ENVIRONMENTAL SCIENCES

CONTENTS

ENVIRONMENT

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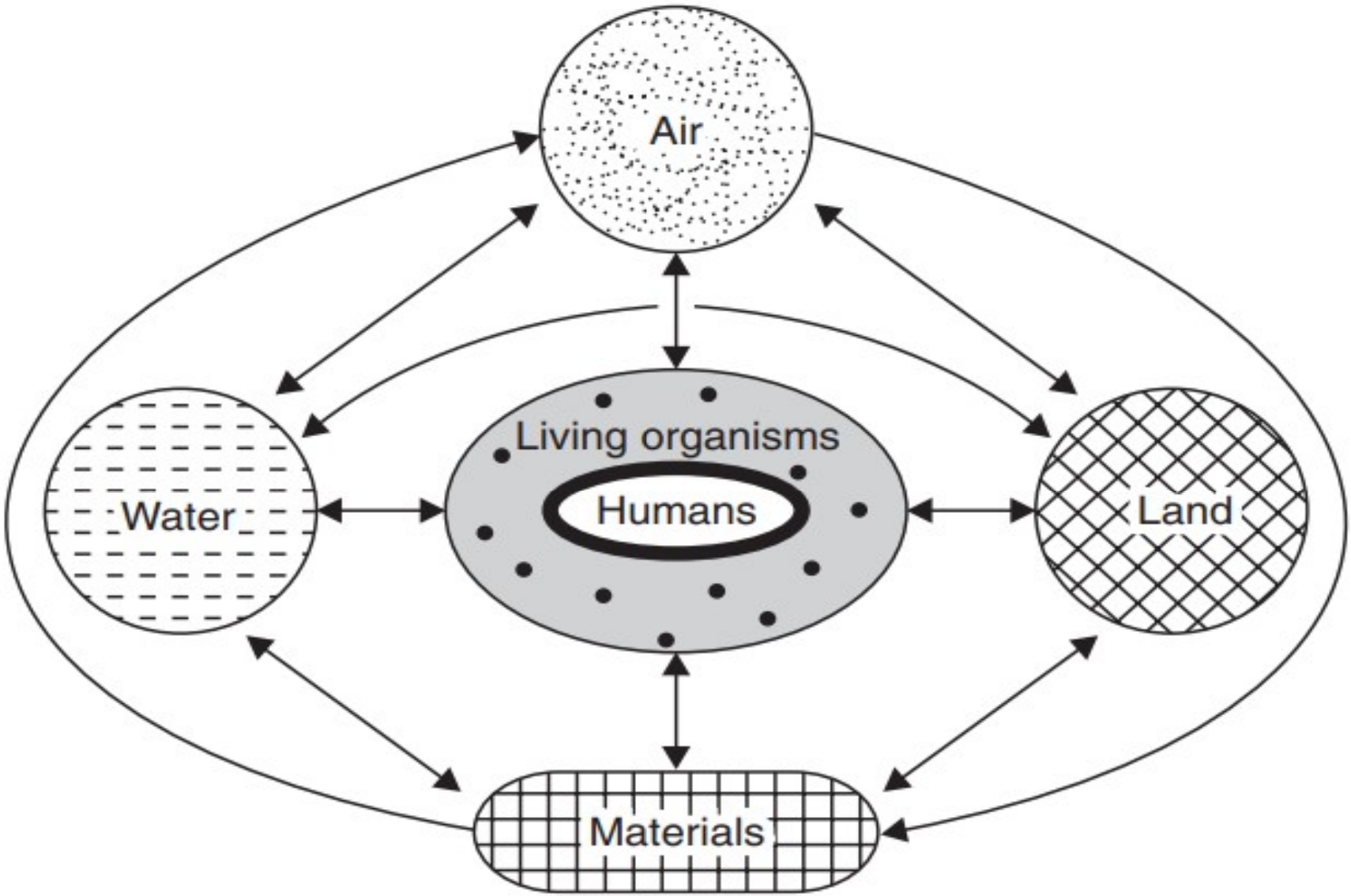
It includes not only the study of physical and biological characters of the environment but also th social and cultural factors and the impact of man on environment.

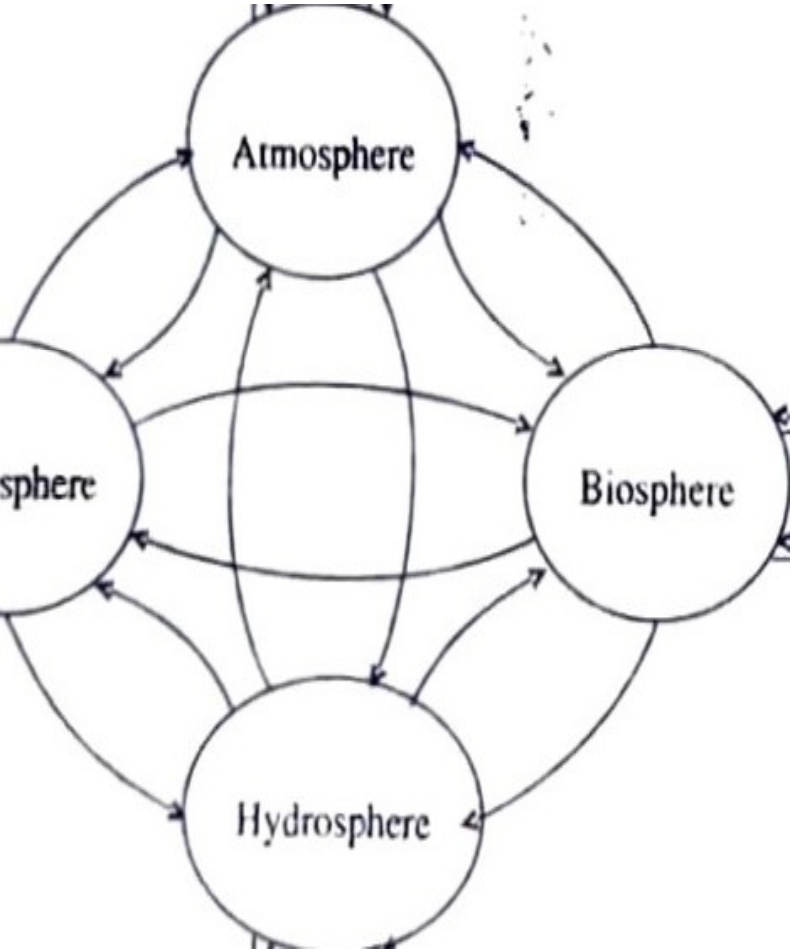
Definition: As per Environment (Protection) Act, 1986, environment includes all the physical an biological surroundings of an organism along with their interactions.

Environment is thus defined as "*the sum total of water, air, and land and the inter-relationship that exist among them and with the human beings, other living organisms, and materials*."

Environment' is a term derived from the French word '*Environner*' that means '*to surround*'.


Air
Water
Living organisms
Humans
Land
Materials

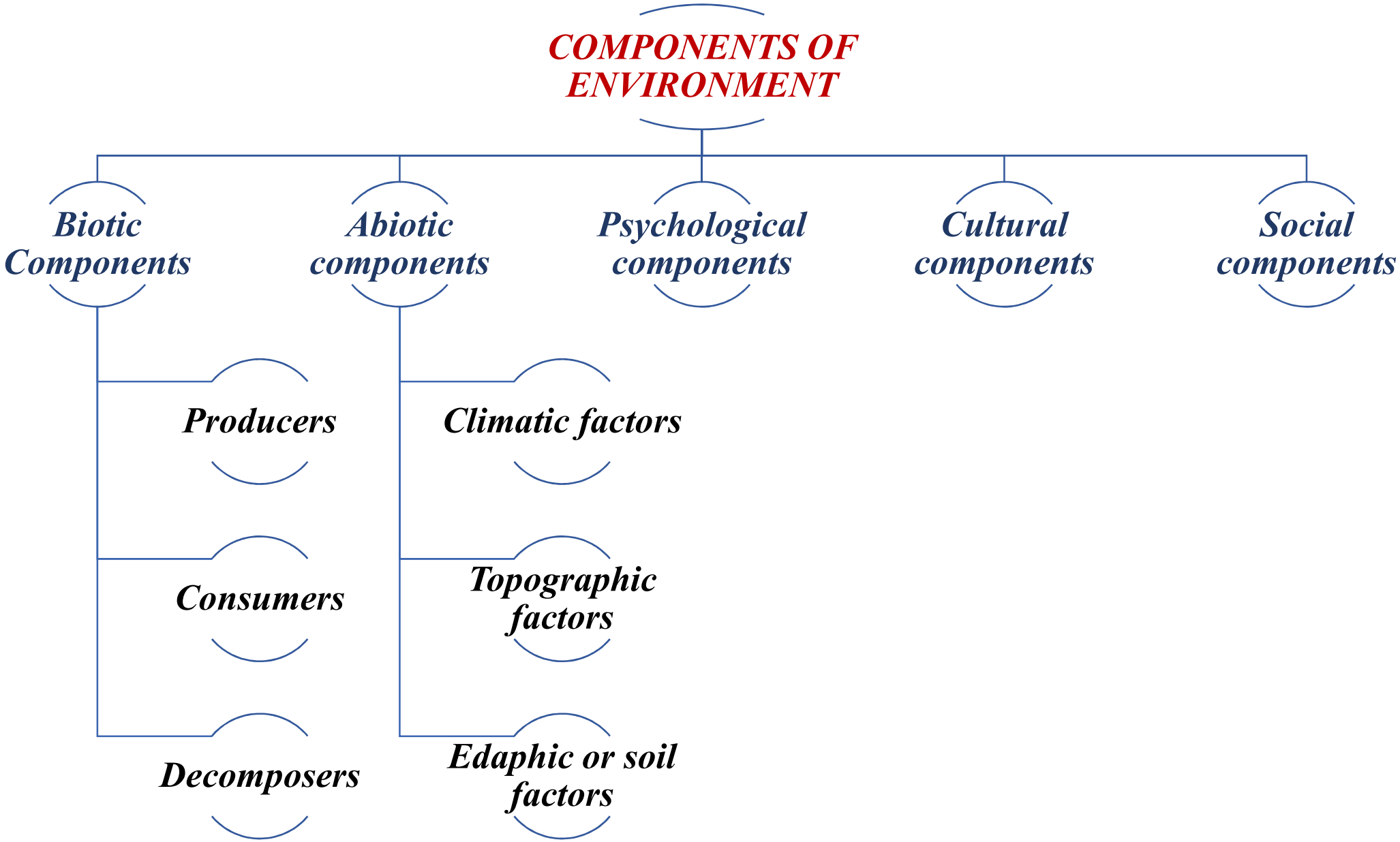
Spheres of Environment



- ✓ ***Atmosphere***: refers to the protective layer of various which surrounds the earth.
- ✓ ***Hydrosphere***: consists of the entire water resource w available in the form of seas, oceans, rivers. st reservoirs, glaciers, and ground water.
- ✓ ***Lithosphere***: solid outer mantle of the Earth cr constitutes of many minerals such as organic matt water, etc.
- ✓ ***Biosphere*****:** It is the layer of the Earth where the existe life takes place.

Components of environment

FACTORS	BIOTIC COMPONENTS	ABIOTIC COMPONENTS
EFINITION	In an ecosystem, there are living things called "biotic factors."	Abiotic factors are all non-living elem as physical circumstances and chemica that have an impact on an ecosystem.
XAMPLES	Biotic resources comprise all forms of vegetation and wildlife.	Sunlight, water, air, humidity, pH, te salinity, precipitation, altitude, type minerals, wind, dissolved oxygen nutrients present in the soil, air, and wa others, are examples of abiotic variable
PENDENCE	Abiotic factors are necessary for the survival and reproduction of biotic factors.	Abiotic factors stand entirely apart f factors.
ORIGIN	The biosphere provides the basis for biotic components.	The lithosphere, hydrosphere, and atmo the sources of abiotic components.


COMPONENTS OF ENVIRONMENT
Biotic Components
Abiotic components
Psychological components
Cultural components
Social components
Producers
Consumers
Decomposers
Climatic factors
Topographic factors
Edaphic or soil factors

Importance of Environment

- ✓ Environmental resources are the source of existence and growth for all human beings.
- ✓ Environment, in which everyone lives, is responsible for giving us a distinctive form as it influences ou development and living. Thus it is always advised to maintain a positive and constructive environment at a times, particularly for children.
- ✓ Positive environment can construct lives while a negative environment can destroy lives.
- ✓ Environment and development share a close association. Individuals perform routine work to accomplis their requirements and to produce things and facilities to make their lives easier.
- ✓ A positive environment attracts people from foreign lands.
- ✓ The environment provides various types of materials and the much-required energy.
- ✓ Natural resources obtained from our environment are essential for our daily life.

Scope of Environmental Studies

Environmental management

Ecosystem structure and function

Research and development

Natural resources conservation

Industry scope

Environmental pollution control

Social development

Need for Public Awareness

Reducing Global Warming

Solve Environmental Problems

Limited resource exploitation

Sustainable development

Changing of the mindset

Implementation of environmental protection plan

Importance of environmental studies

Protecting human health

Promoting environmental protection

Advancing quality education

Encouraging protection of natural resources

Creating jobs in environmental field

Challenges of the environmental studies

Risking population

Poverty

Agricultural growth

Need for ground water

Development and forest

Land degradation

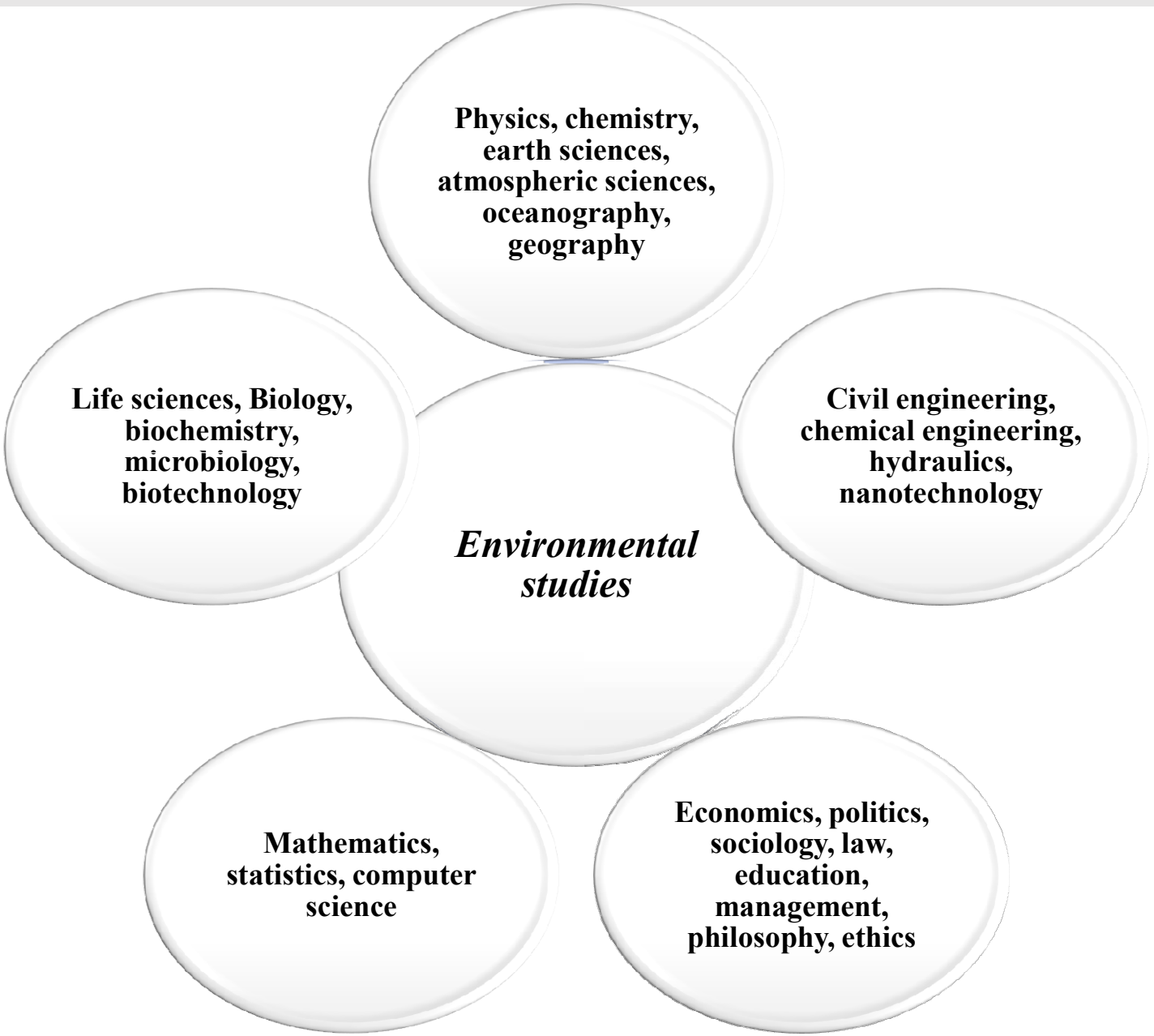
Re-orientation of institutions

Reduction of genetic diversity

Evil consequences of urbanisation

Air and water pollution

MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES



NATURAL RESOURCES

Natural resources can be defined as those exist (on the planet) independent of human actions.

The natural resource can be a substance, an energy unit or a natural process or phenomenon.

Land, soil, water, forests, grasslands, etc. are examples of important natural resources.

Some of the resources (e.g. soil, water) are important components of the life-supporting system.

NATURAL RESOURCES

The term 'resource' refers to anything that can be used to fulfil certain need, derive certain benefit, etc. Generally, resources are kept in reserve and are used when the need arises. Similarly, the natural resources are the substances which are available in nature and can be used by all the living beings in order to ensure their livelihood. ***Natural resources can also be termed as any element of the natural environment which is capable of providing certain benefits to the living beings***. Land, grassland, forests, soil, water, etc., are few examples of natural resources. These examples reflect that a natural resource can be a natural process, an energy unit, a phenomenon, or a substance. Natural resources like waters soil, trees, etc., are crucial ingredients of the life supporting system.

Classification of Natural Resources

1. ***On the Basis of Origin****:* Natural resources can be classified in terms on their source of origin. This can be of two types:
   - **Biotic**: Biotic resources include forests, animals. avian and aquatic resources. These resources are obtained from biosphere. Biotic resources also include mineral fuels like coal and petroleum as they are obtained from dead and decomposed organic matter.
   - **Abiotic:** These resources are obtained from non-living resources and include minerals like gold, iron ore, gypsum, uranium, etc.
2. ***On the Basis of Stage of Development***: Natural resources are also classified on the basis of their stage of development:
   - **Potential Resources:** The resources that exist within a particular region and are utilised in the future are known as potential resources. For example, India has petroleum resources in many areas that have sedimentary rocks But, until these resources are extracted and brought to use they remain potential in terms of state of utilisation.
   - **Actual Resources:** These are resources which have been identified. analysed, extracted and being used currently.
   - **Reserve Resources:** Reserve resources are parts of actual resources that can be commercially utilised in future.
   - **Stock Resources:** Stock resources are those that exist in nature but cannot be utilised due to lack of technical capability, e.g., hydrogen.

3. ***On the Basis of Availability:*** Natural resources are also classified on the basis of availability:
    - **Inexhaustible Natural Resources:** As the name suggests, these resources are available in infinite quantity in nature. They are not expected to get exhausted by human activity. For example, solar energy, rainfall, wind energy. tidal resources, nuclear energy, etc.
    - **Exhaustible Natural Resources:** 'These resources are limited in terms of their applicability and likely to get scarce through human exploitation. For example, oil, coal, iron ore, natural gas. etc. have limited availability of the Earth's surface and are likely to get exhausted if they are excavated and utilised in an unsystematic or indiscrete way.
4. ***On the Basis of Distribution*****:** Natural resources can also be classified on the basis of how they are distributed on the Earth.
    - **Ubiquitous Resources**: These are spread all over the Earth and are present everywhere. For example, land, water and air.
    - **Localised Resources:** Localised resources are available at only certain locations where the environmental conditions favour their existence. For example, fossil fuels. minerals, etc.
5. ***On the Basis Renewability:*** Resources can also be classified on the basis of renewability:
    - **Renewable Resources:** Renewable resources are those resources which can be regenerated over time. However,using them on a very large scale can deplete the productive capacity of these resources, e.g., water.
    - **Non-Renewable Resources**: These resources cannot be substituted easily by natural means. They get consume at a faster rate than they get created by nature. Usage of these resources can reduce the stock over a timeframe of the individual's life, e.g., petroleum, natural gas. etc.

Renewable and Non-Renewable Resources

Renewable Natural resources can be defined as those resources which can be restored by natural cycles. Few examples of renewable resources can be wind, sun, water &, trees, etc., which can be replaced atalmost the same rate of their consumption. Even these resources can get exhausted if wasted, or if used ineffectively. Renewable resources are able to multiply

themselves, either on their own or with the help of external efforts which can be made by human beings.

An example of plants and animals can be considered for understanding these types of resources as these species are substituted now and then as they have the ability to and continue lifecycles. Other examples are natural rubber, silk, jute, animal wool, cotton, leather, wood and wood related products, pulp products, etc., are renewable resources which do not have lifecycles, but can be reused or reprocessed Besides these, other substances such as soil and water can also grouped as renewable resources. Solar energy is regarded as renewable resource, even though it has a fixed life because solar stocks are considered to be infimte in companson to human consumption

2) Non-Renewable Natural Resources: Non-renewable resources are those resources which cannot be restored by using natural processes. These types of natural resources are exhausted more rapidly than they are renewed or restored. These are available in finite quantities which is Impossible increase. Examples Of non-renewable resources are minerals and salts nitrates. carbonate. phosphates. etc., fossil fuels such as coal. petrol, etc metals such as gold. silver, iron, zinc. lead, copper, etc. rt took millions years for fossil fuels like Oil and natural gag to be formed. Thus. once resources get exhausted. people either have to manage without them or to discover a suitable alternate for them. There are following two categories within which non-renewable resources can be divided further

i) Recyclable: Non-renewable resources which can be gathered once they utilised and can be or recycled to its original form are known recyclable resources. Non-errrgy mineral resources which are found Earth's crust like ores of aluminium, mercury. copper, etc.. deposits potassium, phosphate, and minerals that are used in their original state such mica, clay. asbestos, etc.. are soar of the examples of recyclable resources

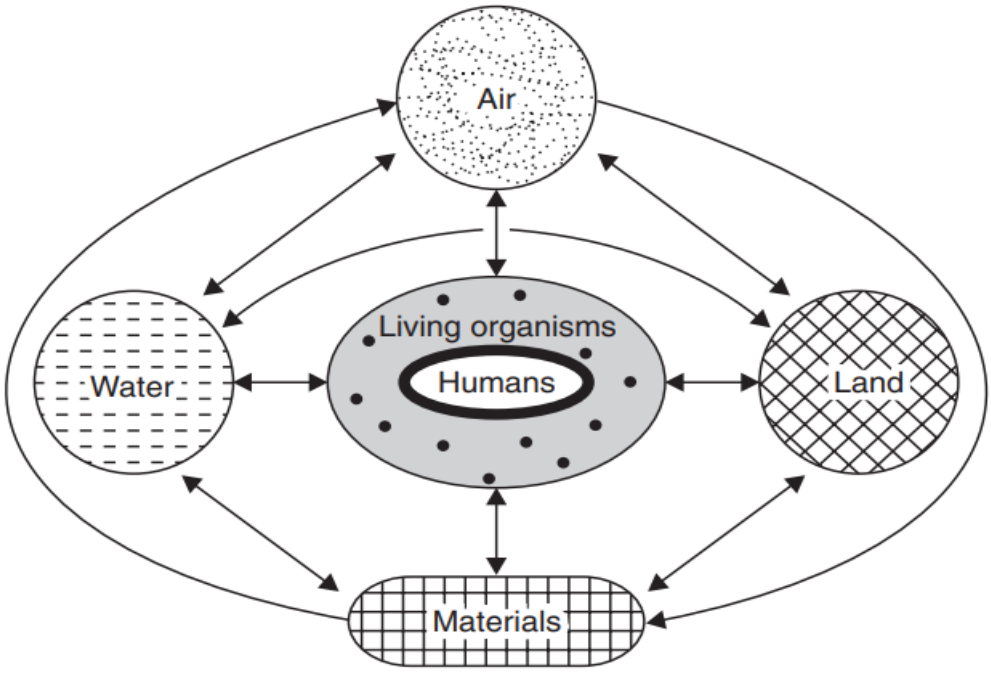
ii) Non-recyclable: There is not a single way available to restore these renewable resources. Uranium and fossil fuels. that fulfil almost energy necessities of humans. are the examples of non-recyclable resourct'Ä

UNIT- I

ENVIRONMENTAL SCIENCES

INTRODUCTION

- **Environmental Sciences** is the scientific study of the environmental system and the status of its inherent or induced changes on organisms.
- It includes not only the study of physical and biological characters of the environment but also the social and cultural factors and the impact of man on environment.
- **Definition:** As per Environment (Protection) Act, 1986, environment includes all the physical and biological surroundings of an organism along with their interactions. Environment is thus defined as *"the sum total of water, air and land and the inter-relationships that exist among them and with the human beings, other living organisms and materials."*
- *Environment'* is a term derived from the French word *'Environner'* that means *'to surround'*.



- The environment is a complex of many variables, which surrounds man as well as the living organisms.

- Environmental studies describe the interrelationships among organisms, the environment and all the factors, which influence life on earth, including atmospheric conditions, food chains, the water cycle, etc.
- It is a basic science about our earth and its daily activities, and therefore, this science is important for one and all.

General scopes of environmental studies

The environmental studies discipline has multiple and multilevel scopes. This study is important and necessary not only for children but also for everyone;

- The study creates awareness among the people to know about various renewable and non-renewable resources in the region. The patterns of utilization and the balance of various resources available for future use in the state of a country are analysed in the study.
- It provides knowledge about ecological systems and causes and effect relationships.
- It provides necessary information about biodiversity richness and the potential dangers to the species of plants, animals and microorganisms in the environment.
- The study enables one to understand the causes and consequences due to natural and main induced disasters (flood, earthquake, landslide, cyclones etc.,) and pollution and measures to minimize the effects.
- It enables one to evaluate alternative responses to environmental issues before deciding on an alternative course of action.
- The study enables environmentally literate citizens (by knowing the environmental acts, rights, rules, legislations, etc.) to make appropriate judgments and decisions for the protection and improvement of the earth.
- The study tries to identify and develop appropriate and indigenous eco-friendly skills and technologies for various environmental issues.
- It teaches the citizens the need for sustainable utilization of resources as these resources are inherited from our ancestors to the younger generation without deteriorating their quality.
- The study enables theoretical knowledge into practice and the multiple uses of the environment.

COMPONENTS OF ENVIRONMENT

The elements that make up the environment can be broadly separated into;

1. Biotic Components

The ecosystem's biotic elements are the living things that make up the ecosystem. Examples of biotic factors include fungi, bacteria, animals, plants, and animals. Based on the source of energy, these biotic components can be further divided into **producers, consumers, and decomposers**.

- **Producers**: These comprise each and every autotroph. They produce food on their own using light energy, such as plants, green algae, and other organisms.
- **Consumers**: All heterotrophs that rely on producers for food, whether directly or indirectly, fall under this category. Herbivores, carnivores, omnivores, and parasites are additional categories for consumers.
- **Decomposers**: These include saprophytes, which use dead materials and its decay as food.

Biotic Components of Different Ecosystems;

- Biotic Components of Terrestrial Ecosystem: Plants, Fungi and Bacteria.
- Biotic Components of Desert Ecosystem: Plants (Drought-tolerant plants), Desert Animals, Birds, Reptiles and Amphibians, Insects.

2. Abiotic components

Abiotic factors are defined as chemical or physical elements that have an impact on living things as a result of their existence or way of life. Also called as "ecological factors" as well.

- **Climatic factors**: light, temperature, rainfall, humidity, atmospheric gases, wind etc.
- **Topographic factors**: height from the sea level, direction of mountains and valleys, slope of the hills, exposure to the sunlight etc.
- **Edaphic or soil factors**: fertility, colour, quality, organic matter etc.

3. Social components: Includes population, social system, social changes and relationships, urbanisation etc.

4. Cultural components: Includes political, economic, moral values of life, religion, industries etc.

5. Psychological components: Includes life realities, self-concepts, level of desires, life space, neighbours, goals of life, environment at the workplace, work satisfaction etc.

NEEDS FOR AWARENESS

- Increasing population, urbanization and poverty have exerted pressure on the natural resources and led to degradation of the environment.
- To prevent the environment from further degradation, the Supreme Court has ordered and initiated environmental protection awareness through government and non-government agencies.
- Environmental pollution cannot be prevented by laws alone. Public participation is equally important with regards to environmental protection.
- Environmental Education (EE) is a process of learning by giving an overall perspective of knowledge and awareness of the environment.
- It sensitizes the society about environmental issues and challenges interested individuals to develop skills and expertise, thereby providing appropriate solutions.
- Climate change, loss of biodiversity, declining fisheries, ozone layer depletion, illegal trade of endangered species, destruction of habitats, land degradation, depleting ground water supplies, introduction of alien species, environmental pollution, solid waste disposal, storm water and sewage disposal pose a serious threat to ecosystems in forest, rural, urban and marine ecosystems.
- Both formal and informal education on the environment will give the interested individual the knowledge, values, skills and tools needed to face the environmental challenges on a local and global level.

SCOPE OF ENVIRONMENTAL STUDIES

Environmental studies aids in ensuring the well-being and health of any country through environmental concerns namely; securing human health, promoting stewardship of natural resources, encouraging creating employment environmental opportunities safeguarding in them in addition to economic development- environmental field. and promoting quality education. Environmental studies make us aware about the significance of preservation and maintenance of our unconsidered emission of pollutants into the environment. Currently, there has been a gradual increase in lot of environmental issues both in terms of size as well as in intricacy levels endangering the existence of humanity.

1. Environmental Management: Numerous autonomous environmental consultants work with the Central and State Control Board and provide guidance to resolve environmental issues offer optimum solution for the future issues. Development of industries causes a lot of pollution and these experts suggest ways to control this pollution level. There are many present consultants who are employed with government pollution control boards; they are into different positions handling policy-making matters. maintenance of ecological balance, pollution control, and so on.

2. Ecosystem Structure and Function: The study of ecosystems primarily entails the study of processes that connect the living organism (or biotic component) with the non-living organism (or abiotic component). Therefore, we need to be acquainted with both the biotic and abiotic components for studying environmental studies.

3. Research and Development: Due to the increase in environmental awareness among public, the scope of research and development is huge. Different governmental bodies and universities offer research studies opportunities with a view to generate new techniques toward examining and controlling the pollutants. Several steps are being taken for decreasing the greenhouse gases and the utilising renewable energy resources due to ever-increasing risk of warming. For all these measures, research and development is crucial.

4. Natural Resources Conservation: Natural resource includes forests, wildlife etc., and conservation of these natural resources involves managing and sustaining forests and maintenance of wildlife Conservation of all these resources hs scope for environmental studies.

5. Industry Scope: Environmental scientists have a diverse role to play ranging preservation of natural resources, working towards maintenance of balance to conservation of biodiversity and regulation of natural resources.

6. Environmental Pollution Control: Each and every person can control pollution by gaining suitable knowledge about environmental science- Everyone can figure out more ways to control pollution and can tackle waste management. environmental science has a great scope in pollution control.

7. Social Development: Making the general public aware of the different environmental issues and further assisting in developing awareness regarding the protection of the environment are the prime objectives of NGOs (Nan Governmental Organisations). They are also responsible for creating a public opinion in the field of social development. They try and spread information

effectuate changes in political policies that directly impact the environment. Controlling population explosion by conducting advisory awareness camp comes under the social dimension of this profession. Thus the study environmental science is vital for social development.

IMPORTANCE OF ENVIRONMENT

- ✓ Environmental resources are the source of existence and growth for all human beings.
- ✓ Environment, in which everyone lives, is responsible for giving us a distinctive form as it influences our development and living. Thus, it is always advised to maintain a positive and constructive environment at all times, particularly for children.
- ✓ Positive environment can construct lives while a negative environment can destroy lives.
- ✓ Environment and development share a close association. Individuals perform routine work to accomplish their requirements and to produce things and facilities to make their lives easier.
- ✓ A positive environment attracts people from foreign lands.
- ✓ The environment provides various types of materials and the much-required energy.
- ✓ Natural resources obtained from our environment are essential for our daily life.

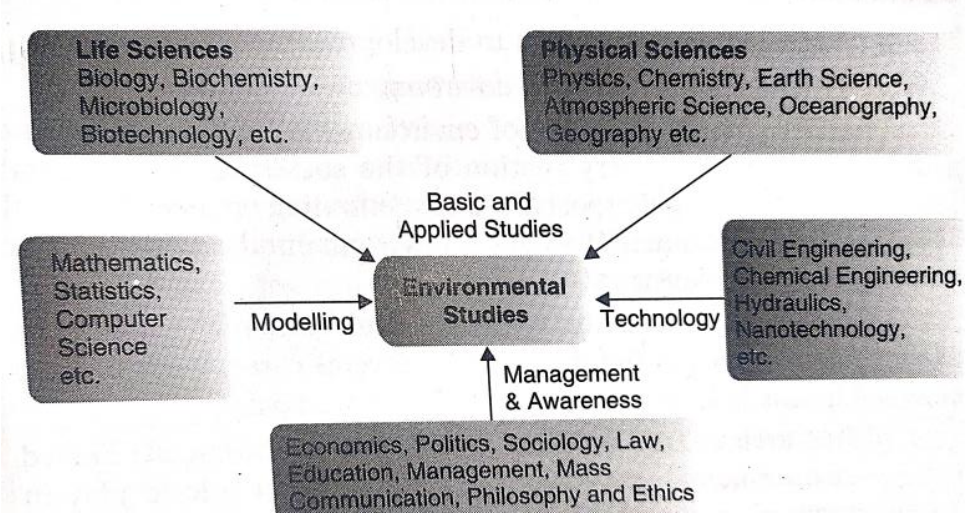
CHALLENGES OF THE ENVIRONMENTAL STUDIES

- ✓ Risking population
- ✓ Poverty
- ✓ Agricultural growth
- ✓ Need for ground water
- ✓ Development and forest
- ✓ Land degradation
- ✓ Re-orientation of institutions
- ✓ Reduction of genetic diversity
- ✓ Evil consequences of urbanisation
- ✓ Air and water pollution

MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

EVS is an interdisciplinary academic subject that investigates, researches, and expands knowledge about the living and physical environment. It also contributes to a better understanding of ecological, political, technological, economic, social, and cultural environmental factors. Environmental Studies, often known as EVS, is the science of physical phenomena in the environment. "Multidisciplinary" refers to the integration of more than one field or area of study.

Environmental Studies is a broad subject of study that includes components of Physics, Chemistry, Medical Science, Agriculture, Geography, and Biology. It is not just limited to environmental protection and resource management.



1. Environmental Science and Biology: Life is the supreme environment concern. Environmental biochemistry is the area that is especially concern with effects caused by environmental chemical species on life. Biologic Environmental studies is different from environmental and ecological sciences as it processes mostly decide the nature, character of these species, their degradation and also their syntheses, mainly in the soil and aquatic environments.

2. Environmental Science and Physics: Applications of physics and physical aspects of problems faced in environmental science are also very essential to analyse. Various topics constitute interesting and challenging applications of physics. For example, evolution of energy-saving "green" materials, development of sensors, storage/discarding of radioactive wastes, energy conservation issues, etc. Moreover, quality of life can also be enhanced with the use of physical sciences in generating technological innovations that change lifestyles

towards more environmentally favourable directions. A proper framework and distinct preparation for genuine problem-solving is attained by integrating physics with environmental science. It also extends a clear understanding of analytic tools in addition to data evaluation and instrumentation.

3. Environmental Science and Chemistry: The interrelation between environment and chemistry is called environmental chemistry. Environmental chemistry can be defined as a study of the sources, effects, movement, reactions, and providence of chemical species in water, air and soil and the impact of technology upon them. The estimation of the nature and quantity of specific pollutants in the environments is one of environmental chemistry's radical challenges.

4. Environmental Science and Sociology: Generally, the sociological study of interactions between the environment and the society is referred to as environmental sociology. However, this definition instantly highlights the unmanageable issues of separating human cultures from the remaining environment. Environmental sociology thus entails various social and cultural facets of environmental science. Environmental policies have simultaneously developed with the evolvement of areas of research and development. This has also helped in increasing the awareness of general public with a view to resolve environmental problems and averts future problems. For this, it is important to consider social and cultural facets (apart from technical facets) of the interrelation between society and environment. Normally, environmental sociology is involved with different themes like democracy, communication. daily life. environmental policy, etc.

5. Environmental Science and Geology: Environmental geology can be defined as a connection between geology and environmental studies. It is an applied science dealing with practical usage of the principals of geology for resolving environmental issues. It is an interdisciplinary study which is closely associated with engineering geology and lightly with environmental geography. Geological environment includes the hydrosphere, the biosphere and the lithosphere and to a certain degree, the atmosphere. Each of the fields mentioned above Include the study of intercommunication of human beings with all these aspects of geological environment.

Following points when put together form environmental geology;

- ✓ Examination of Earth's surface with the help of different study fields like geomorphology and edaphology.

- ✓ Managing minerals, water (including both ground and surface water), land use. fossil fuels and all other hydrogeological and geological resources.
- ✓ Reducing or removing ill-effects of pollution and controlling domestic and industrial waste disposal.
- ✓ Conducting environmental geology related activities generally including litigation.
- ✓ Defining and alleviating exposure of natural hazards on human beings.

6. Environment and Economics: All the forces or factors that create economic influence on humans, his region, and his actions together constitute the economic environment. The total economic environment is composed of both internal and external factors such as agriculture, infrastructure, industrial production, population, resources and different stages in economic development including economic planning, economic philosophy, economic conditions, economic system. economic policies and trade cycle. The economic development of a particular region depends upon easy and sufficient availability of resources and suitable technology to utilise them. The natural resources are now becoming unceasingly concentrated in some particular areas as the distribution of natural resources is unequal due to geographical factors. These naturally gifted areas are now better known as developed countries as they have used these resources to the fullest for economic developments and overall progress.

7. Environment and Political Set-up: The three key political institutions namely, judiciary, executive and legislature and their impact form the political environment of a country. It aids in creating, directing. developing and managing various human activities containing his business activities. anti-pollution laws, etc. The role of executive, better known as the Government, is to implement the decisions made by the legislature. The government functions in public interest and within the boundaries drawn by the Constitution. Development and progress of humanity is primarily governed by a strong and dynamic political environment. The political environment of a country is largely governed by the kind of governments such as democratic, monarchy, dictatorial, communist, etc.. as it is directed by some of its own specific policies. Any modification in the type of government can be differential or unfavourable and can thus impact the country from different directions, i.e., economic, physical, socio-cultural, business and so on, as all these components are mutually dependent.

8. Environment and Population Studies: Population factor has a major and notable part in socio-economic environment of a country, particularly the density or size of the population. Population also influences the natural environment. A large section of the population being

poor or under poverty levels causes more environmental damage because of jointly supporting effect between poverty and environmental change. The poor or underprivileged are the agent as well as the victim of environmental damage. The world population is increasing at an alarming and dangerous rate of 1.7 per cent per year. In case this trend continues for another three or four decades, there will be an increase of another 3.7 billion people or more to the existing population level. Economic and physical environments at domestic and global level would be badly affected by this rapid population growth. With increase in population, the natural resources and traditional land will continually be excessively used and will get depleted with time. Studies related with environmental and population facets are concerned with similar issues.

NATURAL RESOURCES

RENEWABLE & NON-RENEWABLE

WHAT ARE NATURAL RESOURCES?

Resources that occur in our nature are known as Natural Resources.

These can not be produced by our man-kind.

Examples:

1. Sun light
2. Minerals

CLASSIFICATION OF NATURAL RESOURCES

Natural Resources can be classified into ***TWO*** categories:

1. Renewable resources
2. Non-Renewable resources

WHAT ARE RENEWABLE RESOURCES?

- Resources that can be replenished naturally in the course of time are called Renewable Resources.

- **Examples:**

i. Air
ii. Water
iii. Sunlight
iv. Wind

WHAT ARE NON-RENEWABLE RESOURCES?

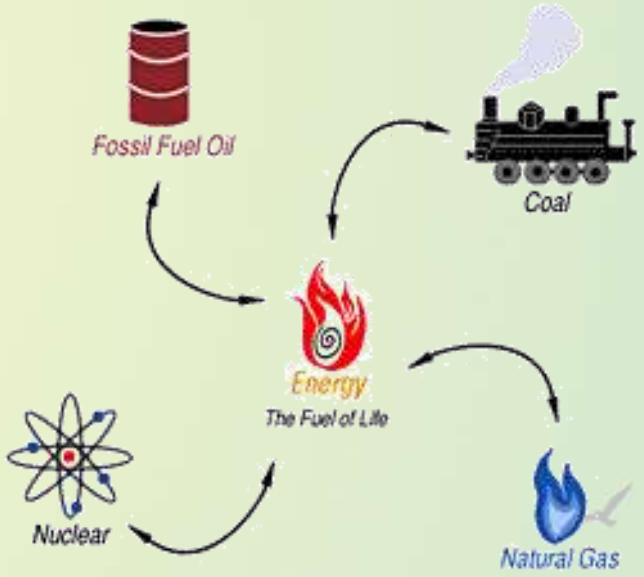
- Resources that exist in limited supply and cannot be replaced if they are used up are called Non-Renewable Resources.

- Examples:

i. Oil
ii. Natural gas
iii. Coal
iv. Nuclear fuels

Renewable Energy

Non-Renewable Energy



RENEWABLE RESOURCES

- Solar energy
- Wind energy
- Hydro power
- Geo Thermal energy

SOLAR ENERGY

SOLAR ENERGY

- **Solar energy** is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar photovoltaic cells.
- The Sun is a powerful source of energy that provides the Earth with as much energy every hour as we collectively use in a year worldwide.

- **Energy from the sun is harnessed in two ways:**

1. Active solar involves capturing and redistributing sunlight through the use of solar panels, pumps or solar fans to generate power usually on a large scale.

2.Passive solar works to reduce the amount of energy traditionally used to power a location, such as a building or house. An example is building a house in the natural direction of sunlight to trap heat.

WIND ENERGY

WIND ENERGY

• The Electrical energy that is obtained from harnessing the wind with wind mills or wind turbines is called **Wind Energy.**

•Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth.

•Wind turbines convert the kinetic energy in the wind into mechanical power.

•Large wind farms consist of hundreds of individual wind turbines which are connected to the electric power transmission network.

HYDRO POWER

HYDRO POWER

- **Hydro power** is the energy derived from the falling water or running water.
- Falling water is channeled through water turbines.
- The pressure of the flowing water on turbine blades rotates a shaft and drives an electrical generator, converting the motion into electrical energy.
- But hydroelectric power doesn't necessarily require a large dam. Some hydroelectric power plants just use a small canal to channel the river water through a turbine.

GEO-THERMAL ENERGY

GEO-THERMAL ENERGY

- **Geothermal energy** is thermal energy generated and stored in the Earth.
- Thermal energy is the energy that determines the temperature of matter.
- The geothermal energy of the Earth's crust originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%).
- The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface.
- Resources of **geothermal energy** range from the shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma.

PROS & CONS
OF
RENEWABLE RESOURCES

SOLAR ENERGY

- **Pros:**

Save Money: A lot of money can be saved as the money paid in the form of Power bill will be reduced.

Green energy: Pollution produced by the burning of fossil fuels like petrol, cutting trees for timber can be decreased to a great extent.

- **Cons (mostly mythical):**

Upfront cost: Some people hold off on purchasing solar panels because they imagine that they can't afford the initial expense. But, the amount spent on installing Solar panels can be gained in a few years, as they save on Electricity produced from traditional sources such as coal, wood etc.

Maintenance: Homeowners unfamiliar with solar technology sometimes fear that complex repairs will be needed. In fact, solar panels have no moving parts, so there's no wear and tear. Rain is generally sufficient to keep the panels free from dust and grime.

WIND ENERGY

- **Pros:**

- Wind energy is a green energy source and does not cause pollution.
- The potential of wind power is enormous – 20 times more than what the entire human population needs.
- The operational costs associated with wind power are low.

- **Cons:**

- Wind is a fluctuating (intermittent) source of energy and is not suited to meet the base load energy demand unless some form of energy storage is utilized (e.g. batteries, pumped hydro).
- The manufacturing and installation of wind turbines requires heavy upfront investments – both in commercial and residential applications.
- Wind turbines can be a threat to wildlife (e.g. birds, bats).

HYDRO POWER

- **Pros:**

- Hydroelectricity is very reliable energy. There are very little fluctuations in terms of the electric power that is being by the plants, unless a different output is desired
- Adjusting water flow and output of electricity is easy. At times where power consumption is low, water flow is reduced and the magazine levels are being conserved for times when the power consumption is high.

- **Cons:**

- Hydroelectric power plants may affect fish is a complex interaction between numerous physical and biological factors.
- Building power plants in general is expensive.
- Electricity generation and energy prices are directly related to how much water is available. A drought could potentially affect this.

GEO-THERMAL ENERGY

- **Pros:**

- No fuel required (no mining or transportation)
- Not subject to the same fluctuations as solar or wind.
- Smallest land footprint of any major power source.
- Virtually limitless supply.

- **Cons:**

- Prime sites are often far from population centers
- Losses due to long distance transmission of electricity
- Sulfur dioxide and silica are emitted.

NON-RENEWABLE RESOURCES

NON-RENEWABLE RESOURCES

1. Oil
2. Natural gas
3. Coal
4. Nuclear resources

OIL

OIL

- Liquid petroleum -crude **oil**- is the only nonrenewable resource in fluid form.
- A fossil fuel that is being used up faster than new reserves are discovered, the oil supply may only last through the middle of this century.
- Industrial nations, with the U.S. far in the lead, are the biggest consumers of crude oil.
- Gasoline, heating oil, and diesel fuel are the primary uses of the resource, although manufacturers utilize oil as the base for such products as plastics and industrial chemicals.

NATURAL GAS

NATURAL GAS

- **Natural gas** is a fossil fuel formed when layers of buried plants, gases, and animals are exposed to intense heat and pressure over thousands of years.
- The energy that the plants originally obtained from the sun is stored in the form of chemical bonds in natural gas.
- It is primarily composed of methane, but contains ethane, propane and butane as well.
- Once drillers extract natural gas, processing plants remove the propane and butane for use as liquefied petroleum gas (LPG), a household and industrial fuel.
- According to the current usage statistics and the volume of world reserves, the supply of natural gas should last another century.

COAL

COAL

- **Coal,** which is a primary resource of energy in India, is the product of millions of years of pressure on original organic matter from plants buried underground.
- It is a combustible black or brownish-black sedimentary rock usually occurring in rock strata in layers or veins called **coal beds** or **coal seams.**
- Anthracite, the purest form of coal, contains about 94 - 95% of carbon.
- At the power plant, coal is commonly burned in a boiler to produce steam. The steam is run through a turbine to generate electricity.
- The global supply of coal, given the current rate at which it is used, should last at least two more centuries.

NUCLEAR ENERGY

NUCLEAR ENERGY

- Nuclear power, or nuclear energy, is the use of exothermic nuclear processes, to generate useful heat and electricity.
- The term includes nuclear fission, nuclear decay and nuclear fusion.
- Presently the nuclear fission of elements in the actinide series of the periodic table produce the vast majority of nuclear energy in the direct service of humankind.
- In nuclear fission, neutrons smash into the nucleus of Uranium atoms and release energy in the form of heat. Water is converted to steam by this heat and it is used to drive the turbines.
- Nuclear (fission) power stations, excluding the contribution from naval nuclear fission reactors, provided about 5.7% of the world's energy and 13% of the world's electricity in 2012.

Steps to be taken for conservation of natural resources

- Use various resources only when needed.
- Avoid the wastage of resources.
- Avoid the use of material from wild life sources.
- Use energy efficient electrical appliances.
- Use pressure cooker for cooking which saves 75% of the LPG used in homes.
- Old vehicles should not be used as they are less fuel-efficient and also cause pollution.
- Utilize renewable energy sources as much as possible. Encourage use of solar cooker, pump etc
- We should recycle the waste and waste water for agriculture purposes.

Thank You..

CHAPTER 2 Aspects of Ecosystems

2.1. ECOSYSTEM

2.1.1. Concept of an Ecosystem

Arthur Roy Clapham, a British Botanist, devised the concept of ecosystem in the year 1930 to signify the biological and physical constituents of an environment in connection with each other as an individual unit. This expression of ecosystem was further elaborated by Arthur Tansley (a British ecologist) in the year 1935. He illustrated it as an interactive system initiated between biocoenosis and their biotope, where biocoenosis mean [illegible] and biotope is the natural environment where they sustain and develop.

According to A.G. Tansley, "Ecosystem is the system resulting from the integration of all the living and non-living factors of the environment".

According to Christopherson, "An ecosystem is a natural system consisting of all plants, animals and microorganisms (biotic factors) in an area functioning together with all the non-living physical (abiotic) factors of the environment".

The ideology that every living organism is constantly involved in a number of correlations with other living elements which are a part of their environment where they survive is known as ecosystem. Ecosystem illustrates any kind of circumstance where there is a link between living organisms and their surrounding environment. It can be confined and considered with a vast array of scope. An ecosystem has all the essential attributes to support life, and is the smallest part of the entire biosphere.

An ecosystem is a natural set of mineral plants, nutrients, animals, and their wastes connected together by a flow of energy, nutrients, and food from one section of the ecosystem to the other. **For example,** seas, grasslands, ponds, deserts, streams, etc., are all ecosystems.

2.1.2. Structure of an Ecosystem

Nearly, all the ecosystems have only one important source of energy, i.e., sunlight. The energy gained from sunlight is used by bacteria, green plants, and some algae to drive the chemical reactions that integrate simple inorganic molecules to form complex organic compounds. This process is called photosynthesis. Ecosystems comprise of different sections, and elements present in the ecosystem keep rotating within these sections. The constituents of the ecosystem define the structure of their ecosystem. An ecosystem structure includes the following components:

1) Abiotic components, and
2) Biotic components.

2.1.3. Abiotic Components

Abiotic structure of an ecosystem includes the chemical and physical components of the ecosystem. Energy, nutrients, geographical factors, climatic factors, toxic substances, and soil factors together constitute abiotic structure.

1) **Physical Factors and Climatic Regime:** Some of the key physical characteristics exerting a powerful impact on the ecosystem are sunlight, shade, availability of water, average temperature, type of soil, solar flux intensity, wind, annual rainfall, altitude, latitude, etc.
   i) **Solar Radiation:** Sunlight is the most important component in the process of photosynthesis. Solar energy is also used in ecosystems to generate heat in the atmosphere, and to evaporate and spread water in the atmosphere.
   ii) **Atmosphere:** Living organisms in the ecosystems are supplied with oxygen and carbon dioxide for respiration and photosynthesis respectively by the atmosphere.
   iii) **Soils:** Complex in nature than other sediments, soils are a mixture of various materials and matters. They include highly reformed soil mineral particles, weathered rock fragments, living organisms, and organic matter.
2) **Chemical Factors:** Chemical factors include inorganic and organic substances. The important essential nutrients or inorganic substances such as oxygen, hydrogen, carbon, sulphur, potassium, nitrogen, and phosphorus are engaged in cycling of materials in the ecosystem. Organic substances are lipids, carbohydrates, proteins, etc., which mainly constitute the living body, and also link the biotic and abiotic components.

2.1.4. Biotic Components

All the living things such as plants, animals, micro-organisms, etc., in an ecosystem are biotic components of the ecosystem. Wastes from living things and dead organisms are also a part of biotic components. Biotic components are present even in those corners of earth where survival is very difficult. Our planet is a collaboration or union of biotic beings.

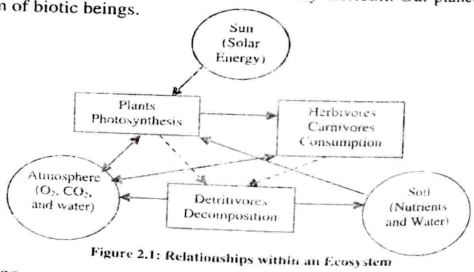


Figure 2.1: Relationships within an Ecosystem

Non-living components of an organism's environment including light, air currents, temperature, moisture, etc., are abiotic components of an ecosystem. These are distinct from biotic components.

Generally biotic components comprise of the following:

2.1.4.1. Producers

Organisms which can produce organic compounds are known as autotrophs or producers. Solar energy is converted into the chemical energy by means of organic substances like enzymes and inorganic substances like CO_2 and water by energy transducers or producers. These producers are mostly green plants including grasses, trees, tiny phytoplankton, etc., and are autotrophic organisms, i.e., self-nourishing organisms. Almost all the producers are green plants which are capable of producing their own food through photosynthesis. These green plants have a green pigment known as chlorophyll which converts solar energy. There are two types of autotrophs namely photoautotrophs which use light energy, and chemoautotrophs which utilise energy produced in an oxidation-reduction process. However, the chemoautotrophs have a negligible significance as producers in the ecosystem.

These two types of producers are discussed below:

1) **Photoautotrophs:** Organisms which produce their own food through photosynthesis are called as photo autotrophs. They include algae, bacteria, green plants, etc.

2) **Chemoautotrophs:** All of these are bacteria. They are even capable of making their own food. The only difference between photoautotrophs and chemoautotrophs is that they use different source of energy. They use sources of energy, and carbon dioxide distinct from the ones used by photoautotrophs.

2.1.4.2. Consumers/ Heterotrophs

Heterotrophs are called as consumers in the ecosystem. These consumers are not able to produce their own food and therefore, gather their food from the surroundings. Heterotrophs are completely relied upon organisms such as green plants, algae, bacteria, etc., which are self-sufficient in producing food. They utilise an organic carbon source to fulfil their energy requirements. Fungi, some protoctists, animals, etc., are examples of heterotrophs. Consumers (heterotrophs) can be categorised into three types explained below:

1) **Primary Consumers:** Primary consumers are herbivores, who get their energy by consuming the producers directly. **For example,** deer, cow, etc.

2) **Secondary Consumers:** Animals who consume primary consumers are called as secondary consumers. Secondary consumers are carnivores and consume meat. Leopard, lion, etc., are few examples to be considered here.

3) **Tertiary Consumers:** These types of consumers survive by consuming other meat-eaters and are carnivorous in nature. Generally, this chain of dependence is known as food chain. Each chain has different levels known as trophic levels.

On the basis of eating habits, consumers are categorised into following three kinds:

1) **Herbivorous:** Consumers who consume only plants or plant products are called as herbivorous. **For example,** cows, rabbits, sheep, mice, deer, groundhogs, grasshoppers, beavers, goats, moose, etc.

2) **Carnivorous:** These consumers consume only meat of other animals. **For example,** spiders, hawks, frogs, foxes, snake, etc.

3) **Omnivores:** The final types of consumers are ones who eat plants as well as meat, i.e., primary consumers and secondary or tertiary consumers. **For example,** squirrels, turtles, bear, etc.

2.1.4.3. Decomposers

Organisms which break-down or chemically decompose deceased or decaying organisms are known as decomposers. While doing so, they perform a natural process called as decomposition. Decomposers are heterotrophic which means that they make use of organic substrates to gain energy, nutrients, and carbon essential for their development and growth; similar to that of herbivorous and predators. The main source of food of decomposers is non-living organic compounds, and dead or decaying organisms.

Decomposers are capable to digest complex organic matter because of the digestive enzymes, and transform this matter into simple compounds. These simple compounds can be used again by producers. Hence, these decomposers are instrumental in completing the food cycle. Bacteria, fungi, etc., are examples of decomposers.

2.1.5. Functions of an Ecosystem

The operational or working method of an ecosystem under natural circumstances is elucidated by the functional characteristics of an ecosystem. The biotic and abiotic components of an ecosystem are very much interlinked in the nature from the operational perspective. They are so interlinked that it is quite complex to segregate them.

However, comprehensive functions of an ecosystem, and their corresponding goods and services are categorised into four fundamental categories:

1) **Regulation Functions:** The ability of natural and semi-natural ecosystems to control and manage vital life support systems and ecological processes with the help of biospheric processes and bio-geochemical cycles comes under regulation functions. Various kinds of services are provided by these group of functions which offer explicit as well as implicit advantages to human beings such as pure air, soil, water, and biological control services, besides maintaining ecosystem's or biosphere's health and well-being.

2) **Habitat Functions:** Wild plants and animals are given the natural environment and habitation to live, and reproduce by natural ecosystems and as a result, it contributes to the preservation of evolutionary processes alongwith genetic and biological diversity.

3) **Production Functions:** Autotrophs make use of nutrients and undergo photosynthesis to convert energy, water, nutrients, and carbon dioxide into an extensive range of carbohydrate structures. These structures are later on utilised by secondary producers to form a comparably huge array of living biomass. Several ecosystems get goods for human consumption extending from genetic materials and energy resources to food and raw materials because of this wide multiplicity or diverse carbohydrate structures.

4) **Information Functions:** Natural ecosystems strive towards maintaining human health and well-being by offering opportunities for cognitive development, aesthetic experience, reflection, spiritual enrichment, and recreation and give an important 'reference function', as majority of human development happened in relation to uncivilised habitat.

There is a basic reasoning in the rank of function categories, even though the ordering of these functions is relatively inconsistent or random. Regulation and habitat function groups are necessary for the protection or preservation of natural components and processes, and hence, essential for maintenance of availability of remaining two functional groups, i.e., production and information.

2.1.6. Energy Flow in the Ecosystem

Use of energy is an integral part of any biological activity. The main source of energy is sun. The energy received from sunlight is converted from radiant form to chemical form by the process of photosynthesis. From chemical form, this energy is transformed into mechanical form by the mechanical activity. The flow of energy always moves in a single direction. This flow of energy cannot travel backwards, i.e., from a current trophic level to the previous trophic level. **Figure 2.2** explains the concept of flow of energy.

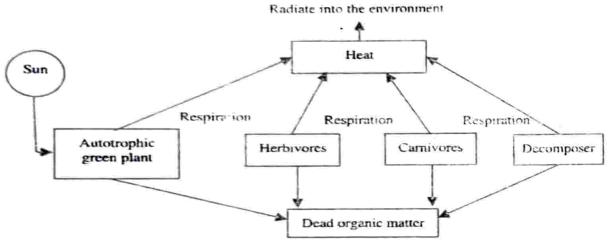


Figure 2.2: Energy Flow in the Ecosystem

The two thermodynamics laws followed by energy flow in ecosystems are explained below:

1) Energy can only be converted from one form to another, as it cannot be created or destroyed.
2) No energy transformations are completely efficient.

For example, a plant biomass of 100kg will not result in the same weight of flesh in an herbivorous animal.

Rather, with the help of the process of respiration, almost all plant biomass is broken down by herbivore in releasing energy for its various activities.

Just 10% of this biomass is stored as flesh in an herbivore. Usually, this rule is known as **ten-per cent rule**.

Raymond Lindeman, famous ecologist, was the first to introduce this law. This law is described as below:

Producer	→	Primary Consumer	→	Secondary Consumer	→	Tertiary Consumer
(1,000 kcal)		(100 kcal)		(10 kcal)		(1 kcal)

As stated in the **ten-per cent rule**, only 10% of the energy is retained in an organism tissues, and the remaining 90% of the energy is utilised at each trophic level.

For example, if a plant traps 1000 kcal of the radiant form of energy, only 10% of it i.e., 100 kcal would be transformed into plant tissue. This can be further used to produce only 10%, i.e., 10 kcal of herbivore tissue. And eventually, only 1 kcal of carnivore tissue is formed.

2.1.7. Ecological Succession

Ecological succession is a basic concept in ecology. It refers to all those predictable and systematic changes that occur in particular community over a period of time. Ecological succession can be brought about by a number of factors like creation of new landforms (lava flow or earthquake) or ecological disturbances (fires, deforestation, etc.) due to human activities.

Primary succession is the succession that occurs [illegible] soil. On the other hand, secondary succession [illegible] where the soil is previously present. The course of [illegible] be influenced by a number of factors like regional environment, [illegible] presence of foreign elements, weather conditions, etc.

A number of these factors help in predicting the successional changes [illegible] community, while others add the element of probability to the prediction. [illegible] initial succession communities are led by fast-growing, well distributed [illegible] referred to as opportunist, fugitive, or r-selected life-histories. [illegible] succession keeps on occurring, these species are generally replaced by competent species like k-selected species.

2.1.7.1. Factors of Ecological Succession

There are number of factors that affect ecological succession. Some of these are discussed below:

1) **Topography:** Weather conditions bring about a number of changes in topographical factors, which are part of secondary succession. These factors generally include events like landslides and mudslides that are [illegible] responsible for changes in the landscape. Such disturbances caused by landslides or mudslides facilitate disturbance-tolerant species to re-populate the habitat.

2) **Soil:** Soil, being an abiotic component of the environment, immensely affects primary ecological succession. Different varieties of plants and trees require different kinds of soil for growth and development. Primary succession is generally led by trees. Soil texture, particularly its pH level, is most affected by the trees that regulate the plant growth and variety. Also, the kind of soil (like sandy, top soil with humus, etc.) is a determining factor that regulates plant variety and plant species.

3) **Climate:** Climate is also an abiotic component of an environment, which plays a part in both primary succession and secondary succession. It plays an important role in determining the course of ecological succession in the environment. An environment which receives less precipitation over a period of time is relatively more prone to events like forest fires caused mainly due to lightning [illegible]

events lead to secondary succession wherein fire resistant and tolerable species replace other species in the region. Similarly, winds may completely transform the structure of the landscape through its sheer erosional power. They can contribute significantly to environmental disturbances by spreading forest fires to nearby areas.

4) **Species Interaction and Competition:** Species interaction and competition in an environment for survival and growth is a biotic factor of primary ecological succession. When succession starts and the first species (also called pioneer species) which come to inhabit the area change the structure of the environment, it leads to settlement and growth of new species of organisms that are resistant to changed conditions. At this point of time, there is high diversity in species.

2.1.7.2. Stages of Ecological Succession

Following are the stages of ecological succession:

1) **Nudation:** Nudation refers to the situation of a bare area which is not inhabited by any organism. Such a process is generally the result of some kind of environmental disturbance. The factors contributing to such disturbances can be either topographical (soil erosion, wind action, etc.), climatic (hails, storm, glaciations, fire, etc.) or biotic (human activities) in nature. The area so formed after the disturbance can support only autotrophic organisms, which can make use of inorganic substrates. In this way, environmental conditions are made suitable for the evolution and development of a new species of organisms. **For example,** generation of acidic substances by lichens results in breaking-down of rocks into soil.

2) **Invasion or Migration:** Invasion or migration is the process that facilitates the arrival of spores, seeds and other reproductive disseminates for the formation of species. Invasive species are foreign species that may spread quickly in the local area. They may threaten ecological equilibrium and may serve as a primary source of ecological disturbance. However, during periods of succession, they are responsible for changing the properties of soil in the region. These species (invasive) are generally the first ones to occupy any area because of their high reproductive capacity and better dispersal mechanisms.

3) **Ecesis:** Ecesis refers to the formation of first plant community. Formation of plant community is largely influenced by the soil structure. This stage of formation of first plant species is also referred to as 'colonisation'. During this stage, plant species which first colonise the area spread widely throughout the region through germination, growth, and reproduction. Generally, ecesis is largely driven by allogenic mechanisms. This is the stage when pioneer species survive the distribution systems of other species. The different maturation rates of pioneer species elongate this process allowing for gradual extinction of some species.

4) **Aggregation:** Aggregation refers to increase in the population of established species in a particular region. In large number of successions, small herbs are replaced by shrubs. This serves as an important source of food for the future colonisers.

5) **Competition:** As soon as some species come to inhabit an area, both intra-specific and inter-specific competition starts between the species. Such a stage is referred to as competition. Species compete for scarce resources like food, water, etc. Such a competition is evident in both plant and animal species. This process of competition either leads to sharing of resources or competitive elimination.

6) **Reaction:** The peculiar environmental condition of the area inhabited by the species is altered due to the action of the species. Such alteration or changes in environmental conditions initiate a whole process of displacement of one species and its replacement by another species. Due to the changed conditions, the present species is unable to survive. The major causal factor is autogenic succession wherein environmental conditions are altered by the inhabiting plants.

7) **Stabilisation or Climax:** Stabilisation refers to the process whereby climax community comes to dominate the area. Climax community can be defined as a community of organisms that are mature, developed and self-sustaining. Climax community is the last stage of ecological succession. The physical and chemical conditions are changed to such an extent that the environment becomes capable of supporting the whole community. Climax communities represent the best form of adaptations to ecological successions. Their community structure continues to remain the same so long that the environment does not experience any kind of disturbance. It thus represents a steady state of ecological equilibrium characterised by set of environmental composition, structure and energy transfers.

2.1.7.3. Types of Ecological Succession

Following are the two major types of ecological succession:

1) **Primary Succession:** Primary succession begins when an area, which has no life is inhabited by new life forms or organisms, generally after certain disastrous natural event that makes the land barren. Generally, the first organisms that appear are algae, fungi and some simple plants like lichens and mosses. After a period of time, a thin layer of soil develops that can support advanced plants like grasses and ferns. After colonisation of the area by plants, land is colonised by some animals like insects, birds and small invertebrates. One of the finest examples of primary succession is found in newly formed lava beds that support pioneer communities only after cooling to moderate temperatures.

2) **Secondary Succession:** Most of the ecological changes take the form of secondary succession. In reality, most of the ecological communities exist in a state of continuous secondary succession. Secondary succession refers to a process wherein an established community is replaced by another group of plant and animal species. This process is usually slow and moves in the direction of forming the climax community. However, most of the ecosystems suffer from disturbances, which may be natural or man-made, that hinder the course of movement of succession.

3) **Autotrophic Succession:** Autotrophic succession is marked by continuous dominance of autotrophic organisms. Autotrophic succession largely starts in an inorganic environment, wherein the flow of energy is retained for an indefinite period of time.

4) **Allogenic Succession:** Sometimes, the replacement of an established community is brought about by some external agent and is not the result of actions of the established community. Such a succession is generally called as allogenic succession.

5) **Autogenic Succession:** In autogenic succession, the established community modifies the characteristics of its own environment. The changes in the environment are the result of continuous reactions of the community with the environment, which leads to replacement of the established community by a new community.

6) **Micro Succession:** Micro succession is observed in microorganisms. The process of succession starts in a largely organic environment with a progressive decline in total energy.

2.1.8. Food Chains

A food chain is a simple illustration of how different organisms get their food from similar or different sources. There are organisms that eat plants while there are others that depend on other animals for their survival.

For example, a simple food chain shows how trees and shrubs are related to animals like deer (that eats shrubs and grasses) and tiger (that eats the deer). Every link in the chain serves as food for the next link. A typical food chain begins with plants and ends with animals.

Food chains are also referred to as food networks or trophic social networks. They illustrate the eating hierarchies that exist between various species in an ecosystem. Organisms are related to other organisms they eat by way of lines of their hierarchies, which are depictive of movement of energy or energy transfer within an ecosystem.

Functions of Food Chains

A food chain serves following functions:

1) It represents the biotic community of the ecosystem.
2) It helps in the movement of energy from one trophic level to another.
3) It helps in understanding the feeding relations between organisms and the nature of interaction in an ecosystem.
4) Food chain helps in understanding the mechanism of energy flow and circulation of matter in ecosystem.
5) A food chain moves matter from one trophic level to another.
6) It gives information about toxic substances and their movement in an ecosystem and reflects on the problem of biological magnification.

Table 2.1: Food Chain Trophic Classification

Level	Name	Energy Source
First	Producer	Autotrophs use radiant energy.
Second	Primary Consumer	Herbivores are heterotrophs that eat autotrophs.
Third	Secondary Consumer	Primary carnivores eat herbivores.
Fourth	Tertiary Consumer	Secondary carnivores eat primary consumers.
Fifth	Decomposers	Decomposers (or saprotrophs) consume dead organisms.

Such a route of food or energy movement is called a **food chain**. Different levels of consumption in a food chain are referred to as **trophic levels**.

Example: Following table shows a typical food chain with different trophic levels

Grass	Grasshopper	Toad	Snake	Hawk	Bacteria of decay
→	→	→	→	→	→
In general,					
Autotrophs (Producers)	Herbivores (Primary Consumers)	Carnivores (Secondary, tertiary, etc., consumers)			Decomposers
→	→		→		

2.1.8.1. Organisms in Food Chains

Primary producers which are generally referred to as **autotrophs** form simple organic substances (food) utilising energy from the sun and some inorganic materials. They are photosynthetic Carley plants whose basic source of energy is sunlight. Quite a few of them that are part of Carley-Paige vent food webs are **chemotrophic**.

They use chemical energy in place of sunlight. All those creatures that get energy from organic substances are called **heterotrophs**. Heterotrophs generally consist of three groups of creatures – herbivores, carnivores and detritivores. Herbivores are those animals that get energy by eating plants; carnivores are those animals that get energy from other animals by consuming them; while, detritivores, scavengers and decomposers depend on detritus or dead biomass for gaining energy.

Sun is the source of energy in a food chain. Some amount of energy is lost at each level of the food chain in the form of faeces, movement energy and heat energy. As such, a small amount of energy reaches to the body of a consumer and even smaller amount is transferred to another level. This forms a Pyramid of Biomass.

Organisms can be categorised into different groups on the basis of their source of energy in a food chain. It is referred to as trophic classification. Organisms deriving energy in the same step of the food chain are grouped in the same trophic level.

2.1.8.2. Types of Food Chains

Following are different types of food chains:

1) **Grazing Food Chain:** The base of grazing food chain is formed by green plants. They obtain energy from sunlight and through the process of photosynthesis, produce food. These green plants are eaten by herbivorous animals, who in turn are eaten by carnivorous animals. As such, grazing food chain starts from plants (producers) and finishes with carnivores.

Example:

Plants (Producers) → Goat (Herbivore) → Tiger (Carnivore)

Algae (Microscopic water plants) → Small animals (insects, larva, Prawns) → Medium size fishes → Large fishes

Grazing food chain depends on the energy from the sunlight because green plants that are the base of this food chain require sunlight for production of food

Divisions of Grazing Food Chain

i) **Predator Food Chain:** In predator food chain, larger animals (predators) depend on smaller animals (prey) for their food requirements.
Example:

Plan ⟶ Larvae (Herbivore) ⟶ Fishes (Primary Carnivore) ⟶ Man (Secondary Carnivore)

ii) **Parasitic Food Chain:** Grazing food chain may get infected from the parasites. Parasites depend on both plants and animals (hosts) for their food requirements.

2) **Detritus Food Chain:** Detritus food chain begins with micro-organisms such as bacteria and fungi, also referred to as detrivores. They possess the unique characteristic that they do not need sunlight as a source of energy for producing food. This kind of .food chain is generally seen in the decomposition of waste.

Example: In a forest ecosystem, leaves fallen from the trees are decomposed by micro-organisms like bacteria and fungi in the absence of sunlight. Small worms eat organic matter available in the forest or other micro-organisms. These worms are food for small birds, which are eaten by big birds like hawks.

Saprophytic Bacteria (Decompose fallen leaves) ⟶ Worms (Detritus consumer) ⟶ Small birds (Small carnivore) ⟶ Hawk (Top carnivore)

Dead Bodies of Animals ⟶ Flie ⟶ Fro ⟶ Sna ⟶ Ha

2.1.8.3. Importance of Food Chains

Following points highlight the importance of food chains:

1) Food chains are helpful in maintaining balance in the ecosystem. They ensure that no single species gets so large in number that it may adversely affect other species on which they depend. This reflects the fact that every organism experiences some kind of predator or environmental threat that limits their number in the area. This ensures that their numbers do not increase to a level that it may adversely affect the nearby ecosystem.

2) One can obtain more energy from primary producers like green plants.

3) The interdependent nature of the food chain ensures that balance is maintained between different species of plants and animals in a community.

For example, if the population of deer in a region suddenly increases, there will be fewer plants and grasses for them to eat. Under such conditions, many deer will die due to insufficient food. Fewer deer will give enough time to plants and grasses to grow and multiply.

In turn, due to a lesser number of deer, a food scarcity for tigers will be established, which can also result in their death. As a result, the population of tigers will decline and consequently, the population of deer will increase.

2.1.9. Food Webs

A food web is a graphical illustration of feeding relationships that exist between different species in an ecosystem. In simple terms, it shows that who is eaten by whom. Such kind of feeding relationship is shown in a more realistic manner by food web in comparison to food chain or trophic pyramid. It also illustrates how energy and matter gets transferred from one species to another due to the interdependent nature of eating habit. Generally, different species are connected to each other in a food web through lines or arrows that are called as "links" and species in a food web, called as "nodes".

Due to their interdependent nature, food webs can be complex and present a complicated picture. But they are brilliantly managed by nature, which ensures its survival over long periods of time. Many plant/animal species occupy the same habitat or ecosystem. They live together and survive for long period of time. A realistic food web is expected to be haphazard and confusing due to the inclusion of a large number of plant and animal species in it.

For example, oak nut produced by many trees serves as food for many rodents and insects. Since there are many rodents, various species of animals like weasels, snakes and racoons have enough food for themselves. Oak nuts containing insects attract many birds, skunks and opossums. The presence of rodents, opossums and weasels attract many foxes, hawks and owls, which shows the inter-connection between different species.

Hence, it is difficult to find simple food chains in an ecosystem. In reality, one finds a number of interdependent and complex food chains that look like a web and as a result, are called **food webs**. A food web that depicts energy transfer in an ecosystem is of the type as shown in the **figure 2.3**:

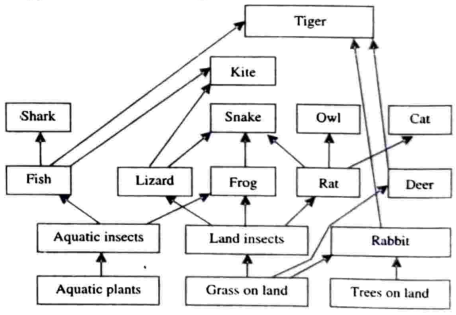


Figure 2.3: Food Web

2.1.9.1. Kinds of Food Webs

In reality, food webs are so complex that it is very difficult to represent them. Their division into broad categories facilitates their understanding. Food webs are generally categorised into following groups:

1) **Source Web:** It consists of one or more node(s), all the predators found in the region and all the food they eat.

Divisions of Grazing Food Chain

i) **Predator Food Chain:** In predator food chain, larger animals (predators) depend on smaller animals (prey) for their food requirements.
Example:

Plan → Larvae (Herbivore) → Fishes (Primary Carnivore) → Man (Secondary Carnivore)

ii) **Parasitic Food Chain:** Grazing food chain may get infected from the parasites. Parasites depend on both plants and animals (hosts) for their food requirements.

2) **Detritus Food Chain:** Detritus food chain begins with micro-organisms such as bacteria and fungi, also referred to as detrivores. They possess the unique characteristic that they do not need sunlight as a source of energy for producing food. This kind of food chain is generally seen in the decomposition of waste.

Example: In a forest ecosystem, leaves fallen from the trees are decomposed by micro-organisms like bacteria and fungi in the absence of sunlight. Small worms eat organic matter available in the forest or other micro-organisms. These worms are food for small birds, which are eaten by big birds like hawks.

Saprophytic Bacteria (Decompose fallen leaves) → Worms (Detritus consumer) → Small birds (Small carnivore) → Hawk (Top carnivore)

Dead Bodies of Animals → Flie → Fro → Sna → Ha

2.1.8.3. Importance of Food Chains

Following points highlight the importance of food chains:

1) Food chains are helpful in maintaining balance in the ecosystem. They ensure that no single species gets so large in number that it may adversely affect other species on which they depend. This reflects the fact that every organism experiences some kind of predator or environmental threat that limits their number in the area. This ensures that their numbers do not increase to a level that it may adversely affect the nearby ecosystem.

2) One can obtain more energy from primary producers like green plants.

3) The interdependent nature of the food chain ensures that balance is maintained between different species of plants and animals in a community.

For example, if the population of deer in a region suddenly increases, there will be fewer plants and grasses for them to eat. Under such conditions, many deer will die due to insufficient food. Fewer deer will give enough time to plants and grasses to grow and multiply.

In turn, due to a lesser number of deer, a food scarcity for tigers will be established, which can also result in their death. As a result, the population of tigers will decline and consequently, the population of deer will increase.

2.1.9. Food Webs

A food web is a graphical illustration of feeding relationships that exist between different species in an ecosystem. In simple terms, it shows that who is eaten by who. Such kind of feeding relationship is shown in a more realistic manner by food webs in comparison to food chain or trophic pyramid. It also illustrates how energy and matter gets transferred from one species to another due to the interdependent nature of eating habit. Generally, different species are connected to each other in a food web through lines or arrows that are called as "links" and species in a food web, called as "nodes".

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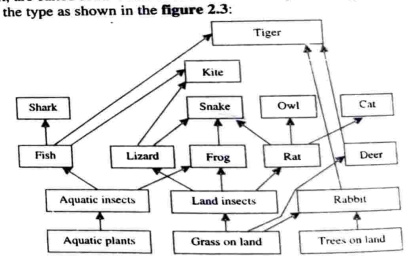

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1) **Source Web:** It consists of one or more node(s), all the predators found in a region and all the food they eat.

2) **Sink Web:** It consists of one or more node(s), the region and the food they eat.

3) **Community Web:** Community web represe connections of who is eaten by whom.

4) **Energy Flow Web:** It represents changes in e node to another, from a resource to a consume

5) **Paleoecological Web:** It is a web that tries t fossils available.

6) **Functional Web:** It focuses on the import exists between different nodes rather than Functional webs consist of sections that network, with each section having different

2.1.9.2. Difference between Food We

A food web is different from the food chain in only a part of the food web. It depicts only connected through feeding habits. In contrast to present a complete picture of the eating habi connected and that it also represent a comb species which occupy same position in a food a food web.

For example, all plants in a food web are c first trophic level. Similarly, all herbivores ar consumer" or second trophic level. Carnivo referred to as "secondary consumers". Where are grouped into tertiary trophic level.

2.1.10. Ecological Pyramids

An ecological pyramid is a graphical productivity at different trophic levels. It is energy pyramid. Biomass is the quantity of Biomass pyramids depict quantity of organic different trophic levels. Whereas, total produ productivity pyramids.

Ecological pyramids start with producers o of the pyramid, and moves through various carnivores and so on. The highest level forn

There are three types of ecological pyramic

1) **Pyramid of Numbers:** It shows the t different trophic levels.

2) **Pyramid of Biomass:** It depicts total organic matter at different trophic leve

3) **Pyramid of Energy:** It shows the levels.

2) **Sink Web:** It consists of one or more node(s), all the prey population inhabiting the region and the food they eat.

3) **Community Web:** Community web represents a collection of nodes and all connections of who is eaten by whom.

4) **Energy Flow Web:** It represents changes in energy content as it moves from one node to another, from a resource to a consumer.

5) **Paleoecological Web:** It is a web that tries to re-build lost ecosystems from the fossils available.

6) **Functional Web:** It focuses on the importance of functional relationship that exists between different nodes rather than on energy flow in an ecosystem. Functional webs consist of sections that represent sub-groups in the larger network, with each section having different levels of interactions and strength.

2.1.9.2. Difference between Food Web and Food Chain

A food web is different from the food chain in the sense that food chain illustrates only a part of the food web. It depicts only the simple and direct relationship connected through feeding habits. In contrast to the food chain, a food web strives to present a complete picture of the eating habits of different animals that are inter-connected and that it also represent a combination of different food chains. All species which occupy same position in a food chain are grouped into trophic level in a food web.

For example, all plants in a food web are categorised into "primary producer" or first trophic level. Similarly, all herbivores are grouped into single group, "primary consumer" or second trophic level. Carnivores form third trophic level and are referred to as "secondary consumers". Wherein carnivores eat other carnivores, they are grouped into tertiary trophic level.

2.1.10. Ecological Pyramids

An ecological pyramid is a graphical illustration of biomass and biomass productivity at different trophic levels. It is also referred to as trophic pyramid and energy pyramid. Biomass is the quantity of organic matter present in an organism. Biomass pyramids depict quantity of organic matter present in different organisms at different trophic levels. Whereas, total production or turnover in biomass is shown by productivity pyramids.

Ecological pyramids start with producers or autotrophs, which remain at the bottom of the pyramid, and moves through various trophic levels, moving from herbivores to carnivores and so on. The highest level forms the top of the food chain.

There are three types of ecological pyramids:

1) **Pyramid of Numbers:** It shows the total number of all individual organisms at different trophic levels.

2) **Pyramid of Biomass:** It depicts total dry weight including the total amount of organic matter at different trophic levels.

3) **Pyramid of Energy:** It shows the level of productivity at different trophic levels.

Pyramids of numbers and biomass may assume either the shape of an upright pyramid or inverted pyramid. The shape of the pyramid in pyramids of numbers and biomass depends on the type of food chain in an ecosystem. Whereas, the shape of pyramids of energy is always upright.

2.1.10.1. Pyramid of Number

It was **Elton** who first stressed that food chains typically show increasing body size when moving upwards in the food chain. Small-sized organisms require less energy as compared to large-sized animals to support themselves. As such, with given amount of energy, small-sized organisms grew larger in number as compared to large-sized organisms.

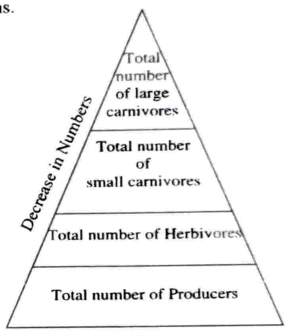


Figure 2.4: Pyramid of Number

As such, communities in an ecosystem are generally depictive of Elton's pyramid of numbers. The species at the lower levels in the pyramids tend to be greater in number than other species, which lies above it.

Secondly, the pyramid of numbers is the result of low ecological efficiency, which means that with each transfer at the higher levels some energy is lost. Thus, the energy reaching the top predators in the pyramid is a small part of what the green plants produced at the beginning of the food chain. Although there are different kinds of organisms and ecosystems, an accepted rule is that energy decreases by some specific amount with each transfer in the food chain. Only around 10% of the energy produced by plants is used and transformed into herbivore biomass, with only 10% of that energy being transformed into carnivore biomass and so on.

The pyramid explains the relationship between total numbers of primary producers and consumers at different trophic levels. Primary producers always form the base of the pyramid followed by upper structures which represents the numbers of consumers at different levels. The top of the pyramid constitutes the number of top carnivores present in an ecosystem.

The shape of the pyramid differs with the type of ecosystem. In aquatic and herbaceous ecosystem, the producers (autotrophs) have a small size but have a large population per unit area. Whereas, in a forest ecosystem, producers are big in size.

but their density of population is not much high. On the other hand, in a grassland or aquatic ecosystem, large numbers of small-sized autotrophs sustain a small population of herbivores. This pyramid has an upright structure. Whereas, parasite food web has an inverted pyramid. The pyramid of numbers facilitates comparison between herbivores and carnivores in terms of their total population.

2.1.10.2. Pyramid of Biomass

In pyramid of biomass, the base of the pyramid is formed by the weight of the autotrophs. The biomass of a single tree is so large that it is bigger than the large number of birds that depend on it for food and shelter. Likewise, the biomass of a single bird is larger than the total number of all parasites that reside in and on the body of the bird. This makes the pyramid of biomass upright in shape, like pyramid of numbers.

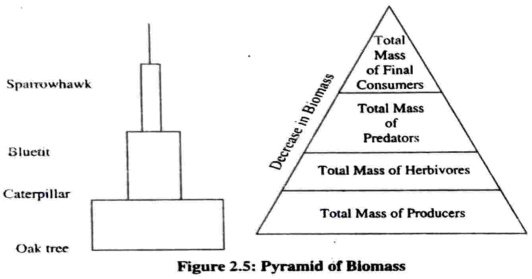


Figure 2.5: Pyramid of Biomass

A tree may need around 10 years to produce first seeds. On the other hand, a diatom may take only a day to reproduce. Within the time span of 10 years, the diatom may reproduce billions of times and if the total biomass of the diatom survives, it will be heavier than a tree. The pyramid of biomass explains the connection between biomass and different trophic levels by measuring the total amount of biomass at different trophic levels present at particular time. Generally, for measuring the amount of biomass, the units used are grams per meter^2 or calories per meter^2.

The pyramid of biomass may be 'inverted' in shape. **For example,** in a pond ecosystem, the total biomass of phytoplankton, which are the primary producers, remains less than the total mass of the heterotrophs like fish and insects. This is because phytoplankton has shorter periods of life, though they reproduce and increase their numbers very quickly.

However, the pyramid of biomass has one problem. They present the different trophic levels of the ecosystem in a manner that it looks like that it contains more energy than it actually does. **For example,** all birds possess beaks and skeletons, which form part of their total mass but are not consumed by animals of higher trophic levels. Whereas, in the pyramid of biomass, beaks and skeletons are measured and taken into account, though they do not form part of energy transfer from one trophic level to another.

2.1.10.3. Pyramid of Energy

Pyramids of energy explain the nature of the ecosystem in the best manner. In this pyramid, the weight and the number of organisms at different trophic levels does not depend on the amount of the fixed energy that is present at the level below it. But rather depend on the rate with which food is being produced. Unlike pyramids of numbers and biomass, which present pictures of standing situations, pyramids of energy (**figure 2.6**) depict a picture of the rate of transfer of food or energy, which is more dynamic in nature. As the amount of energy moving through various trophic levels gradually decreases, the shape of the energy pyramid is always upright.

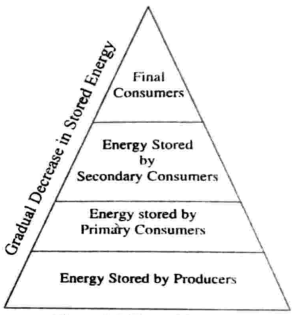


Figure 2.6: Pyramid of Energy

The structure of species consists of not only their number and kinds of species but also consists of a diversity of species. It illustrates the connection between species and total number of individuals on one hand and distribution of individuals in different species in an ecosystem on the other. The total amount of energy measured in terms of Kcal per unit area over a certain period of time, season or year.

In this sense, the pyramid of energy or productivity is of more relevance as it reveals the total production of biomass or energy at different trophic levels. Rather than showing a standing position of the ecosystem, energy pyramids reflect the dynamic flow of energy across various trophic levels. It is measured in terms of grams per meter^2 per year or calories per meter^2 per year. Like other pyramids, it also starts with the producers of the ecosystem which are placed at the bottom of the pyramid and are followed by higher trophic levels.

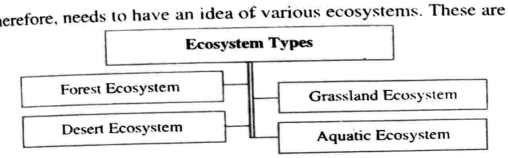
When an ecosystem is functioning properly, the picture is that of a normal ecological pyramid. This is on account of the fact that an ecosystem can be sustained only when there is more energy stored at the lower trophic levels than at the higher levels. This helps the organisms at the lower trophic levels to maintain their population and also transfer some of the energy produced by them to the higher levels. The only exception to this general rule happens when the food web is sustained by the members of an outside community. Only 10% of the energy reaching higher in the food chain is used for building new biomass, which is stored in the form of energy the rest is involved in metabolic processes.

2.2. ECOSYSTEM TYPES

Ecosystems differ from each other in terms of flora, fauna and the climatic conditions. It is therefore important to understand the characteristic features of an ecosystem before trying to make any drastic changes because it is fragile. If the changes are not made keeping the ecosystem in mind then it can lead to a devastating effect on the members of the ecosystem. This is how many beautiful species, plants and cultures have got extinct in the history of mankind.

An ecosystem involves different revolution cycles of energy and matter. The *ad-hoc* intervention of mankind often has the effect of bringing about a disruption in the natural cycles of the ecosystem. This can cause major problems in the ecosystem as the environmental stability is disturbed and the natural flow which existed earlier gets disrupted.

One, therefore, needs to have an idea of various ecosystems. These are as follows:



2.3. FOREST ECOSYSTEM

2.3.1. Introduction

Flora, fauna, and ground conditions within the forest boundaries comprise of a forest ecosystem. Forest ecosystem is relied on all the major resources available ranging from climatic conditions to the members and connections in the food chain. The manner in which fauna survives is dependent on the proportion of flora such as different trees, flowers, fungi, and grasses in a forest ecosystem.

From the most small to the large or giant, every kind of fauna will be a part of the forest ecosystem. The largest predator or primate to the most small or micro bush mouse, all types of birds, mammals, arachnids, and insects are provided with essential shelter, protection, and other living conditions by a forest ecosystem. The most minute creatures and plant are nonetheless significant in the overall structure of the environment in this ecosystem. The association between the food chain is crucial to the balance of the ecosystem ranging from a tiny insect to the largest primate. There is a proper balance and harmony in the resources available in the forest ecosystem. Grass grown in a forest is the food for cattle in the same manner that smaller creatures become source of sustenance for larger ones. Plants in the forest are a source of nourishment for small animals and large herbivorous animals.

2.3.2. Characteristics/Features of Forest Ecosystem

The forest ecosystem has the following features:

1) **Forest Canopy:** The canopy is the most important feature of the forest ecosystem. It refers to the topmost part of the trees community or plant crowns which covers the upper area of the forest. It is important because it acts as an interface between the land and the atmosphere. It also serves as the upper habitat for several biological organisms.

2) **Forest Floor:** It also has a great deal of importance. It consists of the leaves which have fallen from the trees, stems, fruits, wood and twigs, etc. Forest floor simply refers to the land of the forest region which contains many inorganic as well as organic matters. The floor of the forest is also home to many species of fungi and micro-organisms.

3) **Forest Soil:** Forest soil is another feature of forest ecosystem which is most affected by the alterations in climate, geology, quantity of rainfall, etc. The forest soil is also very fertile as it contains all the leaves and parts of trees that fall from the trees. This adds to the organic matter present in the soil. The leaves also become food for fungi and other microorganisms that inhabit the soil.

4) **Complex Structure:** The forest ecosystem is actually a very complex system of various interconnected living and non-living matters. The ecosystem can be small like the backyard of a house or a large one like a reserve forest. The range of the ecosystem is dependent on geology and variety of species and organisms that form a part of it.

2.3.3. Structure of Forest Ecosystem

Around 40% of the world's land is occupied by forests. In India, approximately one-tenth of the total available land is covered by forests. The forest ecosystem has the following parts:

1) **Abiotic Component:** It refers to the organic as well as inorganic matter present in the forest. They are present either in forest atmosphere or soil. The forest soil contains minerals as well as organic debris and decaying matter.

2) **Biotic Component:** The living organisms which are a part of the forest ecosystem exist in the following order:
   i) **Producers:** This segment comprises of the trees. The trees exhibit a great deal of diversity and stratification. This is seen most in tropical and deciduous forests. The diversity of the trees depends on the type of forest which develops because of its favourable climatic conditions. The other members of this segment are shrubs and ground vegetation. The most important members of the flora are varieties like *Tectona grandis*, *Butea frondosa*, *Shorea rubusta* and *Lagerstroemia parvifiora*. Shrubs and ground flora do not hold much importance in temperate coniferous forests. The main varieties of trees in temperate coniferous forests are *Abies*, *Picea*, *Pinus*, *Cedrus*, *Juniperus* *Rhododendron*, etc., whereas in temperate deciduous forests the main varieties are *Quercus*, *Acer*, *Betula*, *Thuja*, *Picea*, etc.
   ii) **Consumers:** Consumers can be:
      a) **Primary Consumers:** This category consists of the herbivores and mainly includes the animals that feed on tree leaves like beetles, grasshoppers, bugs, spiders, termites, ants, etc. Primary consumers can also be larger animals that eat producers' fruits or vegetation like elephants, deer, squirrels, bats, mongooses, moles, etc.
      b) **Secondary Consumers:** This category includes carnivores like snakes, civets, lizards, foxes, etc. They usually feed on the herbivores.

c) **Tertiary Consumers:** These include the top carnivores that eat the carnivores of the secondary level like lions, tigers, etc.

iii) **Decomposers:** The decomposers comprise of a wide assortment micro-organisms like fungi (species of Aspergillus, Coprinus, Polyporus, Ganoderma, Fusarium, Alternaria, Trichoderma, etc.), bacteria (species of Bacillus, Clostridium, Pseudomonas, Angiococcus, etc.), and actinomycetes (species of Streptomyces, etc.). The decomposition rate is lower in temperate forests as compared to tropical and sub-tropical forests.

2.3.4. Functions of Forest Ecosystem

Forests perform a variety of roles in the ecosystem. They are as follows:

1) **Production Function:** Mankind has depended on the products of the forests for a long time. The forests provide humans with the useful goods like wood for cooking and warmth; materials for transport, tools and shelter; food, etc. Wood is used predominantly for the purposes of fuel. They can also be used for the making of furniture. The forests are also a source of oxygen for living organisms. Typically, an acre of forests provides 6 tonnes of oxygen. This is due to a process called photosynthesis through which plants take in carbon-di-oxide from the environment and release oxygen as a by-product.

2) **Protective Function:** The forests also play a big role in the protecting water and maintaining the climatic conditions. When it rains, the leaves play a cushioning role and prevent the water from falling down all its fury on the forest soil. This also prevents the muddy water from seeping into the water sources which can be very harmful to the aquatic life like fishes, aquatic plants and the water ecosystem in general. The trees also prevent the water from evaporating rapidly into the atmosphere.

3) **Regulative Function:** The forest also prevents global warming by regulating the environment's temperature, humidity level, amount of rainfall, geochemical processes, etc.

2.3.5. Types of Forests

Forests can be of different types, which are explained below:

1) **Tropical Forest and Subtropical Forests:** This category of forest is also called rainforest. They are dense and have plenty of trees having wide leaves cover.

They usually occur in the low-lying areas near the Equator. They are also called evergreen forests because they remain green throughout the year and have a thick and dense canopy. These forests also have more than half the species of plants and animals that occupy the Earth's surface. These forests are one of the oldest types of forests that can be found on Earth. These forests absorb a large quantity of carbon dioxide and therefore release a large quantity of oxygen on the Earth's atmosphere. On an average, close to 50% of the Earth's forests are tropical or sub-tropical in nature.

Mangrove forests also come under this category of forests. In terms of biodiversity, they are not as rich as tropical forests. The kind of vegetation found in these forests is mostly angiosperm in nature in the sense that they can even survive in the extreme conditions of floods and excessive salts in the soil.

2) **Plantations:** Plantation is also regarded as a type of forests. A plantation actually a kind of farm or an estate which is employed for the cultivation crops. They occur typically in tropical and sub-tropical areas.

These types of land are typically used for the production of cash crops li coffee, oil seeds, sugarcane, tobacco, sisal, etc., which are grown on a large sca for exporting to other countries. When the plantation is done for industr purposes, it is called forestry. In this type of activity, the trees are planted procuring a particular quantity of wood in a short period of time.

3) **Boreal Forest:** These forests are also popular by their name 'Taiga'. The te 'Boreal' typically means Northern. Such forests occupy 17% of the availa land.

This kind of forests is usually found at 50^0-60^0 latitude. The preva temperature at this altitude is very low and the canopy of these forests allo only a small percentage of the sunlight to enter.

The soil of these forests is not very fertile mainly due to low temperature less amount of sunlight reaching the forest land. The kinds of trees that gro this latitude are pine, spruce and fir. They can withstand extremely temperatures.

The fauna that can be found in these forests include bears, bats, woodpec hawks, deer, fox and many others that can withstand the extremely temperatures.

4) **Temperate Forest:** The temperate forests can be found in both the Northern the Southern hemispheres. The latitude is typically between 25^0- 50^0 and regions are north eastern Asia, North America, western and central Eur These can be deciduous as well as evergreen.

These forests experience all the four types of seasons – summer, spring, w and autumn. They usually have mineral-enriched and fertile soils.

Trees of temperate forests have very broad leaves and the typical example oak, maple, beech, hemlock, cottonwood, elm, etc. Animals living in forests include rabbits, squirrels, wolf, black bear, mountain lion and bobcat

5) **Monsoon or Seasonal Forest:** Monsoon forests (also known as seasonal forests) generally experience two extreme seasons, i.e., high rainfall and ext dryness. The kind of climatic conditions that prevail in these forests are se either extreme rainfall or extreme dryness. These forests can be found in East Asia, West and East Africa, eastern Brazil and north Australia.

The various types of trees that can be found in these forests are woody orchid and many others like; lianas and herbaceous epiphyte, thick bamboo tall teak trees. These trees are highly endangered because of human act especially in place like Africa where almost 90% of the forest cover has removed due to deforestation.

2.4. GRASSLAND ECOSYSTEM

2.4.1. Introduction

An ecosystem which has more water sources than a desert, but inadequate to bear a forest is called as **grassland**. The biome starting from the ends of the desert habitat and extending across the forest land habitat constitutes grassland. More than 25% of the Earth's surfaces are covered by grasslands. Except for Antarctica, all continents have grasslands and constitute most of Asia and Africa. There are different types of grasslands such as plains, savannas, pampas, and prairies.

Grasslands are formed where there is excessive rain for deserts but not sufficient for growth of forests. Grasslands are full of different types of grasses. An example of grasslands can be of a field of wheat although they are mostly cultivated. One of the exceptional qualities of grass is that it grows under the ground. During winter seasons, grass does not grow till it warms up.

2.4.2. Characteristics/Features of Grassland Ecosystem

The grassland ecosystem has the following characteristics:

1) **Temperature:** Grasslands can be found in high temperature belts like the equatorial regions or in mid-to-low temperature belts near the sub-arctic regions. However, they are not found in the extreme Arctic conditions that can be seen in the North and South poles. At the equator, they are either temperate or tropical grasslands.

2) **Precipitation:** Precipitation indicates the quantity of rainfall (or snow) that a region receives. The tropical grasslands get the maximum rainfall of around 60 inches in a year. Temperate grasslands get around 40 inches in a year. Although flooded grasslands are already wet, they receive lesser rainfall approximately 30-40 inches in a year.

3) **Humidity:** Humidity refers to the amount of moisture that is contained in the air. Flooded and tropical grasslands are humid in nature. This indicates a high level of moisture in the atmosphere. The temperate grasslands are slightly less humid and can sometimes also be arid which indicates a lack of moisture in the environment.

4) **Topography:** The topography refers to the altitude and the other features of the surface. Tropical grasslands differ broadly in terms, spreading in areas of high as well as low elevation regions. They are also found in even landscapes, usually hilly areas. Temperate grasslands are found in mid-to-low elevation generally at flat areas. While flooded grasslands are found in low elevated and flat areas.

5) **Plants:** There are numerous varieties of grasses and plants in the grasslands. However, they have certain characteristics in common. The grasses are quite adaptable and can survive in areas that are prone to drought and fire. The long narrow leaves lose water gradually when compared to the broad leaves of other regions. The silica in the soil also allows the grasses to grow tall and thus get maximum exposure to the sunlight.

6) **Invertebrates:** The grasslands are also home to many species of invertebrates. They can be in the form of insects like grasshoppers, locusts and caterpillars. Basically, these insects are consumers of grass. Invertebrates can also include earthworms which act as tillers and help in decomposing the dead and decaying matter.

2.4.3. Structure of Grassland Ecosystem

A grassland ecosystem has the following parts:

1) **Abiotic Component:** The abiotic component comprises of the nutrients which are available in the soil and the environment. The vital nutrients are nitrogen, potassium, phosphorous, sulphur, magnesium, etc. These are provided by water, nitrogen nitrates, sulphates, phosphates, etc., which are existing in the Earth's crust and atmosphere.

2) **Biotic Component:** The biotic component of the grasslands has three segments:
   i) **Producer Organisms:** The chief producers in grasslands are grasses. They may also comprise of few shrubs and forbs. The main types of grasses that are available are *Sp. Brachiaria, Sp. Cynodon, Sp. Desmodium, Sp. Dichanthium, Sp. Digitaria, Sp. Setaria,* etc.
   ii) **Consumer Organisms:** The consumers in a grassland ecosystem are of the following types:
      a) **Primary Consumers:** The primary herbivores exist primarily on a diet of grass. They normally are grazing animals like cows, buffaloes, sheep, rabbits, etc. They also include many varieties of insects.
      b) **Secondary Consumers:** The secondary consumers are those that survive by feeding on the primary consumers. They include species of snakes, frogs, reptiles, foxes, jackals, etc.
      c) **Tertiary Consumers:** The tertiary consumers feed on the secondary consumers and include species like eagles, hawks, etc.
   iii) **Decomposers:** The decomposers exist in the form of fungi and micro-organisms. These organisms help in the decomposition of the dead and decaying matter and thus lead to the creation of nutrients which go into the soil. These nutrients can thus be utilised by the producers of the ecosystem.

2.4.4. Functions of Grassland Ecosystem

The main functions of grassland ecosystem are:

1) **Grasslands Provide Food:** The World Resources Institute (WRI) says that the grasslands are the breeding grounds for many cereals like wheat, rice, barley, sorghum and millet.

2) **Grasslands are Breeding Areas:** The grasslands are also the breeding grounds for many varieties of birds. Important areas like the Andes mountain range, Central Chile and Southern Patagonia ice field regions are considered as important breeding sites by the World Resources Institute.

2.4.5. Types of Grassland Ecosystem

The types of grassland ecosystem are as follows:

1) **Tropical and Sub-tropical Grasslands:** The tropical and subtropical grasslands include the sub-tropical savannahs and the shrublands biome. An example is the Llanos grassland of Northern South America.

2) **Temperate Grasslands:** These are mid-latitude grasslands and include the Prairie and Pacific grasslands of North America, the Pampas of South America (Argentina, Brazil and Uruguay), and the steppes of Europe. These kinds of grasslands contain many species of herbivores like bisons, deer, zebras,

rhinoceros, etc. They also have carnivores like lions, wolves, hyenas, leopards, cheetahs, jaguars, etc. Other animals that are often seen in temperate grasslands are deer, prairie dogs, wild dogs, mice, rabbits, skunks, coyotes, snakes, fox, owls, blackbirds, grasshoppers, locusts, hawks, sparrows, eagles, etc.

3) **Flooded Grasslands:** These grasslands are flooded partially or throughout the year. They can be found in areas like the Everglades in Florida or the Pantanal of South America (Brazil, Paraguay etc.). They are mostly found in tropics and sub-tropics regions.

4) **Montane Grasslands:** These are high altitude grasslands and can be found in the high mountain ranges of the world like the Páramo of the Andes Mountain. They can be classified under shrublands biome.

5) **Tundra Grasslands:** They have some traits which are similar to the montane grasslands. These grasslands can have grasses. Since they have high soil moisture content, very few remain grass-covered nowadays. However, in the Pleistocene ice ages, particular polar grassland (called the steppe-tundra) covered a large part of the Northern hemisphere.

6) **Desert and Xeric Grasslands:** They are also called the desert grasslands. They consist of scanty grassland eco-regions found mainly in deserts and xeric shrublands biome.

2.5. DESERT ECOSYSTEM

2.5.1. Introduction

According to geographical studies, regions or places where the average annual rainfall rarely goes beyond 10 inches every year, and the amount of water gained by precipitation is much less than the amount of water lost due to evapotranspiration are called deserts. Antarctica is an example of a cold desert, similar to hot deserts such as Sahara, Mojave, etc. The common and most notable point of distinction between these two types of deserts is precipitation, which is rainfall in hot deserts and snowfall in cold deserts.

Life exists in very severe and difficult conditions like deserts, even though it may seem to be a barren land without any form of life. There are various species of plants and animals that have adjusted or accustomed to these apparently ill-suited weather conditions. Climate is a determining element for the survival of different life forms in this type of ecosystem. The maximum temperatures in deserts can range from 115° F in day time to 32° F at night time. It is indeed remarkable to know that there are still several species of plants and animals that have not only adapted to these conditions through the years, but also have become a significant part of this ecosystem.

2.5.2. Characteristics/Features of Desert Ecosystem

The desert ecosystems have the following features:

1) **Rainfall and Climate:** The climatic conditions in a desert tend to be hot and dry. This is because the desert comes under the tropical biome which receives direct sunlight. There is a slight variation in the amount of rainfall in desert areas around the world but the average rainfall received is approximately 1 inch annually.

2) **Animal Life:** Though the conditions prevalent are hot and dry, there is a plethora of animal life which can be seen thriving in the desert ecosystem. There

are large varieties of lizards, rats, owls, tortoises, cats, etc. Most of them have adapted to the extreme desert conditions in order to survive.

3) **Plant Life:** The desert ecosystem also supports many plant life forms. The two most commonly seen are the ocotillo (a flowering plant) and the saguaro cactus. These plants have shallow roots but spread over a large distance.

4) **Geographic Features:** The geographical features of the desert ecosystem mainly include sand rocks and gravel. There is a certain hill-like pattern that can be seen in the sand dunes but the land is generally flat. Deserts also have water bodies called oasis.

5) **Soil:** The kind of soil present in an ecosystem describes the type of plants and animals that can survive in that region. Desert soil [illegible] have excessive drainage. Therefore, [illegible]

6) **Light:** The desert ecosystem does not have many [illegible] of the sunlight, therefore, falls [illegible] restricts the kind of flora and fauna that [illegible] that adapt well can survive in this harsh environment.

7) **Temperature:** The temperature in desert areas also fluctuates [illegible] The desert may be very hot during the [illegible] at night. The lack of moisture gives rise [illegible] cover and humidity.

2.5.3. Structure of Desert Ecosystem

The desert ecosystem has the following parts:

1) **Abiotic Component:** These comprise of the soil and the air present in the ecosystem. The main features of the abiotic component of the desert [illegible] are the deficiency of organic matter and the shortage of water. The [illegible] that prevails in the desert ecosystem, [illegible] Also, there is a shortage of adequate rainfall.

2) **Biotic Component:** The biotic components of desert ecosystem exist at three levels.

   i) **Producer Organisms:** The producers in the desert ecosystem are basically the shrubs and bushes alongwith some types of grasses and trees. The roots of the shrubs are spread over a large area. The leaves, branches, etc., of the shrubs are modified to adapt to the particular needs of the desert ecosystem. The ecosystem is dominated by the ubiquitous cactus but there can also be the presence of low level plants like lichens and xerophytic mosses. The cactus can be of many types. Desert plants can also be quite varied. They can [illegible] or also have beautiful flowers. Some types of cactus can also be poisonous. These plants have adapted themselves to the harsh conditions of the desert ecosystem and can withstand even the most stringent living conditions.

   ii) **Consumers:** Consumers in the ecosystem may consist of insects, reptiles. They can also include rats and other creatures of the rodent [illegible] birds and several other mammals. These are categorised as follows:

      a) **Desert Insects and Arachnids:** The desert ecosystem is home to many types of insects. Among them locusts are the most common and dreaded. They manifest themselves as pests and can consume large tracts of agriculture in a single day. Some local swarms are [illegible]

as small towns and can thus cause a lot of havoc. However, there are also some useful insects in this ecosystem. The yucca moth is one such example of an insect. This moth helps in pollination. There are also many ants' species in the desert. The harvester ants is one such variety which gathers seeds and stores them so that they can be used when the weather turns dry. The desert is also home to arachnids. This family includes both spiders and scorpions.

b) **Desert Reptiles:** The reptiles are a unique members of the desert ecosystem. The reptiles have the advantage that they can adjust to extreme temperatures of the desert ecosystem because they can regulate the temperatures of their bodies. The two main members of the desert family are snakes and lizards. The rattlesnake is a deadly member of the snake family. The other types of snakes are cobras, hognose and the kingsnake. Lizards are also a main part of the reptile family and have interesting traits. They can camouflage themselves by changing their colour similar to their surroundings.

c) **Desert Birds:** The birds have also evolved in the desert ecosystem. The sandgrouse is a type of bird that has special feathers that can soak the water. It can then carry this water to its offspring. The other types of birds that can be seen are the Gila woodpecker and the roadrunner.

d) **Desert Mammals:** The camel is the most famous desert mammal. The camel plays a great part in helping the people to survive in the desert ecosystem. The desert mammals tend to burrow in the desert sand. They do this to escape the desert day when the temperature can rise a great deal. There are however some mammals like the kangaroo which do not burrow in the sand. The kangaroo and the spiny anteater are both found in the Australian desert ecosystem. The spiny anteater also lays eggs which makes it a unique mammal. The desert also has foxes and jackals.

iii) **Decomposers:** The decomposers are less in the desert ecosystem because very little decomposition takes place in the desert environment. The most common decomposers are bacteria and fungi.

2.5.4. Functions of Deserts Ecosystem

The desert ecosystem performs the following functions:

1) They extend the conditions for a certain type of life and thus support them. The ecosystem can sustain various species of beetles, scorpions, lizards, snakes, etc. These organisms have developed certain traits which allow them to survive in the harsh conditions of the desert.
2) The desert ecosystem also gives birth to conditions which sustain certain types of plants like cacti, acacia, grasses, etc.
3) The desert ecosystem also performs the function of filtration. It helps in the spread of aerobic bacteria. The sand also acts as a good insulator and reflector of radiation which emanates from the sun.
4) The desert also has a large reservoir of natural resources. The colour of the desert also indicates the kind of mineral that it contains. The red colour of the desert is due to the presence of laterite.

2.5.5. Types of Desert Ecosystem

Desert ecosystems can be of different types and also have varied characteristics. The main types of desert ecosystems are as follows:

1) **Hot and Dry Deserts:** These deserts remain hot the whole year with a high range of temperature because of the conditions of low humidity. In these deserts, short and intense storms are common to occur. The main types of fauna that can be seen are burrowing mammals, insects and various types of reptiles. Examples of this type of desert are the Great Sandy Desert of Australia, the Sahara Desert of North Africa, Sonoran Desert of Arizona and North Western Mexico.
2) **Semi-Arid Deserts:** These are semi-arid in nature. Examples are the Great Basin of Nevada. They tend to have long summers and rainfall during the winters. The quantity of dew in this ecosystem is more than rainfall. The soil tends to be sandy and rocky and has caliche, which are deposits of calcium carbonate.
3) **Coastal Deserts:** These can be seen in the coastal areas of the Pacific Coast. They are characterised by long summers and short periods of the cold season. The rainfall can be as much as 13cm in a year. They can have large animals in their ecosystem like amphibians, owls, eagles, etc
4) **Cold Deserts:** They can be seen in places like Greenland. They have long winters and very short summers. The soil is not fertile and has excessive salty and alluvial silt. The fauna comprises of burrowing mammals, coyotes, lizards and foxes.
5) **Monsoon Deserts:** Monsoons comes in these types of deserts because of the sudden and huge differences in temperature between the continents and the oceans. The monsoon affects parts of India like the coastal areas. Examples of monsoon deserts can be the Aravalli range, the Thar desert in India and Pakistan.
6) **Polar Deserts:** The average rainfall in polar deserts is less than 250 millimetres in a year. The average temperature is less than 10°C. Polar deserts approximately cover 5 million square kilometres area across the globe. These deserts have snow dunes (in low rainfall regions) instead of sand dunes. In summer time, butterflies and beetles can be found here, while some of the larger animals that exist in these deserts may include rabbits, hares, foxes, wolves, polar bears, and reindeer/ caribou.

2.6. AQUATIC ECOSYSTEM

2.6.1. Introduction

The marine environment of the oceans and the freshwater systems like wetlands, rivers, ponds, and lakes together constitute the aquatic ecosystem. A plethora of natural resources is provided by aquatic ecosystems to all human beings. Fish, crustaceans, etc., are the foods provided by them. All the organic and chemical waste formed by humans is broken-down by aquatic systems like oceans and rivers.

Plants and animals in an aquatic ecosystem are found under water. These species of plants and animals are habituated to survive in various kinds of aquatic habitats. The exceptional abiotic attributes of aquatic ecosystem are its physical facets like the quality of water which involve clarity, rate of flow, oxygen content, and salinity. Stagnant ecosystems and running water ecosystems are the two types of aquatic ecosystems. The characteristics of an aquatic ecosystem are changed due to the rocks or mud gravel that form the bed of this ecosystem. The composition of various species of plants and animals living under water are also influenced by this substratum.

2.6.2. Characteristics/Features of Aquatic Ecosystem

The abiotic and biotic parts of the aquatic ecosystem have the following characteristics:

1) **Oxygen:** It is the fundamental need for the sustainability of an aquatic ecosystem. The amount of oxygen available to all living beings in the aquatic system depends upon the factors that influence how it dissolves in the aquatic system. When the water is mixed then the oxygen is exchanged with the air. Many times the dissolved oxygen can get reduced or the oxygen concentrations can vary at various layers because of insufficient mixing in the water.

2) **Temperature:** Temperature has a direct impact on the solubility of many chemicals in the aquatic ecosystem. When the temperature increases then the oxygen requirement of the organisms increase. Human activities can also affect the temperature of the aquatic ecosystem. These include industrial effluents, agriculture, forest harvesting, urban construction, etc.

3) **Alkalinity:** [illegible] and acidity are the significant water [illegible] impact on the [illegible] content and the chemical [illegible] aquatic ecosystem. The ability [illegible] to bear changes in acidity [illegible] important feature. The sustenance of many life forms [illegible] the alkalinity of the ecosystem. Many life functions [illegible] the alkaline properties of water.

4) **Light:** [illegible] the process of photosynthesis. Light, therefore, has a direct bearing on the plant life of the aquatic ecosystem. Similarly, the shade is also necessary for determining the nature of habitats living in the aquatic [illegible].

5) **Substrate:** Substrate refers to the organic and inorganic matter that forms the bed of [illegible]. The influence of substrate on the aquatic [illegible] size of substrate, organic content and contact with [illegible] flow. Substrate stability has a positive correlation with [illegible] organisms that can be found in an ecosystem.

6) **Autotrophic Organisms:** Autotrophic organisms produce organic compounds from inorganic ingredients. The algae are the most important constituent of this segment. They create biomass from carbon dioxide by using sunlight. The biomass concentration typically increases with shallowness of an aquatic system.

7) **Heterotrophic Organisms:** Heterotrophic organisms consume autotrophic organisms and use organic ingredients as energy sources (or input) to create their own biomass. For example, euryhaline organisms which are salt tolerant can exist even in marine ecosystems, while salt intolerant species or stenohaline are not able to survive in salt water ecosystems and are found in the freshwater environment.

2.6.3. Structure of Aquatic Ecosystem

The food cycle in an aquatic ecosystem involves the concentration of organic ingredients [illegible] constant breaking-up of the same into smaller and basic parts. The aquatic ecosystem structure has the following parts:

1) **Abiotic Component:** The aquatic ecosystem encompasses biotic communities that are structured by abiotic environmental factors and biological interactions. The major abiotic environmental factors of the aquatic ecosystem are substrate type, depth, [illegible] water, nutrient present in the water, dissolved oxygen, temperature levels, acidity levels, etc. It is very difficult to measure the importance of these factors and a great deal of experimentation is required to determine their interconnection. For example, sediment often acts as an indicator of the presence of aquatic plants, but they may also get created through peat formation.

2) **Biotic Component:** The biotic component of aquatic ecosystem [illegible] the living organisms living in the water. For example, the wetland plants form canopies which in turn can be used for sedimentation. Similarly, the action of snails can also create mud flats. Since there are relatively lower oxygen levels in the aquatic biosphere, it forces the organisms to adapt. Some aquatic plants produce aerenchyma for carrying oxygen to their roots. The aquatic [illegible] has the following constituent parts:

   i) **Producers:** The producers in the aquatic system include green plants (which have chlorophyll), bacteria and [illegible] capable of producing energy containing [illegible] inorganic materials). The phytoplankton [illegible] component of the aquatic ecosystem [illegible] upon on phytoplankton for its produce[illegible]

   ii) **Consumers:** Consumers [illegible] producers for energy intake as they [illegible] utilising solar energy. These include herbivores as well as omnivores like zooplankton and fishes. The zooplankton [illegible] food that can be consumed by [illegible] ecosystem. The herbivores are [illegible] these, in turn, are a source of energy [illegible] thus called primary consumers whereas [illegible] secondary consumers. Similarly, the [illegible] called secondary or tertiary consumers.

   iii) **Decomposers:** The decomposers are basically the bacteria and fungi. They aid in the decomposition of the dead and decaying matter in the aquatic ecosystem. In this way, they return and recycle the minerals and nutrients in the aquatic ecosystem and influencing the final energy degradation. The decay of dead organisms is influenced by microbial action which results in the formation of bacterial cells, which [illegible] are assigned to the primary level of consumers.

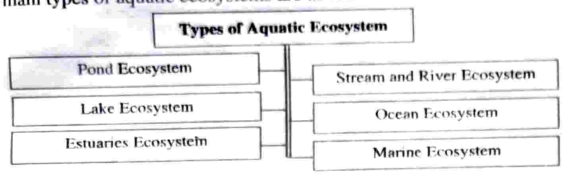
2.6.4. Functions of Aquatic Ecosystem

The aquatic ecosystem performs the following important [illegible] within the system.

1) The aquatic ecosystem plays an important [illegible]
2) It also plays the vital function of purification of the water in the [illegible]
3) The aquatic ecosystem also influences the [illegible]
4) The aquatic ecosystem is also used by humans for [illegible]
5) They are also a source of livelihood for people living near coastal regions and bring in vital tourism earnings.
6) They also play a variety of roles which are [illegible] regulating floods, recharging of groundwater, [illegible] refuge for wildlife.

2.6.5. Types of Aquatic Ecosystem

The main types of aquatic ecosystems are as follows:



2.6.5.1. Pond Ecosystem

The pond ecosystem is a freshwater ecosystem which contains many organisms that depend on each other for their survival and nutrients intake. The pond is a very peculiar ecosystem as it is relatively quieter than other aquatic ecosystems and has no waves. It also does not have any major temperature differences between the top and bottom parts of the ecosystem. The bottom of the pond is usually muddy or silty. Since it is hard to distinguish between the pond and lake ecosystems, they are often used interchangeably. However, in a pond, the temperature is generally dependent on the air temperature. The lakes are similar to ponds but tend to be much larger in size. There is thus some differentiation of temperature in the lakes. This happens mostly in the peak winter and the summer months.

The pond can be thus understood as a shallow water body having relatively quiet water and plenty of vegetation alongwith numerous micro-organisms, animals and big plants.

2.6.5.2. Stream and River Ecosystem

Unlike pond ecosystem, streams and rivers are flowing water ecosystems. The flow of the water varies across streams and different plants and animals adjust to the change in speed flow. In the hilly areas, the plants and animals have to adjust to a very rapid flow in the water. There are some species of plants and animals which can survive only if the water flow is not very fast like skaters and beetles. Some species of fish like Mahseer and Salmon move upstream for breeding as they need crystal-clear water.

Due to deforestation in hilly regions, the all-time water flow has not become periodic. This creates flash floods in rains and lack of water after monsoon as the streams dry-up. The ecosystem of the streams depends upon the maintenance of a clear water supply which has adequate oxygen supply. The streams can also have varying types of beds – muddy, clear or rocky. This also influences the kind of flora or fauna that flourishes in these conditions.

2.6.5.3. Lake Ecosystem

A lake can be considered as a huge pond. The flora in a lake comprises mainly of algae which utilises the sunlight to generate energy. This energy is transferred to all the microscopic animals that feed on the algae. There are also many types of small aquatic animals that depend on the algae and aquatic food such as fishes, snails, etc. These animals are in turn consumed by carnivores which are again consumed by larger fishes. There are also many species like catfish which feed on the muddy river bed and are thus called "bottom dwellers".

In this way, the energy received from the sunlight is circulated across the lake ecosystem. The plants transfer the energy to the herbivores and further to the carnivores. In return, the animals generate waste in the form of excreta which settles at the bottom of the lake and is broken down by bottom dwellers. This acts as an essential nutrient for the growth of aquatic plants. The plants use carbon-di-oxide and release oxygen which in turn gets utilised by the animals of the aquatic ecosystem.

2.6.5.4. Ocean Ecosystem

The ocean ecosystem is different from other aquatic ecosystems as the quantity of saltwater required for maintaining and balancing the aquatic ecosystem is higher than the quantity of freshwater required. There are a variety of flora and fauna that can be found only in the ocean ecosystem. They have a lot in common with freshwater ecosystem like rivers and lakes but they differ with one another because of their high salinity or saltwater content. The ocean ecosystem can be seen in five oceans viz. Atlantic, Arctic, Pacific, Southern and Indian Oceans. These ecosystems are also known as saltwater ecosystems as saltwater is the main ingredient which sustains life in the ocean ecosystem.

The oceans cover 70% of the Earth's surface area. Each of the oceans has its own unique and stable ecosystem. The composition of the marine ecosystem is more stable as compared to the saltwater ecosystem. Other parameters like dissolved oxygen, light, temperature, etc., also vary between marine and ocean ecosystems.

2.6.5.5. Estuaries Ecosystem

Estuary can be understood as a partly bounded coastal body where a river meets with the sea. At this junction, there are species of plants, seaweeds and micro-organisms (phytoplankton) which source nutrients from the ecosystem and grow at a very fast rate because of the richness of the water at this point. The estuary is a very productive nesting ground for many types of flora and fauna though it does seem intimidating.The estuaries are also called open ecosystems because they have linkages to the broader ecosystem. The rivers bring nutrients to the estuaries whereas the tides bring the same from the oceans. The fishes and animals also help to transfer the nutrients from the estuary. The tides also flush nutrients back into the sea.

The excess supply of some nutrients (mainly nitrogen) has caused a lot of changes in the estuary ecosystem. This includes the excessive growth of poisonous algae, reduced availability of oxygen, damages to fish and shellfish ecosystem, etc. This has put the fragile ecosystem of the estuary under pressure and has brought into question the ability of the estuary to sustain such a large and diverse ecosystem.

2.6.5.6. Marine Ecosystem

The marine ecosystems are the biggest of the world's aquatic ecosystems. These include the ecosystems of oceans, salt marshes, estuaries, lagoons, coral seas, etc. These are different from freshwater ecosystems because they have a higher salinity or saltwater content. The marine ecosystem covers 2/3 of the Earth's surface area. They are considered as ecosystems because there is an interdependent relationship between the plant and animal life forms living in this ecosystem.

The World Resource Centre says that coastal ecosystems support 1/3 of all marine life and the estuarine ecosystems are the most productive amongst all the aquatic ecosystems in the world. The marine ecosystems also provide shelter and refuge to many life forms and support a rich biodiversity.

In India, the main marine ecosystems are the Indian Ocean, the Arabian Sea and the Bay of Bengal. The sea is shallow near the coastal parts of India but becomes deeper as one goes further away. The ecosystems of these are however quite varied. Producers of this ecosystem are various types of algae and seaweeds. Several phytoplankton acts as food source for the many types of fish, turtles and other marine life.

India has some of the best coral reefs in the world in the area around Kutch and Andaman & Nicobar Islands. The coral reefs support a wide range of flora and fauna. In this sense, they are second only to evergreen forests in terms of the number of species that they support. Millions of species of fish, crustaceans, starfish, jellyfish, etc., reside in these coral reefs.

2.7. SUMMARY

The details in the module can be summarised as:

1) An ecosystem is a natural system consisting of all plants, animals and microorganisms (biotic factors) in an area functioning together with all the non-living physical (abiotic) factors of the environment.
2) Abiotic structure of an ecosystem includes the chemical and physical components of the ecosystem. Energy, nutrients, geographical factors, climatic factors, [illegible] and soil factors together constitute abiotic structure.
3) All the living things such as plants, animals, micro-organisms, etc., in an ecosystem are biotic components of the ecosystem. Biotic components are present even in those corners of earth where survival is very difficult.
4) Organisms which can produce organic compounds are known as autotrophs or producers.
5) Heterotrophs are completely relied upon organisms such as green plants, algae, bacteria, etc., which are self-sufficient in producing food.
6) Organisms which break-down or chemically decompose deceased or decaying organisms are known as decomposers.
7) Ecological succession refers to all those predictable and systematic changes that occur in particular community over a period of time.
8) A food chain is a simple illustration of how different organisms get their food from similar or different sources. Food chains are also referred to as food networks or trophic social networks.
9) A food web is a graphical illustration of feeding relationships that exist between different species in an ecosystem. It shows that who is eaten by whom.
10) An ecological pyramid is a graphical illustration of biomass and biomass productivity at different trophic levels. It is also referred to as trophic pyramid and energy pyramid.
11) Flora, fauna, and ground conditions within the forest boundaries comprise of a forest ecosystem.
12) An ecosystem which has more water sources than a desert, but inadequate to bear a forest is called as grassland. Grasslands are formed where there is excessive rain for deserts but not sufficient for growth of forests.
13) Regions or places where the average annual rainfall rarely goes beyond 10 inches every year, and the amount of water gained by precipitation is much less than the amount of water lost due to evapotranspiration are called deserts.

14) The marine environment of the oceans and the freshwater systems like [illegible] rivers, ponds, and lakes together constitute the aquatic ecosystem.
15) The pond ecosystem is a freshwater ecosystem which contains many organ[illegible] that depend on each other for their survival and nutrients intake. The pond very peculiar ecosystem as it is relatively quieter than other aquatic ecosy[illegible] and has no waves.
16) Streams and rivers are flowing water ecosystems. The flow of the water [illegible] across streams and different plants and animals adjust to the change in [illegible] flow.
17) The ocean ecosystem is different from other aquatic ecosystems [illegible] of saltwater required for maintaining and balancing the aquatic ecosy[illegible] higher than the quantity of freshwater required.
18) Estuary can be understood as a partly [illegible] with the sea.
19) The marine ecosystem [illegible] include the ecosystems of oceans, [illegible]

2.8. EXERCISE

2.8.1. True or False

1) Ecosystem is the system resulting from the integration of all the [illegible] living factors of the environment.
2) All the living things such as [illegible] are abiotic components of the ecosystem.
3) Variation refers to [illegible] organism.
4) Pyramid of Energy [illegible] trophic levels.
5) Flora, fauna, and ground conditions within the forest boundaries comprise of [illegible] ecosystem.
6) The geographical features of the desert ecosystem mainly include [illegible] gravel.
7) Plants and animals in an aquatic ecosystem are found outside the water.
8) A lake can be considered as a huge pond.

2.8.2. Fill in the Blanks

9) An _____ a natural system consisting of all plants, animals and micro[illegible]
10) Energy, nutrients, geographical factors, [illegible] factors together constitute _____.
11) Organisms which break-down or chemically decompose deceased organisms are known as _____.
12) _____ refers to the formation of [illegible] plant community.
13) A simple _____ shows how trees and shrubs are related to animals [illegible] eats shrubs and grasses) and [illegible]
14) Generally, different species [illegible]

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14) The marine environment of the oceans and the freshwater systems like wetlands, rivers, ponds, and lakes together constitute the aquatic ecosystem.
15) The pond ecosystem is a freshwater ecosystem which contains many organisms that depend on each other for their survival and nutrients intake. The pond is a very peculiar ecosystem as it is relatively quieter than other aquatic ecosystems and has no waves.
16) Streams and rivers are flowing water ecosystems. The flow of the water varies across streams and different plants and animals adjust to the change in speed flow.
17) The ocean ecosystem is different from other aquatic ecosystems as the quantity of saltwater required for maintaining and balancing the aquatic ecosystem is higher than the quantity of freshwater required.
18) Estuary can be understood as a partly enclosed coastal body where a river meets with the sea.
19) The marine ecosystem [illegible] these include the ecosystems of

2.8. EXERCISE

2.8.1. True or False

1) Ecosystem is the system resulting from the [illegible] and non-living factors of the environment.
2) All the living things such as plants, animals, micro-organisms, etc., in an ecosystem are abiotic components of the ecosystem.
3) Nudation refers to the [illegible] any organism.
4) Pyramid of Energy [illegible] different tropnic levels.
5) Flora, fauna, and ground conditions within the forest boundaries comprise of a forest ecosystem.
6) The geographical features of the desert ecosystem mainly include [illegible] rock and gravel.
7) Plants and animals in an aquatic [illegible] are found [illegible]
8) A lake can be considered as a huge pond.

2.8.2. Fill in the Blanks

9) An _____ a natural system consisting of all plants [illegible] organisms.
10) Energy, nutrients, geograph[illegible] factors together constitute _____.
11) Organisms which break-down [illegible] decaying organisms are known as _____.
12) _____ refers to the formation of [illegible] communities.
13) A simple _____ shows how trees and shrubs are [illegible] deer that eats shrubs and grasses) and [illegible]
14) Generally, different species are connected to each other [illegible] through lines or arrows that are called as [illegible]