems advance until they reach a *climax community*. In the climax community, all of the resources are efficiently used and the total mass of vegetation maxes out. Many forests that have not been disturbed in many years are examples of a climax community.

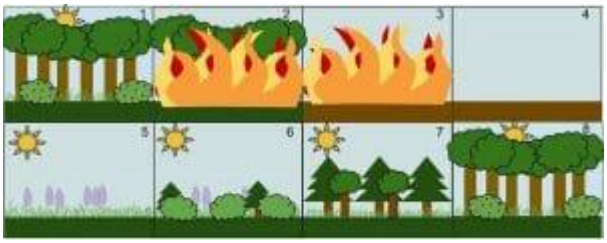
## Types of Ecological Succession

### Primary Succession

When the planet first formed, there was no soil. Hot magma and cold water make hard rocks, as seen by newly formed islands. Primary ecological succession is the process of small organisms and erosion breaking down these rocks into soil. Soil is then the foundation for higher forms of plant life. These higher forms can produce food for animals, which can then populate the area as well. Eventually, a barren landscape of rocks will progress through primary ecological

succession to become a climax community. After years and years, the soil layer increases in thickness and harbors many nutrients and beneficial bacteria that are required to support advanced plant life. If this primary ecosystem is disturbed and wiped out, secondary succession can take place.

## Secondary Succession



The above graphic is an example of secondary ecological succession. The first picture displays a climax community. As the frames progress, the community is destroyed by a fire. As long as the fire does not burn hot enough to destroy the soil and the organisms it harbors, secondary ecological succession will take place. As seen in frame 5, small plants will come back first. After they create a solid layer of vegetation, larger plants will be able to take root and become established. At first, small shrubs and trees will dominate. As the trees grow, they will begin to block the light from most of the ground, which will change the structure of the species below the canopy. Eventually (frame 8), the ecosystem will arrive at a climax community, which may or may not be the similar to the original community. It all depends on which species colonize the area, and which seeds are able to germinate and thrive.

### *3. Autogenic succession:*

After the succession has begun, in most of the cases, it is the community itself which, as a result of its reactions with the environment, modifies its own environment and thus causing its own replacement by new communities. This course of succession is known as autogenic succession.

### *4. Allogenic succession:*

In some cases, the replacement of the existing community is caused largely by any other external condition and not by the existing organism. Such a course is referred to as allogenic succession.

### *5. Autotrophic succession:*

It is characterised by early and continued dominance of autotrophic organisms like green plants. It begins in a predominantly inorganic environment and the energy flow is maintained indefinitely. There is gradual increase in the organic matter content supported by energy flow.

### *6. Heterotrophic succession:*

It is characterised by early dominance of heterotrophs, such as bacteria, actinomycetes, fungi and animals. It begins in a predominantly organic environment, and there is a progressive decline in the energy content.

## General Process of Succession:

The whole process of a primary autotrophic succession is actually completed through a number of sequential steps, which follow one another. These steps in sequence are as follows:

### *I. Nudation:*

The development of bare area is the initial prerequisite. The cause of nudation may be topographic (soil erosion, landslide, volcanic activity, etc), climatic and biotic (human beings and pathogens).

### *II. Invasion:*

This is the successful establishment of a species in a bare area. The species actually reaches this new site from any other area. This whole process is completed in the following three successive stages.

**(i) Migration:**

When the area becomes bare, some plants from the nearby localities move into it in the form of propagules. Several agencies help in the migration.

**(ii) Ecesis:**

It is a process of establishment of immigrants. It is not necessary that all the migrated propagules must stabilize. The stabilization process depends greatly on the conditions prevailing in that area.

**(iii) Aggregation:**
After ecesis, as a result of reproduction, the individual of the species increase in number, and they come close to each other. This process is known as aggregation.

## *III. Competition and coactions:*
After aggregation of a large number of individuals of the species at the limited place, there develops competition mainly for space and nutrition. Individuals of a species affect each other's life in various ways and this is called coactions. The species, if unable to compete with other species, if present, would be discarded.

## *IV. Reaction:*
This is the most important stage in succession. The mechanism of the modification of the environment through the influence of living organisms on it, is known as reaction. As a result of reaction, changes takes place in soil, water, light conditions, temperature etc. of the environment. Due to all these the environment is modified, becoming unsuitable for the existing community which sooner or later is replaced by another community (seral community). The whole sequence of communities that replaces one another in the given area is called a sere, and various communities constituting the sere as seral communities.

## *V. Stabilization (climax):*
This is the final stage of development. Climax community is nearly stable and will not change so long as the climate and physiographic remain the same. However, the environment as well as the community are in a dynamic state.

Some ecologists (Gleason, 1929) have talked of retrogressive succession in which continuous biotic influences have some degenerating influence on the process. Due to destructive effects on organisms, sometimes the development of disturbed communities does not occur and the process of succession instead of progressive becomes retrogressive. As for example, forest may change to shrubby or grassland community. This is called retrogressive succession.

Sometimes due to changes in local conditions as soil characteristics or microclimate, the process of succession becomes deflected in a different direction than that presumed under climatic condition of the area. Thus the climax communities are likely to be different from the presumed climatic climax community. This type of succession is called deflected succession

Ecological Succession in Hydrosere :

It is succession occurring in the aquatic environment. Such a type of succession does not necessarily lead the aquatic communities toward the development of land communities.

Succession is recognizable only if the colonization of plant communities takes place in artificial small and shallow ponds, lakes, etc. where wave action speeds up the process by allowing the erosion of soil towards edge regions. In this way, the filling process also speeds up quickly and consequently the body of water disappears within few years .

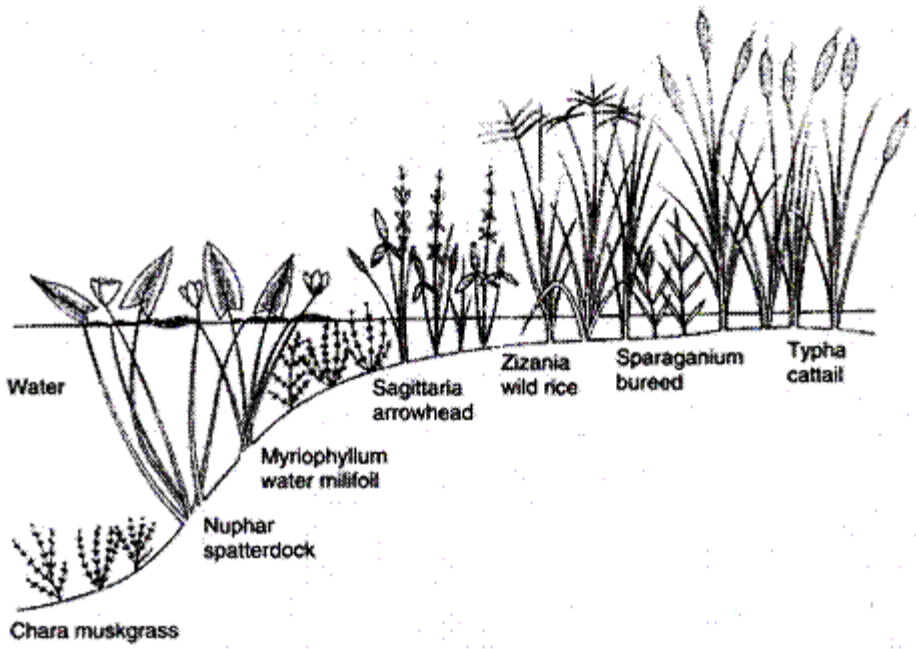



**Fig. 7.1.** Zonation of aquatic vegetation (hydrophytes) along a pond and along river banks. Note the changes in vegetation with water depth.

In a new pond hydrosere starts with the colonisation of phytoplankton and finally terminates into a forest (the climax community).

**The process of aquatic succession :**

**1. Phytoplankton stage:**

In the initial stage of succession algal spores are brought in the body of water. The simple forms of life like bacteria, algae and many other aquatic plants (phytoplankton) and animals (zooplankton) floating in water are the pioneer colonizers. All these organisms add large amount of organic matter and nutrients due to their various life activities and after their death, they settle at the bottom of pond to form a layer of muck.

**2.Rooted Submerged stage:**

The phytoplankton stage is followed by submerged plant stage. When a loose layer of mud is formed on the bottom of the pond, some rooted submerged hydrophytes begin to appear on the new substratum. The submerged aquatic vegetation develops in the regions of ponds or lakes where water depth is about 10 feet or more. The pioneers are hydrila, Potamogeton,, Utricularia, Ceratophyllum, Vallisneria, Chara, etc.

These plants form tangled mass and have marked effects upon the habitat. When these plants die their remains are deposited at the bottom of the ponds or lakes. The eroded soil particles and other transported materials are also deposited at the bottom. This gradually raises the ho t the ponds and lakes up. As this process of stratification progresses the body of water becomes more and more shallow, consequently the habitat becomes less suited for the submerged vegetation but more favourable for other plants.

**3. Rooted Floating stage:**

When the depth of water reaches about 4 to 8 feet, the submerged vegetation starts disappearing from its original place and then the floating plants make their appearance gradually in that area. In the beginning the submerged and floating plants grow intermingled but in the course of time the submerged plants are replaced completely. The most tolerant species in the area are able to reproduce and perpetuate. Their broad leaves floating on the water surface check the penetration of light to deeper layer of water.

This may be one of the main causes responsible for the death of submerged plants. Due to continuous interaction between plant communities and aquatic environment, the habitat becomes changed chemically as well as physically. More water and air borne soil and dead remains of plants are deposited at the bottom. Thus, the substratum rises up in vertical direction. Important floating plants that replace the submerged vegetation are trapa,azolla, , Pistia, Nymphaea, nelumbo etc.

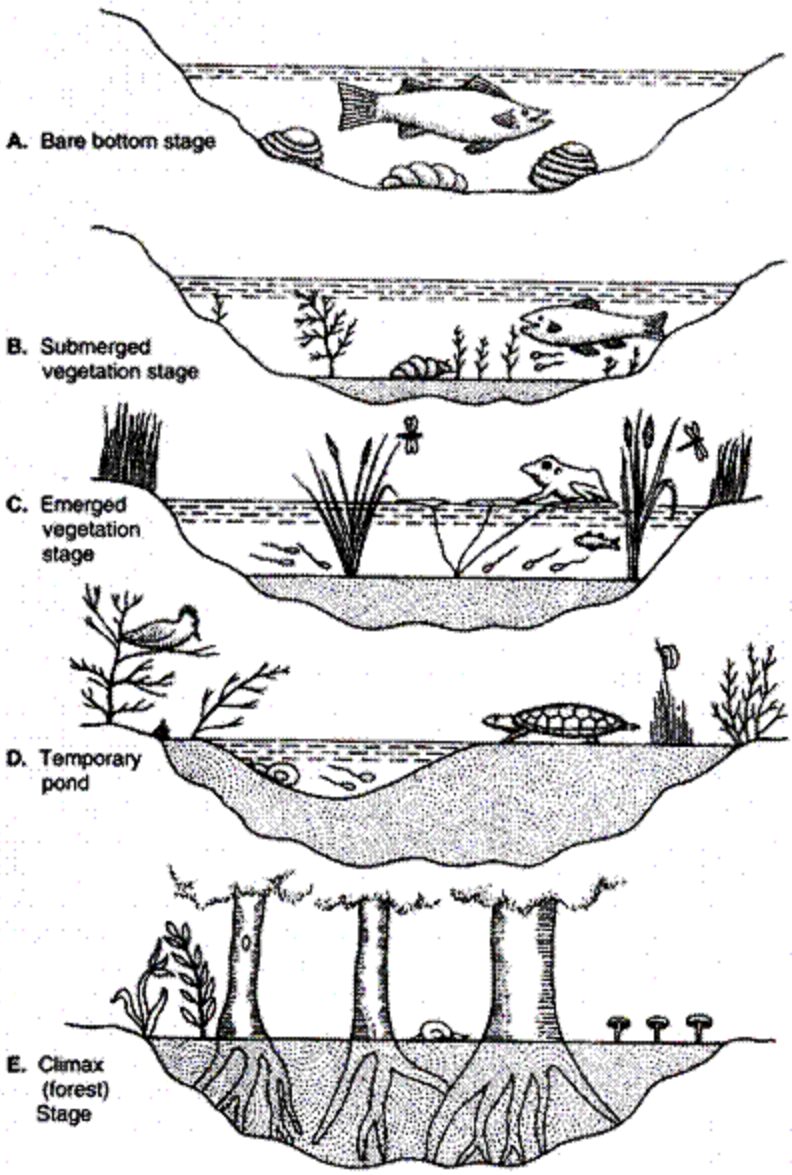



**Fig. 7.2.** Community succession in an open pond.

**4. Reed-swamp stages:**

When the ponds and lakes become too shallow (water depth one to three feet) and the habitat is changed so much that it becomes less suited to the floating plants some other plants which are well adapted to new environment will then come in .Under these conditions, the floating plants start disappearing gradually and their places are occupied by amphibious plants which can live successfully in aquatic as well as aerial environment Important examples are sagrittaria ,dragonflies, Typha, Phragmites (Reed), etc.

5.**Sedge Marsh or Meadow stage:**
The filling process finally results in a marshy soil which may be too dry for the plants of pre-existing community. Now the plants well adapted to new habitat begin to appear in the pre-existing community in mixed state. Important plants that are well suited to marshy habitat are the members of cyperaceae and grammeae. The species of sedge (Carex) and rushes (Juncus), species of Themeda, Iris, Dichanthium, Cymbopogon, Campanula, Mentha, Caltha, Gallium, etc. are the first invaders of marshy area.

As these plants grow most luxuriantly in the marshes, they modify the habitats in several ways. They absorb and transpire a large quantity of water and also catch and accumulate plant debris and wind and water borne soil particles. Consequently a dry habitat results which may be totally unfit for the growth of normal hydrophytes. Gradually the mesophytes start appearing and after some time the sedge vegetation is totally replaced by them.

**6. Woodland stage:**
In the beginning some shrubs and later medium sized trees form open vegetation or woodland. These plants produce more shade and absorb and transpire large quantity of water. Thus, they render the habitat more dry. Shade loving herbs may also grow under t e trees and shrubs. The prominent plants of woodland community are species of Buteazon, Acacia, Cassia, Terminalia, Salix, etc.

**7. Climax forest:**
After a very long time the hydrosere may lead to the development of climax vegetation. As the level of soil is raised much above the water level by progressive accumulation of humus and soil particles, the habitat becomes more dry and certainly well aerated. In such a habitat, well adapted self-maintaining and self-reproducing, nearly stable and uniform plant community consisting mostly of woody trees develops in the form of mesophytic forest.

In the climax forest, all types of plants are met with. Herbs, shrubs, mosses and shade loving plants represent their own communities. Trees are dominant and they have control over the entire vegetation. Bacteria, fungi, and other micro-organisms are more frequently found in the climax vegetation. They react upon the habitat and make the soil rich in the organic materials. At the climax stage, a complete harmony develops between plant community and habitat.

# Nitrogen Cycle

> ***"Nitrogen Cycle is a biogeochemical process which transforms the inert nitrogen present in the atmosphere to a more usable form for living organisms."***

Furthermore, nitrogen is a key nutrient element for plants. However, the abundant nitrogen in the atmosphere cannot be used directly by plants or animals.

Nitrogen Cycle is a biogeochemical process through which nitrogen is converted into many forms, consecutively passing from the atmosphere to the soil to organism and back into the atmosphere.

It involves several processes such as nitrogen fixation, nitrification, denitrification, decay and putrefaction.

The nitrogen gas exists in both organic and inorganic forms. Organic nitrogen exists in living organisms, and they get passed through the food chain by the consumption of other living organisms.

Inorganic forms of nitrogen are found in abundance in the atmosphere. This nitrogen is made available to plants by symbiotic bacteria which can convert the inert nitrogen into a usable form – such as nitrites and nitrates.

Nitrogen undergoes various types of transformation to maintain a balance in the ecosystem. Furthermore, this process extends to various biomes, with the marine nitrogen cycle being one of the most complicated biogeochemical cycles.

## Stages of Nitrogen Cycle

Process of Nitrogen Cycle consists of the following steps – Nitrogen fixation, Nitrification, Assimilation, Ammonification and Denitrification. These processes take place in several stages and are explained below:

### Nitrogen fixation

It is the initial step of the nitrogen cycle. Here, Atmospheric nitrogen (N2) which is primarily available in an inert form, is converted into the usable form - ammonia (NH3).

During the process of Nitrogen fixation, the inert form of nitrogen gas is deposited into soils from the atmosphere and surface waters, mainly through

precipitation. Later, the nitrogen undergoes a set of changes, in which two nitrogen atoms get separated and combine with hydrogen to form ammonia (NH4+).

The entire process of Nitrogen fixation is completed by symbiotic bacteria which are known as Diazotrophs. Azotobacter and Rhizobium also have a major role in this process. These bacteria consist of a nitrogenase enzyme which has the capability to combine gaseous nitrogen with hydrogen to form ammonia.

Nitrogen fixation can occur either by the atmospheric fixation- which involves lightening or industrial fixation by manufacturing ammonia under high temperature and pressure condition. This can also be fixed through man-made processes, primarily industrial processes that create ammonia and nitrogen-rich fertilisers.

### *Types of Nitrogen Fixation*

1. **Atmospheric fixation:** A natural phenomenon where the energy of lightning breaks the nitrogen into nitrogen oxides and is then used by plants.
2. **Industrial nitrogen fixation:** Is a man-made alternative that aids in nitrogen fixation by the use of ammonia. Ammonia is produced by the direct combination of nitrogen and hydrogen and later, it is converted into various fertilisers such as urea.
3. **Biological nitrogen fixation:** We already know that nitrogen is not usable directly from the air for plants and animals. Bacteria like Rhizobium and blue-green algae transform the unusable form of nitrogen into other compounds that are more readily usable. These nitrogen compounds get fixed in the soil by these microbes.

## Nitrification

In this process, the ammonia is converted into nitrate by the presence of bacteria in the soil. Nitrites are formed by the oxidation of Ammonia with the help of Nitrosomonas bacterium species. Later, the produced nitrites are converted into nitrates by Nitrobacter. This conversion is very important as ammonia gas is toxic for plants.

The reaction involved in the process of Nitrification is as follows:

$$2NH_4^+ + 3O_2 \rightarrow 2NO_2^- + 4H^+ + 2H_2O$$

$$2NO_2^- + O_2 \rightarrow 2NO_3^-$$

## Assimilation

Primary producers – plants take in the nitrogen compounds from the soil with the help of their roots, which are available in the form of ammonia, nitrite ions, nitrate ions or ammonium ions and are used in the formation of the plant and animal proteins. This way, it enters the food web when the primary consumers eat the plants.

## Ammonification

When plants or animals die, the nitrogen present in the organic matter is released back into the soil. The decomposers, namely bacteria or fungi present in the soil, convert the organic matter back into ammonium. This process of decomposition produces ammonia, which is further used for other biological processes.

## Denitrification

Denitrification is the process in which the nitrogen compounds makes its way back into the atmosphere by converting nitrate ($NO_3$-) into gaseous nitrogen (N). This process of the nitrogen cycle is the final stage and occurs in the absence of oxygen. Denitrification is carried out by the denitrifying bacterial species- Clostridium and Pseudomonas, which will process nitrate to gain oxygen and gives out free nitrogen gas as a byproduct.

# Nitrogen Cycle in Marine Ecosystem

The process of the nitrogen cycle occurs in the same manner in the marine ecosystem as in the terrestrial ecosystem. The only difference is that it is carried out by marine bacteria.

The nitrogen-containing compounds that fall into the ocean as sediments get compressed over long periods and form sedimentary rock. Due to the geological uplift, these sedimentary rocks move to land. Initially, it was not known that these nitrogen-containing sedimentary rocks are an essential source of nitrogen. But, recent researches have proved that the nitrogen from these rocks is released into the plants due to the weathering of rocks.

# Importance of Nitrogen Cycle

Importance of the nitrogen cycle are as follows:

1. Helps plants to synthesise chlorophyll from the nitrogen compounds.

2. Helps in converting inert nitrogen gas into a usable form for the plants through the biochemical process.
3. In the process of ammonification, the bacteria help in decomposing the animal and plant matter, which indirectly helps to clean up the environment.
4. Nitrates and nitrites are released into the soil, which helps in enriching the soil with necessary nutrients required for cultivation.
5. Nitrogen is an integral component of the cell and it forms many crucial compounds and important biomolecules.

Nitrogen is also cycled by human activities such as combustion of fuels and the use of nitrogen fertilisers. These processes, increase the levels of nitrogen-containing compounds in the atmosphere. The fertilisers containing nitrogen are washed away in lakes and rivers and results in eutrophication.

## Conclusion

- Nitrogen is abundant in the atmosphere, but it is unusable to plants or animals unless it is converted into nitrogen compounds.
- Nitrogen-fixing bacteria play a crucial role in fixing the atmospheric nitrogen into nitrogen compounds that can be used by the plants.
- The plants absorb the usable nitrogen compounds from the soil through their roots. Then, these nitrogen compounds are used for the production of proteins and other compounds in the cell.
- Animals assimilate nitrogen by consuming these plants or other animals that contain nitrogen. Humans consume proteins from these plants and animals and then, the nitrogen assimilates into our system.
- During the final stages of the nitrogen cycle, bacteria and fungi help decompose organic matter, where the nitrogenous compounds get dissolved into the soil which is again used by the plants.
- Some bacteria then convert these nitrogenous compounds in the soil and turn it into nitrogen gas. Eventually, it goes back to the atmosphere.
- These sets of processes repeat continuously and thus maintain the percentage of nitrogen in the atmosphere.

CHAPTER

# 1 Environmental Science : Definition, Scope and Importance

## INTRODUCTION

The science of Environment studies is a multi-disciplinary science because it comprises various branches of studies like chemistry, physics, medical science, life science, agriculture, public health, sanitary engineering etc. It is the science of physical phenomena in the environment. It studies of the sources, reactions, transport, effect and fate of physical a biological species in the air, water and soil and the effect of from human activity upon these.

### Environment Explained

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

*1. What is Surrounded*

The answer to this question is living objects in general and man in particular.

*2. By what Surrounded*

The physical attributes are the answer to this question, which become environment. In fact, the concern of all education is the environment of man. However, man cannot exist or be understood in isolation from the other forms of life and from plant life. Hence, environment refers to the sum total of condition, which surround point in space and time. The scope of the term Environment has been changing and widening by the passage of time. In the primitive age, the environment consisted of only physical aspects of the planted earth' land, air and water as biological communities. As the time passed on man extended his environment through his social, economic and political functions.

*3. Where Surrounded*

The answer to this question. It is in nature that physical component of the plant earth, viz land, air, water etc., support and affect life in the biosphere. According to a Goudie

environment is the representative of physical components of the earth where in man is an important factor affecting the environment.

(*i*) **Definitions of Environment :** Some important definitions of environment are as under:

1. **Boring:** 'A person's environment consists of the sum total of the stimulation which he receives from his conception until his death.'

   It can be concluded from the above definition that Environment comprises various types of forces such as physical, intellectual, economic, political, cultural, social, moral and emotional. Environment is the sum total of all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms.

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

(*ii*) **Scope of Environment:** The environment consists of four segments as under:

1. **Atmosphere:** The atmosphere implies the protective blanket of gases, surrounding the earth:

(*a*) It sustains life on the earth.

(*b*) It saves it from the hostile environment of outer space.

(*c*) It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.

(*d*) It transmits only here ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultra-violate waves below about 300 nm.

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

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

(*i*) Nature 97% of the earth's water supply is in the oceans,

(*ii*) About 2% of the water resources is locked in the polar icecaps and glaciers.

(*iii*) Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit to be used for human consumption and other uses.

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

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

### Element of Environment

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

*(1) Physical elements*

Physical elements are as space, landforms, water bodies, climate soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.

*(2) Biological elements*

Biological elements such as plants, animals, microorganisms and men constitute the biosphere.

*(3) Cultural elements*

Cultural elements such as economic, social and political elements are essentially man-made features, which make cultural milieu.

## ENVIRONMENT STUDIES: IMPORTANCE

Importance of Environment Studies: The environment studies enlighten us, about the importance of protection and conservation of our indiscriminate release of pollution into the environment.

At present a great number of environment issues, have grown in size and complexity day by day, threatening the survival of mankind on earth. We study about these issues besides and effective suggestions in the Environment Studies. Environment studies have become significant for the following reasons:

### 1. Environment Issues Being of International Importance

It has been well recognised that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.

### 2. Problems Cropped in The Wake of Development

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

### 3. Explosively Increase in Pollution

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

### 4. Need for An Alternative Solution

It is essential, specially for developing countries to find alternative paths to an alternative goal. We need a goal as under:

(1) A goal, which ultimately is the true goal of development an environmentally sound and sustainable development.

(2) A goal common to all citizens of our earth.

(3) A goal distant from the developing world in the manner it is from the over-consuming wasteful societies of the "developed" world.

### 5. Need To Save Humanity From Extinction

It is incumbent upon us to save the humanity from exinction. Consequent to our activities constricting the environment and depleting the biosphere, in the name of development.

### 6. Need For Wise Planning of Development

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

### 7. Misra's Report

Misra (1991) recognized four basic principles of ecology, as under:

(*i*) Holism

(*ii*) Ecosystem

(*iii*) Succession

(*iv*) Conversation.

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

Individual<population<community<ecosystem<biome<biosphere.

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

(*i*) Impact of human activities on the environment,

(*ii*) Value system,

(*iii*) Plan and design for sustainable development,

(*iv*) Environment education.

Keeping in view the of goal of planning for environmentally sustainable development India contributed to the United Nations Conference on Environment and Development (UNCED), also referred to as "Earth Summit" held at Rio de Janciro, the Capital of Brazil, 3rd-14th June, 1992.

## NEED FOR PUBLIC AWARENESS

It is essential to make the public aware of the formidable consequences of the Environmental Degradation, if not retorted and reformative measures undertaken, would

result in the extinction of life. We are facing various environmental challenges. It is essential to get the country acquainted with these challenges so that their acts may be eco-friendly. Some of these challenges are as under:

### 1. Growing Population

A population of over thousands of millions is growing at 2.11 per cent every year. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does automatically lead to development, yet the development leads to a decrease in population growth rates. For this development of the women is essential.

### 2. Poverty

India has often been described a rich land with poor people. The poverty and environmental degradation have a nexus between them. The vast majority of our people are directly dependent on the nature resources of the country for their basic needs of food, fuel shelter and fodder. About 40% of our people are still below the poverty line. Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge environment degradation are two facets of the same challenge. The population growth is essentially a function of poverty. Because, to the very poor, every child is an earner and helper and global concerns have little relevance for him.

### 3. Agricultural Growth

The people must be acquainted with the methods to sustain and increase agricultural growth with damaging the environment. High yielding varities have caused soil salinity and damage to physical structure of soil.

### 4. Need to Ground water

It is essential of rationalizing the use of groundwater. Factors like community wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies as lakes is an important challenge. It so finding our suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean which are difficult challenges is essential.

### 5. Development And Forests

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

Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were once green, stand today as wastelands. These areas are to be brought back under vegetative cover. The tribal communities inhabiting forests respects the trees and birds and animal that gives them sustenance. We must recognise

the role of these people in restoring and conserving forests. The modern knowledge and skills of the forest deptt. should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests should be evolved in a well planned way.

### 6. Degradation of Land

At present out of the total 329 mha of land, only 266 mha possess any potential for production. Of this, 143 mha is agricultural land nearly and 85 suffers from varying degrees of soil degradation. Of the remaining 123 mha, 40 are completely unproductive. The remaining 83 mha is classified as forest land, of which over half is denuded to various degrees. Nearly 406 million head of livestock have to be supported on 13 mha, or less than 4 per cent of the land classified as pasture land, most of which is overgrazed. Thus, our of 226 mha, about 175 mha or 66 per cent is degraded to varying degrees. Water and wind erosion causes further degradation of almost 150 mha This degradation is to be avoided.

### 7. Reorientation of Institutions

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

### 8. Reduction of Genetic Diversity

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

### 9. Evil Consequences of Urbanisation

Nearly 27 per cent Indians live in urban areas. Urbanisation and industrialisation has given birth to a great number of environmental problem that need urgent attention. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

### 10. Air and water Population

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

## VARIOUS TYPES OF ENVIRONMENT

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

(*a*) Physical Environment,

(*b*) Social and Cultural Environment, and

(*c*) Psychological Environment.

These may be explained as under:

### 1. Physical Environment

Physical environment, refers to geographical climate and weather or physical conditions wherein and individual lives. The human races are greatly influenced by the climate. Some examples are as under:

(*a*) In the cold countries i.e. European countries the people are of white colour. Likewise, in Asian and African countries, that is, in hot countries people are of dark complexion.

(*b*) The physique of an individual depends on climate conditions as the individual tries to adjust in his physical environment.

(*d*) The human working efficiency also depends on the climatic conditions.

### 2. Social Environment

Social Environment includes an individual's social, economic and political condition wherein he lives. The moral, cultural and emotional forces influence the life and nature of individual behaviour. Society may be classified into two categories as under:

(*i*) An open society is very conductive for the individual developement.

(*ii*) A closed society is not very conductive for the developenment.

### 3. Psychological Environment

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

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

## STRUCTURE OF ENVIRONMENT

Environment is both physical and biological. It includes both living and non-living components.

### (i) Physical Environment

The Physical Environment is classified into three broad categories viz.

(*i*) Solid,

(*ii*) Liquid

(*iii*) Gas.

These represent the following spheres:

(*i*) The lithosphere (solid earth)

(*ii*) The hydrosphere (water component) and

(*iii*) The atmosphere

As such, the three basic of physical environment may be termed as under:

(*i*) Lithospheric Environment

(*ii*) Hydrospheric Environment

(*iii*) Atmospheric Environment

The scientists have classified them into smaller units based on different spatial scales, *e.g.*

(*i*) Mountain Environment

(*ii*) Glacier Environment

(*iii*) Plateau Environment

(*iv*) Coastal Environment

### (ii) Biological Environment

The biological of the environment consists of:

(*i*) Plants (flora)

(*ii*) Animals (fauna).

Thus, the biotic environment further be divided into floral environment and faunal environment. All the organisms work to form their social groups and organizations at several levels. Thus, the social environment is formed. In this social environment the organisms work to derive matter from the physical environment for their sustenance and development. This process gives birth to economic environment. Man claims to be most skilled and civilized of all the organisms. This is the reason why his social organisation is most systematic. The three aspects of man, *e.g.* physical, social and economic, function in the biotic environment as under:

### (i) The Physical Man

The 'Physical Man' is one of the organisms populations or biological community. He is in need of basic elements of the physical environment like habitat (space), air, water and food. Besides, like other biological populations, he releases wastes into the ecosystem.

### (ii) The Social Man

The 'Social Man' performs the following functions:

(*a*) Establishing social institutions,

(*b*) Forming social organisations,

(*c*) Formulating laws, principles and policies,

(*d*) Taking steps to safeguard his existence, interest and social welfare.

### (iii) The Economic Man

The economic man derives and utilises resources from the physical and biotic environment with his skills and technologies. The economic function makes the man an environment/ geomorphic process as he transports matter and energy from one component of the ecosystem to the other. There may be any following two situations:

(*a*) His exploitative functions may be in harmony with the natural environment. Such, functions do not necessarily involve change in the working of the ecosystem.

(*b*) These functions may exceed the critical limit. Consequently, the equilibrium of the environment/ecosystem is disturbed and a great number of environment and ecological problems crop up. These are determental to man him besides to whole population of human species in a given ecosystem.

## QUESTIONS

1. What is Environment? Discuss the scope of Environment.
2. Describe the importance of environment studies.
3. "The need for public awareness about environment is of vital importance." Discuss.
4. Discuss the various types of environment.

### Short Answer Type Questions

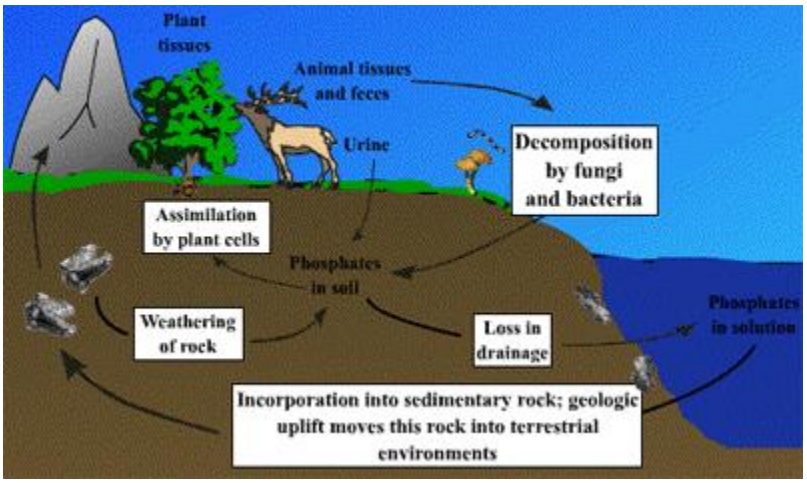
1. Define environments.
2. Discuss the scope of environment.
3. Write a note on the importance of environment studies.
4. Write a note on the need of public awareness about environment.
5. Write a note on physical environment.
6. Write a note on biological environment.

# Phosphorus Cycle

Phosphorus is an important element for all forms of life. As phosphate (PO4), it makes up an important part of the structural framework that holds DNA and RNA together. Phosphates are also a critical component of ATP—the cellular energy carrier—as they serve as an energy ?release' for organisms to use in building proteins or contacting muscles. Like calcium, phosphorus is important to vertebrates; in the human body, 80% of phosphorous is found in teeth and bones.

The phosphorus cycle differs from the other major biogeochemical cycles in that it does not include a gas phase; although small amounts of phosphoric acid (H3PO4) may make their way into the atmosphere, contributing—in some cases—to acid rain. The water, carbon, nitrogen and sulfur cycles all include at least one phase in which the element is in its gaseous state. Very little phosphorus circulates in the atmosphere because at Earth's normal temperatures and pressures, phosphorus and its various compounds are not gases. The largest reservoir of phosphorus is in sedimentary rock.

It is in these rocks where the phosphorus cycle begins. When it rains, phosphates are removed from the rocks (via weathering) and are distributed throughout both soils and water. Plants take up the phosphate ions from the soil. The phosphates then moves from plants to animals when herbivores eat plants and carnivores eat plants or herbivores. The phosphates absorbed by animal tissue through consumption eventually returns to the soil through the excretion of urine and feces, as well as from the final decomposition of plants and animals after death.




The same process occurs within the aquatic ecosystem. Phosphorus is not highly soluble, binding tightly to molecules in soil, therefore it mostly reaches waters by traveling with runoff soil particles. Phosphates also enter waterways through fertilizer runoff, sewage seepage, natural mineral deposits, and wastes from other industrial processes. These phosphates tend to settle on ocean floors and lake bottoms. As sediments are stirred up, phosphates may re-enter the phosphorus cycle, but they are more commonly made available to aquatic organisms by being exposed through erosion. Water plants take up the waterborne phosphate which then travels up through successive stages of the aquatic food chain.

While obviously beneficial for many biological processes, in surface waters an excessive concentration of phosphorus is considered a pollutant. Phosphate stimulates the growth of plankton and plants, favoring weedy species over others. Excess growth of these plants tend to consume large amounts of dissolved oxygen, potentially suffocating fish and other marine animals, while also blocking available sunlight to bottom dwelling species. This is known as eutrophication.

Humans can alter the phosphorus cycle in many ways, including in the cutting of tropical rain forests and through the use of agricultural fertilizers. Rainforest ecosystems are supported primarily through the recycling of nutrients, with little or no nutrient reserves in their soils. As the forest is cut and/or burned, nutrients originally stored in plants and rocks are quickly washed away by heavy rains, causing the land to become unproductive. Agricultural runoff provides much of the phosphate found in waterways. Crops often cannot absorb all of the fertilizer in the soils, causing excess fertilizer runoff and increasing phosphate levels in rivers and other bodies of water. At one time the use of laundry detergents contributed to significant concentrations of phosphates in rivers, lakes, and streams, but most detergents no longer include phosphorus as an ingredient.

**NATURAL RESOURCES: LAND RESOURCE**

**INTRODUCTION** Land is one of the most valuable resource for mankind as well as one of nature's most precious gifts. It is that part of lithosphere that sustains life as well as provides various existential resources to human beings. Land is a mixture of inorganic and organic materials. It provides various kind of resources like food, fibre, medicine, minerals as well as services like agricultural productivity, biological diversity, carbon sequestration etc. The most basic use of land is to support vegetation of various kinds, thereby providing a place for all the terrestrial fauna to exist. Land resource is under huge threat due to misuse and mismanagement by humans. Various anthropogenic activities have led to land losing its productivity leading and becoming degraded and polluted. Land degradation and soil erosion are impacting the various resources and services that we humans obtain from land. It is impacting our quality of life and in many cases our very survival, as we are directly and indirectly dependent on it. An extreme case of land degradation is desertification wherein semidry regions of world are losing their productive capacity to such an extent that they are becoming barren and desert like due to anthropogenic activities and climate change issues.

**LEARNING OBJECTIVES** After going through the lesson, you will be able to Explain the importance, use, threats and problems related to land resource and impact of dams and mines on forest resource Understand concepts of soil erosion, land degradation, desertification and land use change Identify the problems of related land misuse and mismanagement, deforestation 8. Seek solution to address how land resource can be managed in a better and sustainable manner Land resources: Minerals, soil, agricultural crops, natural forest products, medicinal plants, and forest-based industries and livelihoods From a human point of view, land resource includes all those aspects and functions of the land, which can be used to fulfil human needs. Humans have been exploiting land for agriculture, mining, grazing animals and settlement purposes. Land resource can be divided into three categories a. Very stable resources, like relief, geological formations and minerals; b. Moderately stable resources, like soil and water c. Very unstable resources, like vegetation and biodiversity Some of the important resources and services provided by land to humankind are: a. Minerals: Mineral is a pure inorganic substance that occurs naturally in the earth's crust. Almost all minerals are found in the earth's crust. Minerals are non-renewable resources and include metals like iron, copper, aluminium etc and non-metals like phosphates, gypsum, clay, sand etc. Minerals are extremely valuable to humans as they are essential raw material in industries and play a major role in overall development of nation. Minerals available in the earth's crust can be divided into three categories i. Metallic minerals like Iron, aluminium, lead, zinc etc ii. Non-metallic minerals like graphite, felspar, asbestos, limestone etc iii. Mineral fuels like coal, natural gas, petroleum etc India is rich in mineral resources and has sufficient quantities of iron, aluminium, titanium copper, lead and zinc ores. b. Soil: Soil is defined as the outermost thin layer of earth's crust which serves as the natural medium for growth of plants, providing them a substrate for anchorage and essential nutrients for their growth. Soil is a complex mixture of organic and mineral content which is constantly being formed by the chemical decomposition and mechanical disintegration of rocks. Soil is a renewable resource which is constantly being formed and destroyed, mainly by erosion process. The topmost layer of soil rich in organic matter is called humus and is the most fertile layer. Soil forms a fundamental part of the human environment and is as essential as water. Soil provides the substrate to support the productivity and cycling of biological resources, it is the source of nutrients and water for agricultural and forestry ecosystems and acts as a complex buffer against environmental variability. Soil is very rich in microbial biodiversity and is also a major reservoir of carbon. Soil across the world varies with respect to its characteristics and properties which forms the basis for its classification. The major soil groups found in India are alluvial soil, black soil, red soil, laterite soil, desert soil and acid

soils.

**c. Agriculture**: The most dominant use of land resource by humans has been in the form of agriculture in order to meet the food demand of the growing world population. Agricultural ecosystems cover nearly 40% of the land surface. The total world land area suitable for cropping is 4.4 billion hectares out of which 1.6 billion hectares is currently under cultivation. Agriculture is the dominant driving force for the economy of a number of world's developing countries, which includes India as well. Agricultural productivity has increased manifold globally over the last 70-80 years due to increased use of fertilizers and pesticides. But this highly chemical intensive agriculture has also adversely impacted the land and its associated resources. d. Natural Forest Products: Forest products are materials derived from forests for consumption and profitable use. These mainly include timber, firewood, wood pulp for paper and forage for livestock. There are also other non-wood products that are derived from forests which include nuts, resins, gum, medicinal plants, edible fruits, oils etc which are collectively called as non-timber forest products (NTFPs). These NTFP's are considered to have relatively lesser negative effects on forest ecosystem. Forest products are used extensively worldwide for a number of purposes including cooking, animal feeding, as medicines for healing, household subsistence, income generation as well as cultural traditions. These products are also an extremely important source of revenue generation for all countries.

**e. Medicinal plants** :Medicinal plants are valuable natural resources obtained from land (mainly forests) which have been used by human communities since prehistoric times. The immense diversity of medicinal flora in tropical forests is an invaluable source of new pharmaceutical products. About 80% of the world's developing countries are dependent on these traditional medicinal plants for primary health care. For a majority of people living in rural and urban areas in developing countries, medicinal plants are the only available treatment for various minor and major diseases. Moreover the demand for medicinal plants is continuously on the rise as more people are understanding their importance as compared to the allopathic medicines. f. Forest based industries and livelihood: Forest have played a significant role in building up the economy of various countries and have provided a means of living to millions of people. Forest serves as a source of raw materials for large, medium and small scale industries. Globally, about two billion people use fuelwood and charcoal as their main source of energy for cooking and for heating their homes. Millions of rural households obtain income by collecting and selling forest products like food, fuel, medicinal plants and construction materials. Many sell timber from their land areas to logging companies, or make and sell furniture and handicrafts. And industrial logging provides employment and earnings for people in countries like Brazil, India, China and Indonesia. Forests also contribute to livelihoods in an indirect manner as they provide soil nutrients and forage for crops and livestock. They also help in pollinating crops, reduce soil erosion, and provide protection from natural disasters. Globally, it is estimated that between about 1.52 billion people depend on forests for their livelihoods and income and about 200 million people from indigenous communities are almost fully dependent on forests.

**3. LAND COVER AND LAND USE CHANGE** Land cover refers to the observed biophysical cover on the surface of the earth whether vegetation, water, bare soil or urban infrastructure. Land cover can be determined either by field survey or by analyzing satellite and aerial images. The International Geosphere Biosphere Programme (IGBP) has categorized land cover into 17 classes that includes different types of forests, woodlands, scrublands, grasslands wetlands and deserts. The global land area is 13.2 billion ha. Of this, 12 percent (1.6 billion ha) is under cultivation, 28 percent (3.7 billion ha) is under forest and 35 percent (4.6 billion ha) comprises grassland and woodland ecosystems. On the other hand, land use is different from land cover. Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. To illustrate this with an example, 'grassland' is a

term used for land cover, while 'agricultural land', a 'horse ranch' or a 'tennis court' refers to the land use of grassland. Land use change means the conversion of terrestrial land surface for anthropogenic uses. The use of land of results in changes in structure and functioning of ecosystems. Since the start of human civilization (ca 3500 BC onwards), land has been increasing used for settlements, agricultural purposes, grazing of animals, mining, urbanization and industrialization which have drastically altered the land cover. The rapid and large scale human intervention in converting natural landscapes for our own usage has resulted in devastating effects on both biotic and abiotic components of ecosystem. The increased demand for water, waste disposal and food requirements has resulted in land being used in an unsustainable manner, leading to its degradation. Forest cover and composition, cropland expansion, agriculture intensification, urban development and desertification are key drivers of land use change (UNEP, 2007). The major environmental impacts of land use change are:  Climate Change and global warming  Biodiversity loss  Pollution of various kinds  Large scale deforestation  Land degradation and Desertification  Waste aggregation All these concerns have greatly impacted human health, well-being and livelihoods.

**4. LAND DEGRADATION** Land degradation is defined as the deterioration of the productive capacity of land due to overexploitation by humans. Land degradation affects soil chemistry and soil biodiversity and alters the natural ecological processes and ecosystem of the affected area. Land degradation has put the world's ecosystems under intense pressure as their capacity to provide vital resources and services is rapidly decreasing. Degraded lands have reduced capacity for supply of goods (food, timber, fibre, fuel etc) for humankind. The major causes of land degradation are: a) Deforestation b) Soil erosion c) Unpredictable weather patterns or climatic conditions d) Droughts and floods e) Modern agricultural practices f) Soil pollution g) Increasing urbanization Land degradation is a major challenge that needs to be addressed quickly, not just to restore the ecosystem and biodiversity of the affected area but also for maintaining economic growth and social structure in human society.

**5. SOIL EROSION** :- Soil erosion is the loss or removal of top layer of soil due to natural physical agents like wind, water and even gravity. As the topmost layer of soil is the most fertile layer, being extremely rich in organic matter and nutrients, erosion leads to reduced productivity of the soil, which in turn results in the soil unable to support vegetation. Soil formation is a very slow process with 1 cm of soil taking 200-300 years to form from the bed rock. Hence frequent soil erosion takes years to restore naturally. When soil erosion is intense, the natural soil profile is destroyed and may never attain its original capacity. Extensive cultivation, overgrazing and deforestation expose the precious top soil to wind and water erosion. The various natural and anthropogenic (human originated) reasons for soil erosion are: a) Slope of surface: Soil erosion is more common in hill slopes which gets aggravated with removal of natural vegetation b) Soil content: Soil with higher content of sand is more prone to erosion as compared to soil with higher clay amount. c) Weather and climatic conditions: natural factors like high intensity rainfall, floods and droughts also increases soil erosion in affected areas. With global warming and climate change as a major threat, such natural disasters are becoming more frequent leading to soil erosion in many areas d) Deforestation: Deforestation leads to reduction in tree roots, which performed a major function of holding the soil together. In absence of a strong hold, soil is prone to erosion e) Extensive agriculture and cultivation: Modern day chemical intensive farming practices lowers soil organic matter levels, soil biodiversity, and also reduces the soil water content, thus making soil prone to erosion. Excessive irrigation also is a major reason for erosion. f) Overgrazing: In order to feed cattle and cater to the meat and dairy needs of people, large areas of vegetation are exploited for grazing. Thus, overgrazing exposes soil to erosion. Soil conservation has attained great importance today. The remedial measures suggested to arrest soil erosion include: a) Erosion control technologies in farming such as no tillage or low tillage, crop rotation, use mulch cover can greatly reduce erosion of soil

by water b) Adoption of terrace farming, contour farming and setting up structures like windbreaks, live fences, sand fences etc reduce the soil erosion in areas that are naturally prone to erosion. c) Reforestation in areas where large scale vegetation has been removed is an extremely important step as trees are natural binding agents of soil.

**6**. **DESERTIFICATION** Desertification is an extreme case of land degradation in which semidry regions, becomes increasingly arid resulting in loss of water bodies, vegetation and wildlife. It is caused by a variety of factors, which includes both anthropogenic activities as well as climate change. Desertification is one of the most significant global ecological and environmental problem that we face today. According to UNESCO, one third of the earth's land surface, categorised as drylands, is facing the threat of desertification. This would ultimately affect the livelihood of millions of people who are dwelling in these regions who are dependent on goods and services provided by these drylands. One of the major problems that arises out of desertification is migration of people towards presumably resource rich regions like cities, in search of better living conditions. However, large scale migration to cities not only causes economic loss of land that could be cultivated, it also puts additional burden to the resource crunch and pollution in cities. Desertification begins with land slowly getting degraded due to deforestation, overgrazing, modern agricultural practices, increasing urbanization, mismanagement of water resource, exploitation of ground water and destruction of wetland regions . When such degraded land when faces climate change issues, like drought, erratic weather conditions, rainfall deficiency for a continuous period, it results in the land losing its productivity to such an extent that it resembles desert like conditions. Desertification thus leads to loss of farmlands (economic loss), increase in hunger and poverty, social inequality and crowding and overpopulation in towns and cities. In order the prevent drylands from facing desertification, there is a need for an integrated approach with help from multiple stakeholders. There is a need to implement policies and rules that help in better land and water management, educate and spread awareness among people (especially the farming community), provide all necessary support to farmers and local communities, and formulate and promote sustainable methods of agriculture.

**7**. **DEFORESTATION AND ITS CAUSES** Deforestation is the clearing or permanent removal of forest areas so that it is available for other uses. Deforestation is the root cause for land degradation, soil erosion and desertification. According to the United Nations Food and Agricultural Organization, the annual rate of deforestation is estimated to be about 1.3 million square km per decade. Extensive deforestation has taken place in tropical regions as compared to the temperate forests. The depletion of forest areas not only results in loss of trees, which act as a major carbon sink (storage reservoir), but it also leads to release of billion tons of carbon from the dead and decomposing trees. Both these factors significantly impact global warming and climate change, two of the major challenges faced by humanity today. Causes of deforestation Forest lands are cleared mainly to provide for human needs. The major causes or reasons for deforestation are:

a. Agriculture and plantations: The most significant threat to forests are their conversion to agricultural and plantation areas, in order to fulfil the needs of the growing human population. Agriculture is the direct cause for 80 percent deforestation in tropical and subtropical regions. Agriculture patterns have changed significantly since 1950's, as the focus has shifted to more intense agriculture involving new technology, machinery and chemicals in order to meet human requirements. This agricultural intensification, often called as industrial agriculture, has significantly increased the rate of deforestation, impacted terrestrial and aquatic ecosystems, and resulted in large scale biodiversity loss as well.

**b. Urbanization:** Urbanization is another major cause of deforestation which is a result of increasing population, capitalism and globalization. Forests are cleared for setting up residential areas, industries,

commercial hubs, development projects like roads, railways etc. The clearing of forests for such activities has led to habitat degradation, habitat loss and habitat fragmentation, all of which has significantly impacted the ecosystem and biodiversity.

**c. Harvesting wood for use as firewood and timber**: Millions of families still rely on fuelwood as an energy source for various household activities (cooking, heating etc) and forests are still the main source of fuelwood. Expanding urbanization has also increased the demand for wood (for use in furniture, industries, sports goods, equipment etc.) resulting in large scale timber extraction from forests.

d. Illegal logging: Illegal logging is very common across various forest regions of the world. Wood is harvested illegally for various purposes, especially decorative and medicinal, and these illegally harvested wood have huge markets in US and Europe.

**e. Forest Fires:** Every year, fires destroy millions of hectares of forests across the world. Forests may catch fire naturally or through humans. Natural forest fire includes an unplanned burning of forest due to lightning, long spell of high temperature and drought which can spread quickly in warm and windy conditions. On the other hand humaninduced forest fire results from the unauthorized burning practice of forests for attaining farmland. The recent bush fires that occurred in Australia are a prime example of the destruction caused by forest fires, that not only destroyed thousands of hectares of forests, but also released large amounts of greenhouse gases into the atmosphere.

**f. Mining:** With increasing demand for metallic resources, mining has become a major economic activity. Large-scale mining operations, especially those using open-pit mining techniques, has resulted in significant deforestation. Mining projects also require construction of new roads, settlements and townships for people working in the mines which results in clearing of more forest areas. Industrial mining operations have thus caused large scale deforestation especially in tropical countries.

**NATURAL RESOURCES: WATER RESOURCES**

**INTRODUCTION** Our planet Earth is known as blue planet because of the water that covers three-fourths of its surface. Water has a remarkable influence on various aspects of structure and function of our planet that includes shaping the continents, moderation of our climate and survival of organisms. Without water, Life on Earth is impossible. All life-forms including bacteria, plants and animals have 60-70% of water by their body weight. We rely on water not only for our convenience and usage but also for our survival. It is essential for ecosystem health. Although Earth has amply of water, most of it is saline and not suitable to drink, agriculture or other purposes. The vast amount of the remaining three per cent of fresh water is locked up out of practical human reach in the form of glaciers, icecaps and deep ground water aquifers. The very small fraction of fresh water that is accessible to us is distributed extremely unevenly in space and time. This results in serious water related problems, including interregional conflict over access and quality, competition between rural, urban and environmental uses, severe human health problems and constraints on economy. Actually, society spends billions of dollars every years to move water from one wet areas to drier areas, to store it for dry periods or to clean otherwise undrinkable sources. Conflicts often arise over water use because one application decreases the amount available for others. Even regions with readily available fresh water have problems maintaining the quality and quantity of water. The World's renewable fresh water supply is relatively constant; the average amount of water available per person in1850 was about 43,000 cubic meters per year. By 2014, this figure had dropped to around 5,900 cubic meters per year which may further reduce because of the increase in population. Worldwide, freshwater use is increasing as the

population expansion, human activities, and climate change pose increasing pressure on a limited water supply and resulting into a situation where a growing number of countries experience water shortages.

1. The hydrologic cycle and distribution of water Water exists in any of three forms: solid (ice/snow), liquid (marine/fresh water), and vapor (water vapor/steam). Water continuously circulates through the environment, from the ocean to the atmosphere to the land and back to the ocean by the hydrologic cycle. The result is a balance among water in the ocean, on the land, and in the atmosphere. This way hydrologic cycle inter-related various forms of water available on earth surface and also continually renews the supply of fresh water on land, which is essential to terrestrial organisms. However, approximately 97.5% of Earth's water is in the ocean and contains a high amount of dissolved salts. Seawater is too salty for consumption and other uses like agriculture and industries. For example, if you watered your garden with seawater, your plants would die. Most fresh water is unavailable for easy consumption because either it is frozen as polar or glacial ice, about 1.97%, or is present in form of ground water, about 0.5%. Lakes, creeks, streams, rivers, and atmospheric water account for only a small portion—about 0.03%—of Earth's fresh water. The underground establishments of earth contain constructions that collect and store water. Groundwater flows through permeable sediments or rocks slowly—typically covering distances of several millimeters to a few meters per day and ultimately, discharged into rivers, wetlands, springs, or the ocean. Aquifers are underground reservoirs that are either unconfined or confined. Aquifers have a recharge area, the land from which water percolates to replace groundwater. In unconfined aquifers, the recharge area is directly above them because the layers of rock above are permeable and allow surface water directly seep downward, replacing the aquifer contents. The upper boundary of an unconfined aquifer is called as water table. The water table is sandwiched between upper soil surface and lower rock surface. The later, rock surface has sediments and cracks saturated with groundwater. The water table varies in depth depending on the amount of precipitation occurring in an area for e.g. in case of deserts, the water table is generally far distant from the surface. In contrast, wetlands, lakes and streams have the water table that intersects with the surface. In dry conditions, the water table of a well is dropped lower than the depth of the well. A confined aquifer is also known as artesian aquifer. It is a groundwater storage area between impermeable layers of rock. The water in a confined aquifer is trapped and often under positive pressure. In contrast to unconfined aquifers, the recharge area may be hundreds of kilometers away Generally,groundwater resources are considered as nonrenewable because they have taken hundreds or sometimes thousands of years to accumulate, and typically only a minor portion of it is replaced every year by percolation of precipitation. The confined aquifers are recharged particularly slowly.

2. Water Resources of India India accounts for about 2.45 % of world's surface area, 4 % of the world's water resources and about 17.7 % of world's population. Water in India is available from three chief sources- the surface water (rivers, lakes, ponds), ground water (wells, springs), and wetlands. The water availability in India is reducing due to increasing population. The average annual water availability in 2001 was 1816 cubic meters per capita and had been reduced to 1545 cubic meter per capita in the year 2011 which had been further decrease to 1486 cubic meters per capita in the year 2018.

Surface water- It is the water found on Earth's surface in streams and rivers; lakes, ponds, and reservoirs, and wetlands.  Wetland- An area of land covered with water for at least part of the year. Runoff- It is renewable and finite resource precipitated water on land that replenishes surface water. Drainage basin- It is the area of land drained by a single river or stream.  Watershed- It is an area of land that drains snowmelt and rainfall into streams and rivers. Itranges in size from less than 1 km2 for a small stream to a huge portion of the continent for a major river system such as the Mississippi River. Groundwater- It is the form of water which originates as precipitation that percolates into the soil and

goes down through cracks and spaces in sand, gravel, or rock until it is settled by an impenetrable layer and accumulates as groundwater.  Aquifers- It is an underground layer of rock that holds groundwater.

a) Surface Water Resources: In our country, the surface flow takes place through 12 major rivers namely Ganga, Yamuna, Indus, Brahmaputra, Cauvery, Godavari, Krishna, Mahanadi, Mahi, Narmada, Pennar and Tapi. The mean annual flow in all the river basins in India is estimated to be 1,869 cubic km. However, due to various geographical and environmental constraints, only about 35 % of the available surface water can be exploited. Water flow in a river depends on the size of the catchment area of the river and rainfall within the catchment area. The precipitation in India has very high spatial variation, and it is mainly concentrated in Monsoon season. Some of the rivers in the country like the Ganga, the Brahmaputra, and the Indus have huge catchment areas. Much of the annual water flow in south Indian rivers like the Godavari, the Krishna, and the Cauvery has been harnessed, but it is yet to be done in the Brahmaputra and the Ganga basins. In addition to rivers, other surface water resources in India include canals, ponds, lakes, tanks, and wetlands. They are distributed unevenly over the country and retaining about 50 % of these inland surface water resources. b) Groundwater Resources: India has about 432 cubic km of total annual replenishable groundwater resources. The Ganga and Brahmaputra basins have about 45 % of the total replenishable groundwater resources. The groundwater utilization is relatively high in the river basins lying in north-western region and parts of south India. The groundwater utilization is very high in the states of Punjab, Haryana, Rajasthan, and Tamil Nadu. States like Bihar, Gujarat, Uttar Pradesh, Maharashtra and Tripura are utilizing their ground water resources at a moderate rate. However, the utilization of groundwater had been increased over the period of time due to increase in population. If the present scenario continues, the demands for water would definitely require additional supplies and such situation, will act as the deciding factor to development and social, economic and environmental balance all over the world.  c) Lagoons and Backwaters: India has a vast coastline which is the basis for presence of a large number of lagoons and eusteries are present. A lagoon is defined as a water body separated from larger bodies like river by a natural barrier like barrier reefs and island etc. The lagoons in India are very confined in few states like Kerala, Orissa and West Bengal. Although, water is usually brackish in these water resources and is generally used for fishing and irrigation of certain varieties of paddy crops, coconut, etc. However, a backwater can be defines as a water body or a branch of main river that lies alongside the main river or backed up by some kind of obstruction which may be natural or manmade.

3. Water Demand and Utilization India has traditionally been an agricultural country. Agriculture and its related activities are the leading source of livelihood for about two-third of its population. Besides this, water is also required in large amount for domestic, industrial, energy and other needs. Unlike land, availability of water varies from time to time and place to place in India. Being a monsoon land, the bulk of rainfall is confirmed to a brief period of 3-4 months of monsoon season.

However, due to increase in population and changing lifestyle, water consumption increases dramatically with season and time.  In addition, conversion of agricultural land to residential or commercial purposes reduces the open area available for natural recharging of groundwater during monsoon periods. In fact, more than 90 % of India’s water demand is for agriculture. Hence, to meet the increased agricultural production, development of irrigation has been consigned very high priority in our Five Year Plans. For this, various multipurpose river valleys projects like the Damodar River Valley project, Bhakra-Nangal project, Kosi Project, Hirakud Dam project, Nagarjuna Sagar Project, Narmada Valley Project, Indira Gandhi Canal Project, etc. have been taken up to fullfill the need. The share of agricultural sector in total water utilization is much higher than other sectors (Table 1)