Quick Revision Material

Follow Us: AKS IAS

AKS IAS®

Foundation For Competitive Exams

PRELIMS

QRM

ENVIRONMENT AND ECOLOGY

सत्यमेव जयते
UPSC

MAIN BRANCH
HYDERABAD

REGIONAL BRANCH
VIZAG

www.aksias.com

8448449709

FOREWARD

Dear Aspirants,

Every one of our student aims to get their dream job and seeks the right tools that helps them complete their career defining tests. We aim to be one of the main tool to help an aspirant become the one they aspire to be. AKS IAS thrives to be the best step a student takes towards his/her goal and we do achieve it nearly every time. Our publishing unit is one of the essential means to serve our intentions through AKS IAS Material and various imprinted and forthcoming titles.

This Exclusive book has been prepared and compiled keeping in mind the needs of those, who are looking for a focused and intensive approach, who wish to streamline their preparation strategy for the various competitive examinations.

AKS IAS Academy's - committed team has prepared this book following certain norms to ensure non-partisan treatment of the subject, a dedicated effort to help you prepare best to crack the Examinations. Explaining each and every detail required. This all-inclusive volume will facilitate the aspirants to amass a complete and detailed understanding of the concerned subject.

We wish you the best for your Test preparation!

M.S.Shashank
Director - AKS IAS Academy

*This book refrains from passing judgements on events and personalities of any period.

Contents

1. Environment

The environment is defined as 'the sum total of living, nonliving components; influences and events, surrounding an organism'. Everything that surrounds or affects an organism during its life time is collectively known as its environment which comprises both living (biotic) and nonliving (abiotic) components.

Biosphere

Biosphere is the life supporting layer which surrounds the earth and makes existence of life possible without any protective layer.

The biosphere consists of living organisms, physical environment and energy. It is the zone of assemblage of lithosphere, atmosphere, hydrosphere and living organisms together.

There are three components of biosphere, are:

- **Biotic or organic components:** It includes micro-organisms, plants and animals including man.
- **Inorganic or abiotic component:** It includes physical environment of soil, water, air, temperature and sunlight.
- **Energy component:** Solar and geothermal energy etc.

Biosphere is termed as an open system as there is continuous inward and outward flow of energy and matter.

Biosphere always tends to maintain equilibrium between flow of energy and output of the matter. If this equilibrium is maintained environmental and ecological balances are also maintained. Disturbances in the biosphere equilibrium bring ecological and environmental disturbances which have long term or short term effects on the very existence of living beings.

2. Ecology

Ecology deals with the inter-relationships amongst organisms and interactions between organisms and their environment. In other words, Ecology is the study of organism in relation with the surrounding in which they live. The surrounding is the environment of the living organisms and nonliving things in the vicinity.

The term Ecology is being derived from two Greek words namely,'**Oikos' meaning home or place to live in and 'logos' means study**. It means the study of the home of nature.

Levels of organization in ecology:

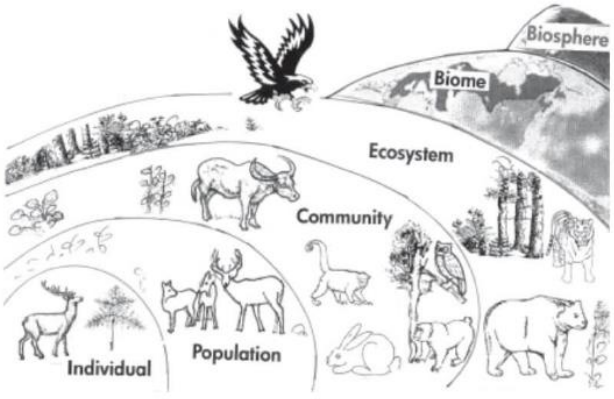
The various ecological levels of organisation are described below:

Individual: An individual organism is a distinct unit of life in nature. It is the basic unit of ecological hierarchy. Ex: Plant, Animal, Bacteria.

Population: It is a group of individuals of a plant or animal species inhabiting a given area at a particular time. Ex: All the frogs living in a pond constitute a population.

Community: It is an assemblage of populations of plants, animals, bacteria, and fungi that live in an area that show **interaction** and **interdependence**.

Ex : A gross land community dominated by grasses, it may contain herbs, shrubs, and trees along with associated animals of different species



3. Ecosystem

An ecosystem is defined as a structural and functional unit of biosphere consisting of community of living beings and physical environment, both interacting and exchanging materials between them. Ecosystem is a self-contained, dynamic system composed of a natural community along with its physical environment.

Components of ecosystem:

- **Abiotic Components:** Abiotic components or abiotic factors are non-living chemical and physical parts of the ecosystem that affect living organisms and the functioning of ecosystems. Ex: Soil, Topography, Water, Atmosphere etc.
- **Biotic Components: Biotic components**, or **biotic** factors, can be described as any living **component** that affects another organism or shapes the ecosystem. Ex: Green Plants, Non-Green Plants, Animals, Parasites, Decomposers etc.
- The environment is not static. Both biotic and abiotic factors are in a flux and keep changing.

4. Ecotone

An **ecotone** is a zone of junction or a transition area between two biomes (diverse ecosystems). Ecotone is the zone where two communities meet and integrate.

For e.g. the mangrove forests represent an ecotone between marine and terrestrial ecosystem. Other examples are grassland (between forest and desert), estuary (between fresh water and salt water) and riverbank or marshland (between dry and wet).

Characteristics of Ecotone

- It may be narrow (between grassland and forest) or wide (between forest and desert).
- It has **conditions intermediate** to the adjacent ecosystems. Hence it is a **zone of tension.**
- Usually, the number and the population density of the species of an outgoing community decreases as we move away from the community or ecosystem.
- A well-developed ecotone contains some organisms which are entirely different from that of the adjoining communities.

Ecocline

- Ecocline is a zone of gradual but continuous change from one ecosystem to another when there is no sharp boundary between the two in terms of species composition.
- Ecocline occurs across the environmental gradient (gradual change in abiotic factors such as altitude, temperature (thermocline), salinity (halocline), depth, etc.).

Edge Effect – Edge Species

- Edge effect refers to the **changes in population or community** structures that **occur at the boundary of two habitats (ecotone)**.
- Sometimes the number of species and the population density of some of the species in the ecotone is much greater than either community. This is called **edge effect**.
- The organisms which occur primarily or most abundantly in this zone are known as **edge species**.
- In the terrestrial ecosystems edge effect is especially applicable to **birds**.
- For example, the **density of birds is greater in the ecotone** between the forest and the desert.

5. Ecological Niche

- Niche refers to the **unique functional role and position of a species in its habitat or ecosystem**.
- The functional characteristics of a species in its habitat is referred to as “niche” in that common habitat.
- In nature, many species occupy the same habitat, but they perform different functions:

1. **habitat niche** – where it lives, food niche – what is eats or decomposes & what species it competes with,
2. **reproductive niche** – how and when it reproduces,
3. **physical & chemical niche** – temperature, land shape, land slope, humidity & another requirement.

- Niche plays an important role in the **conservation of organisms**. If we have to conserve species in its native habitat, we should have knowledge about the **niche requirements of the species**.

Difference between niche and habitat

- The habitat of a species is like its 'address' (i.e. where it lives) whereas niche can be thought of as its "profession" (i.e. activities and responses specific to the species).
- **A niche is unique for a species while many species share the habitat**.
- **No two species in a habitat can have the same niche**. This is because of the **competition** with one another until one is displaced.
- For example, a large number of different species of insects may be pests of the same plant, but they can co-exist as they feed on different parts of the same plant.

Functions of Ecosystem

- **Ecological succession** or ecosystem development.
- **Homeostasis** (or cybernetic) or feedback control mechanisms.
- **Energy flow** through the food chain.
- **Nutrient cycling** (biogeochemical cycles).

6. Ecological Succession

Ecological Succession is the process by which a natural community moves, through a sequential change in the structure and composition, from a simpler level of organization to a more complex community.

Succession is a long-term cumulative, directional and largely predictable process of natural development of different communities at the same site in a definite sequence over a period of time. Such changes occur either in response to an environmental change or induced by the intrinsic properties of the community itself.

Succession continues till a community develops maximum equilibrium to the environment. It is called **Climax Community**.

Types of Succession:

Ecological Successions have been described using several criteria. Accordingly, there are several types of succession.

Autogenic and Allogenic Succession

When succession is brought by living inhabitants of that community is called Autogenic Succession, while changes brought by outside forces is known as Allogenic Succession.

Induced Succession

Man has controlled succession in such a way as to obtain a managed steady state in which good amount of organic matter can be harvested. It is called induced succession. In induced succession, like agriculture, a

young state is maintained by various types of inputs and protective measures.

Primary Succession

It is the succession that takes on a primary bare area or an area which was not previously inhabited by plants. Such an area is biologically sterile and is, therefore, quite hostile in starting. Succession is also slow.

Secondary Succession

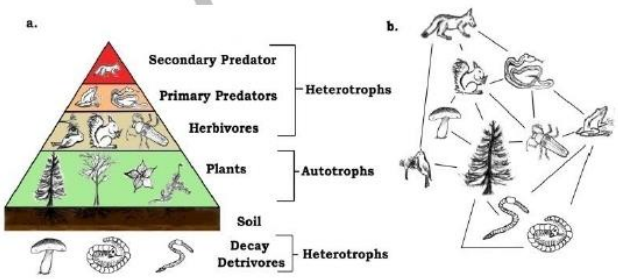
It occurs on a site which has become bare secondarily due to destruction of previous vegetation. The area is biologically fertile and hence favourable for reappearance of plant life. Succession is quite rapid

Homeostasis in Ecosystem

- Homeostasis is the **maintenance of stable equilibrium**, especially through physiological (through bodily part functions. E.g. Cooling your body through sweating processes.
- Organisms try to maintain the constancy of its internal environment despite varying external environmental conditions that tend to upset their homeostasis.

Energy Flow Through an Ecosystem – Trophic Levels

- A trophic level is the representation of energy flow in an ecosystem.
- The trophic level of an organism is the position it occupies in a food chain.
- Trophic level interaction deals with how the members of an ecosystem are connected based on nutritional needs.



- Energy flows through the trophic levels from producers to subsequent trophic levels is **unidirectional**.
- Energy level **decreases** from the first trophic level upwards due to loss of energy in the form of heat at each trophic level.
- This energy loss at each trophic level is quite significant. Hence there are usually not more than four-five trophic levels (beyond this the energy available is negligible to support an organism).
- The trophic level interaction involves three concepts namely:
  1. **Food Chain**
  2. **Food Web**
  3. **Ecological Pyramids**

7. Food Chain

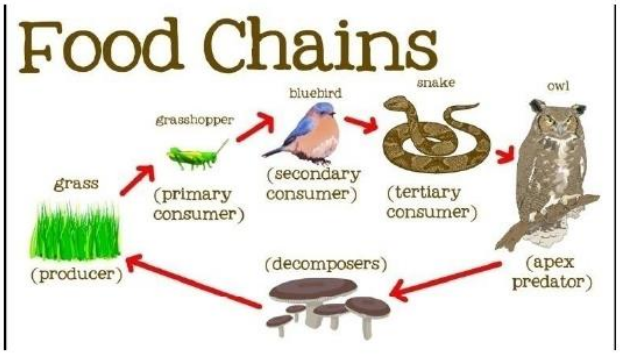
- Transfer of food energy from green plants (producers) through a series of organisms with repeated eating and being eaten link is called a food chain. E.g. Grasses → Grasshopper → Frog → Snake → Hawk/Eagle.
- Each step in the food chain is called trophic level.
- A food chain starts with producers and ends with top carnivores.
- The trophic level of an organism is the position it occupies in a food chain.
- Types of Food Chains: **1) Grazing food chain and 2) Detritus food chain.**

Grazing food chain

The consumers which start the food chain, utilising the **plant or plant part as their food**, constitute the grazing food chain.

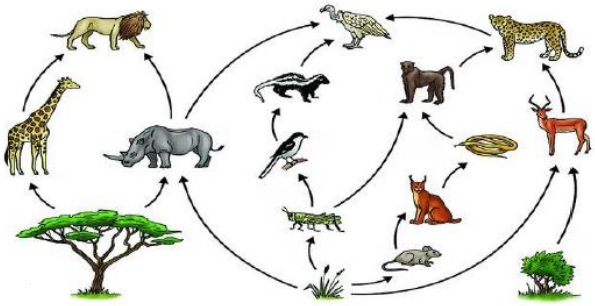
Detritus food chain

This type of food chain **starts from organic matter** of dead and decaying animals and plant bodies from the grazing food chain.



Food Web

- **Multiple interlinked food chains make a food web**.
- Food web represents all the **possible paths of energy flow** in an ecosystem.
- If any of the intermediate food chains is removed, the succeeding links of the chain will be affected largely.
- The food web provides more than one alternative for food to most of the organisms in an ecosystem and therefore increases their chance of survival.



All biotic components of the ecosystem are interlinked with each other and Biotic interaction between the organism is fundamental for survival and functioning of an ecosystem and it determines the sustainability of the ecosystem.

Types of Biotic interaction

Parasitism

- It is a type of interaction between two species which results in damage and harm to one member and benefit to another member.
- As in case of tick-host relationship, tick gains benefit by sucking blood while host is harmed as it loses blood.
- Ticks, lice and mites are external parasites while tapeworm, roundworm etc. are an example of internal parasites.
- The life cycle of a parasite is quite complex; they need hosts (most of the parasite make host weak and vulnerable to the predation) and vectors in order to complete their life cycle, as in case of a malarial parasite which requires a vector (mosquito) to spread to other hosts.

Commensalism

- In this type of relationship one species benefits without affecting the other.
- Barnacles growing on the back of the whale, Orchid growing as an epiphyte on some mango branch, cattle egret and grazing cattle in close association, Sea anemone and the Clown Fish are some of the classic examples of the Commensalism.

Mutualism

- In this type of relationship both the partners benefit from one another.
- When similar interaction occurs within a species, it is known as cooperation.

Examples-

- Rhizobium a bacterium which is found at the root nodules of a leguminous plant is a good example of the Mutualism. In this relationship, the plant supplies the water, mineral, food to the bacterium while Rhizobium fixes the atmospheric nitrogen which is used by the plant.
- Lichens a mutual relationship between algae and fungus. In this mutual cooperation, fungus gives protection and raw material for the preparation of the food while Green Algae synthesizes the food for both.

- Pollination is also an example of Mutualism, as the pollinator gets the nutrition/food (nectar, pollen) from the plant and plants gets its pollen transferred to other flowers for cross-fertilization thus helping the plant to reproduce similar kind of species.

Predation

- In this type of Biological interaction, a predator feeds upon its prey and in this type of relationship, one species is benefitted while other is harmed.
- Although the predator may or may not kill its prey, the act of predation often results in the death of its prey and the tissues of the prey are eventually consumed by the predator.
- Example- An interaction between Lion and Deer results in predation.
- Sometimes a species can act as both as a prey and as a predator. Like in case of Snake, as it becomes prey to Hawk while acts as a predator with Frog.

Competition

- In this type of interaction both the species compete with each other for the resources like food, shelter, mating, and both the species get harmed out of the process of competition.
- Two species consuming the same kind of resources and due to limited availability of resources conflict arises between them (Remember competition in UPSC exam, can you explain how the people are getting harmed due to the competition in UPSC?). Competition may also occur between two different species like Trees, shrubs, herbs competing with each other for water, light etc.
- Competition leads to the elimination of the less fit or the weaker species from the ecosystem (Survival of the fittest by Darwin).

Amensalism

- In this relationship, one species is harmed while other is neither harmed nor benefitted and remains unaffected.
- When an organism excretes the chemicals as a part of the normal metabolism of its own, but which may severely impact other nearby species, this kind of relationship is seen.
- Example-A large tree inhibits the growth of small plants laying nearby due to its shades, while small plants have no effect on the large tree.

Biotic Interaction			
S.No.	Type	Spices 1	Species 2
1.	Mutualism	(+)	(+)
2.	Commensalism	(+)	(0)
3.	Amensalism	(–)	(0)
4.	Competition	(–)	(–)
5.	Predation	(+)	(–)
6.	Parasitism	(+)	(–)
(+) Benefited (–) Harmed			
(0) Neither Benefited nor harmed.			

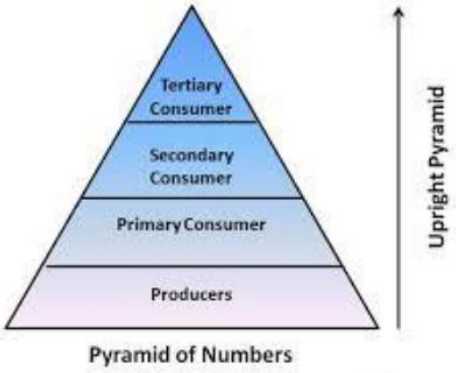
8. Ecological Pyramids

- The pyramidal representation of trophic levels of different organisms based on their **ecological position** (producer to final consumer) is called as an ecological pyramid.
- The pyramid consists of a number of horizontal bars depicting specific trophic levels. The length of each bar represents the total number of individuals or biomass or energy at each trophic in an ecosystem.
- The food **producer forms the base of the pyramid** and the top carnivore forms the tip. Other consumer trophic levels are in between.
- The ecological pyramids are of three categories:
  1. **Pyramid of numbers,**
  2. **Pyramid of biomass, and**
  3. **Pyramid of energy or productivity.**

Pyramid of Numbers

- Pyramid of numbers represents the total number of individuals of different species (population) at each trophic level.
- Depending upon the size, the pyramid of numbers **may not always be upright**, and **may even be completely inverted**.
- It is very difficult to count all the organisms, in a pyramid of numbers and so the pyramid of number does not completely define the trophic structure for an ecosystem.

Pyramid of numbers – upright

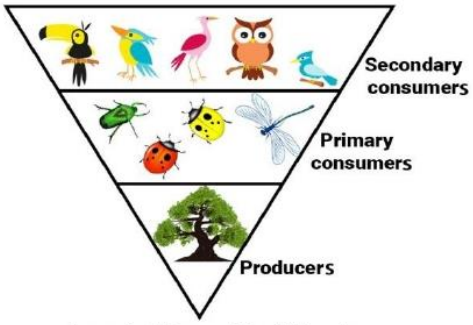


Pyramid of Numbers

- In this pyramid, the number of individuals is decreased from lower level to higher trophic level.
- This type of pyramid can be seen in the **grassland ecosystem** and **pond ecosystem**.
- The grasses occupy the lowest trophic level (base) because of their abundance.
- The next higher trophic level is primary consumer – herbivores like a grasshopper.
- The individual number of grasshoppers is less than that of grass.
- The next energy level is a primary carnivore like rats.
- The number of rats is less than grasshoppers, because, they feed on grasshoppers.
- The next higher trophic level is secondary carnivore like snakes. They feed on rats.
- The next higher trophic level is the top carnivore like Hawk.
- With each higher trophic level, the number of individual decreases.

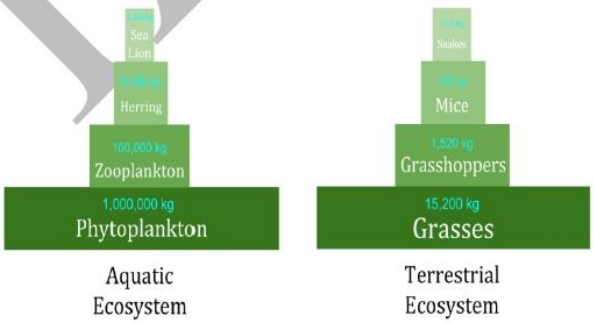
Pyramid of numbers – inverted

- In this pyramid, the number of individuals is increased from lower level to higher trophic level. E.g. **In aquatic ecosystem and tree ecosystem.**



Inverted Pyramid of Numbers

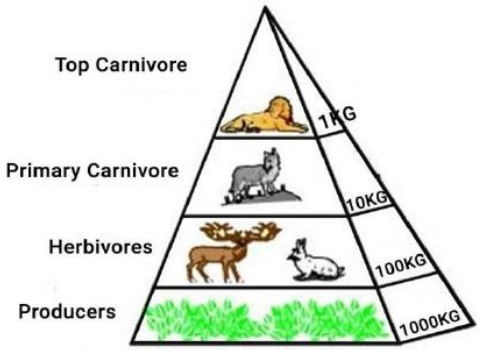
Pyramid of Biomass



- Pyramid of biomass is usually determined by collecting all organisms occupying each trophic level separately and measuring their dry weight.
- This overcomes the size difference problem because all kinds of organisms at a trophic level are weighed.
- Each trophic level has a certain mass of living material at a particular time called the **standing crop**.
- The standing crop is measured as the mass of living organisms (biomass) or the number in a unit area.

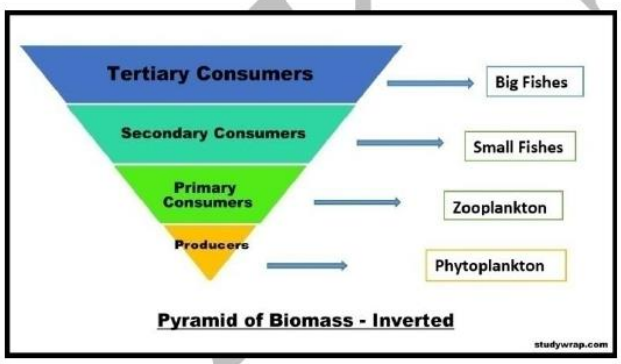
Pyramid of Biomass – upright

- For **most ecosystems on land**, the pyramid of biomass has a large base of primary producers with a smaller trophic level perched on top.
- The biomass of producers (autotrophs) is at the maximum. The biomass of next trophic level i.e. primary consumers is less than the producers. The biomass of next higher trophic level i.e. secondary consumers is less than the primary consumers. The top, high trophic level has very less amount of biomass.



Upright Pyamid of Biomass in aTerrestrial Ecosystem

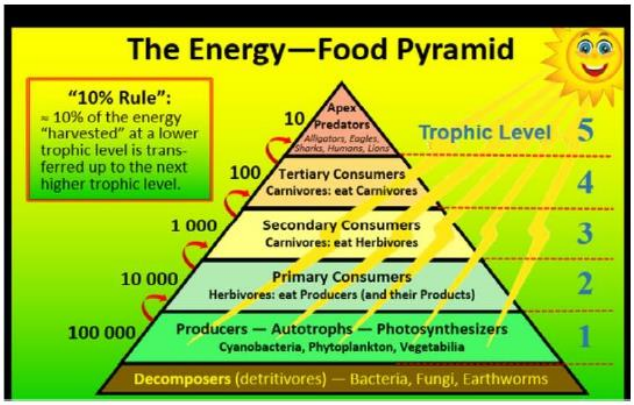
Pyramid of Biomass – Inverted



- In contrast, in many **aquatic ecosystems**, the pyramid of biomass may assume an inverted form. (**In contrast, a pyramid of numbers for the aquatic ecosystem is upright**)
- This is because the producers are tiny phytoplankton that grows and reproduces rapidly.
- Here, the pyramid of biomass has a small base, with the consumer biomass at any instant exceeding the producer biomass and the pyramid assumes an inverted shape.

Pyramid of Energy

- To compare the functional roles of the trophic levels in an ecosystem, an energy pyramid is most suitable.
- An energy pyramid represents the amount of energy at each trophic level and loss of energy at each transfer to another trophic level. Hence **the pyramid is always upward**, with a large energy base at the bottom.
- Suppose an ecosystem receives 1000 calories of light energy in a given day. Most of the energy is not absorbed; some is reflected to space; of the energy absorbed only a small portion is utilized by green plants, out of which the plant uses up some for respiration and of the 1000 calories; therefore only 100 calories are stored as energy-rich materials.
- Now suppose an animal, say a deer, eats the plant containing 100 calories of food energy. The deer use some of it for its metabolism and stores only 10 calories as food energy. A lion that eats the deer gets an even smaller amount of energy. Thus, usable energy decreases from sunlight to producer to herbivore to carnivore. Therefore, the energy pyramid will always be upright.
- Energy pyramid concept helps to explain the phenomenon of **biological magnification** – the tendency for toxic substances to increase in concentration progressively with higher trophic levels.



9. Ecological Efficiency

- Ecological efficiency describes the efficiency with which energy is transferred from one trophic level to the next.
- The number of trophic levels in the grazing food chain is restricted as the transfer of energy follows 10 per cent law – only 10 per cent of the energy is transferred to each trophic level from the lower trophic level.
- The decreases at each subsequent trophic level is due to two reasons:
- At each trophic, a part of the available energy is lost in respiration or used up in **metabolism**.
- A part of the energy is lost at each transformation.

Limitations of Ecological Pyramids

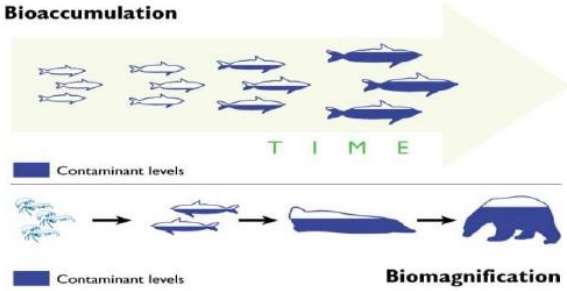
- It does not consider the same species belonging to two or more trophic levels.
- It assumes a simple food chain, something that seldom exists in nature; **it does not accommodate a food web**.
- Moreover, **saprophytes** (plant, fungus, or microorganism that lives on decaying matter) are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

Pollutants and Trophic Level – Biomagnification

- Pollutants move through the various trophic levels in an ecosystem.
- Non-degradable pollutants (**persistent pollutants**), which cannot be broken down by detrivores, not only move through the various trophic levels but also remain in that tropic level for a very long duration.
- **Chlorinated Hydrocarbons (Organochlorides)** are the most damaging non-degradable pollutants that are long-lasting.

Movement of these pollutants involves two main processes:

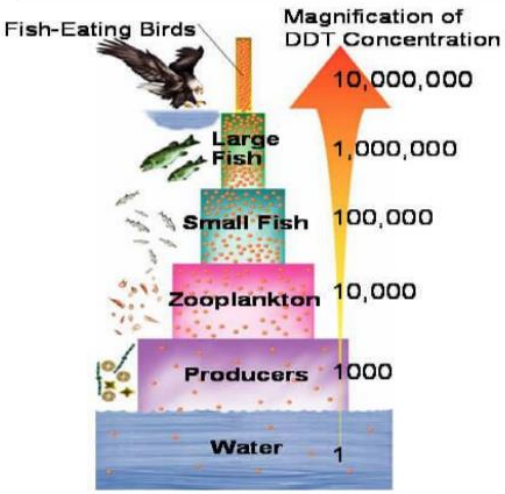
1. **Bioaccumulation**
2. **Biomagnification**



Bioaccumulation

- Bioaccumulation is the **gradual accumulation of pollutants, chemicals (chronic poisoning) or other substances in an organism**.
- Bioaccumulation occurs when the rate of loss of the substance from the body of the organism through catabolism (breakdown of complex molecules in living organisms), or excretion is lower than the rate of accumulation of the substance.
- As persistent organic pollutants like DDT are long-lasting, the risk of bioaccumulation is high even if the environmental levels of the pollutant are not high.

10. Biomagnification



- Biomagnification refers **to progressive bioaccumulation (increase in concentration) at each tropical level with the passage of time.**
- In order for biomagnification to occur, the pollutant must have a long biological half-life (long-lived), must not be soluble in water but must be soluble in fats. E.g. DDT.
- If the pollutant is soluble in water, it will be excreted by the organism.
- Pollutants that dissolve in fats are retained for a long time. Hence it is traditional to measure the amount of pollutants in fatty tissues of organisms such as fish.
- In mammals, milk produced by females is tested for pollutants since the milk has a lot of fat in.

Biogeo- Chemical Cycling or Nutrient Cycling

- Energy flow and nutrient circulation are the major functions of the ecosystem.
- Energy is lost as heat forever in terms of the usefulness of the system. On the other hand, nutrients of food matter never get used up. They can be **recycled** again and again indefinitely.
- **Carbon, hydrogen, oxygen, nitrogen and phosphorus** as elements and compounds makeup 97% of the mass of our bodies and are more than 95% of the mass of all living organisms.
- In addition to these, about 15 to 25 other elements are needed in some form for the survival and good health of plants and animals.
- These elements or mineral nutrients are always in circulation moving from non-living to living and then back to the non-living components of the ecosystem in a more or less circular fashion.
- This circular fashion is known as **biogeochemical cycling** (bio for living; geo for atmosphere).
- Among the most important nutrient cycles are the **carbon nutrient cycle** and the **nitrogen nutrient cycle**.
- There are many other nutrient cycles that are important in ecology, including a large number of trace mineral nutrient cycles.

Types of Nutrient Cycles

Based on the replacement period, a nutrient cycle is referred to as Perfect or Imperfect cycle.

- A perfect nutrient cycle is one in which **nutrients are replaced as fast as they are utilized**.
- **Most gaseous cycles** are generally considered as perfect cycles.
- In contrast **sedimentary cycles** are considered relatively imperfect, as **some nutrients are lost from the cycle and get locked into sediments** and so become unavailable for immediate cycling.
- Based on the nature of the reservoir, a nutrient cycle is referred to as Gaseous or Sedimentary cycle
- **Gaseous Cycle:** the reservoir is the **atmosphere or the hydrosphere — water cycle, carbon cycle, nitrogen cycle**, etc. and
- **Sedimentary Cycle:** the **reservoir is the earth's** crust (soluble elements mostly found in earth's crust) **— phosphorous cycle, sulphur cycle, calcium cycle, magnesium cycle** etc.

Carbon cycle

Carbon is a minor constituent of the atmosphere as compared to oxygen and nitrogen. However, without carbon dioxide life could not exist because it is vital for the production of carbohydrates through photosynthesis by plants.

It is the element that anchors all organic substances from coal and oil to DNA (deoxyribonucleic acid: the compound that carries genetic information).

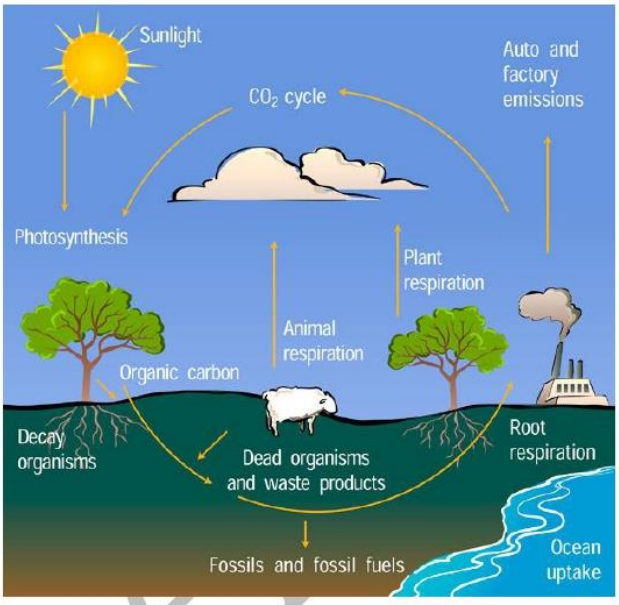
Carbon is present in the atmosphere, mainly in the form of carbon dioxide (CO_2). Carbon cycle involves a continuous exchange of carbon between the atmosphere and organisms.

Carbon from the atmosphere moves to green plants by the process of **photosynthesis**, and then to animals. By process of respiration and decomposition of dead organic matter, it returns to the atmosphere. It is usually a short term cycle.

Some carbon also enters a long term cycle. It accumulates as **un-decomposed organic matter in the peaty layers of marshy soil** or as insoluble carbonates in bottom sediments of aquatic systems which take a long time to be released.

In deep oceans, such carbon can remain buried for millions of years till geological movement may lift these rocks above sea level. These rocks may be exposed to erosion, releasing their carbon dioxide, carbonates and bicarbonates into streams and rivers.

Fossil fuels such as coals, oil and natural gas etc. are organic compounds that were buried before they could be decomposed and were subsequently transformed by time and geological processes into fossil fuels. When they are burned the carbon stored in them is released back into the atmosphere as carbon dioxide.



11. Nitrogen Cycle (Gaseous Cycle)

- Nitrogen is an essential component of protein and required by all living organisms including human beings. Nitrogen is needed for our DNA, RNA and proteins and is critical to human agriculture. Nitrogen, a component of proteins and nucleic acids, is essential to life on Earth. Although 78% by volume of the atmosphere is nitrogen gas, this abundant reservoir exists in a form unusable by most organisms. Through a series of microbial transformations, however, nitrogen is made available to plants, which in turn ultimately sustain all animal life.
- **The steps, which are not altogether sequential, fall into the following classifications:**

Nitrogen Fixation

- Nitrogen enters the living world by way of bacteria and other single-celled prokaryotes, which convert atmospheric nitrogen N_2—into biologically usable forms in a process called nitrogen fixation. Some species of nitrogen-fixing bacteria are free-living in soil or water, while others are beneficial symbionts that live inside of plants.

- Nitrogen-fixing microorganisms capture atmospheric nitrogen by converting it to ammonia (NH_3) which can be taken up by plants and used to make organic molecules. The nitrogen-containing molecules are passed to animals when the plants are eaten. They may be incorporated into the animal's body or broken down and excreted as waste, such as the urea found in urine.
- Nitrogen fixation, in which nitrogen gas is converted into inorganic nitrogen compounds, is mostly (90 percent) accomplished by certain bacteria and blue-green algae (see nitrogen fixation). A much smaller amount of free nitrogen is fixed by abiotic means (e.g., lightning, ultraviolet radiation, electrical equipment) and by conversion to ammonia through the Haber-Bosch process.
- Nitrates and ammonia resulting from nitrogen fixation are assimilated into the specific tissue compounds of algae and higher plants. Animals then ingest these algae and plants, converting them into their own body compounds

Ammonification

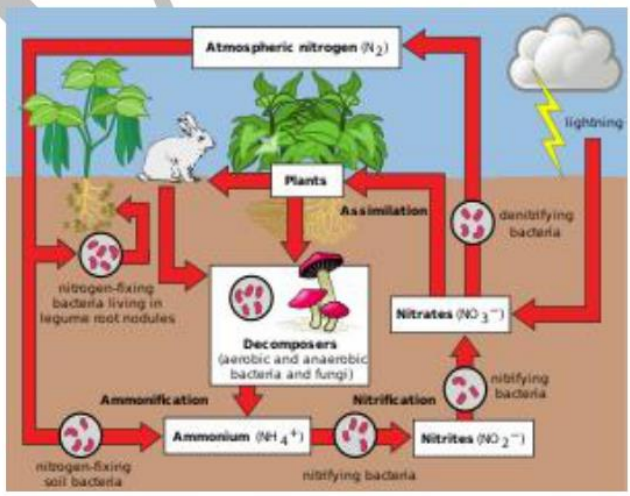
- When plants or animal die organic nitrogen is again released back into the soil. Bacteria or fungi present in the soil convert them back into ammonium. This process is also called as
- The remains of all living things and their waste products are decomposed by microorganisms in the process of **ammonification**, which yields ammonia. (Under anaerobic, or oxygen-free, conditions foul-smelling putrefactive products may appear, but they too are converted to ammonia in time.) Ammonia can leave the soil or be converted into other nitrogen compounds, depending in part on soil conditions.

Nitrification

- In this process, the ammonia is converted into nitrate by the presence of bacteria in the soil. Ammonia is oxidized to form nitrites by bacteria such as Nitrosomonas species. Nitrates are converted into nitrates by Nitrobacter. This conversion is very important as ammonia gas is toxic for plants.

Denitrification

- Denitrification is the process that converts nitrate to nitrogen gas, thus removing bioavailable nitrogen and returning it to the atmosphere. Dinitrogen gas (N2) is the ultimate end product of denitrification, but other intermediate gaseous forms of nitrogen exists. Some of these gases, such as nitrous oxide (N2O), are considered greenhouse gases, reacting with ozone and contributing to air pollution.
- Unlike nitrification, denitrification is an anaerobic process, occurring mostly in soils and sediments and anoxic zones in lakes and oceans.



12. OXYGEN CYCLE

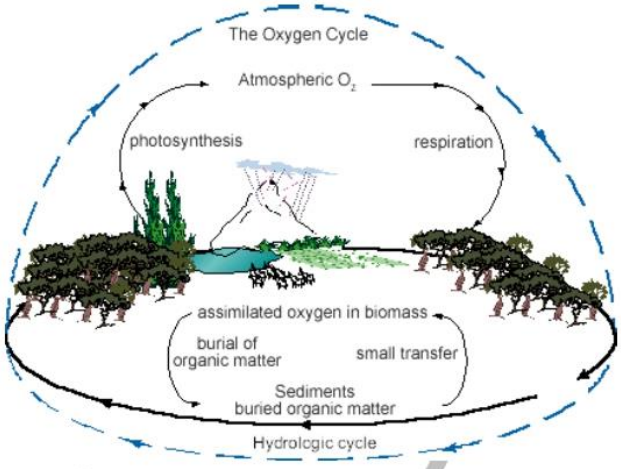
- Oxygen in the atmosphere is about 21%, and it is the second most abundant gas after nitrogen.
- It is mostly utilized by living organisms, especially man and animals in respiration.
- Oxygen is also the most common element of human body. Oxygen is also used during combustion, decomposition, and oxidation.
- The circulation of oxygen is through three main flow systems including the (air) atmosphere, the biosphere, and the earth's crust.
- In the oxygen cycle, the main driving factor is photosynthesis which is the process whereby green plants and algae make their own food by use of solar energy, water, and carbon dioxide to gives off oxygen as a by-product.
- Hence, for oxygen to remain in the atmosphere, it has to circulate through various forms of nature which is essentially termed as the oxygen cycle. The circulation depends on the various activities on Earth.

Oxygen is produced by:

- **Plants** – Plants produce oxygen via photosynthesis
- **Sunlight** – Some oxygen is produced when sunlight reacts with water vapour in the atmosphere.

Oxygen is used up in:

- **Respiration** – All organisms use oxygen for respiration.
- **Decomposing**– When plants and animals die, they decompose. This process uses up oxygen and releases carbon dioxide into the air.
- **Rusting** – Also called oxidation, this process causes metals to rust. Also a process which uses up oxygen.
- **Combustion**– The process by which fire is generated also requires oxygen, along with heat and fuel. This process also uses up oxygen and releases carbon di oxide into the atmosphere.



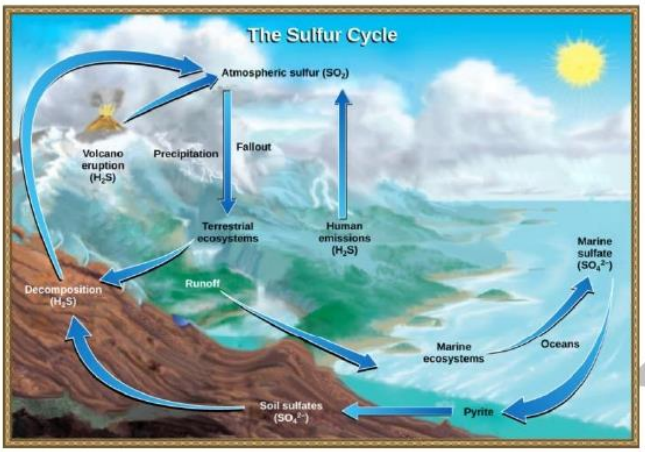
Sedimentary cycles

13. SULPHUR CYCLE

- The sulphur reservoir is in the soil and sediments where it is locked in organic (coal, oil and peat) and inorganic deposits (pyrite rock and sulphur rock) in the form of sulphates, sulphides and organic sulphur.
- It is released by weathering of rocks, erosional runoff and decomposition of organic matter and is carried to terrestrial and aquatic ecosystems in salt solution.
- The sulphur cycle is mostly sedimentary except two of its compounds, hydrogen sulphide (H_2S) and sulphur dioxide (SO_2), which add a gaseous component.
- Sulphur enters the atmosphere from several sources like volcanic eruptions, combustion of fossil fuels (coal, diesel etc.), from the surface of the ocean and gases released by decomposition.
- Atmospheric hydrogen sulphide also gets oxidised into sulphur dioxide.
- Atmospheric sulphur dioxide is carried back to the earth after being dissolved in rainwater as weak sulphuric acid (acid rain).
- Whatever the source, sulphur in the form of sulphates is taken up by plants and incorporated through a series of metabolic processes into sulphur bearing amino acid which is incorporated

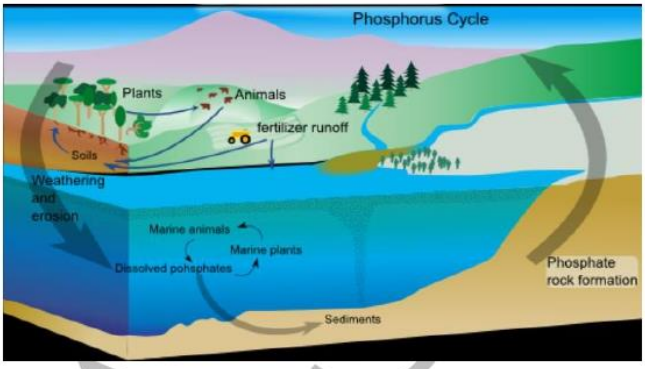
in the proteins of autotroph tissues. It then passes through the grazing food chain.

- Sulphur bound in a living organism is carried back to the soil, to the bottom of ponds and lakes and seas through excretion and decomposition of dead organic material.



14. PHOSPHORUS CYCLE

- Phosphorus is an essential nutrient for plants and animals.
- It is a part of DNA molecules, of molecules that store energy (ATP and ADP) and of fats of cell membranes. Phosphorus is also a building block of certain parts of the human and animal body, such as the bones and teeth.
- Phosphorus can be found on earth in water, soil and sediments. Unlike the compounds of other matter cycles phosphorus cannot be found in air in the gaseous state. This is because phosphorus is usually liquid at normal temperatures and pressures. It is mainly cycling through water, soil and sediments. In the atmosphere phosphorus can mainly be found as very small dust particles.
- Phosphorus moves slowly from deposits on land and in sediments, to living organisms, and then much more slowly back into the soil and water sediment. The phosphorus cycle is the slowest one of the matter cycles. The phosphorus cycle appears somewhat simpler than the nitrogen cycle, because phosphorus occurs in fewer chemical forms.

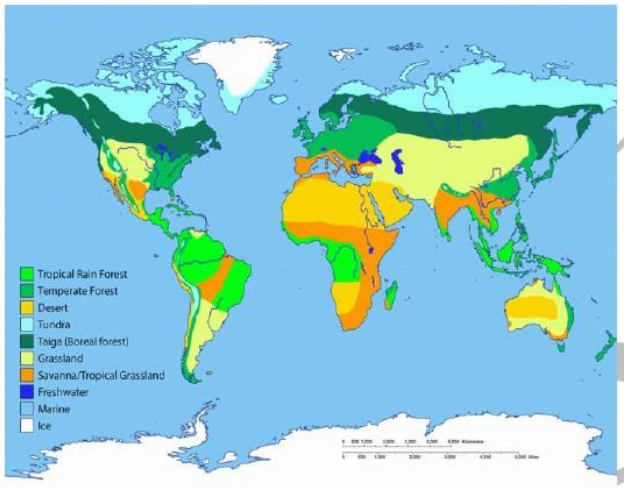


A natural ecosystem is an assemblage of plants and animals which functions as a unit and is capable of maintaining its identity.

There are two main categories of ecosystems: 1) Terrestrial ecosystem or Biomes and 2) Aquatic ecosystem.

15. Biomes or Terrestrial Ecosystems

- The terrestrial part of the biosphere is divisible into enormous regions called **biomes**.
- No two biomes are alike. They are characterized, by distinct climate (precipitation and temperature mainly), vegetation, animal life and general soil type.
- The climate determines the boundaries of a biome and abundance of plants and animals found in each one of them.



Tundra

- Arctic and Alpine Tundra Biome

Forest

- Taiga or Boreal Biome (Evergreen Coniferous forests)
- Temperate Deciduous Biome (North Western Europe – British Type Climate)
- Temperate Rainforest Biome
- Sub-Tropical Deciduous Biome in Eastern China, South Eastern USA
- Temperate Deciduous Biome (Mediterranean Climate)
- Tropical Deciduous Biome (Monsoon Climate)
- Savanna or Tropical Wet and Dry Biome
- Tropical Rain Forest Biome

Grassland

- Steppe or Temperate Grassland Biome
- Savanna or Tropical Wet and Dry Biome (Tropical Shrublands and Grasslands)

Desert

- Tropical and Mid Latitude Desert Biome

Tundra Biome

- There are two types of tundra – arctic and alpine.
- Alpine tundra occurs at high mountains above the tree line. E.g. High ranges of the Himalayas, Andes, Alps etc.
- There are **no trees** in the tundra (due to **permafrost**).
- The lowest form of vegetation like **mosses, lichens** are sparsely found on bare rocks.
- Coastal lowlands **reindeer moss** which provides the only pasturage for reindeers.
- In the summer, birds migrate north to prey on the numerous insects which emerge when the snow thaws.
- Insects have short life cycles which are completed during the favourable period of the year.
- Animals like the reindeer, arctic fox, wolves, musk-ox, polar bear, lemming, arctic hare, arctic willow live in tundra region.
- **Reptiles and amphibians are almost absent**.
- Most of the animals have **long life**, e.g. arctic willow has a life span of 150 to 300 years.
- They are protected from chillness by the presence of **thick cuticle and epidermal hair or fur**.
- Mammals **have a large body size and small tail and ear** to avoid the loss of heat from the surface.

Taiga or Boreal Biome

- Boreal forest soils are characterized by thin **podzols** and are rather poor. This is because:
- **The weathering of rocks proceeds slowly** in cold environments

- **the litter derived from conifer needle (leaf) is decomposed very slowly** and is not rich in nutrients (humus content is low).
- conifers do not shed their leaves frequently.
- The predominant vegetation is an evergreen coniferous forest with species such as spruce, fir and pine.
- The conifers require little moisture are best suited to this type of sub-Arctic climate.
- The productivity of boreal forest is lower than those of any other forest ecosystem.
- Animals found in this region include Siberian tiger, wolverine, lynx, wolf, bear, red fox, squirrel, and amphibians like Hyla, Rana, etc.

Temperate Deciduous Biome (North-Western Europe – British Type Climate)

- Soils of temperate forests are **podzolic** and fairly deep.
- The natural vegetation of this climatic type is **deciduous**.
- The trees shed their leaves in the cold season.
- This is an adaptation for protecting themselves against the winter snow and frost.
- Shedding begins in autumn, the 'fall' season. Growth begins in spring.
- Some of the common species include oak, elm, ash, birch, beech, and poplar.

Temperate Rainforest Biome

- This is a small biome in terms of area covered. The main stretch of this habitat is along the northwestern coast of North America from northern California through southern Alaska.
- There are also small areas in southern Chile, New Zealand, Australia and a few other places around the world.
- **Big coniferous trees** dominate this habitat, including Douglas fir, Western red cedar, Mountain hemlock, Western hemlock, Sitka spruce and Lodgepole pine.
- In addition to the trees, mosses and lichens are very common, often growing as **epiphytes**.
- Grizzly bears are the common mammals found in Alaska.

Steppe or Temperate Grassland Biome

- They are practically **treeless**, and the grasses are much shorter.
- Grasses are fresh and nutritious.
- Poleward, an increase in precipitation gives rise to a transitional zone of wooded steppes where some conifers gradually appear.
- Do not have much animal diversity.

Temperate Deciduous Biome (Mediterranean Climate)

- Trees with small broad leaves are widely spaced and never very tall.
- Regions with adequate rainfall are inhabited by low, broad-leafed evergreen trees (mostly evergreen oaks).
- **Fire** is an important hazardous factor in this ecosystem, and the adaptation of the plants enable them to regenerate quickly after being burnt.
- Plants are in a continuous struggle against heat, dry air, excessive evaporation and prolonged droughts.
- They are, in short **xerophytic (drought tolerant)**.

Tropical Deciduous Biome (Monsoon Climate)

- Tropical Monsoon Forests are also known as a drought-deciduous forest; dry forest; dry-deciduous forest; tropical deciduous forest.
- **Teak, neem, bamboos, sal, shisham, sandalwood, khair, mulberry** are some of the important species.

Savanna or Tropical Wet and Dry Biome

- The savanna landscape is typified by **tall grass and short trees**.
- The trees are deciduous, **shedding their leaves in the cool, dry season** to prevent excessive loss of water through transpiration, e.g. acacias.

- Trees usually have **broad trunks**, with water-storing devices to survive through the prolonged drought.
- Many trees are umbrella shaped, exposing only a narrow edge to the strong winds.
- Savanna biome is **rich in mammal, bird and reptile diversity**.

Tropical Rain Forest Biome

- High temperature and abundant rainfall support a luxuriant tropical rain forest.
- The equatorial vegetation comprises a multitude of evergreen trees, e.g. mahogany, ebony, dyewoods etc.
- In the coastal areas and brackish swamps, mangrove forests thrive.
- All plants struggle upwards (most epiphytes) for sunlight resulting in a peculiar layer arrangement (canopy).

Aquatic ecosystems

Aquatic ecosystems are water-based ecosystems. Lakes, ponds, estuaries, saltwater marshes, oceans, and thermal vents are all examples of aquatic ecosystems, but each has different characteristics.

Factors Limiting the Productivity of Aquatic Habitats

Sunlight

- Sunlight penetration rapidly diminishes as it passes down the column of water.
- The depth to which light penetrates a lake determines the extent of plant distribution.
- Suspended particulate matters such as clay, silt, phytoplankton, etc. make the water turbid.
- Turbidity limits the extent of light penetration and photosynthetic activity in a significant way.
- Based on light penetration and plant distribution they are classified as photic and aphotic zones.

Photic zone

- Photic (or "euphotic") zone is the portion that extends from the lake surface down to where the light level is 1% of that at the surface. The depth of this zone depends on the transparency of water.
- Photosynthetic activity is confined to the photic zone. Both photosynthesis and respiration activity takes place.

Aphotic zone

- The lower layers of the aquatic ecosystems, where light penetration and plant growth are restricted form the aphotic zone (profundal zone).
- Only respiration activity takes place in this zone. The aphotic zone extends from the end of the photic zones to bottom of the lake.

Dissolved Oxygen

- In freshwater the average concentration of dissolved oxygen is 10 parts per million by weight.
- This is 150 times lower than the concentration of oxygen in an equivalent volume of air.
- Oxygen enters the aquatic ecosystem through the air-water interface and by the photosynthetic activities of aquatic plants.
- Dissolved oxygen escapes the water body through the air-water interface and respiration of organisms (fish, decomposers, zooplankton, etc.).
- The amount of dissolved oxygen retained in water is also influenced by temperature.

Temperature

- Since water temperatures are less subject to change, the aquatic organisms have narrow temperature tolerance limit.
- As a result, even small changes in water temperature are a great threat to the survival of aquatic organism when compared to the changes in air temperatures in the terrestrial organisms.

16. Marine Ecosystem

- Marine ecosystems cover approximately 71% of the Earth's surface and contain approximately 97% of the planet's water.
- They generate 32% of the world's net primary production.
- They are distinguished from freshwater ecosystems by the presence of dissolved compounds, especially salts, in the water.
- Approximately 85% of the dissolved materials in seawater are sodium and chlorine. Seawater has an average salinity of 35 parts per thousand (ppt) of water.
- Actual salinity varies among different marine ecosystems.
- Marine ecosystems can be divided into many zones depending upon water depth and shoreline features:
- The **oceanic zone** is the vast open part of the ocean where animals such as whales, sharks, and tuna live.
- The **benthic zone** consists of substrates below water where many invertebrates live.
- The **intertidal zone** is the area between high and low tides. Other near-shore (neritic) zones can include estuaries, salt marshes, coral reefs, lagoons and mangrove swamps.
- In the deep water, hydrothermal vents may occur where chemosynthetic sulfur bacteria form the base of the food web.
- Aquatic ecosystems perform many important environmental functions. For example, they recycle nutrients, purify water, attenuate foods, recharge ground water and provide habitats for wildlife.

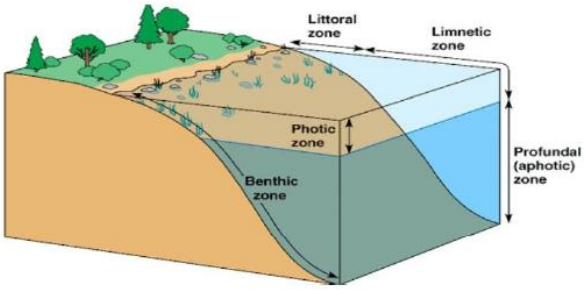
Aquatic Organisms

- The aquatic organisms are classified on the basis of their zone of occurrence.
- **Neuston:** These organisms live at the air-water interface, e.g. floating plants.
- **Periphyton:** These are organisms which remain attached to stems and leaves of rooted plants or substances emerging above the bottom mud such as sessile algae.
- **Plankton:** Microscopic floating organisms such as algae, diatoms, protozoans and larval forms are called plankton. This group includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton).
- The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems.
- **Nekton:** This group contains powerful swimmers that can overcome the water currents.
- **Benthos:** The benthic organisms are those found living at the bottom of the water mass.

17. Aquatic Ecosystems

- Aquatic ecosystems refer to plant and animal communities occurring in water bodies.
- Aquatic ecosystems are classified into two subgroups: 1) Freshwater ecosystems, such as rivers, lakes and ponds; 2) Marine ecosystems, such as oceans, estuary and mangroves.
- Aquatic ecosystems are classified on the basis of salinity into the following types:
- **Freshwater ecosystems:** water on land which is continuously cycling and has low salt content (**always less than 5 ppt**) is known as fresh water.
- There are two types of freshwater ecosystems: 1) Static or still water (Lentic) ecosystems, e.g. pond, lake, bogs and swamps. 2) Running water (Lotic) ecosystems, e.g. springs, mountain brooks, streams and rivers.
- **Marine ecosystems:** the water bodies containing salt concentration equal to or above that of seawater (i.e., **35 ppt or above**). E.g. shallow seas and open ocean.
- **Brackish water ecosystems:** these water bodies have salt content in between **5 to 35 ppt**.

e.g. **estuaries, salt marshes, mangrove swamps and forests**.



18. Wetland Ecosystem

- Wetlands are areas of marsh or peatland with water that is static or flowing, fresh, brackish or saline, including areas of marine water the depth of which at low tide does not exceed 6 m.
- Wetlands are **transition zones (**ecotone**)** between terrestrial and aquatic ecosystems.
- E.g. **Mangroves**, lake littorals (marginal areas between highest and lowest water level of the lakes), floodplains (areas lying adjacent to the river channels beyond the natural levees and periodically flooded during high discharge in the river) and other marshy or swampy areas.
- These habitats experience periodic flooding from adjacent deepwater habitats and therefore supports plants and animals specifically adapted to such shallow flooding or waterlogging.
- Waterlogged soil adapted plant life (**hydrophytes**), and **hydric soils (not enough O_2)** are the chief characteristics of wetlands.

Importance of Wetlands

- Wetlands are indispensable for the countless benefits or "ecosystem services" that they provide humanity, ranging from freshwater supply, food and building materials, and biodiversity, to flood control, groundwater recharge, and climate change mitigation.
- Wetlands are habitat to aquatic flora and fauna, numerous species of native and **migratory birds**.
- Wetlands are an important resource for sustainable tourism.
- They carry out water purification, filtration of sediments and nutrients from surface water.
- They help in nutrients recycling, groundwater recharging and stabilisation of local climate.
- Play an important role in flood mitigation by controlling the rate of runoff.
- Buffer (act as a riparian buffer) shorelines against erosion and pollutants.
- They act as a genetic reservoir for various species of plants (especially rice).

Reasons for depletion

- Excessive pollutants (Industrial effluents, domestic waste, agricultural runoff etc.) are dumped into wetlands beyond the recycling capacity.
- Habitat destruction and deforestation create ecological imbalance by altering the population of wetland species.
- Conversion of wetlands for agriculture and encroachment by public and mafia.
- Overfishing and fish farming (Aquaculture).
- Overgrazing in marshy soils.
- Removal of sand from beds near seas makes the wetland vulnerable to wave action and tidal bore.

Mitigation

- Demarcation of wetlands using the latest technology, proper enforcement of laws and stringent punishments for violators.
- Preventing unsustainable aquaculture and cultivation of shellfish.
- Treating industrial effluents and water from farmlands before discharging into wetlands.
- Utilizing wetlands on a sustainable basis by giving enough time for natural regeneration.
- Artificial regeneration for a quick recovery.
- Afforestation, weed control, preventing invasive species is the key to wetland conservation.
- Preventive measures to stop the introduction of exotic invasive species like **water hyacinth**.

- Soil conservation measures & afforestation.
- Preventing grazing in peripherals of wetlands.
- Wildlife conservation, sustainable tourism, eco-tourism and sensitizing local populace.
- Eutrophication abatement by processing nutrient rich discharge into the water body.
- Involving the local population in the conservation of wetlands.

Measures to Protect Wetlands

1. **Ramsar Convention on Wetlands**
2. **Ramsar Sites in India**
3. **Wetlands International**
4. **National Wetlands** Conservation **Programme (NWCP)**

19. National Wetlands Conservation Programme (NWCP)

- NWCP was implemented in the year 1985-86.
- Under the programme, 115 wetlands have been identified by the MoEF which require urgent conservation and management interventions.
- Criteria for identification of wetlands of national importance under NWCP are the same as those prescribed under the **Ramsar Convention on Wetlands**.

Objectives

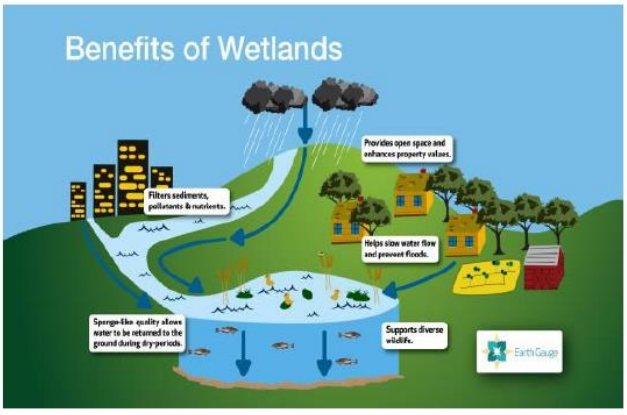
- to lay down policy guidelines for conservation and management of wetlands.
- to provide financial assistance for undertaking intensive conservation measures.
- to monitor the implementation of the programme.
- to prepare an inventory of Indian wetlands.

20. Ramsar Convention on Wetlands

- **International treaty** for "**the conservation and sustainable use of wetlands**".
- It is also known as the **Convention on Wetlands**.
- It is named after the city of **Ramsar in Iran**.
- At the time of joining the Convention, **each Contracting Party undertakes to designate at least one wetland site for inclusion in the List of Wetlands of International Importance**.
- The inclusion of a "Ramsar Site" in the List embodies the government's commitment to take the steps necessary to ensure that its ecological character is maintained.
- There are over 2,300 Ramsar Sites on the territories of 170 Ramsar Contracting Parties across the world.

The Montreux Record

- The Montreux Record is a **register of wetland sites** on the List of Wetlands of International Importance where **changes in ecological character** have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference.
- It is maintained as part of the **Ramsar List**.



Ramsar sites in india

As of February 2020, there are 37 Ramsar Sites in India.

21. Estuarine Ecosystem

An estuary is a place where a river or a stream opens into the sea (mouth of the river). It is a partially enclosed coastal area of brackish water (salinity varies between 0-35 ppt) with one or more rivers or streams flowing into it, and with a free connection to the open sea.

At the estuaries, freshwater carrying fertile silt and runoff from the land mixes with the salty sea water. Estuaries form a transition zone (ecotone) between river environments and maritime environments.

Examples of estuaries are river mouths, coastal bays, tidal marshes, lagoons and deltas.

Mangroves

Mangroves represent a characteristic littoral (near the seashore) forest ecosystem. These are mostly evergreen forests that grow in sheltered low lying coasts, estuaries, mudflats, tidal creeks backwaters (coastal waters held back on land), marshes and lagoons of tropical and subtropical regions.

Mangroves grow **below the high water level of spring tides**. The best locations are where abundant silt is brought down by rivers or on the backshore of accreting sandy beaches.

Mangroves are **highly productive ecosystems**, and the trees may vary in height from 8 to 20 m. They protect the shoreline from the effect of cyclones and tsunamis. They are breeding and spawning ground for many commercially important fishes.

Since mangroves are located between the land and sea, they represent the best example of **ecotone**. Mangroves are shrubs or small trees that grow in coastal saline or brackish water.

Mangroves are salt tolerant trees, also called **halophytes**, and are adapted harsh coastal conditions. Mangrove vegetation **facilitates more water loss**. Leaves are thick and contain salt-secreting glands. Some block absorption of salt at their roots itself.

They contain a complex salt filtration system and complex root system to cope with salt water immersion and wave action. They are adapted to the **low oxygen (anoxic)** conditions of waterlogged mud. They produce **pneumatophores (blind roots)** to overcome the respiration problem in the **anaerobic soil** conditions.

Mangroves occur worldwide in the **tropics and subtropics**, mainly between latitudes 25° N and 25° S. They require **high solar radiation** to filter saline water through their roots. This explains why mangroves are confined to only tropical and sub-tropical coastal waters.

Mangroves occur in a variety of configurations. Some species (e.g. **Rhizophora**) send arching prop roots down into the water. While other (e.g. **Avicennia**) send vertical "Pneumatophores" or air roots up from the mud. Adventitious roots which emerged from the main trunk of a tree above ground level are called stilt roots.

Prop roots

Silt roots

Mangroves in india

Importance of Mangroves

- Mangrove plants have (additional) special roots such as prop roots, pneumatophores which help to impede water flow and thereby enhance the **deposition of sediment in areas** (where it is already occurring), stabilise the coastal shores, provide a breeding ground for fishes.
- Mangroves moderate monsoonal tidal floods and reduce inundation of coastal lowlands.
- They prevent coastal soil erosion.
- They protect coastal lands from tsunami, hurricanes and floods.
- Mangroves enhance the natural recycling of nutrients.
- Mangrove supports numerous florae, avifauna and wildlife.
- Provide a safe and favourable environment for breeding, spawning, rearing of several fishes.
- They supply woods, firewood, medicinal plants and edible plants to local people.
- They provide numerous employment opportunities to local communities and augments their livelihood.

22. Coral Reefs

Coral reefs are the colonies of tiny living creatures that are found in oceans. They are the underwater structures that are formed of coral polyps that are held together by calcium carbonate. Coral reefs are also regarded as the tropical rainforest of the sea and occupy just 0.1% of the ocean's surface but are home to 25% of marine species. They are usually found in shallow areas at a depth less than 150 feet. However, some coral reefs extend even deeper, up to about 450 feet.

Coral bleaching

Coral bleaching occurs when coral polyps expel algae that live inside their tissues. Normally, coral polyps live in an endosymbiotic relationship with these algae, which are crucial for the health of the coral and the reef. The algae provides up to 90 percent of the coral's energy.

Factors affecting Coral Reefs

- **Extreme climate conditions:** High temperature of water leads to the declination of these corals as they cannot survive in high temperature. As estimated by scientists, most of the coral reefs of the world will soon decline with the increasing rates of ocean warming.
- **Overfishing:** It is another major concern as it is leading to an ecological imbalance of the coral reefs.
- **Coastal development:** Development of coastal infrastructure and tourist resorts on or close by these coral reefs causes significant damages.
- **Pollution:** The toxic pollutants which are dumped directly into the ocean can lead to the poisoning of the coral reefs as it increases the nitrogen level of the seawater leading to an overgrowth of algae.
- **Sedimentation:** Construction along the coasts and islands lead to soil erosion increasing the sediments in the river. As a result, it can smother corals by depriving them of the light needed to survive.

Growth conditions for Coral Reefs

- The temperature of the water should not be below 20°C. The most favourable temperature for the growth of the coral reefs is between 23°C to 25°C. The temperature should not exceed 35°C.
- Corals can survive only under saline conditions with an average salinity between 27% to 40%.
- Coral reefs grow better in shallow water having a depth less than 50 m. The depth of the water should not exceed 200m.

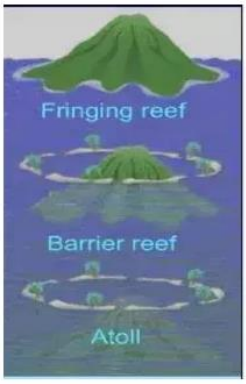
Types of Coral Reefs

Coral Reefs are differentiated into three categories based on their shape, nature and mode of occurrence.

Fringing Reef: The coral reefs that are found very close to the land and forms a shallow lagoon known as Boat Channel are called Fringing Coral Reefs. The Fringing Reefs develop along the islands and the continental margins. They grow from the deep bottom of the sea and have their seaward side sloping steeply into the deep sea.

Barrier Reef: Barrier Reefs are considered as the largest, highest and widest reefs among the three coral reefs. They develop off the coast and parallel to the shore as a broken and irregular ring. Being the largest reef among the all, they run for 100kms and is several kilometres wide. One example of Barrier Reef is the Great Barrier Reef of Australia which is 1200 mile long.

Atolls: An atoll can be defined as a reef that is roughly circular and surrounds a large central lagoon. This lagoon is mostly deep having a depth of 80-150 metres. The atolls are situated away from the deep sea platforms and are found around an island or on a submarine platform in an elliptical form.



23. Environment pollution

Pollution is **any undesirable change in physical, chemical or biological characteristics of air, land, water or soil. Agents that bring about such an undesirable change are called as pollutants.**

Pollutants can be solid, liquid or gaseous substances present in greater concentration than in natural abundance and are produced due to human activities or due to natural happenings.

Harmful effects of pollution

Pollution currently poses one of the greatest public health and human rights challenges, disproportionately affecting the poor and the vulnerable.

- Pollution is not just an environmental issue, but affects the health and well-being of entire societies.
- Despite the huge impacts on human health and the global economy, and the opportunity to apply simple and affordable solutions, pollution has been undercounted and insufficiently addressed in national policies and international development agendas.
- Pollution of all kinds can have negative effects on the environment and wildlife and often impacts human health and well-being.

Classification of pollutants:

The classification of pollutants is done from different point of view:

Depending upon their **existence** in nature pollutants are of two types: namely **quantitative and qualitative pollutants**

- **Quantitative pollutants:** These are those substances normally occurring in the environment, that acquire the status of a pollutant when their concentration gets increased due to the un-mindful activities of man. For example: carbon dioxide
- **Qualitative pollutants:** These are those substances which do not normally occur in nature but are added by man, for example, insecticides.

Depending upon the **form** in which they persist after being released into the environment, the pollutants are categorized into two types, namely **primary and secondary pollutants:**

- **Primary Pollutants**: These are those which are emitted directly from the source and persist in the form in which they were added to the environment. Examples: ash, smoke, fumes, dust, nitric oxide, sulphur dioxide, hydrocarbons etc.
- **Secondary Pollutants**: These are those which are formed from the primary pollutants by chemical interaction with some constituents present in the atmosphere. Examples are Sulphur trioxide, nitrogen dioxide, aldehydes, ketones, ozone etc.

From the **ecosystem point of view**, i.e., according to their natural disposal, pollutants are of two types:

- **Non-degradable Pollutants**: These are the substances that either do not degrade or degrade very slowly in the natural environment. Example: mercury salts, long chain phenolic chemicals, DDT and Aluminum cans etc.
- **Bio-degradable Pollutants**: These are the pollutants that are quickly degraded by natural means. Heat or thermal pollution, and domestic sewage are considered in this category as these can be rapidly decomposed by natural processes or by engineered systems such as municipal treatment, plants etc.

Air pollution

Air pollution may be defined as the presence of any solid, liquid or gaseous substance including noise and radioactive radiation in the atmosphere in such concentration that may be directly and indirectly injurious to humans or other living organisms, plants, property or interferes with the normal environmental processes.

Air pollutants are of two types

- suspended particulate matter, and
- gaseous pollutants like carbon dioxide (CO_2), NOx etc.

CAUSES OF AIR POLLUTION:

- **Burning fossil fuels** releases gases and chemicals into the air. **Air pollution in the form of carbon dioxide and methane raises the earth's temperature.**
- **Smog or ground-level ozone** occurs when emissions from combusting fossil fuels react with sunlight. **Smog can irritate the eyes and throat** and also **damage the lungs**.
- **Soot, or "particulate matter,"** is made up of tiny particles of chemicals, soil, smoke, dust, or allergens, in the form of gas or solids that are carried in the air.
- **Hazardous air pollutants** are emitted during **gas or coal combustion.**
- **Sulphur dioxide** is produced from burning coal in thermal power plants.
- **Carbon monoxide** is produced from the incomplete burning of carbon-based fuels.
- **Chloroflorocarbons** are released mainly from air conditioning systems and refrigeration.

GOVERNMENT INITIATIVES TO COMBAT AIR POLLUTION

- **Notification of National Ambient Air Quality Standards 2009**, forecasting 12 pollutants to indicate the level of air quality for protection of public health and sector-specific emission and effluent standards for industries.
- Setting up of monitoring network for assessment of ambient air quality in different cities
- Introduction of cleaner or alternate fuel like CNG, LPG etc and ethanol blending.
- Launching of National Air Quality Index (AQI).
- Pass over from BS-IV to BS-VI standards for vehicles by 1st April 2020.

24. GREENHOUSE GASES AND GLOBAL WARMING:

Greenhouse gases are another source of air pollution. Greenhouse gases such as carbon dioxide and methane occur naturally in the atmosphere. In fact, they are necessary for life on Earth. They absorb sunlight reflected from Earth, preventing it from escaping into space. By trapping heat in the atmosphere, they keep Earth warm enough for people to live. This is called the **greenhouse effect.**

But human activities such as burning fossil fuels and destroying forests have increased the amount of greenhouse gases in the atmosphere. This has increased the greenhouse effect, and average temperatures across the globe are rising.

GLOBAL WARMING

- Increase in worldwide average temperatures, caused in part by human activity, is called **global warming.**
- **Global warming is causing ice sheets and glaciers to melt**. The melting ice is causing sea levels to rise at a rate of 2 millimeters (0.09 inches) per year.
- The rising seas will eventually flood low-lying coastal regions. Entire nations, such as the islands of Maldives, are threatened by this climate change.

Lifetime and potential of GHG

Types of Greenhouse Gases

GHG Categories	GWP Value*	Major Sources
Carbon dioxide (CO_2)	1	Fossil fuel combustion, deforestation
Methane (CH_4)	25	Landfills, rice paddies, digestive tracts of cattle and sheep
Nitrous oxide (N_2O)	298	Fertilizer, animal waste
Hydrofluorocarbons (HFCs)	Varies (up to 14,800)	Semiconductor manufacturing and other industrial processes
Perfluorocarbons (PFCs)	Varies (up to 12,200)	Same as HFCs, plus aluminum smelting
Sulfur hexafluoride (SF_6)	22,800	Electrical transmission systems, magnesium and aluminum production

* Global warming potential

Source: U.S. Environmental Protection Agency

EFFECTS OF AIR POLLUTION:

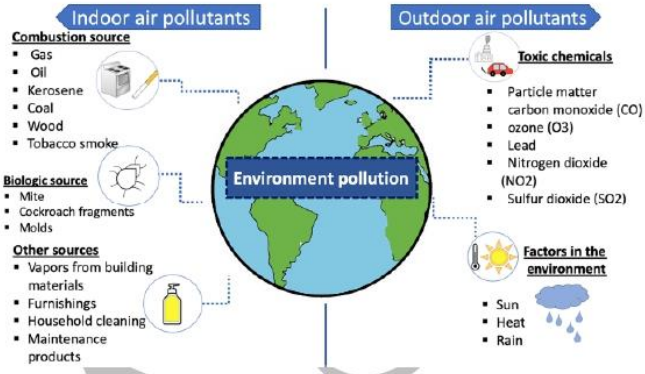
Ocean acidification is a direct consequence of increased human-induced carbon dioxide (CO_2) concentrations in the atmosphere. CO_2 dissolves in **sea** water it forms carbonic acid, thereby decreasing the **ocean's** pH, leading to a suite of changes collectively known as **ocean acidification**

It has the potential to **change marine ecosystems** and impact many ocean-related benefits to society

Changes in species growth and reproduction, as well as **structural and functional alterations in ecosystems**, will **threaten food security, harm fishing industries** and **decrease natural shoreline protection.**

It will also increase **the risk of inundation and erosion** in low-lying areas, thereby hampering climate change adaptation and disaster risk reduction efforts.

Chloroflorocarbons (CFCs) damage the ozone layer, a region in Earth's upper atmosphere. The ozone layer protects Earth by absorbing much of the sun's harmful ultraviolet radiation. When people are exposed to more ultraviolet radiation, they are more likely to develop **skin cancer, eye diseases, and other illnesses.**

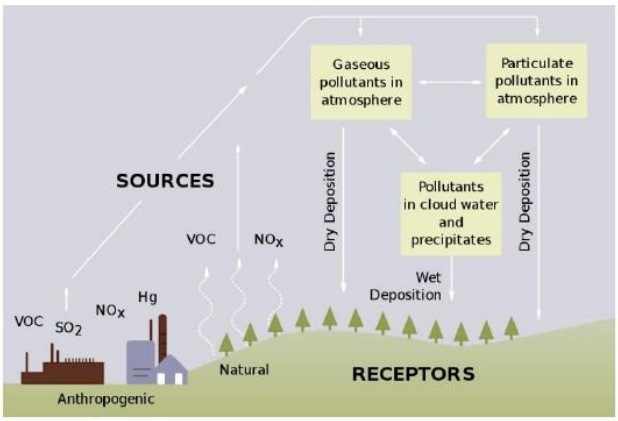


Acid Rain:

Normally rain water has a pH of 5.6 due to the presence of H+ ions formed by the reaction of rain water with carbondioxide present in the atmosphere.

When the pH of the rain water drops below 5.6, it is called acid rain.

It refers to the ways in which acid from the atmosphere is deposited on the earth's surface. Oxides of nitrogen and sulphur which are acidic in nature can be blown by wind along with solid particles in the atmosphere and finally settle down either on the ground as dry **deposition** or in water, fog and snow as **wet deposition.**



SMOG

The word smog is derived from smoke and fog. It is **caused by the burning of large amounts of coal,**

vehicular emission and industrial fumes(Primary pollutants), that react in the atmosphere with sunlight to form secondary pollutant.

This is the most common example of air pollution that occurs in many cities throughout the world.

There are two types of smog:

- **Classical smog** occurs in cool humid climate. It is a mixture of smoke, fog and sulphur dioxide. Chemically it is a reducing mixture and so it is also called as reducing smog.
- **Photochemical smog** occurs in warm, dry and sunny climate. The main components of the photochemical smog result from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides produced by automobiles and factories.

Fly ash

Fly ash is a fine powder, which is the by-product of burning coal in thermal power plants.

Fly ash **includes substantial amounts micron sized earth elements of oxides of silica, aluminium and calcium.** Element like Arsenic, Boron, Chromium, lead etc. are also found in trace concentrations.

Table 2.4 : TLV and Biological Effects of Some Common Gaseous Pollutants

Pollutants	TLV in ppmv		Biological Effects
	TWA	STEL	
Carbon monoxide (CO)	50	400	O_2 transportation by haemoglobin is affected Cardio-vascular system is affected. May caus death.
Hydrogen sulphide (H_2S)	10	15	Irritates eyes and the entire respiratory tract.
Chlorine (Cl_2)	1	3	Irritates eyes, skin and the respiratory trac Damages lungs. At high concentration cause death.
Ammonia (NH_3)	25	35	Irritates skin, respiratory tract, mucous mem branes and eyes. At high concentration cause serious edema, asphyxia and finally death.
Nitrogen oxides :			
NO	25	—	Less toxic than NO_2.
NO_2	5	—	Irritates eyes, throat and lungs. At high concen tration causes pulmonary edema and finally death
Ozone (O_3)	0.1	0.3	Irritates eyes, throat and lungs. Causes pulmonar congestion, asthma, edema.
Sulphur dioxide (SO_2)	2	5	Irritates conjunctiva, upper respiratory tract an throat. At high concentration causes death.

Environmental concerns with fly ash:

- Fly ash is a major source of PM 2.5, fine, pollution particles, in summer it causes air pollution.
- It becomes air borne, and gets transported to a radius of 10 to 20 kms. It can settle on water and other surfaces. It can also contaminate water and soil systems.
- Fly ash contains heavy metals from coal, a large amount of PM 2.5 and black carbon (BC). Proper disposal of fly ash is still not happening in many places.
- The wet disposal of Fly ash results in leaching of toxic heavy metals in ground water system.

Advantages of Fly Ash Utilization

- **Prevents Soil Erosion**– Helps restrict usage of topsoil for manufacturing of bricks.
- Used in variety of **construction works**– Fly ash is a proven resource material for many applications of construction industries, like Flyash bricks have been found to show better strength.
- Fly ash can be used as a replacement for some of the **Portland cement** contents of concrete. It is environmentally beneficial because it reduces the Portland cement, a major contributor of CO2, required in concrete.

Government Measures to promote Fly Ash Utilization

- Maharashtra has become the first state to adopt **Fly Ash Utilization Policy**, paving way for prosperity by generating "wealth from waste", and environment protection.
- **Central Electricity Authority (CEA)** has been **monitoring the fly ash generation** and its utilization in the country at coal/ lignite based thermal power stations since 1996-97.
- The Ministry of Environment, Forests and Climate Change (MoEFCC) issued **notifications on Fly Ash Utilization in 2016** that had following feature so Mandatory uploading of details of fly ash available on Thermal Power Station's (TPS) website
- Increase in **mandatory jurisdiction** of area of application from 100 km to 300 km;
- Cost of transportation of fly ash to be borne entirely by TPS up to 100 km.

- A mobile app for ash management- **ASH TRACK** was created to help establish a link between fly ash users and power plant executives.

Noise pollution

Unwanted or excessive sound that can have deleterious effects on human health and environmental quality

Noise pollution is commonly generated inside many industrial facilities and some other workplaces, but it also comes from highway, railway, and airplane traffic and from outdoor construction activities.

However, exposure to excessive noise can affect your health and damage hearing**. Harmful or annoying levels of noise are considered noise pollution or sound pollution.**

Noise is measured in term of **decibels** (dB), as per WHO (World Health Organization) has prescribed optimum noise level as 45 dB by day to 35 dB at night.

Impacts of noise pollution:

- **Hypertension:** a direct result of noise pollution caused elevated blood levels for a longer period of time.
- **Hearing loss:** It can be directly caused by noise pollution, such as around 140 dB for adult or 120 dB for children.
- **Sleep disturbances** are usually caused by constant air or land traffic at night, and they are a serious condition in that they can affect everyday performance and lead to serious diseases.
- **Child development:** Children appear to be more sensitive to noise pollution, are known to affect children, from hearing impairment to psychological and physical effects.
- Various **cardiovascular dysfunctions**: Elevated blood pressure caused by noise pollution, especially during the night, can lead to various cardiovascular diseases.
- **Dementia**
- **Psychological dysfunctions and noise annoyance**

Laws Governing Noise Pollution

- Air (Prevention and Control of Pollution) Act, 1981: It includes 'Noise' as an air pollutant.
- Noise Pollution (Regulation and Control) Rules, 2000: It defines and regulates noise pollution and its sources.
- Environment (Protection) Rules, 1986: It prescribes noise standards for motor vehicles, air-conditioners, refrigerators, diesel generators and certain types of construction equipment.
- Noise emanating from industry is regulated by State Pollution Control Boards / Pollution Control Committees (SPCBs / PCCs) for states / Union territories under the Air (Prevention and Control of Pollution) Act, 1981.

Water pollution

Water pollution is the contamination of natural water present in lakes, rivers, streams, oceans, and groundwater due to inflow or deposition of pollutants directly or indirectly into the water systems.

Any modifications or change in the chemical, physical and biological properties of water that can cause any harmful consequences on living things and the environment is **known as water pollution.**

Polluted water not only does this spell disaster for aquatic ecosystems, the pollutants also seep through and reach the groundwater, which might end up in our households as contaminated water we use in our daily activities, including drinking.

Causes of Water Pollution:

- **Industrial effluents**: Industrial effluents have a complex nature of pollutants and include organic and inorganic substances like pharmaceutical residues, dyes, and metals, requiring treatment before discharge in wastewater streams.
- **Social and Religious Practices**: The religious activities are deeply rooted in its cultural heritage; millions of people take holy bath and perform religious activities
- **Use of Detergents and Fertilizers:** Many laundry detergents contain approximately 35 percent to

75 percent **phosphate salts. Over enrichment of phosphate can cause the water body** to become **choked with algae and other plants**.

- **Agricultural run-offs- Use of insecticides and pesticides**: Agricultural Runoff (**non-point source**) is water from farm fields due to irrigation, rain, or melted snow that flows over the earth that can absorb into the ground, enter bodies of waters or evaporate.
- **Mining activities:** Mining activities emit several metal waste and sulphides from the rocks and is harmful for the water.
- **Accidental leakage Marine pollution:** Oil spill pose a huge concern as large amount of oil enters into the sea which does not dissolve with water; there by opens problem for local marine wildlife such as fish, birds and sea otters etc.
- **Burning of fossil fuels**: Fossil fuels like coal and oil when burnt produce substantial amount of ash in the atmosphere. The particles which contain toxic chemicals (often of sulfur, which is present in coal) when mixed with water vapor result in acid rain.
- **Facilities handling radioactive materials**: The element that is used in production of nuclear energy is Uranium which is a highly toxic chemical.
- Nuclear waste can have serious environmental hazards if not disposed-off properly.
- **Urban development and run off** : As more cities and towns are developed, they have resulted in increased use of fertilizers to produce more food, soil erosion due to deforestation, increase in construction activities, inadequate sewer collection and treatment, landfills as more garbage is produced, increase in chemicals from industries to produce more materials.

Sources of water pollution:

Classifications of water pollution according to identifiability, can be either a Point or a Non-point source

Point Source:

When **contamination originates from a single source**, it's called point source pollution.

Point source pollution can include:

- on-site septic systems
- leaky tanks or pipelines containing petroleum products
- municipal landfills
- livestock wastes
- industrial/factory wastewater
- municipal sewage treatment plants

Non-point source:

- Nonpoint source pollution is **contamination derived from diffuse sources.**
- Nonpoint source pollution is the leading cause of water pollution, but it's difficult to regulate, since there's no single, identifiable culprit.

These include:

- Excess fertilizers, herbicides and insecticides from agricultural lands and residential areas.
- Oil, grease and toxic chemicals from urban runoff and energy production.
- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks.
- Salt from irrigation practices and acid drainage from abandoned mines.
- Bacteria and nutrients from livestock, pet wastes and faulty septic systems.

Eutrophication:

'Eu' means well or healthy and 'trophy' means nutrition. The enrichment of water bodies with nutrients causes eutrophication of the water body. Discharge of domestic waste, agricultural surface runoff, land drainage and industrial effluents in a water body leads to rapid nutrients enrichment in a water body. The excessive nutrient enrichment in a water body encourages the growth of algae duckweed, water hyacinth, phytoplankton and other aquatic plants. The

biological demand for oxygen (BOD) increases with the increase in aquatic organisms. As more plants grow and die, the dead and decaying plants and organic matter acted upon by heterotrophic protozoans and bacteria, deplete the water of dissolved oxygen (DO). Decrease in DO result in sudden death of large population of fish and other aquatic organisms including plants, releasing offensive smell and makes the water unfit for human use. The sudden and explosive growth of phytoplankton and algae impart green colour to the water is known as water bloom, or "**algal blooms**". These phytoplankton release toxic substances in water that causes sudden death of large population of fishes. This phenomenon of nutrient enrichment of a water body is called eutrophication. Human activities are mainly responsible for the eutrophication of a growing number of lakes and water bodies in the country.

Measurement of quality of water:

Dissolved Oxygen(DO): It is a measure of the amount of free oxygen available in river systems. Presence of organic and inorganic wastes in water decreases the dissolved oxygen content of the water. DO below 8 ppm (Parts Per Million) indicates pollution and below 4 ppm indicates heavy pollution. In unpolluted water, DO should be about 14 ppm.

Biological oxygen demand(BOD): is the amount of oxygen that will be consumed by bacteria or other aerobic microorganisms while decomposing organic matter under aerobic conditions. As tested, it is expressed in milligrams of oxygen consumed per liter of sample during a fixed incubation period. It is generally used as an indicator of the amount of organic pollution in a water sample. So, the BOD in polluted waters will generally be higher than in clean water. The higher value of BOD indicates low DO content of water. Since BOD is limited to biodegradable materials only. Therefore, it is not a reliable method of measuring pollution in water.

Chemical oxygen demand(COD): it is a slightly better mode used to measure pollution load in water. COD measures the amount of oxygen that will be consumed by the chemical breakdown, or oxidation (degeneration) of organic pollutants in water. The measurement of COD is also expressed in milligrams per liter under a specific oxidizing agent, temperature and time and can be completed in hours. This measurement looks for the oxygen consumed by a specific chemical oxidation process, and is not a substitute for BOD, or DO. It also is an indicator of the amount of organic pollution in a water sample. The COD is less specific than BOD as it measures the oxygen consumption for any pollutant that can be chemically oxidized, versus BOD which is only that portion which is biodegradable.

Invasive species: Invasive plant species water hyacinth aquatic weed, also called 'Terror of Bengal' destroy micro environment to their advantage by producing allelochemicals which cause the destruction of native species and local biodiversity.

Government Efforts to control the Ground Water Pollution

- "A Master Plan for Artificial Recharge of Groundwater" has been developed by the **Central Ground Water Board (CGWB) in 2013**. According to this plan, over **85 billion cubic metres** will be recharged in rural and urban areas in a phased manner by 2023.
- **Legislations and programmes to protect groundwater :** Water (Prevention and Control of Pollution) Act, 1974; Environmental Protection Act, 1986; the creation of Arsenic task force in West Bengal in 2005 and the launch of Salinity Ingress Prevention Scheme in Gujarat in 2008.
- **Atal bhujal Yojna**, a central sector scheme to improve groundwater management and restore the health of country's acquifers.
- **National Project on Aquifer Management (2016):** The project proposes to cover 1.4 million sq km under aquifer mapping between 2017 and 2022.
- **National Water Policy 2012** which proposes a framework for creation of a system of laws and institutions and for a plan of action with a unified national perspective.

- **National Aquifer Mapping and Management Programme**: It was initiated as a part of the Ground Water Management and Regulation scheme to delineate and characterize the aquifers to develop plans for ground water management.
- **Atal Jal Yojana:** It aims to conserve groundwater in seven states facing the biggest declines in aquifer levels mainly due to over-extraction for water-intensive crops. These are Maharashtra, Haryana, Karnataka, Rajasthan, Madhya Pradesh, Uttar Pradesh and Gujarat.
- **Paani Bacho, Paise Kamao**" (save water, earn money) scheme: It was launched by Punjab State Power Corporation Limited (PSPCL) to provide direct benefit transfer for electricity to agricultural consumers. Farmers get Rs 4 as direct benefit for each unit of electricity saved.

jal jeevan mission

The Union Minister for Finance while presenting the budget **announced Jal Jeevan Mission to ensure HarGharJal (piped water supply) to all rural households by 2024.**

composite water management index 2.0

NITI Aayog in association with Ministry of JAL Shakti and Ministry of Rural Development released Composite Water Management Index 2.0

NITI Aayog first launched and conceptualized the Composite Water Management Index in 2018 as a tool to instill a sense of cooperative and competitive federalism among the states.

Radioactive pollution:

The radioactive pollution is defined as the physical pollution of living organisms and their environment as a result of release of **radioactive substances** into the environment during **nuclear explosions** and **testing of nuclear weapons**, **nuclear weapon production** and decommissioning, **mining of radioactive ores**, handling and disposal of radioactive waste, and **accidents at nuclear power plants.**

Radioactivity is a phenomenon of **spontaneous emission of particles such as protons (alpha particles), electrons (beta particles), and gamma rays (short wave electromagnetic radiation) due to the disintegration of atomic nuclei of some elements.**

It's **generated by uranium mining, nuclear power plants, and the production and testing of military weapons,** as well as by universities and hospitals that use radioactive materials for research and medicine.

Sources of Radioactive Radiations

Natural Sources: They include cosmic rays from space and terrestrial radiations from radio-nuclides present in earth's crust such as radium-224, uranium-238, thorium-232, potassium-40, carbon-14 etc.

Man-made Sources:

- Nuclear power plants
- Nuclear weapons
- Transportation of nuclear material
- Disposal of nuclear waste
- Uranium mining
- Radiation therapy

Effects:

- They include **x-rays, gamma rays, cosmic rays and other atomic radiations caused by the emissions of radioactive elements.**
- Ionizing radiation has **high penetration power** and can cause a breakage of macro-molecules
- The molecular damage may produce short range (immediate) and long range (delayed) effects.
- **Short range effects include burns, impaired metabolism, dead tissues and death of several organisms.**
- **Long range effects include mutations leading to increased incidence of tumours and cancers, shortening of life-span and developmental.** The mutated gene can persist in living organisms and may affect their progeny.

Soil pollution

- Soil pollution is defined as the **presence of toxic chemicals (pollutants or contaminants) in soil, in high enough concentrations to pose a risk** to human health and/or the ecosystem.
- In the case of contaminants which occur naturally in soil, even when their levels are not high enough to pose a risk, **soil pollution is still said to occur if the levels of the contaminants in soil exceed the levels that should naturally be present.**
- Soil contamination or soil pollution can occur either because of human activities or because of natural processes. However, mostly it is due to human activities.
- The soil contamination can occur due to the **presence of chemicals such as pesticides, herbicides, ammonia, petroleum hydrocarbons, lead, nitrate, mercury, naphthalene, etc** in an excess amount.

25. Land degradation

Land degradation—the **deterioration or loss of the productive capacity of the soils for present and future**—is a global challenge that affects everyone through food insecurity, higher food prices, climate change, environmental hazards, and the loss of biodiversity and ecosystem services.

Land degradation is **caused by** multiple forces, including **extreme weather conditions** particularly drought, and human activities that pollute or degrade the quality of soils and land utility negatively affecting food production, livelihoods, and the production and provision of other ecosystem goods and services.

India faces a severe problem of land degradation. About **32% of the Total Geographical Area o**f the country is undergoing the process of desertification/land degradation.

A **2016 report by the ISRO** found that about 29% of India's land (in 2011-13) was degraded, this being a 0.57% increase from 2003-05.

At the **COP-13, India had committed to restoring 13 million hectares** of degraded and deforested land by the year 2020 and an additional 8 million hectares by 2030.

Land degradation is happening at an alarming pace, contributing to a dramatic decline in the productivity of croplands and rangelands worldwide.

Threats to land integrity:

Land degradation has accelerated during the 20th century due to increasing and combined pressures of **agricultural and livestock production** (over-cultivation, overgrazing, forest conversion), **urbanization, deforestation, and extreme weather events such as droughts and coastal surges which salinate land.**

Desertification:

Desertification is a type of land degradation in which a relatively dry land region becomes increasingly arid. Desertification leads to losing bodies of water as well as vegetation and wildlife.

India was the signatory to United Nations Convention to Combat Desertification in Paris on June 17, 1994. The main agenda of this convention is **to achieve land degradation neutrality by 2030**.

Deforestation:

Deforestation is the **permanent removal of trees to make room for something besides forest.** This can include clearing the land for agriculture or grazing, or using the timber for fuel, construction or manufacturing.

Overgrazing:

Overgrazing occurs when the consumption of vegetation biomass by livestock and other grazers (e.g., wildlife) exceeds the vegetation's ability to recover in a timely fashion, thus exposing the soil and reducing the vegetation's productive capacity.

26. Soil Salinity:

Soil salinity is a measure of the concentration of all the soluble salts in soil water.

Factors affecting soil salinity:

Several factors affect the amount and composition of salts in soils:

- **Irrigation water quality** – The total amount of dissolved salts in the irrigation water, and their composition, influence the soil salinity.
- **Fertilizers applied –Overuse and misuse of fertilizers** leads to salinity buildup, and should be avoided.
- **Irrigation regimen and type of irrigation system** – The higher the water quantity applied, the closer soil salinity is to irrigation water salts concentration.

27. Soil Erosion:

Soil erosion is a **naturally occurring process** that affects all landforms. In agriculture, soil erosion refers to the **wearing-away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage.**

Land conservation measures

CoP 14: un convention on desertification

14th Conference of Parties (CoP14) of the UNCCD was **convened in India for the first time.**

Outcomes :

- **Adoption of Delhi Declaration**: Commitment for a range of issues, including gender and health, ecosystem restoration, taking action on climate change, private sector engagement, Peace Forest Initiative and recovery of five million hectares of degraded land in India.
- **Drought Toolbox:** It is a sort of knowledge bank which contains tools that strengthen the ability of countries to anticipate and prepare for drought effectively and mitigate their impacts.
- **International coalition for action on Sand and Dust storms** (SDS): SDS source base map will be developed with the goal of improving monitoring and response to these storms.
- **Sustainability, Stability and Security (3S) initiative:** Launched by 14 African countries to address migration driven by land degradation and aims at restoring land and creating green jobs for migrants and vulnerable groups.
- **Youth Caucus on Desertification and Land convened** its first official gathering in conjunction with the UNCCD COP14 to bring together youth advocates from different parts of the world, to build their capacity, share knowledge, build networks and to engage them meaningfully in the UNCCD processes.

United Nations Convention to Combat Desertification (UNCCD)

- It is one of the three Conventions that **came out of the historic 1992 Earth Summit in Rio de Janeiro including UN Framework Convention on Climate Change** and Convention on Biological Diversity.
- It was established **in 1994,** it is **sole legally binding international agreement that links environment & development to sustainable land management.**
- The **2018 – 2030 Strategic Framework of convention is** a comprehensive international commitment to **attain Land Degradation Neutrality (LDN) aiming** for:
- Restoration of productivity of degraded land.
- Enhancing the livelihoods of people dependent on them.
- Mitigating the impact of droughts on vulnerable populations.
- India is also **a part of the Bonn Challenge**, which is an international effort to bring 150 million hectares of the world's **degraded and deforested land into restoration by 2020, and 350 million hectares by 2030.**

28. Land Degradation Neutrality (LDN)

- UNCCD defines LDN as a state whereby the amount and quality of land resources which is necessary to support ecosystem functions and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems.

Steps taken to achieve LDN

- **LDN Target Setting Programme:** Under this, UNCCD is supporting interested countries in the national land degradation neutrality (LDN) target setting process, including the definition of national baselines, targets and associated measures to achieve LDN.
- **Creation of an LDN fund** to invest in bankable projects on land rehabilitation and sustainable land management worldwide including sustainable agriculture, sustainable livestock management, agroforestry, etc.
- **Global Land Outlook** by UNCCD demonstrates the central importance of land quality to human wellbeing, assesses current trends in land conversion, degradation and loss, identifies the driving factors and analyzes the impacts etc.

In India:

- **National Action Plan (NAP)** to combat desertification was launched in 2001 for 20 years.
- **Desertification and Land Degradation Atlas (2016)** of entire country was prepared by ISRO and 19 other partners using Indian remote sensing satellites data in GIS environment.
- Schemes like Integrated Watershed Development Program, Per Drop More Crop, National Afforestation Program, National Green Mission, etc. have components to tackle Land degradation.

29. Waste and its management

SOLID WASTE:

"**Solid waste**" means any garbage or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, resulting from industrial, commercial, mining, and agricultural operations, and from community activities.

It is important to note that the definition of solid waste is not limited to wastes that are physically solid. Many solid wastes are liquid, semi-solid, or contained gaseous material.

Types of Solid Waste:

It can be classified into different types **depending on their source:**

Municipal Solid Waste (MSW): It consists of household waste, construction and demolition debris (CnD), sanitation residue, and waste from streets, generated mainly from residential and commercial complexes.

Industrial Solid Waste (ISW): In a majority of cases it is termed as hazardous waste as they may contain toxic substances, are corrosive, highly inflammable, or react when exposed to certain things e.g. gases.

Biomedical waste or hospital waste: It is usually infectious waste that may include waste like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc., usually in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc.

Hazardous Waste: "Hazardous waste" means any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances.

Bioremediation

Bioremediation technologies **utilize naturally occurring microorganisms**, such as bacteria, fungi, and yeast, **to degrade hazardous substances into non-toxic or less toxic substances**.

Bioremediation related technologies

- **Bioventing** – an in situ remediation technology that uses microorganisms to biodegrade organic constituents in the groundwater system.
- **Bioleaching** – extraction of metals from their ores through the use of living organisms instead of using harmful chemical substances such as cyanide etc.,
- **Land farming**– ex-situ waste treatment process that is performed in the upper soil zone or in biotreatment cells. Contaminated soils, sediments, or sludges are transported to the Landfarming site, incorporated into the soil surface and periodically turned over to aerate the mixture
- **Composting** – Aerobic bacteria and fungi decompose the organic matter into compost used as fertilizer.
- **Bio-augmentation** – the addition of Achaea or bacterial cultures required to speed up the rate of degradation of a contaminant.
- **Bio-stimulation** – modification of the environment to stimulate existing bacteria capable of bioremediation.

Treatment methods for solid waste:

- **Thermal treatment: Incineration is the combustion of waste in the presence of oxygen, so that the waste is converted into carbon dioxide, water vapour and ash**. Also labeled Waste to Energy (WtE) method, it is a means of recovering energy from the waste.
- **Pyrolysis and gasification:** In this method, thermal processing is in complete absence of oxygen or with less amount of air.
- **Biological treatment methods:** This involves **using micro-organisms to decompose** the biodegradable components of waste. The 2 types of processes:
- **Aerobic:** This needs the presence of oxygen and includes windrow composting, aerated static pile composting & **in-vessel composting, vermiculture**
- **Anaerobic digestion:** Takes place in the absence of oxygen.