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ENVIRONMENT

CONCEPTS



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ECOSYSTEM AND ITS DYNAMICS

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.

■ Components of Environment:

- **Abiotic Components:** Soil, Topography, Water, Atmosphere etc.
- **Biotic Components:** 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.

What is 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.
- Biosphere is affected and modified by certain factors directly or indirectly. These factors are called as modifiers. Three types of biosphere modifiers are known:
 - ▶ **Physical modifiers:** They affect the biosphere by change in air quality, air flow, temperature changes, water flow, fire, excavation and construction works.
 - ▶ **Chemical modifiers:** It alters the chemical composition of air, water and soil. It may be brought in due to multitude of pollutants.
 - ▶ **Biological modifiers:** Biological factors like cropping patterns, population pressures, manipulations of species density or distribution and species genetics can also modify the biosphere equilibrium.

What is Ecology?

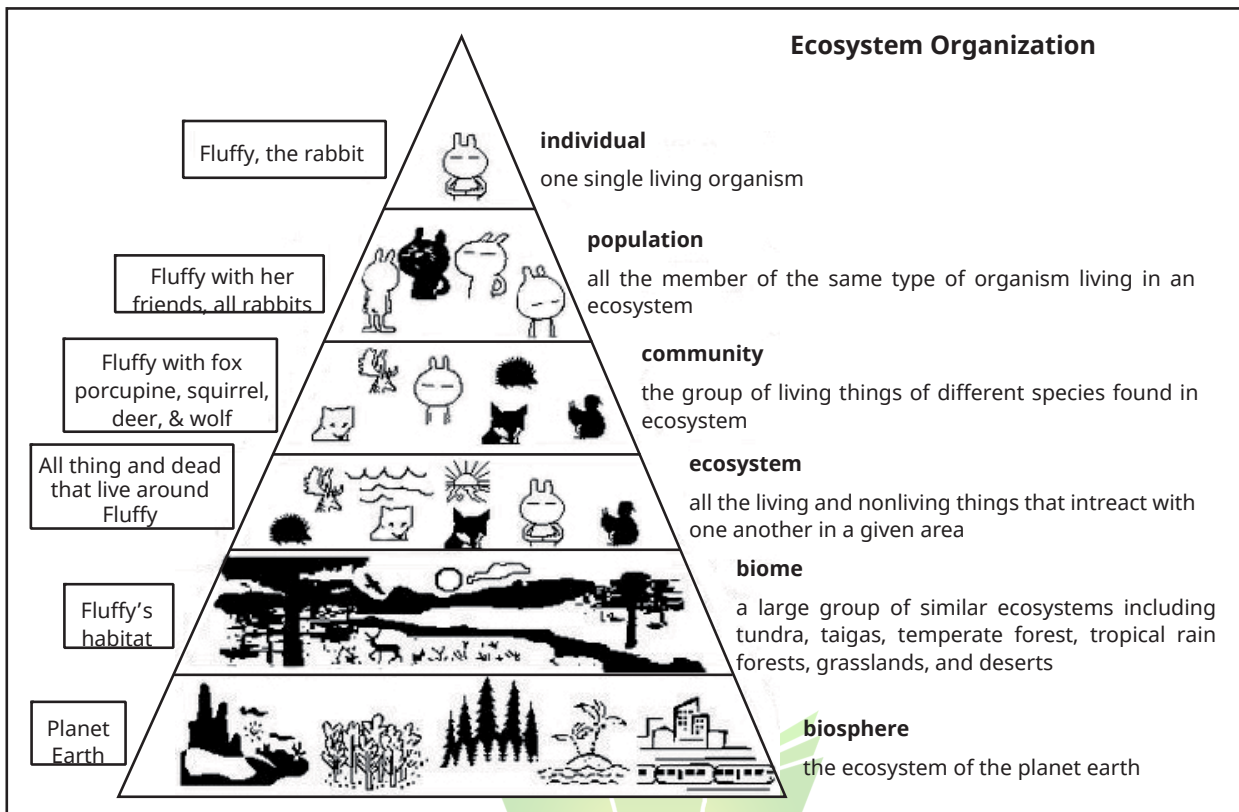
- Ecology deals with the inter-relationships amongst organisms and interactions between organisms and their environment. In other words, Ecology is the study of organism in relation with the surrounding in which they live. The surrounding is the environment of the living organisms and nonliving things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

■ Types of Ecology

- **Autecology/Species Ecology:** The study of reciprocal relationships between every stage of development of a population/species and its environment is called autecology.
- **Synecology:** It is the study of reciprocal relationships between composition, organization and development of communities and their environment. Synecology is further divided into following:
 - ▶ **Population Ecology:** Study of interactions of individuals- population of single species with each other.
 - ▶ **Community Ecology:** The study of inter-relationships and inter-dependencies of groups of individuals of distinct species of plants, animals and micro-organisms together.
 - ▶ **Biome Ecology:** The study of interactions and interrelationships of more than one biological community in various stages of succession under similar climatic condition of the area concerned in the study.
 - ▶ **Ecosystem Ecology:** The study of interactions and inter-relationships of all organisms among themselves and with their environment.
- **Habitat Ecology:** Habitat is an ecological area which is inhabited by a species of living being. Habitat ecology studies variation in habitats in terms of their physical characteristics like topography, soils, insolation, temperature, water, minerals, weather and climate etc. Habitat ecology is further divided on the basis of different habitats and their mutual relationship with their inhabitants into forest ecology, grassland ecology, fresh water ecology, estuarine ecology, island ecology, marine ecology, coral reef ecology etc.
- **Applied Ecology:** It is the study of specialized field of ecology which are concerned with conservation and economic exploitation of organisms e.g., agronomy, agriculture, animal husbandry, forestry, wildlife management, conservation ecology, pollution ecology.
- **Systems Ecology:** Branch of ecology dealing with interpretation of ecological concepts and processes in terms of mathematical models and formulae.
- **Genecology:** Study of genetic composition and changes in relation to the origin of ecotypes, new species, etc.
- **Social Ecology:** It is a critical social theory of American socialist Murray Bookchin. It advocates a constructive and transformative outlook on current social and environmental issues. It suggests that the roots of the current ecological and social problems can be traced in the unordered modes of social organization. It says that apart from the natural disasters, majority of the concurrent ecological dislocations have ethnic, economic, cultural and gender conflicts among others. It also says that the present ecological problems cannot be resolved without dealing with the problems of society.

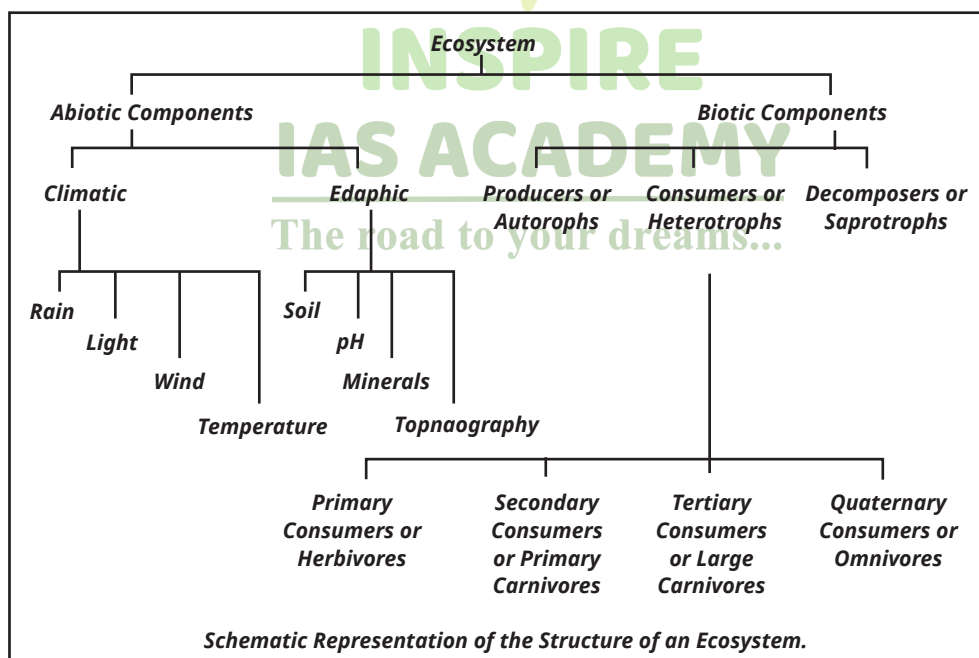
What is Ecosystem?

- 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

The components of the ecosystem are divided as:



■ Abiotic Components:

Abiotic components are non-living chemical and physical factors on an ecosystem. The non-living factors are either resources or conditions. Important abiotic components can be listed as follows:

- **Physical factors:** They sustain and limit the growth of organisms in an ecosystem.
 - ▶ **Light:** Light energy (sunlight) is the primary source of energy in nearly all ecosystems. It is the energy that is used by green plants (which contain chlorophyll) during the process of

photosynthesis; a process during which plants manufacture organic substances by combining inorganic substances.

- ▶ **Temperature:** The distribution of plants and animals is greatly influenced by extremes in temperature.
- ▶ **Water:** The life on earth originated in water and is unsustainable without water.
- ▶ **Atmospheric gases:** The most important gases used by plants and animals are oxygen, carbon dioxide and nitrogen. Oxygen is used by all living organisms during respiration. Carbon dioxide is used by green plants during photosynthesis. Nitrogen is made available to plants by certain bacteria and through the action of lightning.
- ▶ **Soil:** Various characteristics of the soil such as soil composition, grain size and aggregation determine the percolation and water holding capacity of the soils. These characteristics along with parameters such as pH, mineral composition and topography determine to a large extent the vegetation in any area. This in turn dictates the type of animals that can be supported.
- **Organic compounds:** They are the building blocks of living systems and therefore, make a link between the biotic and abiotic components. Examples are: Carbohydrates, proteins, lipids and humus substances.
- **Inorganic compounds:** Such as carbon, carbon dioxide, sulphur, nitrates, phosphates and ions of other metals are necessary for survival.

■ Biotic Components

The biotic components in an ecosystem include the living organisms. They are grouped in to 3 classes based on the organism's role in the flow of material and energy within the ecosystem:

- **Producers (Autotrophs):**
 - ▶ Autotrophs produce organic compounds from carbon dioxide as a carbon source. They take energy from the sun (or from inorganic sources in some cases) to convert it into organic molecules or food, e.g., plants, algae, bacteria, etc.
 - ▶ A portion of food synthesized, is used by autotrophs for their growth and other biological functions and remaining is stored for future use. This stored food in autotrophs is utilized as food by other organisms (called heterotrophs).
- **Consumers (Heterotrophs):**
 - ▶ They are called heterotrophs and they consume food synthesized by the autotrophs. Based on food preferences they can be grouped into three broad categories:
 - ▶ Herbivores (e.g. cow, deer and rabbit etc.) feed directly on plants, carnivores are animals which eat other animals (eg. lion, cat, dog etc.) and omnivores organisms feeding upon both plants and animals e.g. human, pigs and sparrow.
- **Decomposers:**
 - ▶ Decomposers are organisms (often fungi or bacteria) that break down organic materials to gain nutrients and energy. Decomposition is a natural process but decomposers accelerate it. The role that decomposers perform in an ecosystem is extremely important.
 - ▶ When an organism dies, it leaves behind nutrients that are locked together.
 - ▶ Decomposers unlock these nutrient and release as raw nutrients (such as nitrogen, phosphorus, and magnesium) in a form which are usable for plants. Decomposers also convert organic carbon into Carbon dioxide, which can be trapped by photosynthesizers.

■ 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

pattern of secondary succession repeat itself every time.

The Process of Succession

- The characteristic sequence of the successional stages includes 8 elementary processes, namely:
- **Nudation:** It is the creation of bare area. Nudation can occur due to physiographic, climatic or biotic agents.
- **Migration:** Migration starts when gemmule moves from the parent area and arrives in a new area. A gemmule consists of reproductive structure like seed, spore or propagule. Migration is influenced by four factors—mobility, agent, distance and topography.
- **Colonization:** The nature of topography of the bare area also determines the type of the initial vegetation. For example, on bare rock only the spores of some cyanophytes or the soredia of lichens can stick and germinate while in a saline area only the seeds of some halophytes can grow. The first arrivals in a bare area are called Pioneers or pioneer colonizers. The occupation of a bare area by the pioneers and other invaders is called colonization.
- **Ecesis:** The establishment of plants in a new place is called ecesis. It consists of three processes—germination, growth and reproduction.
- **Aggregation:** It is the increase in number of the colonizing individuals. In the beginning the pioneers are few in number and grow far from one another. They produce a large number of disseminules which spread in the open areas and increase the number of pioneers. If invasion continues and the invaders are also able to multiply, the phenomenon is called Mixed Aggregation.
- **Competition:** It may be intra-specific (among individuals of the same species) or inter-specific (among individuals of the different species). Competition occurs when the availability of a necessity becomes inadequate to meet the optimum requirement of all the individuals growing in that area.
- **Invasion:** Various other types of plants try to establish in the space left by the elimination of plants due to competition.
- **Reaction:** It is the change brought about by colonizers in the habitats. The first reaction is localized. It consists of such changes as bindings of soil particles, assisting in weathering or building soil at the bottom of a water reservoir. Death of roots produces channels in the soil for quick absorption of rain water. Humus produced by the death of older or weak plants increases water retention, aeration and nutrition of the soil. The reaction of the early colonizers is such as to make the habitat less favourable to them and more favourable to invaders.
- **Stabilization:** Continuous competition invasion and reaction give rise to continuous changes in the environment and structure of vegetation. After a long interval some individuals arise which are in complete harmony with the climate of the area. This is termed as stabilization.

■ Ecotone

An ecotone is a zone of junction or a transition area between two biomes (diverse ecosystems). It is the zone where two communities meet and integrate. For e.g. the mangrove forests represent an ecotone between marine and terrestrial ecosystem.

Characteristics of Ecotone:

- It may be narrow (between grass-land and forest) or wide (between forest and desert).
- It has conditions intermediate to the adjacent ecosystems. Hence it is a zone of tension.
- It is linear as it shows progressive increase in species composition of one in-coming community and a simultaneous decrease in species of the other out-going adjoining community.
- A well-developed ecotone contains some organisms which are entirely different from that of the adjoining communities.
- Sometimes the number of species and the population density of some of the species are much greater in this zone 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.

Ecocline

- It 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.
- It occurs across the environmental gradient (gradual change in abiotic factors such as altitude, temperature (thermocline), salinity (halocline), depth, etc.).

Niche

- It 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 are referred to as "niche" in that common habitat.
- In nature, many species occupy the same habitat, but they perform different functions:
 - ▶ **Habitat niche** - where it lives,
 - ▶ **Food niche** - what it eats or decomposes & what species it competes with,
 - ▶ **Reproductive niche** - how and when it reproduces,
 - ▶ **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.

■ Functions of an Ecosystem

The function of an ecosystem is a broad, vast and complete dynamic system.

It can be studied under the following three heads:

- **Energy flow**
- **Nutrient cycling (Biogeochemical cycles)**
- **Ecological succession or ecosystem development**

Energy Flow

- Energy is the basic force responsible for all metabolic activities.
- The flow of energy from producer to top consumers is called energy flow which is unidirectional.
- Energy flows through the trophic levels: from producers to subsequent trophic levels.
- There is a loss of some energy in the form of unusable heat at each trophic level.
- The trophic level interaction involves three concepts namely:
 - ▶ **Food Chain**
 - ▶ **Food Web**
 - ▶ **Ecological Pyramids**

Food Chain

- The unidirectional transfer of food energy from the producers, through a series of organisms (herbivores to carnivores to decomposers) with repeated eating and being eaten, is known as food chain. It is the movement of organic matter and energy from the producer level through various consumer levels.
- The various steps in a food chain are called trophic levels and transfer of energy in term of food from **one trophic level** to another is called energy flow. Energy flow is **always unidirectional**.

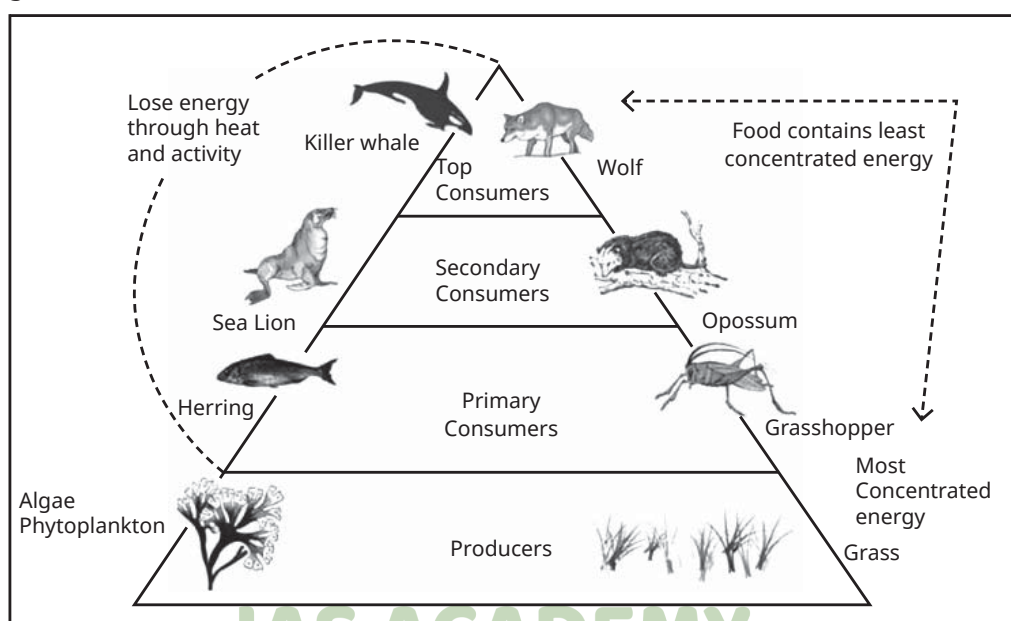
■ Types of Food Chains

Grazing Food Chain

- It is the most common food chain. It is also called predator food chain as predation occurs at every step.
- The consumers which start the food chain, utilizing the plant or plant part as their food, constitute the grazing food chain. This food chain begins from green plants at the base and the primary consumer is herbivore.

Detritus Food Chain

- It begins with detritus or dead organic matter.
- The food energy present in detritus passes into detritivores and decomposers who feed over it.
- Detritivores and decomposers are consumed by smaller carnivores which in turn become food for larger carnivores and so on.



Flow of energy in the Food Chain

- Flow of energy in an ecosystem **is always unidirectional** or one way that is, it passes from solar radiations to producers, then to herbivores and then to carnivores and omnivores. As there is gradual increase in the trophic level of food chain, there is decrease in the content and flow of energy. This happens because:
 - ▶ **Approx. 20%** of the energy captured by producers is dissipated in respiration and metabolic activity.
 - ▶ Rest energy stored in producers goes down to herbivores in the form of food through food chain.
 - ▶ In the herbivores, a lot of the energy assimilated from the food is dissipated in ingestion and digestion of food, respiration and metabolism, body functions, egestion and heat. **Only 10%** of this energy is stored by herbivores in the form of building material of body.
 - ▶ Herbivores are eaten by carnivores; the 10% stored energy of herbivores goes down to carnivores. Carnivores dissipate a majority of this assimilated energy in digestion, respiration, body functions and heat. Only 10% of the energy is stored in carnivores.
 - ▶ Higher carnivores and omnivores are similarly able to store only 10% of the carnivores' energy.
 - ▶ Hence flow of energy in a food chain follows a **Ten Percent Law**. This was proposed by **Lindeman** in 1942.

Food Web

- Simple food chains are very rare in nature because each organism may obtain food from more than

one trophic level. Thus in an ecosystem, the various food chains are interconnected to each other to form a network called food web. The concept of food web was introduced by Charles Elton in 1927.

- A food web illustrates all possible transfers of energy and nutrients among the organisms in an ecosystem, whereas a food chain traces only one pathway of the food. Food webs are very important in maintaining the stability of an ecosystem.

Composition of Food Web

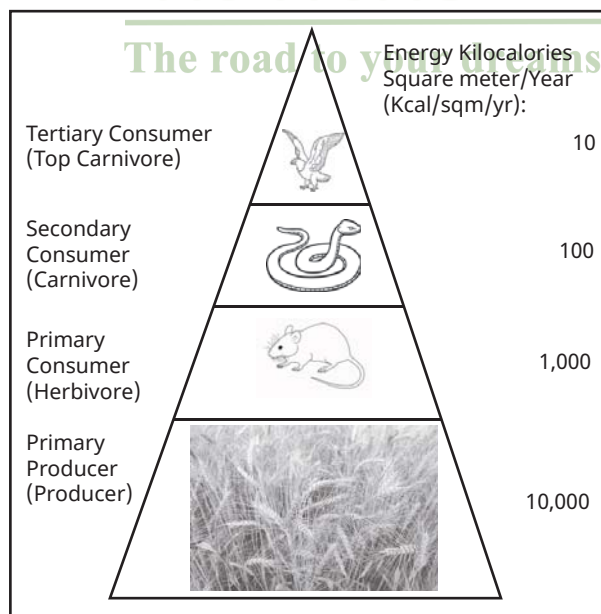
- A food web operates according to food preferences of the organisms at each trophic level. However, availability of food source and other compulsions are equally important. In Sunderbans, the tigers eat fish and crab in the absence of their natural preys.
- Some organism normally operates at more than one trophic level. Thus human beings are not only herbivores but also carnivores of various levels. Jackals are both carnivores and scavengers. Snakes feed on mice (herbivores) as well as frogs (carnivores). Wild cats prey upon mice as well as birds and squirrels. A wolf eats fox as well as rabbit and deer.

■ Ecological Pyramids

Ecological pyramids are the graphic representations of trophic levels in an ecosystem. The producers make the base of the pyramid and the subsequent tiers of the pyramid represent herbivore, carnivore and top carnivore levels. They are pyramidal in shape and they are of three types:

Pyramid of Energy

- The pyramid of energy or the energy pyramid describes the overall nature of the ecosystem. During the flow of energy from organism to other, there is considerable loss of energy in the form of heat. The primary producers like the autotrophs there is more amount of energy available. The least energy is available in the tertiary consumers. Thus, shorter food chain has more amount of energy available even at the highest trophic level.
- The energy pyramid always **upright and vertical**.
- An energy pyramid reflects the laws of thermodynamics with the conversion of solar energy to chemical energy and heat energy at each trophic level and with the loss of energy being depicted at each transfer to another trophic level. Hence the pyramid is always upward, with large energy base at the bottom.



Pyramid of Numbers

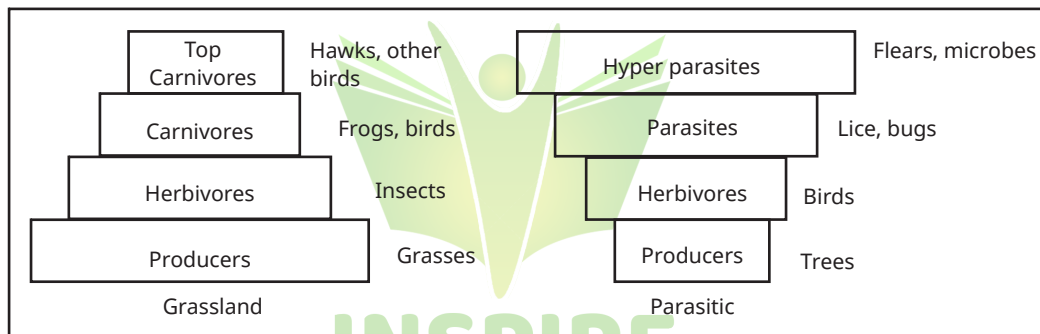
- It is a graphic representation of the number of individuals per unit area of various trophic levels stepwise with producers being kept at the base and top carnivores kept at the tip. In most cases,

the pyramid of number is upright with members of successive higher trophic level being less than the previous one.

- The maximum number of individuals occurs at the producer level. The producers support comparatively fewer numbers of herbivores, the latter fewer number of primary carnivores and so on. Top carnivores are very few in number.
- In grassland, a larger number of grass plants or herbs support a fewer number of grasshoppers that support a still smaller number of frogs, the latter still smaller number of snakes and the snakes support very few peacocks or falcons.
- A similar case is found in a pond ecosystem where a large number phytoplankton support comparatively smaller number of zooplanktons the latter fewer number of small-sized fishes, the small-sized fishes become food of still fewer larger-sized fishes or water birds.
- The number of pyramids in a higher trophic level is generally smaller than that of the lower trophic level because the organisms of the higher trophic level are dependent for their food and energy on the organisms of the lower trophic level.

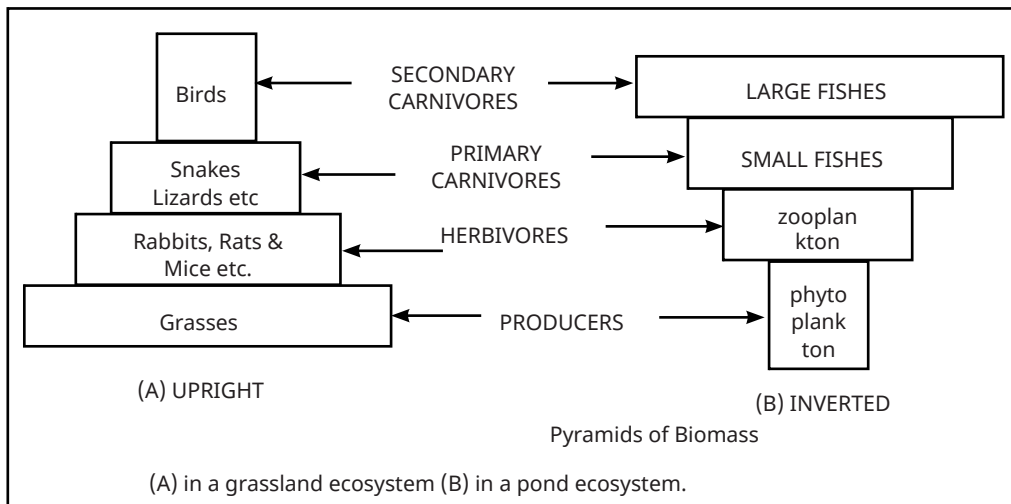
Pyramid of Numbers Inverted

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



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.
 - ▶ **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.



Bioaccumulation

- It is the process of accumulation of persistent and toxic substances or chemicals in an organism.
- It occurs when any substance assimilated by any organism does not get metabolised or egested at the equivalent rate of its absorption.
- This is usually seen with substances with higher biological self-life like pesticides, insecticides and other persistent non-degradable pollutants.
- The longer the self-life of the substance, the greater would be the risk poisoning from the substance, even if the level of substance in the surrounding is under control.

Examples of Bioaccumulation

- Accumulation of the mercury used in industrial processes of the stiffening of the hats in the brain cells of humans caused Mercury poisoning.
- Accumulation of strontium-90 in the atomic bomb affected areas where it causes problems in bone formation.
- Eating of coastal fishes in heavily polluted area can lead to accumulation of heavy metals in the human body

Biomagnification

- It is a phenomenon of gradual increase in the concentration of chemicals and toxic substances accumulated in the tissues of organisms at successively higher trophic levels of food chain. It refers to a process where persistent pollutants like pesticides and heavy metals move up in the food chain and get accumulated at the top most trophic level of the food chain.

Process of Biomagnification

- Pesticides like DDT and other industrial pollutants like mercury etc. degrade very slowly in the ecosystem, thus these substances remain for a longer time and interfere with the dynamics of food chain.
- These substances are washed away from agricultural field or from water bodies and get accumulated on the producers of the food chain.
- Since these are slow metabolizing, so they are transferred from one trophic level to other with the biomass.
- As in a food chain, the number of individual decrease per trophic level successively so, the net amount of these persistent substances per individual keeps on increasing successively with the higher trophic levels of food chain.
- In this way, the maximum bioaccumulation of these persistent pollutants is seen at the top most trophic level of the food chain, this gradual increase in the relative amount of persistent pollutants per individual in any food chain with successive trophic levels is Biomagnification.

- The increase in concentration is due to
 - ▶ Persistent nature of pollutants
 - ▶ Food chain dynamics
 - ▶ Slow rate of degradation of certain substances
- Due to biomagnification, worst impacts of pollutants are seen in the top most consumers or secondary carnivore or omnivore in a food chain. These top consumers include Humans, Tigers, Vultures etc.

Examples of Biomagnification

- The great **Indian Bengal Vultures** are pushed to extinction due to bioaccumulation and biomagnification of anti-inflammatory Drug Diclofenac. Diclofenac entered in the vulture's food chain from humans and beef industries. Diclofenac is excessively used in Dairies to counter the effects of oxytocin. Oxytocin is a human hormone which helps in child birth and milk production. It is inappropriately used in dairies to induce milking, with extreme abdominal as a side effect. Diclofenac injected frequently in cattle to counter pain gets accumulated in cattle's and is transferred to vultures from beef remains.
- Maximum accumulation of agricultural pesticide and insecticide DDT, DDE etc. is seen in Humans.



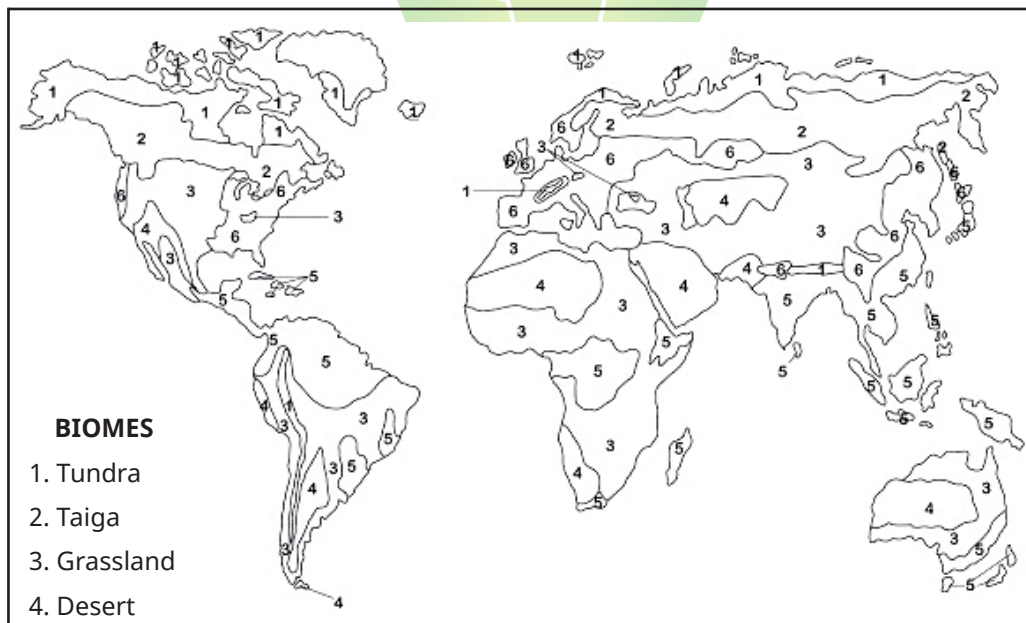
BIOMES: TERRESTRIAL

An ecosystem is a functional unit of nature encompassing complex interaction between its biotic (living) and abiotic (non-living) components.

Terrestrial Ecosystem

A terrestrial ecosystem is an ecosystem found only on landforms. Six primary terrestrial ecosystems exist: **tundra, taiga, temperate deciduous forest, tropical rain forest, grassland and desert.**

Major Terrestrial Biomes of the World



Tundra

Tundra biome is the coldest of all the biomes. It is among the harshest biome and they are found in the arctic region and on top of mountains where the climate is cold and windy and the rainfall is scanty. The tundra regions are covered with snow most of the year and summer brings blooms of wild flowers.

Arctic Tundra Biome

- The arctic tundra is located in the northern hemisphere.
- It encircles the North Pole and extends south to the coniferous forest of the taiga.
- The arctic has cold, desert like conditions.
- The growing season in the tundra region is about 50 to 60 days.
- The average winter temperature is about -34°C , the average summer temperature is about 3 to

12°C, and this enables the biome to sustain life. Rainfall varies in different regions of the arctic.

- There is about 15 cm to 25 cm of yearly precipitation which includes melting snow.
- Soil formation is slow.
- A layer of permanently frozen subsoil known as permafrost exists and consists mostly of gravel and finer material.
- When there is saturation of the upper surface, there may be formation of bogs and ponds which provide moisture for plants.
- In this region there is no deep root system vegetation, though there are a wide variety of plants that can resist the cold climate.

Alpine Tundra Biome

- The Alpine tundra is located on the mountain regions throughout the world, there are at the high altitudes where trees cannot grow.
- The growing season in these regions is about 180 days.
- The temperature during the night is below freezing.
- The soil in the alpine is well drained.
- The vegetation in the alpine tundra is similar to the arctic tundra.
- The vegetation includes plants like tussock grasses, small-leafed shrubs, dwarf trees and heaths.
- The fauna of the alpine tundra are well adapted to its climate, the animals of the alpine include mammals like marmots, pikas, mountain goats, elk and sheep; birds like grouse like birds and insects like butterflies, grasshoppers, beetles, springtails, etc.

Taiga

- Taiga is the largest land biome and it makes up of about 29% of the world's forest cover; a large part of this biome is located in Russia and Canada.
- The boreal forest occurs between 50 and 60 degrees of the north latitudes. It can be found along the broad belt of Eurasia and North America, 2/3rd of it is in Siberia, the rest of it in Scandinavia, Alaska and Canada.
- Taiga is found in the northern parts of North America, Europe and Asia.
- The climate of the taiga is very cold.
- The taiga has a subarctic climate and the temperature ranges between seasons, but the dominant feature of the taiga is the long and cold winters.
- The summers are short, temperature is about 10°C and it lasts around for 1-3 months.
- The winter temperatures are below freezing and reaches and it lasts for five to seven months.
- Throughout the whole year the temperature vary from -54°C to 30°C.
- The summers are short, warm and humid.
- Precipitation in this region varies from 20cm to over 200 cm; the precipitation is mostly in the form of snow. During the growing season the ground is moist.
- The summers have extremely long day length.
- There is explosive plant growth in the summer, and yet the growing season is short and less.

Grassland

- Grasslands are characterized as lands dominated by grasses rather than large shrubs or trees.
- Very few trees or tall large plants grow in the grasslands.
- Forest or bush fires can also eradicate the sparse tree population.
- The lack of trees is mainly due to soil type and precipitation.
- Grassland biomes are normally situated between a forest and a desert.

- In fact, grasslands surround every desert in Asia.
- Twenty-five percent of the Earth is covered by the grassland biome.
- There is a grassland biome on each continent with the exception of Antarctica.
- Tropical and temperate are the two kinds of grasslands.
- Tropical grasslands experience warm weather all year long while temperate grasslands have hot summers and cold winters.
- Grasslands are perfect for cropping and pasturing because its soil runs deep and is extremely fertile.
- Periodic fires, whether they are human induced or occur spontaneously, are very important to the grassland to ensure that invasive plants do not take over.

Savanna Grassland

- Savanna is grassland with scattered individual trees.
- Savannas of one sort or another cover almost half the surface of Africa (about five million square miles, generally central Africa) and large areas of Australia, South America, and India.
- Savannas are always found in warm or hot climates where the **annual rainfall is from about 50.8 to 127 cm (20-50 inches) per year.**
- It is crucial that the rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur.
- If the rain were well distributed throughout the year, many such areas would become tropical forest.

Temperate Grassland

- Temperate grasslands are characterized as having grasses as the dominant vegetation.
- Trees and large shrubs are absent.
- Temperatures vary more from summer to winter, and the amount of rainfall is less in temperate grasslands than in savannas.
- The major manifestations are the velds of South Africa, the puszta of Hungary, the pampas of Argentina and Uruguay, the steppes of the former Soviet Union, and the plains and prairies of central North America.
- Temperate grasslands have hot summers and cold winters.
- Rainfall is moderate.
- The amount of annual rainfall influences the height of grassland vegetation, with taller grasses in wetter regions.

Tropical Rainforest Biome

The Tropical Rainforest can be found in three major geographical areas around the world:

- Central America in the Amazon River basin.
- Africa - Zaire basin, with a small area in West Africa; also eastern Madagascar.
- Indo-Malaysia - west coast of India, Assam, Southeast Asia, New Guinea and Queensland, Australia

Characteristics

- Rainforests only cover around **2 percent the total surface area of the Earth**, but really about 50 percent of the plants and animals on the earth live in the rainforest.
- Rainforests are found on all of the different continents, except for Antarctica because it is far too cold there for the environment to be conducive.
- Rainforests help to regulate the temperatures around the world and the weather patterns as well.
- Tropical rainforest get lots of rain; in one year they typically **receive between 50 and 260 inches**

(125 to 660 centimeters) of rain.

- The tropical rainforest biome is hot; it has an average temperature of about 77 degrees Fahrenheit (25 degrees Celsius). The temperature never falls below 64 degrees Fahrenheit (17.8 degrees Celsius).
- Tropical Rainforests are extremely humid, due to all the rainfall, the average humidity is between 77 and 88 percent.
- The Amazon Rainforest in South America is the largest tropical rainforest in the world; however these forests are also located in Africa, Central America, Australia, Asia, Mexico and on numerous Caribbean, Pacific, and Indian Ocean islands.
- Tropical rainforest biomes are generally located near the equator; this is why they are said to have an equatorial climate.

Desert Biome

- Deserts are dry or arid areas that receive less than 250 mm of rain each year. Deserts can be hot or cold. They contain plants and animals that are specially adapted to these extremely dry conditions.

Locations

- Hot deserts are located at the Sahara, Arabian, Australian, Australia, Arabian, Peninsula, Mexico/ S.W. USA, S.W. Africa, S.W. USA. Others include Argentina, South America, North Africa, Indian, Pakistan and Kalahari deserts.
- Coastal deserts are found at Peru and Chile.
- Cold deserts are located at China, Mongolia, Iran, Afghanistan, S.W. Africa, W. China, Argentina, South America, Middle East, Antarctica and USA.
- Semi-arid deserts/ Steppes or moderately dry lands are located at USA, Canada, Ukraine and China.

Deciduous Forest Biome

- Forests in which majority of trees lose their vegetative parts, such as leaves, after a particular season are called as deciduous forests.
- A deciduous forest supports diverse ecological types.
- Plants usually grow in the warm temperate climate with abundant moisture and produce new leaves and flowers in spring.
- In summer, long trees support the growth of shade-tolerant trees and plants by casting their shade.
- Leaves fall off in autumn and provide required material for decomposers, soil bacteria.

■ Tropical Deciduous Forest**Features**

- Area has warm summer and moderately cold winter.
- **Precipitation is abundant ranging from 75 cm to 150 cm.**
- Temperature remains **moderate 20 - 27C in summer and - 12C in winter.**
- Soil is rich in minerals and organic matter.
- Bamboo, Sal, Shisham, Sandalwood, Khair, Kusum, Aijun, Mulberry are other commercially important species, grown in most deciduous forests.
- The dry forest is found in areas of rainfall ranging between 100 cm and 70 cm.

■ Temperate Deciduous Forest**Features**

- Temperate deciduous forests can be found in the eastern part of the United States and Canada, most of Europe and parts of China and Japan.
- Temperate deciduous forests get between 30 and 60 inches of precipitation a year.
- Precipitation in this biome happens year round.
- Deciduous forests have a long, warm growing season as one of four distinct seasons.
- There is abundant moisture. The soil typically is rich.
- The leaves dropped from trees provide a steady source of organic material for the soil.
- Many species live in the soil and break down the organic matter.
- Tree leaves are arranged in strata: canopy, understory, shrub, and ground.
- A great deal of light is therefore filtered out before it reaches the ground.
- With the dropping of their leaves during one season, trees stop photosynthesis and enter a dormant period.
- Three main types of trees are characteristic of these forests: **northern hardwood, central hardwood, and southeast pine and oak.**





BIOMES: AQUATIC

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

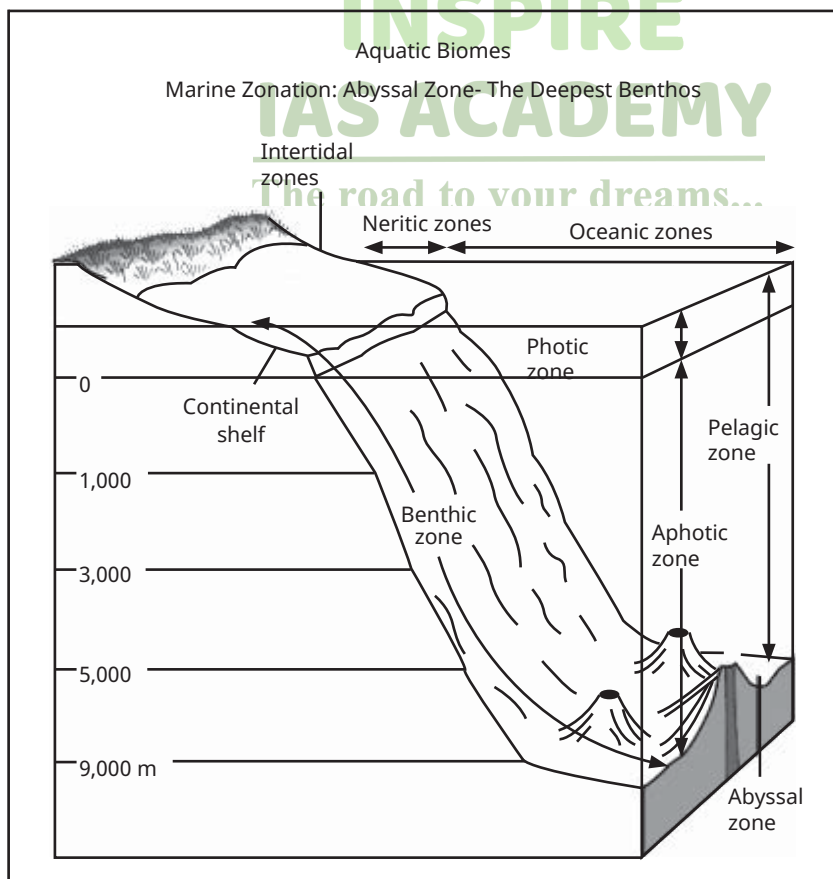
- ▶ Since water temperatures are less subject to change, the aquatic organisms have narrow temperature tolerance limit.
- ▶ As a result, even small changes in water temperature are a great threat to the survival of aquatic organism when compared to the changes in air temperatures in the terrestrial organisms.

- **Winterkill**

- ▶ An ice layer on the top of a water body can effectively cut off light.
- ▶ Photosynthesis stops but respiration continues in such water body.
- ▶ If the water body is shallow, the oxygen gets depleted, and the fish die. This condition is known as winterkill.

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 floods, recharge ground water and provide habitats for wildlife.

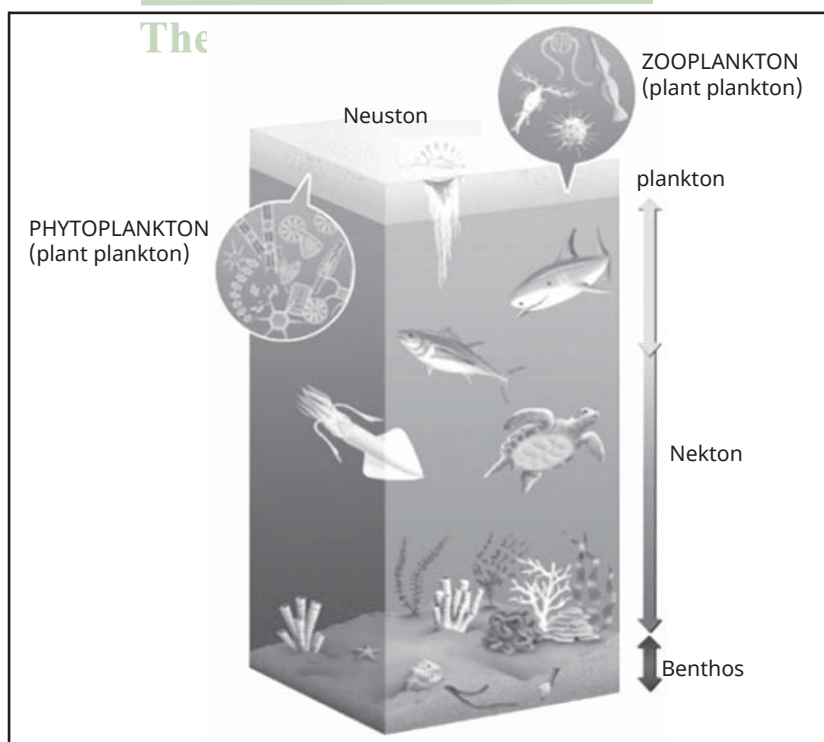


The organisms living in water may be classified into the following types:

- The surface living organisms, which are called as **Planktons**, whose movements are mostly controlled by the currents. Algae, protozoa, rotifers, copepods and cladocera belong to this group.
- Animals living at the bottom of water bodies are called as Benthos. These are further divided according to the mode of feeding into filter feeders and deposit-feeders (or sediment feeders). Midge larvae, clams and other microscopic organisms thrive as benthos.
- Active swimming forms called as Nektons. Fishes, aquatic insects, water beetles, amphibians, turtles, water snakes, tadpoles of frogs and Tilapia live as nektons.
- Organisms (both plants and animals) attached or clinging to stems and leaves of rooted plants or projected surfaces. These are called as Periphytons. Sessile algae, fungi, protozoa, hydra, microcrustacea, rotifera and snails come under this category.
- The organisms which are resting and swimming on the surface of water are called as Neustons. Insects, mosquito larvae, some bacteria and algae come under this group.

Lotic Ecosystem

- Lotic aquatic systems are those systems which contain flowing waters. The mass of water in these systems is in a state of perpetual motion. Streams and rivers are familiar examples of such systems.
- The basic function of these lotic bodies of water is to carry the surplus rain water back to the sea.
- The major abiotic factors controlling the lotic ecosystems are:
 - ▶ Slope and geomorphic conditions including the nature of substratum.
 - ▶ Physico-chemical properties of water. Temperature, color, alkalinity, pH and dissolved oxygen.
 - ▶ Flow velocity and quantity.
 - ▶ Type and amount of suspended and bed-load sediments.
 - ▶ Turbidity.
 - ▶ Thickness of water column and the depth of light penetration.
 - ▶ The climatological factors like atmospheric temperature, humidity, sun shine hours, evapotranspiration and wind.



■ Plankton

- The term 'plankton' refers to the group of organisms which float in the surface waters of the rivers, lakes and oceans.
- Includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton) found in all aquatic ecosystems, except certain swift moving waters.
- The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems.
- The growth rate, productivity and species diversity of plankton in tropical waters especially in mangrove waters are high.

Phytoplankton

- Phytoplanktons are microscopic plant organisms that live in aquatic environments, both salty and fresh.
- Some phytoplanktons are bacteria, some are protists, and most are single-celled plants. Among the common kinds are cyanobacteria, silica-encased diatoms, dinoflagellates, green algae, and chalk-coated coccolithophores.
- Phytoplankton produce more than 60% of oxygen produced from all plants.
- Like land plants, all phytoplankton have chlorophyll to capture sunlight, and they use photosynthesis to turn it into chemical energy. They consume carbon dioxide, and release oxygen. All phytoplankton photosynthesize, but some get additional energy by consuming other organisms.
- These micro-algae are present throughout the lighted regions of all the seas and oceans including the Polar Regions.
- Their total biomass is many times greater than that of the total plants on land and they serve as the "pasture grounds" in the aquatic environment.

■ Factors Affecting Phytoplanktons Biodiversity

Light

- Phytoplanktons are limited to the uppermost layers of the ocean where light intensity is sufficient for photosynthesis to take place.
- The photosynthetic rate varies with light intensity.

Nutrients

- The major inorganic nutrients required by phytoplankton for growth and reproduction are nitrogen and phosphorus.
- Diatoms and silicoflagellates also require silicate (SiO_2) in significant amounts.
- Some phytoplankton can fix nitrogen and can grow in areas where nitrate concentrations are low.
- They also require trace amounts of iron which limits phytoplankton growth in large areas of the ocean because iron concentrations are very low.

Temperature

- Temperature acts along with other factors in influencing the variation of photosynthetic production.
- Generally, the rate of photosynthesis increases with an increase in temperature, but diminishes sharply after a point is reached.
- Temperature, together with illumination, influences the seasonal variation of phytoplankton production in the temperate latitudes.

Salinity

- Besides light and temperature, salinity also is known to influence primary production.

Grazing by Zooplankton

- The grazing rate of zooplankton is one of the major factors influencing the size of the standing crop of phytoplankton, and thereby the rate of production.

Distribution

- Marine phytoplanktons are not uniformly distributed throughout the oceans of the world. The highest concentrations are found at high latitudes, with the exception of upwelling areas on the continental shelves, while the tropics and subtropics have 10 to 100 times lower concentrations.
- In addition to nutrients, temperature, salinity and light availability; the high levels of exposure to solar UV-B radiation that normally occur within the tropics and subtropics may play a role in phytoplankton distributions.
- Phytoplankton productivity is limited to the euphotic zone, the upper layer of the water column in which there is sufficient sunlight to support net productivity.
- The position of the organisms in the euphotic zone is influenced by the action of wind and waves.

■ Importance of phytoplankton

The Food Web

- Phytoplankton are the foundation of the aquatic food web, the primary producers, it feeds everything from microscopic animal-like zooplankton to whales.
- Small fish and invertebrates graze on the phytoplanktons, and then those smaller animals are eaten by bigger ones.
- **Phytoplankton – The Carbon Cycle and Climate Change**
- Phytoplanktons are responsible for most of the transfer of carbon dioxide from the atmosphere to the ocean. Carbon dioxide is consumed during photosynthesis, and the carbon is incorporated in the phytoplankton, just as carbon is stored in the wood and leaves of a tree. Most of the carbon is returned to near-surface waters when phytoplanktons are eaten or decompose, but some falls into the ocean depths.
- Worldwide, this “biological carbon pump” transfers about 10 gigatonnes of carbon from the atmosphere to the deep ocean each year. Even small changes in the growth of phytoplankton may affect atmospheric carbon dioxide concentrations, which would feed back to global surface temperatures.

Zooplankton

- Zooplankton play vital role in food web of the food chain, nutrient recycling, and in transfer of organic matter from primary producers to secondary consumers like fishes.
- They are more abundant within mangrove water-ways than in adjacent coastal waters, and a large proportion of the juvenile fish of mangrove habitat are zooplanktivorous.
- The zooplanktons determine the quantum of fish stock.
- Hence, zooplankton communities, based on their quality and species diversity, are used for assessing the productivity vis-à-vis fishery resource, fertility and health status of the ecosystem. Tiny flagellates, giant jellyfish (>500m)

Sea-grass

- Sea grasses are (angiosperms) marine flowering plants that resemble grass in appearance.
- They produce flowers; have strap-like or oval leaves and a root system.
- They grow in shallow coastal waters with sandy or muddy bottoms and require comparatively calm areas.
- They are the only group of higher plants adapted to life in the salt water.

- Major Sea grass meadows in India occur along the south east coast of Tamil Nadu and in the lagoons of a few Lakshadweep Islands. There are few grass beds around Andaman and Nicobar islands also.
- The rich growth of seagrasses along the Tamil Nadu coast and Lakshadweep islands is mainly due to high salinity, clarity of the water and sandy substratum.

Functions

- Sea grass beds physically help
 - ▶ To reduce wave and current energy,
 - ▶ To filter suspended sediments from the water and
 - ▶ Stabilize bottom sediments to control erosion
- Provides habitat for marine invertebrates and fishes.
- Seagrass beds are widespread in lagoon and in such areas; the population of fish and migratory birds are also higher due to the availability of food and shelter.
- Sea grasses on reef flats and near estuaries are also nutrient sinks, buffering or filtering nutrient and chemical inputs to the marine environment.

Threats to Sea Grass Beds

- Eutrophication, siltation, trawling, coastal engineering constructions and over exploitation for commercial purposes are the major threats for sea grass beds.

Management

- The major seagrass beds should be mapped and areas have to be identified for preservation.
- Dredging should be carried out far away from seagrass beds as siltation/turbidity destroys seagrass beds.

Seaweeds

- Seaweeds are (thalloid plants) macroscopic algae, which mean they have no differentiation of true tissues such as roots, stems and leaves. They have leaf-like appendages.
- Seaweeds, the larger and visible marine plants are found attached to rocks, corals and other submerged strata in the intertidal and shallow sub tidal zones of the sea.
- Seaweeds grow in shallow coastal waters wherever sizable substrata is available. Based on the colour of their pigmentation, sea weeds are broadly classified into different classes such as: Blue-green, Green, Brown, Red etc.

Functions of seaweeds

- Food for marine organism,
- Habitat for fish breeding grounds,
- Source of sediment.

Uses of seaweeds

- Seaweeds are important as food for humans, feed for animals, and fertilizer for plants.
- Seaweeds are used as a drug for goiter treatment, intestinal and stomach disorders.
- Products like agar-agar and alginates, iodine which are of commercial value, are extracted from seaweeds.
- By the biodegradation of seaweeds methane like economically important gases can be produced in large quantities.
- Extracts of some seaweed species show antibacterial activity.

- Seaweeds are also used as the potential indicators of pollution in coastal ecosystem, particularly heavy metal pollution due to their ability to bind and accumulate metals strongly.

Harmful effects of Seaweeds

- Rotting seaweed is a potent source of hydrogen sulfide, a highly toxic gas, and has been implicated in some incidents of apparent hydrogen-sulphide poisoning.
- It can cause vomiting and diarrhea.





BIODIVERSITY

- The word “biodiversity” is an abbreviated version of “biological diversity”.
- The **Convention on Biological Diversity** defines biodiversity as: “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems.”
- Thus, Biodiversity refers to the variety of forms - the different plants, animals and micro-organisms.
- It also includes the genes they contain and the ecosystem they form.
- It deals essentially with dynamic processes and increases when new genetic variation is produced and decreases on the loss of genetic variation or species extinction.

■ Types of Biodiversity

There are three distinct levels of biodiversity though all of them are components of a much intricate web.

Genetic Diversity

- It refers to variation of genes within species. This variation can exist between different populations of the same species as well as between individuals within a population.
- Genetic diversity provides organisms and ecosystems with capacity to recuperate after change has occurred.
- Thus Genetic diversity is a level of biodiversity that refers to the total number of genetic characteristics in the genetic makeup of a species. It is distinguished from genetic variability, which describes the tendency of genetic characteristics to vary.
- Genetic diversity plays a great role in the adaptability and survival of a species. A species that has a large degree of genetic diversity among its individuals will have more variations from which to choose the most fitting allele.

Species Diversity

- Species diversity is a measure of the diversity within an ecological community that incorporates both species richness (the number of species in a community) and the evenness of species' abundance.
- Species diversity can be measured in terms of:
 - ▶ **Species richness** –refers to the number of various species in a defined area.
 - ▶ **Species abundance** – refers to the relative numbers among species. For example, the number of species of plants, animals and microorganisms may be more in an area than that recorded in another area.
 - ▶ **Taxonomic or phylogenetic diversity** – refers to the genetic relationships between different groups of species.
- Species diversity is not evenly distributed across the globe. The overall richness of species is concentrated in equatorial regions and tends to decrease as one move from equatorial to Polar Regions.

- In addition, biodiversity in land ecosystems generally decreases with increasing altitude. The other factors that influence biodiversity are amount of rainfall and nutrient level in soil. In marine ecosystems, species richness tends to be much higher in continental shelves.

Ecosystem Diversity

- It refers to the presence of different types of ecosystems. For instance, the tropical south India with rich species diversity will have altogether different structure compared to the desert ecosystem which has far less number of plant and animal species.
- Likewise, the marine ecosystem although has many types of fishes, yet it differs from the freshwater ecosystem of rivers and lakes in terms of its characteristics. So such variations at ecosystem level are termed as ecosystem diversity.

Functional Diversity

- Functional diversity refers to the diversity of ecological processes that maintain and are dependent upon the other components of diversity. It includes the many ecological interactions among species e.g. competition, predation, parasitism, mutualism, etc. as well as ecological processes such as nutrient retention and recycling.
- It also includes the varying tempos and intensities of natural disturbances that many species and communities require if they are to persist.

Patterns of Biodiversity

- Biodiversity is not uniform throughout the world but varies with latitude and altitude.
- Favourable environmental conditions favour speciation and make it possible for a larger number of species to exist there, i.e., biodiversity is more in such areas than the others.
- Species diversity decreases from the equator towards the poles. Tropics (latitudinal range of 23.5°S) have more species than temperate or polar areas.
- There are three different hypothesis proposed by scientists for explaining species richness in the Tropical region:
 - ▶ **Tropical latitude** receives more solar energy than temperate regions, which lead to high productivity and high species diversity.
 - ▶ **Tropical regions** have less seasonal variations and have more or less constant environment. This promotes the niche specialization and thus, high species richness.
 - ▶ **Temperate regions** were subjected to glaciations during ice age, while Tropical regions remained undisturbed which led to an increase in the species diversity in this region.

■ Biodiversity Hotspots

- Norman Myers, a British Ecologist, developed the concept of Hot spots in 1988 to designate priority areas for in situ conservation. According to him, the hot spots are the richest and the most threatened reservoirs of biodiversity on the earth.
- **To qualify as a biodiversity hotspot, a region must meet two strict criteria:**
 - ▶ It must have **at least 1,500** vascular plants as endemics — which are to say, it must have a high percentage of plant life found nowhere else on the planet. A hotspot, in other words, is irreplaceable.
 - ▶ It must have **30%** or less of its original natural vegetation. In other words, it must be threatened.

■ Biodiversity Hotspots in India

The Eastern Himalayas Hot Spot

- The eastern Himalayas are the region encompassing Bhutan, northeastern India, and southern, central and eastern Nepal. The region is geologically young and shows high altitudinal variation.

- The abrupt rise of the Himalayan Mountains from less than 500 meters to more than 8,000 meters results in a diversity of ecosystems that range from alluvial grasslands and subtropical broad leaf forests along the foot hills to temperate broad leaf forests in the mid hills, mixed conifer and conifer forests in the higher hills, and alpine meadows above the tree line.

Indo-Burma

- The Indo-Burma region encompasses several countries.
- It is spread out from Eastern Bangladesh to Malaysia and includes North-Eastern India south of Brahmaputra River, Myanmar, the southern part of China's Yunnan province, Lao People's Democratic Republic, Cambodia, Vietnam and Thailand.

Western Ghats and Sri Lanka

- Western Ghats, also known as the "Sahyadri Hills" encompasses the mountain forests in the southwestern parts of India and highlands of southwestern Sri Lanka.
- The entire extent of hotspot was originally about 1,82,500 square kms, but due to tremendous population pressure, now only 12,445 square km or 6.8% is in pristine condition.
- The wide variation of rainfall patterns in the Western Ghats, coupled with the region's complex geography, produces a great variety of vegetation types.
- These include scrub forests in the low-lying rainshadow areas and the plains, deciduous and tropical rainforests up to about 1,500 meters, and a unique mosaic of montane forests and rolling grasslands above 1,500 meters.
- In Sri Lanka diversity includes dry evergreen forests to dipterocarpus dominated rainforests to tropical montane cloud forest.

■ THREATS TO BIODIVERSITY

Threat to biodiversity stems mainly from: habitat fragmentation, degradation and loss; shrinking genetic diversity; invasive alien species; declining forest resource base; climate change and desertification; over exploitation of resources; impact of development projects; and impact of pollution.

Causes of Biodiversity losses ('The Evil Quartet')

- **Habitat loss and fragmentation:** Habitat of various organisms are altered or destroyed by uncontrolled and unsustainable human activities such as deforestation, slash, and burn agricultural, mining and urbanization. This results in the breaking up of the habitat into small species, which effects the movement of migratory animals and also, decreases the genetic exchange between populations leading to a declination of species. E.g.
 - ▶ Tropical rain forests (loss from 14% to 6%). Thousands hectares of rain forests is being lost within hours.
 - ▶ The Amazon rain forest is being cut for cultivating soya beans or for conversion of grasslands for cattle.
 - ▶ Due to fragmentation, animals requiring large territories and migratory animals are badly affected.
- **Over-exploitation:** Due to over-hunting and over-exploitation of various plants and animals by humans, many species have become endangered or extinct. Many species like Stellar's sea cow, Passenger pigeon etc. are extinct due to over-exploitation.
- **Alien species invasions:** Accidental or intentional introduction of non-native species into a habitat has led to the declination or extinction of indigenous species. Alien species cause decline or extinction of indigenous species. E.g.
 - ▶ The **Nile Perch** introduced in Lake Victoria (East Africa) caused extinction of more than 200 species of native fish, cichlid fish in the lake.
 - ▶ Invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia) caused damage to our native species.

- ▶ The illegal introduction of the African Catfish (*Clarias gariepinus*) for aquaculture is posing a threat to the indigenous catfishes in our rivers.
- **Co-extinction:** In a native habitat, one species is connected to the other in an intricate network. The extinction of one species causes the extinction of other species, which is associated with it in an obligatory way. E.g.
 - ▶ Extinction of the parasites when the host is extinct.
 - ▶ Co-evolved plant-pollinator mutualism where extinction of one leads to the extinction of the other

■ Invasive Species

Definition

- Invasive species also called introduced species, alien species, or exotic species, any non-native species that significantly modifies or disrupts the ecosystems it colonizes.
- Such species may arrive in new areas through natural migration, but they are often introduced by the activities of other species.
- Human activities, such as those involved in global commerce and the pet trade, are considered to be the most common ways invasive plants, animals, microbes, and other organisms are transported to new habitats.
- The most common characteristics of invasive species are rapid reproduction and growth, high dispersal ability, ability to survive on various food types and in a wide range of environmental conditions and the ability to adapt physiologically to new conditions, called phenotypic plasticity.

What are their impacts?

- The direct threats of invasive species include preying on native species, outcompeting native species for food or other resources, causing or carrying disease, and preventing native species from reproducing or killing a native species' young.
- There are indirect threats of invasive species as well. Invasive species can change the food web in an ecosystem by destroying or replacing native food sources. The invasive species may provide little to no food value for wildlife. Invasive species can also alter the abundance or diversity of species that are important habitat for native wildlife.
- Invasive alien species are a major driver of biodiversity loss. In fact, an analysis of the **IUCN Red List** shows that they are the second most common threat associated with species that have gone completely extinct, and are the most common threat associated with extinctions of amphibians, reptiles and mammals.
 - ▶ An example is the **Micronesian Kingfisher *Todiramphus cinnamominus* which was endemic to the island of Guam**, but following predation by invasive alien snakes (Brown tree snake *Boiga irregularis*) it became Extinct in the Wild in 1986 when the last remaining wild birds were taken into captivity for captive breeding. In fact the Brown tree snake has caused much extinction on Guam, including the local extinction of over half of Guam's native bird and lizard species as well as two out of three of Guam's native bat species.
- Invasive alien species can also lead to changes in the structure and composition of ecosystems leading to significant detrimental impacts to ecosystem services, affecting economies and human wellbeing.
 - ▶ For example the **Water Hyacinth *Eichhornia Crassipes*, a native to South America** is spreading across Africa, Asia, Oceania and North America. It is a fast growing floating aquatic plant forming dense mats on the water surface, limiting oxygen and preventing sunlight reaching the water column. Infestations have led to reduced fisheries, blocked navigation routes, increased cases of vector borne diseases, reduced hydropower capacity and affecting access to water.

■ Invasive Species in India

Some Commonly Found Alien Species:

- **African apple snail (*Achatina fulica*):** The most invasive among all alien fauna in India, this mollusc was first reported in the Andaman and Nicobar Islands. It is now found across country and is threatening the habitat of several native species.
- **Papaya Mealy Bug (*Paracoccus marginatus*):** Native of Mexico and Central America, it is believed to have destroyed huge crops of papaya in Assam, West Bengal and Tamil Nadu.
- **Cotton Mealy Bug (*Phenacoccus solenopsis*):** Native to North America, it has severely affected cotton crops in Deccan.
- **Amazon sailfin catfish (*Pterygoplichthys pardalis*):** This species is responsible for destroying the fish population in the wetlands of Kolkata.

Effects of Loss of Bio-Diversity

- **Loss of cultural diversity:** The loss of both genetic and ecosystem diversities result in a loss of cultural diversity. As new strains and systems are introduced, they result in an overall change, the extinction of many species embedded in religion, mythology and folklore etc.
- **Ecosystem breakdown:** The loss of a species can have deleterious effects on the remaining species in an ecosystem. The loss of even one species can ruin an entire forest ecosystem of plants and animals.
- **Food insecurity:** Reduced biodiversity means millions of people face a future where food supplies are more vulnerable to pests and disease and where water is in irregular or short supply.
- **Economic impact:** The loss of plant species also means the loss of unknown economic potential, as extinct plants can hardly be harvested for food crops, fibers, medicines, and other products that forests, especially rainforests, provide.





ENDANGERED SPECIES

- An endangered species is a type of organism that is threatened by extinction.
- A plant or animal species existing in such a small number that it is in danger of becoming extinct, especially such species placed in jeopardy as a result of human activity. One of the principal factors in the endangerment or extinction of a species is the destruction or pollution of its native habitat. Other factors include overhunting, intentional extermination, and the accidental or intentional introduction of alien species that outcompete the native species for environmental resources.

■ The causes of endangerment

- Endangerment is a broad issue, one that involves the habitats and environments where species live and interact with one another.
- Although some measures are being taken to help specific cases of endangerment, the universal problem cannot be solved until humans protect the natural environments where endangered species dwell.
- There are many reasons why a particular species may become endangered.
- Although these factors can be analyzed and grouped, there are many causes that appear repeatedly.
- Given below are several factors leading to endangerment:

Habitat Loss

- Our planet is continually changing, causing habitats to be altered and modified.
- Natural changes tend to occur at a gradual pace, usually causing only a slight impact on individual species.
- However, when changes occur at a fast pace, there is little or no time for individual species to react and adjust to new circumstances.
- This can create disastrous results, and for this reason, rapid habitat loss is the primary cause of species endangerment.
- The strongest forces in rapid habitat loss are human beings. Nearly every region of the earth has been affected by human activity, particularly during this past century.
- It can be difficult for an individual to recognize the effects that humans have had on specific species.
- It is hard to identify or predict human effects on individual species and habitats, especially during a human lifetime. But it is quite apparent that human activity has greatly contributed to species endangerment.

Introduction of Exotic Species

- Native species are those plants and animals that are part of a specific geographic area, and have ordinarily been a part of that particular biological landscape for a lengthy period of time.
- They are well adapted to their local environment and are accustomed to the presence of other native species within the same general habitat.

- Exotic species, however, are **interlopers**.
- These species are introduced into new environments by way of human activities, either **intentionally or accidentally**.
- These interlopers are viewed by the native species as foreign elements.
- They may cause no obvious problems and may eventually be considered as natural as any native species in the habitat.
- However, exotic species may also seriously disrupt delicate ecological balances and may produce a plethora of unintended yet harmful consequences.
- The worst of these unintended yet harmful consequences arise when introduced exotic species put native species in jeopardy by preying on them.
- This can alter the natural habitat and can cause a greater competition for food.
- Species have been biologically introduced to environments all over the world, and the most destructive effects have occurred on islands.
- Introduced insects, rats, pigs, cats, and other foreign species have actually caused the endangerment and extinction of hundreds of species during the past five centuries.
- Exotic species are certainly a factor leading to endangerment.

Overexploitation

- A species that faces overexploitation is one that may become severely endangered or even extinct due to the rate in which the species is being used.
- Unrestricted whaling during the 20th century is an example of overexploitation, and the whaling industry brought many species of whales to extremely low population sizes.
- When several whale species were nearly extinct, a number of nations (including the United States) agreed to abide by an international moratorium on whaling.
- Due to this moratorium, some whale species, such as the grey whale, have made remarkable comebacks, while others remain threatened or endangered.
- Due to the trade in animal parts, many species continue to suffer high rates of exploitation.
- Even today, there are demands for items such as rhino horns and tiger bones in several areas of Asia. It is here that there exists a strong market for traditional medicines made from these animal parts.

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Other Factors

- Disease, pollution, and limited distribution are more factors that threaten various plant and animal species.
- If a species does not have the natural genetic protection against particular pathogens, an introduced disease can have severe effects on that species.
- For example, rabies and canine distemper viruses are presently destroying carnivore populations in East Africa.
- Domestic animals often transmit the diseases that affect wild populations, demonstrating again how human activities lie at the root of most causes of endangerment.
- Pollution has seriously affected multiple terrestrial and aquatic species, and limited distributions are frequently a consequence of other threats; populations confined to few small areas due to loss of habitat, for example, may be disastrously affected by random factors.

■ Protection of endangered species at National level

- Endangered species in India comprise large varieties of rare species of wild animals, aquatic animals and insects.
- Indian wildlife consists of numerous species of birds, mammals, reptiles etc, and is well known for comprising one of the richest varieties in the world.

- The Indian wildlife also contains several endangered species that are living critically on the verge of extinction.
- An endangered species is defined as a population of a living being that is at the danger of becoming extinct because of several reasons.
- Either they are few in number or are threatened by the varying environmental or predation parameters.
- The endangered species in India have been identified by different national and international organizations like the World Wildlife Fund (WWF), International Union for Conservation of Nature and Natural Resources (IUCN) and the wildlife institute India (WII).

Statistics of Endangered Species in India

- As per the official records, in India, there are over 1.30 Lacs endangered animal species, although some experts believe that the number may be even more than the projected figures.
- However, some claim that the number is actually much more.
- The number of endangered species in India accounts for around 8.86 % of the world`s mammals.
- The mammals are extended over 186 genera, 45 families and 13 orders out of which around 89 species are listed as threatened in the IUCN Red List of Threatened Animals (IUCN 2006).

■ Types of Endangered Species in India

The endangered species in India have been divided into 4 main categories.

- **Critically Endangered (CR)**
- **Endangered (EN),**
- **Vulnerable (VU) and**
- **Threatened.**

This classification was done by the International Union for Conservation of Nature and Natural Resources (IUCN) and Wildlife Institute of India (WII), in the year 2004. The population of the endangered species has been decreasing with the passing time.

Critically Endangered and Endangered Species in India

- Among the endangered species in India, one of the most critically endangered one is the **Siberian Tiger**.
- Another endangered species in India is **one of the big cats, the Golden Leopard with black marks**.
- The number of this species has been reduced to as low as 14,000 in India.
- The **main reasons behind the decline of Leopard population in India have been the loss of habitat and also human population pressure on wildlife reserves in India**.
- These reasons are also a matter of great concern for the other endangered species in India.
- The major reason behind the habitat loss is the spread of agriculture.
- The Royal Bengal Tigers were also extensively being captured for pet trade, zoos and research, as well as for use in Oriental medicine, in the past.

Some more critically endangered species

- India is home to very diverse and rich wildlife which includes over 172 endangered species.
- A great deal of effort has been made in the last sixty years to preserve the natural habitats as well as the population of the wildlife across the Indian landscape.
- With the encroachment of human activities on these lands, the natural habitat has been destroyed and has shrunk considerably.
- This has endangered not only the smaller avian, reptile and mammal`s population but also eroded endemic flora and fauna.

Actions/Laws for Wild Life Conservation Chronologically:

- **3 BC** – The earliest codified laws can be attributed to **King Ashoka**, who in his decrees engraved on edicts, prohibited the killing of certain species of animals.
- **1873** – The **Madras Act** was passed to prevent the indiscriminate destruction of wild elephants. This was the first Act under the British regime for regional protection of wild life.
- **1887** – The **Wild Birds Protection Act of 1887** was passed which enabled the British government to frame rules prohibiting possession or sale of any kind of specified wild birds only during breeding Season. Also this Act was only applicable to those areas, which were under the control and supervision of Municipalities and cantonments under the British regime.
- **1912** – The **Wild Birds and Animals Protection Act of 1912** was passed. For the first time, a codified law was enacted prohibiting the killing and capturing of wild animals and the disobedience of which entailed a penal offence. The Act was also comprised scheduled animals, which listed birds and animals which could not be killed, captured or sold.
- **1935- The Wild Birds and Animals Protection Act No 27 of 1935** was enacted. This was a landmark year in the history of wild life as it was for the first time that the provincial government, could by notification, set aside an area to be a sanctuary for protection and growth of wild animals and birds.
- **1935-** This year also witnessed the passing of the **government of Indian Act 1935** in which the legislative powers were distributed between federal and provincial legislatures. The **Protection of Wild Birds and Wild Animals was entrusted to the provincial legislature vide Entry 25 of the State List.**
- **1952-** The first wildlife authority, in the form of an advisory board, was set up in 1952 called the Central Board for Wild Life renamed as **Indian Board for Wildlife.**
- **1972- The Wild Life protection Act 1972** (Act No 53 of 1972) was passed. It was the first comprehensive Act passed for the protection of wild animals. However, subject to licences, hunting was permitted for certain purposes such as special, big and small games. Further the Act also permitted trade of trophies of scheduled animals under a licence.
- **1973- The project Tiger** was launched. Subsequently, several other schemes were initiated for protection of specific habitats and to save threatened species such as the Asiatic Lion in Gujarat, Barasigha in Madhya Pradesh, Hangul in Kashmir and many more.
- **1976 - The constitution (forty-second Amendment) Act 1976 was passed in which art 48A** was inserted in the Directive principles of state policy, which read as under – The state shall Endeavour to protect and improve the environment and to safeguard the forests and Wildlife of the country' A separate chapter IVA was incorporated where art 51A (g) states –Its shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures' Also the protection of wild animals and birds was transferred as 17B in the concurrent list of the constitution.
- **1976- Ratification of the convention on International Trade in Endangered species of Wild fauna and flora (CITES) by India on October 18.**
- **1976/77-** A separate **Directorate of wildlife Education and Research** was established.
- **1980-** The **Forest conservation Act 1980** was passed, which is inter alia, also aimed to preserve the natural habitat of Indian wildlife.
- **1982-** In the Amendment Act No 23 of 1982, sections 11 and 12 of wild life Act 1972 were amended which permitted the capture and translocation of wild animals for scientific management and introduction of endangered species in alternative suitable habitat. The licensing practice for carrying out business in trophies and an animal article was also amended in **Section 44 of the WLPA.**
- **1982-** The **Wildlife Institute of India** was established whose prime objective was to provide a professional and scientific support to the management and development of wildlife in India.
- **1983** –The **National Wildlife Action plan** was adopted by the Indian board for wildlife which was inspired by the World Conversation strategy and the Bail Action Plan. The Chairperson of IBWL, Smt. Indira Gandhi, the then prime Minister of India, outlined a board framework and strategy for wildlife preservation of India.

- **1986-** A Major step was taken to **enforce the provision of CITES under art 253 of the Constitution of India**. A separate Chapter V-A was inserted in the WLP, which prohibited trade and commerce in trophies, animal articles derived from animals listed in the scheduled of the Act.

■ Critical analysis of Position in India

- India is a home to very diverse and rich wildlife which includes over 172 endangered species.
- A great deal of effort has been made in the last sixty years to preserve the natural habitats as well as the population of the wildlife across the Indian landscape.
- The **Bengal tiger, Asiatic water buffalo and Indian elephant** are just some of the magnificent animals walking the plains and tropical rain forest across India.
- It is amazing to see the herds migrate from jungle to jungle in order to sustain their population in a good and natural habitat. With the encroachment of human activities on these lands, the natural habitat has been destroyed and has shrunk considerably.
- This has **endangered not only the smaller avian, reptile and mammal's population but also eroded endemic flora and fauna.**
- Wildlife in India is considered **sacred to the culture and heritage** of the country.
- A great deal of effort has been made in collaboration with **international environmental protection and wildlife conservation organizations** to ensure the safety of the natural habitat of Indian wildlife.
- Unfortunately agricultural land has been given the priority and the natural habitat has been eroded to make way for human occupation.
- As human encroachment and settlement increased across the Indian landscape, the wildlife was cornered in specific areas.
- These were eventually declared as protected and endangered areas.
- Once this status was awarded to a particular area or breed of animal or species of bird, a great deal of effort was maintained to prevent the poaching and hunting of wildlife.
- This helped in increasing the awareness and subsequently the population of endangered and exotic species.
- There are quite a few sanctuaries, for example the ones in **Gujarat, Jammu and Kashmir, Kerala, Goa and Madhya Pradesh** among others.
- A good thing about the network of Wildlife Protection in India is that there is **one basic administration that runs the Forestry and Wildlife Department.**
- It has different subsets in each state and the Central Government acts as the main advisory to each of these divisions.
- The **creation of the Wildlife Protection Act has made it mandatory for each union territory to have wildlife advisory boards.**
- Furthermore, with the **addition of wildlife preservation in the Constitution the situation has greatly improved in terms of safeguarding wildlife populations across India.**
- With the use of information and experience of international wildlife protection agencies like the World Wildlife Federation which has placed 172 species on the endangered animal list in India, the total number of national parks and sanctuaries has risen from **5 parks to 104 national parks.**
- Further, the number of **sanctuaries has increased from 60 to 531 parks** in the last decade.
- Another interesting fact about the sanctuaries and parks for conserving wildlife in India is that they are distributed throughout the Indian landscape and even on some islands.
- The biodiversity in India is spread across plains and mountains along with the plateaus and coastal areas.
- Each of these areas has been given **full attention and therefore resulted in the creation of safe havens for aquatic and land populations of endangered species across India.**
- **From crocodiles to Tigers and elephants to peacocks there are many species which are protected under the national conservation projects across the country.**

■ Most Endangered Wild Animal Species of India

Indian Tiger

- The All members of Felide family, which includes three great cats Asiatic Lion, Bengal Tigers, wild cats and leopard, found in India are not in the so good population, Because of the excessive poaching, big cats in India are on the verge of extinction.
- There is only 1411 Royal Bengal Tiger left in India, Asiatic or great India lion only found in Gir national park.
- One of the most endangered species of felide family is snow leopard, found only in Himalaya Ranges.
- Snow leopard along with another felide member clouded leopard are the two highly endangered species of big cats found now only with great range of Himalayas.



Ganges Dolphin

- The **Ganges River Dolphin is member of Cetacea family**, which includes marine mammals porpoises and whales. Dolphins primarily found in the Ganges and Brahmaputra Rivers and their tributaries in India. They share their habitat with crocodiles, fresh water turtles. The blind Dolphin of holy river **Ganges is the National Aquatic Animal of India.**
- **The India Rive shark** is also listed as one of the endangered Species in India.



Gharial

- The gharial is one of the three crocodylians found in India the longest of all living crocodylians.
- The **holy river Ganage is one the most habitat of the Gharial in India, the king of rivers also found in Chambal, Irrawady and Brahmaputra rivers.**
- The gharial is listed as a **most critically endangered species** in India.
- Mass Gharial Deaths in Chambal river is still a mystery, one of the major cause is **"polluted river water"**.



Indian Bustard

- The Great Indian bustard is one of the **world's heaviest flying birds** is one of such rarest birds of Indian Sub-continent.
- The Bird is found only in some parts of **Gujarat, Maharashtra, and Rajasthan.**
- Less than a thousand survive today and the species is threatened by hunting and loss of its habitat.
- **Indian Vulture is another endangered birds of India**, vultures were being found dead and dying throughout India.
- **Indian King Vulture found sharply in Gujarat, Rajasthan and Uttar Pradesh.**



Indian Rhinoceros

- The Great Indian Rhinoceros also called as **One Horned Rhinoceros found in India.**
- The Indian Rhinoceros has a single black horn which is present in both male and female species.
- The Great Indian Rhinoceros is the fourth largest animal in the world.
- The large endangered mammal is primarily found in parts of north-eastern India, Today about 3,000 rhinos live in the wild, 2,000 of which are found in **Manas and Kaziranga National Park Assam.** Excessive hunting for its horn reduced their natural habitat drastically.



Indian Wild Dog

- **Indian Wild Dog or Dhole** is one of the **top predators** of wild forest, living in packs, hunting cooperatively and highly social animals.
- An Asiatic wild dog is also called the **whistling hunter**, because it has an **extraordinary vocal call.**
- Dhole is found in national parks of Assam, Bengal, Gujarat, Kashmir, Madhya Pradesh, and Nilgiri Biosphere reserve of south India.
- It is estimated that only 2500 Dholes are left in the wild.
- Threats to the dhole species include habitat destruction and loss of its main prey.
- There is a documentary available in Nat Geo as **"The PACK"**, which was one of the best documentary ever made on Asiatic wild dogs.



Red Panda

- The beautiful and endangered species, Indian Red Panda is also known by the name of **Red Fox.**
- From the two kinds of Red Pandas in the world, **only one variety is found in India.**
- India has 20 protected areas with **Sikkim, Arunachal Pradesh and West Bengal's Khangchendzonga and Namdapha National Park.**
- The endangered Red Panda live in temperate climates, in deciduous and coniferous forests, usually with an under story of **bamboo and hollow trees.**



ENVIRONMENT AND HEALTH

An environmental illness can occur when you are exposed to toxins or substances in the environment that make you sick. These health hazards may be found where you live, work, or play.

What causes environmental illnesses?

Exposure to some types of chemicals can cause an environmental illness. The more of the chemical you are exposed to, the more likely you are to get ill. Examples include:

- **Chemicals in cigarettes** are known to cause lung cancer.
- **Exposure to asbestos**, an insulating material found in some older buildings, can cause tumors, lung cancer, and other diseases.
- **Wood-burning stoves** and poorly vented gas ranges can produce smoke or gases that can cause breathing problems.
- **Unsafe drinking water** from a rural well polluted with pesticides or other poisons from a nearby industrial plant could cause allergies, cancer, or other problems.
- **Certain chemicals in the workplace** may cause sterility in men or fertility problems in women.
- **Lead poisoning** can cause health problems, most commonly in children. It can also cause high blood pressure, brain damage, and stomach and kidney problems in adults.

■ Some of the environmental diseases are mentioned below:

Allergies and Asthma The road to your dreams...

- Slightly more than half of the 300 million people living in the U.S. are sensitive to one or more allergens.
- They sneeze, their noses run and their eyes itch from pollen, dust and other substances.
- Some suffer sudden attacks that leave them breathless and gasping for air.
- This is allergic asthma. Asthma attacks often occur after periods of heavy exercise or during sudden changes in the weather.
- Some can be triggered by pollutants and other chemicals in the air and in the home.
- Doctors can test to find out which substances are causing reactions.
- They can also prescribe drugs to relieve the symptoms.

Birth Defects

- Sometimes, when pregnant women are exposed to chemicals or drink a lot of alcohol, harmful substances reach the fetus.
- Some of these babies are born with an organ, tissue or body part that has not developed in a normal way.
- Aspirin and cigarette smoking can also cause birth problems. Birth defects are the leading cause of death for infants during the first year of life. Many of these could be prevented.

Blue Baby Syndrome

- Blue baby syndrome refers to the bluish appearance of body. Blue baby syndrome can occur due to multiple reasons.
- It is also believed to be caused by the consumption of high nitrate content in water which leads to decrease in the oxygen-carrying capacity of haemoglobin, particularly among children.

Cancer

- Cancer occurs when a cell or group of cells begins to multiply more rapidly than normal.
- As the cancer cells spread, they affect nearby organs and tissues in the body.
- Eventually, the organs are not able to perform their normal functions.
- Cancer is the second leading cause of death in the U.S., causing more than 500,000 deaths each year.
- Some cancers are caused by substances in the environment: **cigarette smoke, asbestos, radiation, natural and manmade chemicals, alcohol, and sunlight.**
- People can reduce their risk of getting cancer by limiting their exposure to these harmful agents.

Dermatitis

- Dermatitis is a fancy name for inflamed, irritated skin.
- Many of us have experienced the oozing bumps and itching caused by poison ivy, oak and sumac.
- Some chemicals found in paints, dyes, cosmetics and detergents can also cause rashes and blisters.
- Too much wind and sun make the skin dry and chapped.
- Fabrics, foods, and certain medications can cause unusual reactions in some individuals.

Emphysema

- Air pollution and cigarette smoke can break down sensitive tissue in the lungs. Once this happens, the lungs cannot expand and contract properly. This condition is emphysema. For these people, each breath is hard work.
- Even moderate exercise is difficult.
- Some emphysema patients must breathe from tanks of oxygen.

Heart Disease

- Heart disease is the leading cause of death in the United States and is a major cause of disability.
- While these may be due in part to poor eating habits and/or lack of exercise, environmental chemicals also play a role.
- While most chemicals that enter the body are broken down into harmless substances by the liver, some are converted into particles called free radicals that can react with proteins in the blood to form fatty deposits called **plaques, which can clog blood vessels.** A blockage can cut off the flow of blood to the heart, causing a heart attack.

Itai-Itai Disease

- It was first documented in Japan in 1912. It is also called 'ouch-ouch' disease.
- The term 'itai-itai' disease was coined by the locals due to the severe pain felt in the spine and joints.
- The disease occurs from **cadmium poisoning** and leads to the softening of bones and kidney failure.

Lead Poisoning

- Sometimes, infants and children will pick up and eat paint chips and other objects that contain lead.

- Lead dust, fumes and lead-contaminated water can also introduce lead into the body.
- Lead can damage the brain, kidneys, liver, and other organs.
- Severe lead poisoning can produce headaches, cramps, convulsions, and even death. Even small amounts can cause learning problems and changes in behavior.
- Doctors can test for lead in the blood and recommend ways to reduce further exposure.

Mercury Poisoning

- Mercury is a silvery metal that is extremely poisonous.
- Very small amounts can damage the kidneys, liver and brain.
- Years ago, workers in hat factories were poisoned by breathing the fumes from mercury used to shape the hats.
- Today, mercury exposure usually results from eating contaminated fish and other foods that contain small amounts of mercury compounds. Since the body cannot get rid of mercury, it gradually builds up inside the tissues.
- If it is not treated, mercury poisoning can eventually cause pain, numbness, weak muscles, loss of vision, paralysis and even death

Nervous System Disorders

- The nervous system, which includes the brain, spinal cord and nerves, commands and controls our thoughts, feelings, movements, and behavior.
- The nervous system consists of billions of nerve cells. They carry messages and instructions from the brain and spinal cord to other parts of the body.
- When these cells are damaged by toxic chemicals, injury or disease, this information system breaks down.
- This can result in disorders ranging from mood changes and memory loss to blindness, paralysis and death.

Pneumoconiosis

- Pneumoconiosis is also called 'black lung disease'.
- It is caused by the deposition of coal dust in the lungs of coal miners. Thus, it affects the respiratory system of the victims.

Queensland Fever

- People do not usually get diseases from farm animals. However, those who work with hides and animal products can get sick from breathing the infected dust around them.
- This illness is called Queensland fever because it was first discovered among cattle ranchers and dairy farmers in Queensland, Australia.
- It is caused by a tiny organism that infects livestock and then spreads to the milk and feces.
- Symptoms include fever, chills, and muscle aches and pains.
- Researchers have developed vaccines to protect livestock workers from this illness.

Sunburn and Skin Cancer

- Almost everyone has stayed in the sun too long and been burned.
- Too much sunlight can also produce the most common type of cancer—skin cancer.
- Some skin cancers are easy to treat because they do not spread beyond the surrounding tissue.
- Others, like melanoma, are much more dangerous because they spread to other parts of the body. Deaths due to melanoma are increasing by 4 percent each year.

Tooth Decay

In the 1930's, health experts noticed that people who lived in areas where the water contained natural chemicals called fluorides had fewer cavities. Today, all U.S. residents are exposed to fluoride to some degree, and its use has resulted in a significant decline in tooth decay. National surveys report that the incidence of tooth decay among children 12 to 17 years of age has declined from 90 percent in 1971 to 67 percent in 1988. Dentists can also protect young

Uranium Poisoning

- Uranium is a dangerous element because it is radioactive.
- This means it gives off high-energy particles that can go through the body and damage living tissue.
- A single high dose of radiation can kill. Small doses over a long period can also be harmful.
- For example, miners who are exposed to uranium dust are more likely to get lung cancer. Uranium poisoning can also damage the kidneys and interfere with the body's ability to fight infection.
- While most people will never come in contact with uranium, those who work with medical x-rays or radioactive compounds are also at risk.

Xeroderma Pigmentosa

- Xeroderma is a rare condition that people inherit from their parents.
- When these people are exposed to direct sunlight, their skin breaks out into tiny dark spots that look like freckles.
- If this condition is not treated, the spots can become cancerous. These areas must then be removed by a surgeon.

Yusho Poisoning

- In 1968, more than one thousand people in western Japan became seriously ill.
- They suffered from fatigue, headache, cough, numbness in the arms and legs, and unusual skin sores.
- Pregnant women later delivered babies with birth defects.
- **These people had eaten food that was cooked in contaminated rice oil.**
- Toxic chemicals called PCB's (polychlorinated biphenyls) had accidentally leaked into the oil during the manufacturing process. Health experts now refer to this illness as "**Yusho,**" which means "**oil disease.**"
- For years, PCB's were widely used in the manufacturing of paints, plastics and electrical equipment.
- When scientists discovered that low levels of PCB's could kill fish and other wildlife, their use was dramatically reduced.
- By this time, PCB's were already leaking into the environment from waste disposal sites and other sources.
- Today, small amounts of these compounds can still be found in our air, water, soil, and some of the foods we eat.

Zinc Deficiency/ Poisoning

- Zinc is a mineral that the body needs to function properly.
- In rare cases, people can be poisoned if there is too much zinc in their food or water.
- However, most people can take in large quantities without any harmful effects.
- In areas where nutrition is a problem, people may not get enough zinc from their diet.
- This can lead to retarded growth, hair loss, delayed sexual maturation, eye and skin lesions, and loss of appetite.

POLLUTION AND MITIGATION EFFORTS

- Pollution is defined as an addition of undesirable material into the environment as a result of human activities.
- The agents which cause environmental pollution are called pollutants.
- Pollutants may be defined as a physical, chemical or biological substance unintentionally released into the environment which is directly or indirectly harmful to humans and other living organisms.

■ Classification of Pollutants

According to the form in which they persist after being released into the environment:

- **Primary Pollutants:** These are pollutants persisted in the environment in the form it is released from the source. e.g., Carbon Dioxide, Nitrogen Oxide, Sulphur dioxide, DDT.
- **Secondary Pollutants:** These are formed from primary pollutants through change or reaction after primary pollutants being released into atmosphere. e.g., Nitrogen oxide and hydrocarbons react photochemically to produce PAN (Peroxyacyl nitrates) and Ozone is formed.

According their Nature of Degradation:

- **Biodegradable Pollutants:** Those pollutants which can be broken down into simpler, harmless, substances in nature in due course of time (by the action of micro-organisms like certain bacteria) are called biodegradable pollutants.
- **Example:** Domestic wastes (garbage), urine, sewage, agriculture residues, paper, wood, cloth, cattle dung, animal bones, leather, wool, vegetable stuff or plants are biodegradable pollutants.
- **Non-Biodegradable Pollutants:** Those pollutants which cannot be broken down into simpler, harmless substances in nature are called non-biodegradable pollutants.
- **Example:** DDT, plastics, polythene, bags, insecticides, pesticides, mercury, lead, arsenic, metal articles like aluminum cans, synthetic fibers, glass objects, iron products and silver foils are non-biodegradable pollutants.

According to their Existence in Nature:

- **Quantitative Pollutants:** These are those substances normally occurring in the environment, which acquire the status of a pollutant when their concentration gets increased due to the activities of man.
- **For example,** carbon dioxide, if present in the atmosphere in concentration greater than normal due to automobiles and industries, causes measurable effects on humans, animals, plants or property, and then it is classified as a quantitative pollutant.
- **Qualitative Pollutants:** These are those substances which do not normally occur in nature but are manmade.

For example: Insecticides, Fungicides, Herbicides, DDT, etc.

According to the Origin of Pollutants:

- **Natural Pollutants:** These are the pollutants emitted by natural processes.
- **Anthropogenic Pollutants:** These are pollutants caused by manmade activities.

■ Pollution Indicator Species

- A species of organism that can indicate an area of pollution by its presence or absence in that specific area.

1. Lichen

- Lichens are plants that grow in exposed places such as rocks or tree bark.
- They need to be very good at absorbing water and nutrients to grow there.
- Rainwater contains just enough nutrients to keep them alive.
- Air pollutants dissolved in rainwater, especially sulfur dioxide, can damage lichens and prevent them from growing.
- This makes lichens natural indicators of air pollution.

2. Indicator of Water Pollution

- Water pollution is caused by the discharge of harmful substances into rivers, lakes and seas.
- Many aquatic invertebrate animals cannot survive in polluted water, so their presence or absence indicates the extent to which a body of water is polluted.

3. Fish Survival and Water Oxygen

- One simple way to measure the health of a given water source is to examine the survival of fish in that source of water.
- Fish rely heavily on the dissolved oxygen in water to survive, so if oxygen levels are low due to pollution, no varieties of fish will survive.

■ AIR POLLUTION

- Rising issue of air pollution has increasingly been becoming a serious concern, particularly in metro cities.
- A large number of cities and towns do not meet the standards for pollutants specifically for particulate matter.
- In a few cities including Delhi, the ambient particulate matter concentrations are much above the standards i.e. three to four times or even higher.
- Air quality regulation and actions for abatement of air pollution is undertaken under various provisions of Air (Prevention and Control of Pollution) Act, 1981 and Environment (Protection) Act, 1986 which prescribes the mechanism and authorities for handling the issue.
- The major impact is highlighted with reference to health of people.
- As per the available data for Delhi and NCR for last five years, Particulate Matter (PM10 and PM2.5) concentrations are the major concern for the entire area, however a few violations are observed in NO2 concentrations in Delhi, Meerut and Faridabad.
- The concentration of SO2 is within the standard limit at all the locations in all the last five years.
- PM10 are inhalable coarse particles, which are particles with a diameter between 2.5 and 10 micrometers (µm) and PM2.5 are fine particles with a diameter of 2.5 µm or less.

■ Indoor Air Pollution and Health

Indoor Air Quality (IAQ) refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. Understanding and controlling common pollutants indoors can help reduce your risk of indoor health concerns.

Health effects from indoor air pollutants may be experienced soon after exposure or, possibly, years later.

Immediate Effects

- Some health effects may show up shortly after a single exposure or repeated exposures to a pollutant.
- These include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Such immediate effects are usually short-term and treatable.
- Sometimes the treatment is simply eliminating the person's exposure to the source of the pollution, if it can be identified.
- Soon after exposure to some indoor air pollutants, symptoms of some diseases such as asthma may show up, be aggravated or worsened.
- The likelihood of immediate reactions to indoor air pollutants depends on several factors including age and preexisting medical conditions.
- In some cases, whether a person reacts to a pollutant depends on individual sensitivity, which varies tremendously from person to person.
- Some people can become sensitized to biological or chemical pollutants after repeated or high level exposures.
- Certain immediate effects are similar to those from colds or other viral diseases, so it is often difficult to determine if the symptoms are a result of exposure to indoor air pollution.
- For this reason, it is important to pay attention to the time and place symptoms occur. If the symptoms fade or go away when a person is away from the area, for example, an effort should be made to identify indoor air sources that may be possible causes.
- Some effects may be made worse by an inadequate supply of outdoor air coming indoors or from the heating, cooling or humidity conditions prevalent indoors.

Long-Term Effects

- Other health effects may show up either years after exposure has occurred or only after long or repeated periods of exposure.
- These effects, which include some respiratory diseases, heart disease and cancer, can be severely debilitating or fatal.
- It is prudent to try to improve the indoor air quality in your home even if symptoms are not noticeable.
- While pollutants commonly found in indoor air can cause many harmful effects, there is considerable uncertainty about what concentrations or periods of exposure are necessary to produce specific health problems.
- People also react very differently to exposure to indoor air pollutants.
- Further research is needed to better understand which health effects occur after exposure to the average pollutant concentrations found in homes and which occurs from the higher concentrations that occur for short periods of time.

■ Primary Causes of Indoor Air Problems

Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the area. High temperature and humidity levels can also increase concentrations of some pollutants.

Pollutant Sources

There are many sources of indoor air pollution. These can include:

- Fuel-burning combustion appliances

- Tobacco products
- Building materials and furnishings as diverse as:
 - ▶ Deteriorated asbestos-containing insulation
 - ▶ Newly installed flooring, upholstery or carpet
 - ▶ Cabinetry or furniture made of certain pressed wood products
- Products for household cleaning and maintenance, personal care, or hobbies
- Central heating and cooling systems and humidification devices
- Excess moisture
- Outdoor sources such as:
 - Radon
 - Pesticides
 - Outdoor air pollution.

Initiatives on Air Pollution Mitigation:

- **National Ambient Air Quality Standards** envisaging **12 pollutants** have been notified under EPA, 1986 and 115 emission/effluent standards for 104 different sectors of industries, besides 32 general standards for ambient air have also been notified.
- Government is executing a nation-wide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of Six hundred and Ninety-One (691) manual operating stations covering Three Hundred and three (303) cities/towns in twenty-nine (29) states and four (6) Union Territories of the country. In addition, there are 86 real-time Continuous Ambient Air Quality Monitoring stations (CAAQMS) in 57 cities. Delhi has 10 Manual Stations and 18 CAAQMS. 20 additional CAAQMS are at various stages of installation in Delhi.
- **With reference to Vehicular pollution the steps taken include introduction of cleaner / alternate fuels like gaseous fuel (CNG, LPG etc.), ethanol blending, universalization of BS-IV by 2017; leapfrogging from BS-IV to BS-VI fuel standards by 1st April, 2020;** ongoing promotion of public transport network of metro, buses, e-rickshaws and promotion of carpooling, streamlining granting of Pollution Under Control Certificate, lane discipline, vehicle maintenance etc.
- **National Air Quality index (AQI) was launched by the Prime Minister in April, 2015 starting with 14 cities and now extended to 34 cities.**
- **A Graded Response Action Plan for control of air pollution in Delhi and NCR region has been notified.** This plan specifies actions required for controlling particulate matter (PM emissions from various sources and prevent **PM10 and PM2.5** levels to go beyond 'moderate' national Air Quality Index (AQI) category. The measures are cumulative. Emergency and Severe levels include cumulatively all other measures listed in the lower levels of AQI including Very Poor, Poor and Moderate. Actions listed in the Poor to Moderate category need to be implemented though out the year.
- **Central Pollution Control Board (CPCB)** has issued a comprehensive set of directions under section 18 (1) (b) of Air (Prevention and Control of Pollution) Act, 1986 for implementation of 42 measures to mitigate air pollution in major cities including Delhi and NCR comprising of action points to counter air pollution in major cities which include control and mitigation measures related to vehicular emissions, re-suspension of road dust and other fugitive emissions, bio-mass/municipal solid waste burning, industrial pollution, construction and demolition activities, and other general steps.
- In order to involve people in the effort, Government had launched a campaign called '**Harit Diwali and Swasth Diwali**' during September 2017 involving over 2000 schools in Delhi and over two lakh schools in the country. **The Government had also organized a Mini Marathon for 'Swachh Hawa for Swachh and Swasth Bharat'** on 15th October 2017 at India Gate in which nearly 15,000 school children had participated.
- Regular co-ordination meetings are held in the Ministry at official and ministerial level with Delhi and other State Governments to avoid the emergency situation. In this regard several meetings have been held this year under the chairmanship of Hon'ble Minister for Environment Forest and

Climate Change and Secretary (EF&CC) involving Environment Minister of the States and Senior State Functionaries including Chief Ministers, Ministers, Chief Secretaries and Additional Chief Secretaries.

- CPCB had taken a number of Proactive steps to help improve ground implementation .40 CPCB teams deployed for ground feedback on air polluting activities in Delhi –September 01, 2017 onwards Field visit to four pollution hotspots (Anand Vihar, ITO, Punjabi Bagh and DTU) and suggested interventions July 2017 .On the spot reporting to DPCC, and weekly summary reports to Delhi Govt.
- During air pollution emergency period from 7.11.2017 to 14.11.2017 and measures like ban on construction, sprinkling of water, ban on entry of truck etc. which are there under GRAP were implemented.
- **A High Level Task Force (HLTF) headed by Principal Secretary to PM has been constituted by the government for management of air pollution in Delhi and NCR.** First meeting of Task Force was held on 4th December 2017. On the basis of direction of the Task Force, Sub-Committee of High Level Task Force for Prevention of Stubble Burning in Haryana, Uttar Pradesh and Punjab has been constituted and report has been submitted for consideration by the HLTF. The Task Force has proposed a draft Air Action Plan on Abatement of Air Pollution in the Delhi National Capital Region in which time bound activities have been outlined. This has been put in the public domain for suggestions/comments from citizens and experts for possible refinements.

■ WATER POLLUTION

India consists 1/25th of world's water resources. The total utilizable water resources of the country are assessed as 1086 km³.

Sources of Water Pollution

There are various classifications of water pollution. The two chief sources of water pollution can be seen as Point and Non Point:

- **Point Source** refers to the pollutants that belong to a single source. An example of this would be emissions from factories into the water.
- **Non Point Source** on the other hand means pollutants emitted from multiple sources. Contaminated water after rains that has traveled through several regions may also be considered as a Non point source of pollution.

Sources are:

- Chemical fertilizers and pesticides
- Industrial waste: Industries produce huge amount of waste which contains toxic chemicals and pollutants such as lead, mercury, sulphur, asbestos, nitrates and many other harmful chemicals.
- Mining activities
- Marine dumping: The garbage produce by each household in the form of paper, aluminum, rubber, glass, plastic, food if collected and deposited into the sea in some countries.
- Accidental Oil leakage
- Burning of fossil fuels
- Radioactive Waste
- Animal waste- contributes to the biological pollution of water streams
- Construction activities
- Leaking landfills

■ Measurement of Water Pollution

Biological Oxygen Demand (BOD)

- BOD is the amount of dissolved oxygen needed by bacteria in decomposing the organic wastes present in water. It is expressed in milligrams of oxygen per litre of water.

- The higher value of BOD indicates low Dissolved Oxygen content of water. Since BOD is limited to biodegradable materials. Therefore, it is not a reliable method of measuring pollution load in water.

Chemical Oxygen Demand (COD)

- COD measures the amount of oxygen in parts per million required to oxidize organic (biodegradable and non- biodegradable) and oxidizable inorganic compounds in the water sample.

Total Organic Carbon

- Organic matter content is typically measured as total organic carbon and dissolved organic carbon, which are essential components of the carbon cycle. The Total Organic Carbon test measures all organic carbon as CO₂. Therefore, all inorganic CO₂, HCO₃⁻, etc. must be removed prior to the analysis.
- TOC is often used when levels of organic matter (OM) are low. Total organic carbon is a good parameter to measure and actually a more accurate indication of some of the pollutants that cause the most problems than a BOD test. TOC doesn't differentiate between that portion of organic carbon, which can be metabolized (assimilated).

■ Harmful Effects of Water Pollution

- Some polluted water looks muddy, smells bad, and has garbage floating in it. Some polluted water looks clean, but is filled with harmful chemicals you can't see or smell.
- Polluted water is **unsafe for drinking and swimming**. Some people who drink polluted water are exposed to **hazardous chemicals** that may make them sick years later. Others consume bacteria and other tiny aquatic organisms that cause disease. **The United Nations estimates that 4,000 children die every day from drinking dirty water.**
- Sometimes, polluted water harms people indirectly. **They get sick because the fish that live in polluted water are unsafe to eat.** They have too many pollutants in their flesh.
- There are **some natural sources of water pollution**. **Oil and natural gas**, for example, can leak into oceans and lakes from natural underground sources. **These sites are called petroleum seeps.** The **world's largest petroleum seep is the Coal Oil Point Seep, off the coast of the U.S. state of California.** The Coal Oil Point Seep releases so much oil that **tar balls wash up on nearby beaches. Tar balls are small, sticky pieces of pollution that eventually decompose in the ocean.**
- **Human activity also contributes to water pollution.** Chemicals and oils from factories are sometimes dumped or seep into waterways. These chemicals are called runoff. **Chemicals in runoff can create a toxic environment for aquatic life.** Runoff can also help create a fertile environment for cyanobacteria, also called blue-green algae. Cyanobacteria reproduce rapidly, creating a harmful algal bloom (HAB). Harmful algal blooms prevent organisms such as plants and fish from living in the ocean. They are associated with "dead zones" in the world's lakes and rivers, places where little life exists below surface water.
- **Mining and drilling** can also contribute to water pollution. **Acid mine drainage (AMD) is a major contributor to pollution of rivers and streams near coal mines.** Acid helps miners remove coal from the surrounding rocks. The acid is washed into streams and rivers, where it reacts with rocks and sand. It releases chemical sulfur from the rocks and sand, creating a river rich in sulfuric acid. Sulfuric acid is toxic to plants, fish, and other aquatic organisms. Sulfuric acid is also toxic to people, making rivers polluted by AMD dangerous sources of water for drinking and hygiene.
- **Buried chemical waste can also pollute water supplies.** For many years, people disposed of chemical wastes carelessly, not realizing its dangers. In the 1970s, people living in the Love Canal area in Niagara Falls, New York, suffered from extremely high rates of cancer and birth defects. It was discovered that a chemical waste dump had poisoned the area's water. In 1978, 800 families living in Love Canal had to abandon their homes.
- If not disposed of properly, **radioactive waste from nuclear power plants can escape into the environment.** Radioactive waste can harm living things and pollute the water.

- **Sewage that has not been properly treated is a common source of water pollution.** Many cities around the world have poor sewage systems and sewage treatment plants. Delhi, the capital of India, is home to more than 21 million people. **More than half the sewage and other waste produced in the city are dumped into the Yamuna River.** This pollution makes the river dangerous to use as a source of water for drinking or hygiene. It also reduces the river's fishery, resulting in less food for the local community.
- **A major source of water pollution is fertilizer used in agriculture.** Fertilizer is material added to soil to make plants grow larger and faster. Fertilizers usually contain large amounts of the elements nitrogen and phosphorus, which help plants grow. Rainwater washes fertilizer into streams and lakes. There, the nitrogen and phosphorus cause cyanobacteria to form harmful algal blooms.
- **Rain washes other pollutants into streams and lakes.** It picks up animal waste from cattle ranches. Cars drip oil onto the street, and rain carries it into storm drains, which lead to waterways such as rivers and seas. Rain sometimes washes chemical pesticides off of plants and into streams. Pesticides can also seep into groundwater, the water beneath the surface of the Earth.
- **Heat can pollute water.** Power plants, for example, produce a huge amount of heat. Power plants are often located on rivers so they can use the water as a coolant. Cool water circulates through the plant, absorbing heat. The heated water is then returned to the river. Aquatic creatures are sensitive to changes in temperature. Some fish, for example, can only live in cold water. Warmer river temperatures prevent fish eggs from hatching. Warmer river water also contributes to harmful algal blooms.
- **Another type of water pollution is simple garbage. The Citarum River in Indonesia,** for example, has so much garbage floating in it that you cannot see the water. Floating trash makes the river difficult to fish in. Aquatic animals such as fish and turtles mistake trash, such as plastic bags, for food. Plastic bags and twine can kill many ocean creatures. Chemical pollutants in trash can also pollute the water, making it toxic for fish and people who use the river as a source of drinking water. The fish that are caught in a polluted river often have high levels of chemical toxins in their flesh. People absorb these toxins as they eat the fish.
- **Garbage also fouls the ocean.** Many plastic bottles and other pieces of trash are thrown overboard from boats. The wind blows trash out to sea. Ocean currents carry plastics and other floating trash to certain places on the globe, where it cannot escape. The largest of these areas, called the Great Pacific Garbage Patch, is in a remote part of the Pacific Ocean. **According to some estimates, this garbage patch is the size of Texas. The trash is a threat to fish and seabirds, which mistake the plastic for food. Many of the plastics are covered with chemical pollutants.**
- **Eutrophication**
 - ▶ Eutrophication refers to the addition of artificial or non-artificial substances, such as nitrates and phosphates, through fertilizers or sewage, to a fresh water system.
 - ▶ It can be anthropogenic or natural. It leads increase in the primary productivity of the water body or "bloom" of phytoplankton.
 - ▶ The overgrowth causes the loss of oxygen in the water leading to severe reductions in fish and other animal populations.
 - ▶ Eutrophication escalates rapidly when high nutrients from fertilizers, domestic and industrial wastes, urban drainage, detergents and animal, sediments enter water streams.
 - ▶ The cultural eutrophication process consists of a continuous increase in the contribution of nutrients, mainly nitrogen and phosphorus (organic load) until it exceeds the capacity of the water body (i.e. the capacity of a lake, river or sea to purify itself) , triggering structural changes in the waters.

■ Some Water Treating Measures

Septic Tanks and Sewage Treatments:

- Septic tanks treat sewage at the place where it is located, rather than transporting the waste through a treatment plant or sewage system.

- Septic tanks are usually used to treat sewage from an individual building.
- Solid material is separated depending on their density. Heavier particles settle at the bottom of the tank whereas lighter particles, such as soap scum, will form a layer at the top of the tank.
- Biological processes are used to help degrade the solid materials. The liquid then flows out of the tank into a land drainage system and the remaining solids are filtered out.

Industrial Water Treatment:

- In a water treatment plant, sewage goes through a number of chambers and chemical processes to reduce the amount and toxicity of the waste.
- **Primary Phase:** This is where some of the suspended, solid particles and inorganic material is removed by the use of filters.
- **Secondary Phase:** Involves the reduction of organic, this is done with the use of biological filters and processes that naturally degrade the organic waste material.
- **Tertiary Phase:** This stage must be done before the water can be reused. Almost all solid particles are removed from the water and chemical additives are supplied to get rid of any left-over impurities.

Ozone Wastewater Treatment:

- It is a method that is increasing in popularity. An ozone generator is used to break down pollutants in the water source.
- The generators convert oxygen into ozone by using ultraviolet radiation or by an electric discharge field.
- Ozone is a very reactive gas that can oxidise bacteria, moulds, organic material and other pollutants found in water. Using ozone to treat wastewater has many benefits:
 - ▶ Kills bacteria effectively.
 - ▶ Oxidises substances such as iron and sulphur so that they can be filtered out of the solution.
 - ▶ There are no nasty odours or residues produced from the treatment.
 - ▶ Ozone converts back into oxygen quickly, and leaves no trace once it has been used

Denitrification:

- It is an ecological approach that can be used to prevent the leaching of nitrates in soil, this in turn stops any ground water from being contaminated with nutrients.

■ MARINE POLLUTION

- The 1982, United Nations Convention on the Laws of the Sea defined Marine Pollution, “the introduction by man, directly or indirectly, of substances or energy into the marine environment which results or is likely to result in such deleterious effects as harm to living resources and marine life”.

Sources of Marine Pollution

- The three main sources of marine pollution are direct discharge as effluents and solid wastes from land or human activities at sea (like shipping), run off mainly via rivers, and atmospheric fall out.

Effects of Marine Pollution

- The effects of Marine Life
- Ghost Fishing
- Creation of Dead Zones
- Increase in Algal Blooms
- Acidification of Oceans
- Leads to loss of marine life (choking of marine life, depletion of oxygen)

Concept of Algal Bloom

- Algal bloom is a rapid increase or accumulation in the population of algae in freshwater or marine water systems, and is recognized by the discoloration in the water from their pigments.
- Algal blooms are the consequence of Eutrophication.
- Eutrophication is the response to the addition of nutrients such as nitrates and phosphates naturally or artificially, fertilizing the aquatic ecosystem.

Concept of Ghost Fishing

- 'Ghost Fishing' is what fishing gear does when it has been lost, dumped or abandoned. Imagine a fishing net that gets snagged on a reef or a wreck and gets detached from the fishing vessel. Nets, long lines, fish traps or any man made contraptions designed to catch fish or marine organisms are considered capable of ghost fishing when unattended, and without anyone profiting from the catches, they are affecting already depleted commercial fish stocks. Caught fish die and in turn attract scavengers which will get caught in that same net, thus creating a vicious circle.

Concept of Dead Zone

- Dead zones are the areas in oceans and large bodies of freshwater like lakes where the level of dissolved oxygen is too low to sustain marine life.
- In such zones, most marine life either dies or migrates to other areas, thus turning these hypoxic zones into biological deserts. **The largest dead zone is present in Gulf of Mexico.**

■ Causes

Human Activities:

- Increased use of chemical fertilizers, mainly nitrogenous fertilizers. □
- Chemical fertilizers, as well as pesticides and insecticides used in intensive farming, escape into water bodies like rivers and eventually end up in the ocean.
- Runoff from sewage and landfills □
- Burning of gasoline □
- Oil spills can further reduce the level of dissolved oxygen in water

Natural Causes:

- Apart from human activities, some naturally occurring changes also contributes to the phenomenon of dead zones:
 - ▶ coastal upwelling □
 - ▶ changes in wind □
 - ▶ water circulation patterns

Effects

- Leads to reproductive problems in marine life
- Dead zone is an invisible trap, there is no escaping for marine life
- Great impact on benthic biomass and biodiversity
- Contributes to climate change

Concept of Ocean Acidification

- When carbon dioxide (CO₂) is absorbed by seawater, chemical reactions occur that reduce seawater pH, carbonate ion concentration, and saturation states of biologically important calcium carbonate minerals.

- These chemical reactions are termed “ocean acidification”. Burning of fossil fuels releases CO₂ and other gases which upon absorption by ocean are directly contributing to ocean acidification.
- Release of NO₂ and SO₂ also cause acid rain which can contribute to ocean acidification.

Impact:

- The impacts of ocean acidification could be enormous.
- The change in ocean chemistry leads to collapsing food webs, corrosive polar seas, dying coral reefs and mass extinctions – which could alter our food, water and air forever.
- Acidity is measured using pH measurements.
- The higher a pH value is, the more basic, or non-acidic the substance is. The lower the pH value is the more acidic a substance is.

Oil Spill

- An oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially marine areas, due to human activity, and is a form of pollution.
- The term is usually applied to marine oil spills, where oil is released into the ocean or coastal waters, but spills may also occur on land.
- Oil spills may be due to releases of crude oil from tankers, offshore platforms, drilling rigs and wells, as well as spills of refined petroleum products (such as gasoline, diesel) and their by-products, heavier fuels used by large ships such as bunker fuel, or the spill of any oily refuse or waste oil.

Oil Zapping

Oil Zapping is a bio-remediation technique involving the use of ‘oil zapping’ bacteria.

How does Oil Zapper Work?

- There are five different bacterial strains that are immobilized and mixed with a carrier material such as powdered corn cob. This mixture of five bacteria is called Oil Zapper. Oil zapper feeds on hydrocarbon compounds present in crude oil and the hazardous hydrocarbon waste generated by oil refineries, known as Oil Sludge and converts them into harmless CO₂ and water. The Oilzapper is neatly packed into sterile polythene bags and sealed aseptically for safe transport. The shelf life of the product is three months at ambient temperature.
- The oil zapping bacteria was developed over a period of seven years by TERI and the project was supported by the Department of Biotechnology (Government of India) and the Ministry of Science and Technology

■ LAND POLLUTION

- Article 1 of the **UN Convention to Combat Desertification** defines land degradation as a “reduction or loss in arid, semi-arid and dry sub-humid areas of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and / or water; (ii) deterioration of the physical, chemical, and biological and economic properties of soil; and (iii) long-term loss of natural vegetation” (Ministry of Environment, Forests and Climate Change, GoI, 2014).
- Land degradation is the process of deterioration of soil or loss of fertility of soil.

Causes of Land Degradation

- Population;
- Human Activities;
- Urbanization;
- Soil erosion;

- Soil contamination;
- Soil salinization;
- Soil sealing;
- Overgrazing;
- Acidification of Soil;
- Mining and quarrying activities;
- Improper crop rotations;
- Use of Chemical Fertilizer and pesticides.

Harmful Effects of Land Pollution

- Many of the same pollutants that foul the water also harm the land. **Mining sometimes leaves the soil contaminated with dangerous chemicals.**
- **Pesticides and fertilizers** from agricultural fields are blown by the wind. They can harm plants, animals, and sometimes people. **Some fruits and vegetables absorb the pesticides** that help them grow. When people consume the fruits and vegetables, the pesticides enter their bodies. Some pesticides can cause cancer and other diseases.
- A pesticide called DDT (dichlorodiphenyltrichloroethane) was once commonly used to kill insects, especially mosquitoes. In many parts of the world, mosquitoes carry a disease called malaria, which kills a million people every year. Swiss chemist Paul Hermann Muller was awarded the Nobel Prize for his understanding of how DDT can control insects and other pests. DDT is responsible for reducing malaria in places such as Taiwan and Sri Lanka.
- In 1962, American biologist Rachel Carson wrote a book called *Silent Spring*, which discussed the dangers of DDT. She argued that it could contribute to cancer in humans. She also explained how it was destroying bird eggs, which caused the number of bald eagles, brown pelicans, and ospreys to drop. In 1972, the United States banned the use of DDT. Many other countries also banned it. But DDT didn't disappear entirely. Today, many governments support the use of DDT because it remains the most effective way to combat malaria.
- **Trash is another form of land pollution.** Around the world, paper, cans, glass jars, plastic products, and junked cars and appliances mar the landscape. Litter makes it difficult for plants and other producers in the food web to create nutrients. Animals can die if they mistakenly eat plastic.
- **Garbage often contains dangerous pollutants such as oils, chemicals, and ink. These pollutants can leech into the soil and harm plants, animals, and people.**
- **Inefficient garbage collection systems contribute to land pollution.** Often, the garbage is picked up and brought to a dump, or landfill. Garbage is buried in landfills. Sometimes, communities produce so much garbage that their landfills are filling up. They are running out of places to dump their trash.
- A massive landfill near Quezon City, Philippines, was the site of a land pollution tragedy in 2000. Hundreds of people lived on the slopes of the Quezon City landfill. These people made their living from recycling and selling items found in the landfill. However, the landfill was not secure. Heavy rains caused a trash landslide, killing 218 people.
- Sometimes, landfills are not completely sealed off from the land around them. **Pollutants from the landfill leak into the earth in which they are buried.** Plants that grow in the earth may be contaminated, and the herbivores that eat the plants also become contaminated. So do the predators that consume the herbivores. This process, where a chemical builds up in each level of the food web, is called bioaccumulation.
- Pollutants leaked from landfills also leak into local groundwater supplies. There, **the aquatic food web (from microscopic algae to fish to predators such as sharks or eagles) can suffer from bioaccumulation of toxic chemicals.**
- Some communities do not have adequate garbage collection systems, and trash lines the side of roads. In other places, garbage washes up on beaches. Kamilo Beach, in the U.S. state of Hawaii, is littered with plastic bags and bottles carried in by the tide. **The trash is dangerous to ocean life**

and reduces economic activity in the area. Tourism is Hawaii's largest industry. Polluted beaches discourage tourists from investing in the area's hotels, restaurants, and recreational activities.

- Some cities incinerate, or burn, their garbage. Incinerating trash gets rid of it, but it can release dangerous heavy metals and chemicals into the air. **So while trash incinerators can help with the problem of land pollution, they sometimes add to the problem of air pollution.**

Sustainable Land Management (SLM)

- It is crucial to minimizing land degradation, rehabilitating degraded areas and ensuring the optimal use of land resources for the benefit of present and future generations.
- SLM is based on four common principles:
 - ▶ Land-user-driven and participatory approaches;
 - ▶ Integrated use of natural resources at ecosystem and farming systems levels
 - ▶ Multilevel and multi-stakeholder involvement; and
 - ▶ Targeted policy and institutional support, including development of incentive mechanisms for SLM adoption and income generation at the local level.

Some of the methods for sustainable management of land are:

- Management on overgrazing: Management practices like water development, placement of salt and supplements, fertilizer application, fencing, burning can control the overgrazing.
- Managing irrigation: Irrigation system can be controlled like drip irrigation to reduce soil erosion. Using high and low salt water was most effective in maintaining the productive capacity of the clay soil.
- Managing urban sprawl: The urban planning is the most important factor, to control the urban sprawl. Fertile field near by the urban area need to be protected by the local government rules. There should be a proper waste management system dumping of these waste generated as part of urban sprawling will degrade the land, can cause soil salinity, acidity and loss of it vegetative properties.
- Managing mining and quarrying: The impact can be reduced by proper management of mining process, using advanced technologies rather than conventional methods. After mining by proper back filling, spreading the soil back over the top, the land can be reclaimed.
- Managing agricultural intensification: Agricultural intensification need to be managed properly to reduce the environmental effect. This can be done through education of the farmers.

■ NOISE POLLUTION

- Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms.
- According to the **World Health Organization**, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is.
- **Exposure for more than 8 hours to constant noise beyond 85 dB may be hazardous.**
- If you work for 8 hours daily in close proximity to a busy road or highway, you are very likely exposed to traffic noise pollution around 85dB.

■ Various Causes of Noise Pollution

1. Industrialization

- Most of the industries use big machines which are capable of producing a large amount of noise.
- Apart from that, various equipment like compressors, generators, exhaust fans, grinding mills also participates in producing big noise.
- Therefore, you must have seen workers in these factories and industries wearing earplugs to minimize the effect of noise.

2. Poor Urban Planning

- In most of the developing countries, poor urban planning also plays a vital role.
- Congested houses, large families sharing small space, fight over parking, frequent fights over basic amenities leads to noise pollution which may disrupt the environment of society.

3. Social Events

- Noise is at its peak in most of the social events.
- Whether it is marriage, parties, pub, disc or place of worship, people normally flout rules set by the local administration and create nuisance in the area.
- People play songs on full volume and dance till midnight which makes the condition of people living nearby pretty worse.
- In markets, you can see people selling clothes via making a loud noise to attract the attention of people.

4. Transportation

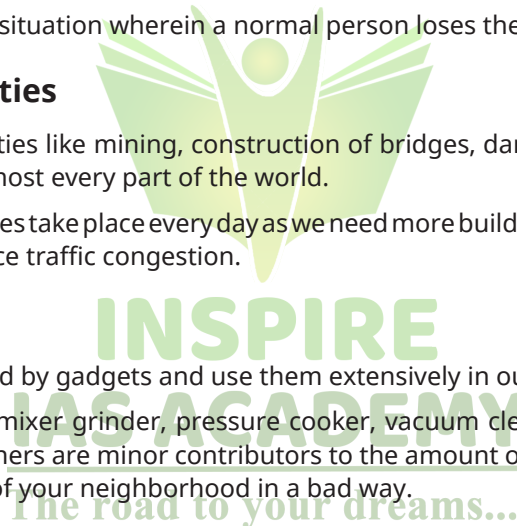
- A large number of vehicles on roads, airplanes flying over houses, underground trains produce heavy noise and people get it difficult to get accustomed to that.
- The high noise leads to a situation wherein a normal person loses the ability to hear properly.

5. Construction Activities

- Under construction activities like mining, construction of bridges, dams, buildings, stations, roads, flyovers takes place in almost every part of the world.
- These construction activities take place every day as we need more buildings, bridges to accommodate more people and to reduce traffic congestion.

6. Household Chores

- We people are surrounded by gadgets and use them extensively in our daily life.
- Gadgets like TV, mobile, mixer grinder, pressure cooker, vacuum cleaners, washing machine and dryer, cooler, air conditioners are minor contributors to the amount of noise that is produced but it affects the quality of life of your neighborhood in a bad way.



■ Effect of Noise Pollution on Human Health

- **Hypertension** is, in this case, a direct result of noise pollution caused elevated blood levels for a longer period of time.
- **Hearing loss** can be directly caused by noise pollution, whether listening to loud music in your headphones or being exposed to loud drilling noises at work, heavy air or land traffic, or separate incidents in which noise levels reach dangerous intervals, 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, and a number of noise-pollution-related diseases and dysfunctions are known to affect children, from hearing impairment to psychological and physical effects. Also, children who regularly use music players at high volumes are at risk of developing hearing dysfunctions. In 2001, it was estimated that 12.5% of American children between the ages of 6 to 19 years had impaired hearing in one or both ears
- **Various cardiovascular dysfunctions.** Elevated blood pressure caused by noise pollution, especially during the night, can lead to various cardiovascular diseases.
- **Dementia** isn't necessarily caused by noise pollution, but its onset can be favored or compounded by noise pollution.

- **Psychological dysfunctions and noise annoyance.** Noise annoyance is, in fact, a recognized name for an emotional reaction that can have an immediate impact.

■ Effects of Noise Pollution on Wildlife and Marine Life

- Our oceans are no longer quiet. Thousands of oil drills, sonars, seismic survey devices, coastal recreational watercraft and shipping vessels are now populating our waters, and that is a serious cause of noise pollution for marine life.
- Whales are among the most affected, as their hearing helps them orient themselves, feed and communicate.
- Noise pollution thus interferes with cetaceans' (whales and dolphins) feeding habits, reproductive patterns and migration routes, and can even cause hemorrhage and death.
- Other than marine life, land animals are also affected by noise pollution in the form of traffic, firecrackers etc., and birds are especially affected by the increased air traffic.



ENVIRONMENTAL CONVENTION

■ Agreement on the Conservation of African-Eurasian Migratory Waterbirds

- The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an **intergovernmental treaty** dedicated to the **conservation of migratory waterbirds** and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago.
- Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.

Species Covered by AEWA

- AEWA covers **255 species of birds ecologically dependent on wetlands** for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the South African penguin.
- **All AEWA species cross international boundaries during their migrations** and require good quality habitat for breeding as well as a network of suitable sites to support their annual journeys. International cooperation across their entire migratory range, as provided by AEWA, is therefore essential for the conservation and management of migratory waterbird populations and the habitats on which they depend.

The AEWA Action Plan

- The AEWA Action Plan specifies different measures to be undertaken by Contracting Parties to warrant the conservation of migratory waterbirds within their national boundaries.
- These include species and habitat protection and the management of human activities as well as legal and emergency measures.
- Research and monitoring, education, awareness-raising and capacity building are also essential tasks for the implementation of the Agreement.
- In addition, special protective measures are to be implemented for those waterbird populations of particular conservation concern, listed in Column A of the Action Plan.

■ The Bamako Convention

- The Bamako Convention is a treaty **of African nations prohibiting the import into Africa of any hazardous (including radioactive) waste**. The convention came into force in 1998.

Origin

- The Bamako convention is a response to Article 11 of the **Basel convention** which encourages parties to enter into **bilateral, multilateral and regional agreements on Hazardous Waste to help achieve the objectives of the convention**.

Specificity

The Bamako convention uses a format and language similar to that of the Basel convention, except that:

- it is much stronger in prohibiting all imports of hazardous waste, and
- It does not make exceptions on certain hazardous wastes (like those for radioactive materials) made by the Basel convention.

What does the Convention cover?

- The Convention covers **more wastes** than covered by the Basel Convention as it **not only includes radioactive wastes but also considers any waste with a listed hazardous characteristic or a listed constituent as a hazardous waste**; the Convention also covers national definitions of hazardous waste.
- Other products also covered under the Convention as waste include that have been severely restricted or have been subject of prohibitions.

Purpose of the Convention

- To prohibit the import of all hazardous and radioactive wastes into the African continent for any reason;
- To minimize and control Trans boundary movements of hazardous wastes within the African continent.
- To prohibit all ocean and inland water dumping or incineration of hazardous wastes.
- To ensure that disposal of wastes is conducted in an “environmentally sound manner”.
- To promote cleaner production over the pursuit of a permissible emissions approach based on assimilative capacity assumptions
- To establish the precautionary principle.

■ Basel Convention

- The Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 by the Conference of Plenipotentiaries in Basel, Switzerland, in response to a public outcry following the discovery, in the 1980s, in Africa and other parts of the developing world of deposits of toxic wastes imported from abroad.
- Awakening environmental awareness and corresponding tightening of environmental regulations in the industrialized world in the 1970s and 1980s had led to increasing public resistance to the disposal of hazardous wastes – in accordance with what became known as the NIMBY (**Not in My Back Yard**) **syndrome** – and to an escalation of disposal costs.
- This in turn led some operators to seek cheap disposal options for hazardous wastes in Eastern Europe and the developing world, where environmental awareness was much less developed and regulations and enforcement mechanisms were lacking.
- It was against this background that the Basel Convention was negotiated in the late 1980s, and its thrust at the time of its adoption was to combat the “toxic trade”, as it was termed. The Convention entered into force in 1992.

Objective

- The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes.
- Its scope of application covers a wide range of wastes defined as “**hazardous wastes**” based on their origin and/or composition and their characteristics, as well as two types of wastes defined as “other wastes” - household waste and incinerator ash.

Aims and provisions

The provisions of the Convention center around the following principal aims:

- The reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- The restriction of Trans boundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- A regulatory system applying to cases where Trans boundary movements are permissible.

■ The Carpathian Convention

- The Carpathians are one of Europe's largest mountain ranges, a unique natural treasure of great beauty and ecological value, and home of the headwaters of major rivers.
- They also constitute a major ecological, economic, cultural, recreational and living environment in the heart of Europe, shared by numerous peoples and countries.
- The Carpathian Convention is a sub-regional treaty to foster the sustainable development and the protection of the Carpathian region.
- It has been signed in May 2003 by seven Carpathian States (Czech Republic, Hungary, Poland, Romania, Serbia, Slovak Republic, Ukraine).

About

- The Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention) was adopted and signed by the seven Parties (Czech Republic, Hungary, Poland, Romania, Serbia, Slovak Republic, Ukraine) in May 2003 in Kyiv, Ukraine, and entered into force in January 2006.
- It is the only multi-level governance mechanism covering the whole of the Carpathian area and besides the Alpine Convention the second sub-regional treaty-based regime for the protection and sustainable development of a mountain region worldwide.

Vision

- The common vision of the Parties to the Carpathian Convention is to pursue comprehensive policy and cooperation in order to guarantee protection and sustainable development of the Carpathians.
- The improvement of the quality of life, the strengthening of local economies and communities, and the conservation of natural values and cultural heritage should go hand in hand in the Carpathian area.
- The Convention provides a framework for cooperation and multi-sectoral policy coordination, a platform for joint strategies for sustainable development, and a forum for dialogue between all stakeholders involved – from the local community and various NGO's up to the regional and national Governments, Institutions of the European Union and the United Nations.

■ Convention on Biological Diversity

- The Convention on Biological Diversity (CBD) was signed at the Earth Summit in Rio de Janeiro, Brazil, in 1992 and entered into force on 29 December 1993.
- It is the first global agreement to cover all aspects of biological diversity: the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising from the use of genetic resources.

Role

- The Secretariat of the Convention on Biological Diversity was established (Article 24) to support the goals of the Convention. Its principal functions are to prepare for, and service, meetings of the Conferences of the Parties (COP) and other subsidiary bodies of the Convention, and to coordinate with relevant international bodies.

- As a neutral organization staffed by international civil servants, the Secretariat is accountable to the COP and its subsidiary bodies and carries out those tasks that fall under its associated mandate.
- The Secretariat is institutionally linked to UN Environment, its host institution and, pursuant to decision II/19, is located in Montreal, Canada since 1996.
- The Secretariat plays a significant role in supporting the implementation of the Convention.
- This can be fulfilled, for example by compilation of national reports on compliance by domestic authorities.
- The Secretariat transmits such reports and information to the COP and sometimes elaborates a synthesis of the national reports and information on implementation.
- The **Secretariat also acts as information clearing house.**

■ **Convention on International Trade in Endangered Species of Wild Fauna and Flora**

- **CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora)** is an international agreement between governments.
- Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.
- Widespread information nowadays about the endangered status of many prominent species, such as the tiger and elephants, might make the need for such a convention seem obvious.
- But at the time when the ideas for CITES were first formed, in the 1960s, international discussion of the regulation of wildlife trade for conservation purposes was something relatively new.
- With hindsight, the need for CITES is clear. Annually, international wildlife trade is estimated to be worth billions of dollars and to include hundreds of millions of plant and animal specimens.
- The trade is diverse, ranging from live animals and plants to a vast array of wildlife products derived from them, including food products, exotic leather goods, wooden musical instruments, timber, tourist curios and medicines.
- Levels of exploitation of some animal and plant species are high and the trade in them, together with other factors, such as habitat loss, is capable of heavily depleting their populations and even bringing some species close to extinction.
- Many wildlife species in trade are not endangered, but the existence of an agreement to ensure the sustainability of the trade is important in order to safeguard these resources for the future.
- Because the trade in wild animals and plants crosses borders between countries, the effort to regulate it requires international cooperation to safeguard certain species from over-exploitation.
- CITES was conceived in the spirit of such cooperation.
- Today, it accords varying degrees of protection to more than 37,000 species of animals and plants, whether they are traded as live specimens, fur coats or dried herbs.

How CITES works

- CITES works by subjecting international trade in specimens of selected species to certain controls. All import, export, re-exports and introduction from the sea of species covered by the Convention has to be authorized through a licensing system.
- Each Party to the Convention must designate one or more Management Authorities in charge of administering that licensing system and one or more Scientific Authorities to advise them on the effects of trade on the status of the species.
- The species covered by CITES are listed in three Appendices, according to the degree of protection they need.

■ **Convention on the Conservation of Migratory Species of Wild Animals**

- As an environmental treaty of the United Nations, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.
- As the only global convention specializing in the conservation of migratory species, their habitats and migration routes, CMS complements and co-operates with a number of other international organizations, NGOs and partners in the media as well as in the corporate sector.
- Migratory species threatened with extinction are listed on Appendix I of the Convention. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Besides establishing obligations for each State joining the Convention, CMS promotes concerted action among the Range States of many of these species.
- Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional agreements.
- In this respect, CMS acts as a framework Convention. The agreements may range from legally binding treaties (called Agreements) to less formal instruments, such as Memoranda of Understanding, and can be adapted to the requirements of particular regions. The development of models tailored according to the conservation needs throughout the migratory range is a unique capacity to CMS.

Organizational Structure of the Convention

- The **Conference of the Parties** (COP) is the decision-making body of the Convention. It meets at three-yearly intervals.
- Its **Standing Committee** (StC) gives policy and administrative guidance between meetings.
- The **Scientific Council** (ScC) meets between COP sessions to offer scientific advice and identify research and conservation priorities.
- The **Secretariat** develops and promotes Agreements, services meetings, supports and supervises research and conservation projects and co-operates with governments and partner organizations. The Secretariat is provided by the United Nations Environment Programme (UNEP) and is based in Bonn, Germany and has an out-posted office in Abu Dhabi, United Arab Emirates.

■ Minamata Convention on Mercury

- The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury.
- The Convention draws attention to a global and ubiquitous metal that, while naturally occurring, has broad uses in everyday objects and is released to the atmosphere, soil and water from a variety of sources. Controlling the anthropogenic releases of mercury throughout its lifecycle has been a key factor in shaping the obligations under the Convention.
- Major highlights of the Minamata Convention include a ban on new mercury mines, the phase-out of existing ones, the phase out and phase down of mercury use in a number of products and processes, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining.
- The Convention also addresses interim storage of mercury and its disposal once it becomes waste, sites contaminated by mercury as well as health issues.
- The Minamata Convention is named after the Japanese city of Minamata, which experienced a severe, decades-long incidence of mercury poisoning after industrial wastewater from a chemical factory was discharged into Minamata Bay.
- The wastewater contained methylmercury, which bioaccumulated in fish and shellfish in the bay. Local people who consumed seafood from Minamata Bay became very sick, and many died or were left severely disabled.

What does the Minamata Convention require?

The Minamata Convention requires that party nations:

- Reduce and where feasible eliminate the use and release of mercury from artisanal and small-scale gold mining (ASGM).
- Control mercury air emissions from coal-fired power plants, coal-fired industrial boilers, certain non-ferrous metals production operations, waste incineration and cement production.
- Phase-out or take measures to reduce mercury use in certain products such as batteries, switches, lights, cosmetics, pesticides and measuring devices, and create initiatives to reduce the use of mercury in dental amalgam.
- Phase out or reduce the use of mercury in manufacturing processes such as chlor-alkali production, vinyl chloride monomer production, and acetaldehyde production.
- In addition, the Convention addresses the supply and trade of mercury; safer storage and disposal, and strategies to address contaminated sites.
- The Convention includes provisions for technical assistance, information exchange, public awareness, and research and monitoring. It also requires Parties to report on measures taken to implement certain provisions. The Convention will be periodically evaluated to assess its effectiveness at meeting its objective of protecting human health and the environment from mercury pollution.

■ Rotterdam Convention

- The Rotterdam Convention is an international treaty designed to facilitate informed decision-making by countries with regard to trade in hazardous chemicals.
- It establishes a list of covered chemicals and requires parties seeking to export a chemical on that list to first establish that the intended importing country has consented to the import.
- It also requires that a party seeking to export a chemical that is not listed under the Convention but that is subject to a ban or severe restriction in its own territory must provide notice to the importing country of the proposed export. The Convention entered into force on February 24, 2004.

How Does the Prior Informed Consent Procedure Work?

- The Rotterdam Convention establishes a prior informed consent ("PIC") procedure to ensure that restricted hazardous chemicals are not exported to countries that do not wish to receive them.
- The PIC procedure does not ban or restrict any chemicals, nor does it mean that any individual country must automatically prohibit their import.
- Parties implement the PIC procedure through extensive information exchange, priority attention to national decisions on imports, and obligations related to export controls.

What Chemicals Are Covered Under the Rotterdam Convention?

- The Rotterdam Convention applies to industrial chemicals and pesticides that meet the criteria for listing under the Convention, generally because they have been banned or severely restricted in party countries or are severely hazardous pesticide formulations.
- Chemicals are subject to the PIC procedure if they are included in Annex III of the Rotterdam Convention.

■ Stockholm Convention

- The Stockholm Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs).
- POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife.
- POPs circulate globally and can cause damage wherever they travel.

- In implementing the Convention, Governments will take measures to eliminate or reduce the release of POPs into the environment.
- Over 152 countries ratified the Convention and it entered into force, on 17 May 2004. The Stockholm Convention focuses on eliminating or reducing releases of POPs.
- It sets up a system for tackling additional chemicals identified as unacceptably hazardous.
- Ultimately, the Convention points the way to a future free of dangerous POPs and promises to reshape our economy's reliance on toxic chemicals.

The Stockholm Convention is perhaps best understood as having five essential aims:

- Eliminate dangerous POPs, starting with the 12 worst
- Support the transition to safer alternatives
- Target additional POPs for action
- Cleanup old stockpiles and equipment containing POPs
- Work together for a POPs-free future

■ **Tehran Conventions**

- The understanding of the necessity to protect and preserve the **Caspian Sea's natural resources** for future generations and that this goal can only be achieved through international cooperation **was at the heart of the intent to create the Framework Convention for the Protection of the Marine Environment of the Caspian Sea, the Tehran Convention.**
- By ratifying the Convention the five Parties Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan confirmed their readiness to go the path of sustainable development and to take environmental concerns into account in their development planning.
- Having entered into force in 2006, the Tehran Convention is the first regional legally binding instrument signed by all five Caspian littoral states.
- It serves as an overarching governance framework which lays down the general requirements and the institutional mechanism for environmental protection and sustainable development in the Caspian Sea region.
- Under its umbrella the Parties have developed additional Protocols on priority areas of common concern.
- The effective implementation of the Tehran Convention and its Protocols will support the protection of the marine environment and with it of the livelihoods, health and well-being of present and future generations around the Caspian Sea.



CLIMATE CHANGE

- The **United Nations Framework Convention on Climate Change (UNFCCC)** defines '**climate change**' as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
- The major characteristics of climate change include rise in average global temperature, ice cap melting, changes in precipitation, and increase in ocean temperature leading to sea level rise. **Climate change leads to Global Warming.**

■ Factors Affecting Climate Change

- There are many factors which either magnify or reduce the effects of the earth's climate.
- Factors such as greenhouse gases increase the temperature of earth, while some aerosols and volcanic eruption reduce the temperature of the earth.
- For example, large volcanic eruptions can eject enough ash into the atmosphere to reduce the temperature for a year or more until the sulphur particles settle on the ground. These sulphur particles reflect sunlight from the earth.
- Estimation of the effect of each gas on climate change depends on the following three factors:
- **Concentration of gas in the atmosphere:** Concentration of gas in the atmosphere is described in terms of parts per million (ppm). For example, at present, there are nearly 420 parts of carbon per million. Before Industrial revolution, concentration of carbon was only 270 ppm. If carbon concentration increases beyond 450 ppm, then it is believed that Earth would face catastrophic impacts.
- **Life span of gas in the atmosphere:** Life span in the atmosphere varies with the nature of the gas. Life span of CO₂ ranges from 50-200 years; methane has a life span of 12 years; nitrous oxide has a life span of 120 years and fluorinated gas has a life span of even more than 1000 years.
- **Global warming potential of a gas:** The same quantity of methane has 21 times, nitrous oxide has 310 times and fluorinated gases have 140 to 23,900 times global warming potential as that of carbon dioxide.

GLOBAL WARMING

- Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns.
- Global warming can occur from a variety of causes, both natural and human induced.
- In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities.

Impacts of Global Warming

- Rise in Sea level
- Changes in rainfall patterns

- Increased likelihood of extreme events such as heat wave, flooding, hurricanes, etc
- Melting of the ice caps
- Melting of glaciers
- Widespread vanishing of animal populations due to habitat loss
- Spread of disease (like malaria, etc)
- Bleaching of Coral Reefs
- Loss of Plankton due to warming of seas

■ Gases that contribute to the greenhouse effect include:

Gases that trap heat in the atmosphere are called greenhouse gases.

- **Carbon dioxide (CO₂):** Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees and other biological materials, and also as a result of certain chemical reactions (e.g., manufacture of cement). Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- **Methane (CH₄):** Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous oxide (N₂O):** Nitrous oxide is emitted during agricultural and industrial activities, combustion of fossil fuels and solid waste, as well as during treatment of wastewater.
- **Fluorinated gases:** Hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

How long do they stay in the atmosphere?

- Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years.
- All of these gases remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions.

■ Non Green House Gases and Aerosols

Black Carbon

- It is a component of fine particulate matter of the size 2.5 μm. It consists of pure carbon, which originates from the incomplete combustion of fossil fuels, coal, biofuel, biomass, wood, rubber etc. It is emitted in the form of soot.
- **SOOT** is an air borne mass of impure carbon particles resulting from the incomplete combustion of hydrocarbons. It originates from pyrolysis.

Brown Carbon

Brown carbon is brown smoke released by the combustion of organic matter. It coexists with black carbon when released in the atmosphere.

Sources of brown carbon are:

- Breakdown products from biomass burning
- Tar materials from smouldering fires

- Coal combustion
- Combustion of fossil fuels and automobile exhaust
- Mixture of organic compounds emitted from soil
- Formed in the atmosphere from reactions of biogenic organic gases, given off naturally by trees and other organisms, that condenses to form aerosol particles.

Blue Carbon

- It is the carbon captured by the world's oceans and coastal ecosystems.
- This carbon is captured by living organisms in oceans is stored in the form of aquatic biomass.
- Blue carbon ecosystem act as the major sink for capturing atmospheric carbon and reducing warming effects.

Green Carbon

- It is the carbon captured into terrestrial plant biomass in photosynthesis and stored in the plants and soil of natural ecosystems and is a vital part of the global carbon cycle.

Radioactive Forcing and Global Warming

- **Net radiation:** It is defined as the difference between the solar radiation absorbed by the Earth-atmosphere system and the long wave radiation emitted by the Earth-atmosphere system to space. Net radiation influences the Earth's climate because it determines the energy available for heating the atmosphere, ocean and land. Hence net radiation influences the seasonal variation of rainfall and the strength of the global circulation patterns.
- **Radioactive Forcing:** The change in net radiation caused by changes in concentration of greenhouse gas or aerosol concentrations is called as **radioactive forcing or climate forcing**. It is quantified at tropopause or the zone between troposphere and the stratosphere. The unit of radioactive forcing is **watts per square meter of the Earth's surface**. It is observed in two different trends
 - ▶ **Positive radioactive forcing:** It means that the amount of incoming solar energy is more than the amount of radiations going out. It warms the earth- atmosphere system
 - ▶ **Negative radioactive forcing:** It means that the amount of outgoing energy is more than the amount of incoming energy. It cools earth- atmosphere system

■ Global Warming Potential (GWP) *... dreams...*

- Global warming potential (GWP) is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide.
- A GWP is calculated over a specific time interval, commonly 20, 100, or 500 years. GWP is expressed as a factor of carbon dioxide (whose GWP is standardized to 1).
- The GWP depends on the following factors:
 - ▶ The absorption of infrared radiation by a given species
 - ▶ The spectral location of its absorbing wavelengths
 - ▶ The atmospheric lifetime of the species
- Thus, a high GWP correlates with a large infrared absorption and a long atmospheric lifetime. The dependence of GWP on the wavelength of absorption is more complicated. Even if a gas absorbs radiation efficiently at a certain wavelength, this may not affect its GWP much if the atmosphere already absorbs most radiation at that wavelength. A gas has the most effect if it absorbs in a "window" of wavelengths where the atmosphere is fairly transparent.

Causes of Climate Change

- The amount of solar energy, its absorption, distribution, radiation and redistribution in the atmosphere or overall the energy budget of the earth are the major factors which effect the climate and can cause a definite change.

- The change in climate can be seen as a long-term process or the short-term process. Amongst the causes responsible for climate change the natural factors attribute to the long-term climate change while the anthropogenic (manmade) factors attribute to the short-term change in the climate. The factors responsible for climate change are broadly grouped into following categories
 - ▶ Extra-terrestrial sources
 - ▶ Terrestrial sources
 - ▶ Anthropogenic sources

Extra-Terrestrial Sources of Climate Change

- **Interstellar Nebulae:** The path of earth around the galaxy is elliptical and its passage in every 270 to 400 million years is near to centre of the galaxy. In every 300 million years, earth passes through the dust lane arm of the galaxy. The arm has accumulation of interstellar matter or the Nebulae. This nebula of galaxy interpose between sun and earth, because of which there is reduction in solar radiation reaching the earth surface which might bring in a climate change.
- **Solar irradiance:** There is a regular fluctuation in the amount of energy irradiated from the outer surface of the sun or the photosphere, this alteration brings changes in the temperatures and precipitation.
- **Sunspot Cycles:** Sunspots are temporary spots on the photosphere of the sun which are caused by increased magnetic flux. During sunspot, surface temperature of the sun decreases but the events of solar flares and coronal mass ejection increases. Sunspots are seen in every 11 years' cycle. Increase in sunspot activity increases the events of warming and vice versa.
- **Extra-terrestrial bodies collision:** Collision of extra-terrestrial bodies like meteorites, comets etc. near the earth's axis of revolution produces a cloud of dust between the sun and earth. It reduces the net solar radiation on earth. It is also likable that the extra-terrestrial events would have caused the Big Freeze on earth some 12,000 years ago.

Terrestrial Sources of Climate Change

- **Atmospheric dust:** Atmospheric particulates reduce the amount of solar energy reaching the earth surface. Majority of the atmospheric particulates remain in the troposphere or lower stratosphere. Atmospheric particulates are caused due to following:
 - ▶ **Dust particulates**
 - ▶ **Salt particles**
 - ▶ **Pollens**
 - ▶ **Smoke and soot**
 - ▶ **Volcanic dust and Ashes**
- **Solar Albedo:** It is the measure of effectiveness in reflecting radiant solar energy. Surface albedo is the ratio of radiation reflected to radiation incident. Albedo is dimensionless and is measured in a scale of 0 to 1. Black bodies or black hole has albedo scale of 0 and white bodies have albedo in the scale of 1. The average albedo at the top of atmosphere is 30 - 35%. Surface albedo varies from location to location.
- Factors which affect the surface albedo in any area are:
 - ▶ Geographical and surface characteristics
 - ▶ Composition of the atmosphere
 - ▶ Position of the sun
 - ▶ Angle and wavelength of incident solar rays
- **Continental drift and Pole wandering:** The drifting of continents explained by plate tectonics causes change in relative position of continents, ocean basins and the poles. The clustering of continents around the pole causes glaciation of major land masses while scattering away of continents from the poles causes deglaciation of any area.
- **Oceanic Variation:** Ocean currents can alter climate, as they transfer vast amount of heat in climate system. They affect the water vapor content of atmosphere significantly.

Anthropogenic Sources of Climate Change

The main human activities that contribute to an enhancement of the natural greenhouse effect are:

- Combustion of fossil fuels, which releases greenhouse gases.
- Clearing of forests for agriculture, which releases carbon dioxide through increased biomass decay.
- Deforestation, soil tillage and land degradation, which release carbon from the land system and reduce its capacity to absorb and store carbon

■ Impacts of the Climate Change:

Impact on Biodiversity

- Climate change is expected to have a significant influence on terrestrial biodiversity at all system levels – ecosystem, species and genetic diversity.
- The changing climate will stimulate species-level changes in range and abundance, life cycle and behaviour, and, over time, genetic evolutionary responses.
- These changes will in turn be linked with changes in natural disturbance patterns and changes in ecosystem structure and function.

Impact on Agriculture

- According to World Meteorological Organization, climate change can adversely impact global environment, agricultural productivity and the quality of human life.
- More importantly in developing countries, it will be difficult for farmers to carry on farming in the increased temperatures.
- While in temperate latitudes a rise in temperature would help countries increase food productivity, it will have adverse effects in India and countries in the tropics.
- The monsoon accounting for 75% of India's rainfall significantly impacts country's agriculture and livelihood of tens of millions of small farmers.
- Climate change is likely to intensify the variability of monsoon dynamics, leading to a rise in extreme seasonal aberrations, such as increased precipitation and devastating floods in some parts of the country as well as reduced rainfall and prolonged droughts in other areas.

Impact on fisheries and Aquaculture

- Climate change, more particularly harsher weather conditions, will have impact on the quality, productivity, output and viability of fish and aquaculture enterprises, thereby affecting fishing community.
- The small-scale fishers may be faced with greater uncertainty as availability, access, stability and use of aquatic food and supplies would diminish and work opportunities would dwindle. Aquaculture development opportunities will increase in particular in tropical and sub-tropical regions.
- The climate change in warmer regions offers new opportunities as production in warmer regions will increase because of better growth rates, a longer growing season and the availability of new fish farming areas where it was once too cold.

Impact on Demography

- Rising sea levels owing to climate change would force communities in low-lying coastal areas and river deltas to move to higher ground level.
- Similarly, increase in frequency of droughts due to climate change would force farmers and pastoralists, who rely on rainfall to raise their crops and livestock, to migrate to areas in search of land and water.
- This migration/displacement of people would result in direct conflict and competition between migrants and established communities for access to land and water.

- It may be difficult for displaced communities to maintain their farming or pastoral traditions.

Impact on Glacier

- Glaciers the world over are thinning and shrinking as the planet warms, and glaciers in the Himalayas are receding faster than anywhere else.
- If the earth keeps warming at the current rate, Himalayan glaciers are likely to disappear altogether in 25 years.
- In the absence of glaciers, rivers in the Indo-Gangetic plain will become much more seasonal, threatening the rabi crop as well as domestic and industrial water supplies in the non-monsoon months.
- In addition, more precipitation will fall as rain rather than snow and the greater water run-offs will increase flooding.

Impact on Weather

- Increasing global temperatures will lead to higher maximum temperatures, more heat waves, and fewer cold days over most land areas.
- More severe drought in some areas, combined with other factors, has contributed to larger and more frequent wildfires.

Impact on Human Health

- Changes in the greenhouse gas concentrations and other drivers alter the global climate and bring about myriad human health consequences.
- Environmental consequences of climate change, such as extreme heat waves, rising sea-levels, changes in precipitation resulting in flooding and droughts, intense hurricanes, and degraded air quality have impact directly and indirectly on the physical, social, and psychological health of humans.

Impact on Water Resources

- Climate change will have an impact on the predictability and variability in the availability of water and also increase in frequencies of droughts and floods.
- Worst sufferers would be farmers of the rainfed agriculture, which covers 60% of all cultivated land in the country.
- The risk of crop failures will increase in semi-arid zones with prolonged dry seasons forcing people to migrate, when stability of food production cannot be assured.
- Irrigated areas in large river basins and deltas can also be at risk because of a combination of factors, such as reduced runoff, salinity, increasing floods, sea level rise, urban and industrial pollution.

Lead to Sea Level Rise

- The Bay of Bengal points to the sea rising 3.14 mm a year in the mangrove swamps of 'the Sunderbans delta' against a global average of 2 mm, threatening the low-lying area which is home to about 4 million people.
- A trend of sea level rise of 1 cm. per decade has been recorded along the Indian coast. The major delta area of the Ganga, Brahmaputra and Indus rivers, which have large populations reliant on riverine resources, will be affected by changes in water regimes, salt water intrusions and land loss.
- The rise in sea temperature also causes coral bleaching, which negatively affects fishes, sponges, giant clams, and other sea creatures.
- The El Nino event of 1998 resulted massive mortality of corals in the Lakshadweep and Andaman and Nicobar islands.

Threat to Cities

- The Indian cities will face the impact of climate change in various forms. Indian urban infrastructure is less advanced and over-stressed in most cities.

- The floods and heavy rains caused by climate change will devastate the urban dwellings and make havoc to the lakhs of poor lives.
- Nowadays rural population is migrating towards cities increasing the demands of power, housing and drinking water and transportation.
- The water scarcity due to glacial melting and irregular rainfalls will reduce the availability of clean drinking water.

Steps taken by Government for mitigation:

- **India's Energy Conservation Act (Energy Conservation Act), 2001;** The 2010 amendment to the ENERGY CONSERVATION ACT created PAT scheme as a market-based trading scheme enable industries to meet the mandatory energy efficiency standards that had begun to be developed under the original Energy Conservation Act.
- **PAT scheme** is now India's main effort-defining policy. It is overseen by the BEE and was introduced by the National Mission on Enhanced Energy Efficiency (NMEEE).
- **Use of Renewable Energy**-The Electricity Act 2003 together with the National Electricity Policy 2005 (NEP) and the Tariff Policy (TP) mandate promotion of electricity generation from renewable sources. The Electricity Act and these policies envisage regulatory interventions for promotion of renewable energy sources.
- **Climate Friendly Transport Sector**-Transport India has taken substantial initiatives to make the transport sector less emission intensive. One of the major initiatives has been upgradation of vehicular emission norms such as Bharat Stage II, Bharat Stage III and Bharat Stage IV. The commercial manufacture of battery-operated vehicles has begun in India with a view to promoting low/ no carbon emitting vehicles.
- **Conservation of Agriculture, Forest and Water Resources**- National Mission for Sustainable Agriculture. There are also programmes for crop improvement and drought proofing. India has launched an ambitious Green India Mission to increase the quality and quantity of forest cover in 10 million ha of land. Also an incentive-based additional special grant of US\$ 1.2 billion had been announced by the central government to all states for sustainable forestry management.
- **Forestry Sector**- The National Forest Policy (1988), Participatory Forest Management/Joint Forest Management Programme, National Afforestation Programme, National Forestry Action Programme and National Watershed Development Project for Rainfed Areas.
- **Coastal Area**- Coastal Ocean Monitoring and Prediction Systems (COMAPS), Land Ocean Interactions in the Coastal Zone (LOICZ), Integrated Coastal and Marine Area Management (ICMAM), and Society of Integrated Coastal Management (SICOM).
- **Enhancing Adaptive Capacity**- the National Bank for Agriculture and Rural Development (NABARD) is India's National Implementing Entity (NIE) for the Adaptation Fund created under the UNFCCC. At present, NABARD is the only NIE in the Asia Pacific Region.

PROTECTED AREA NETWORK IN INDIA

- India is one of the 17 mega diverse countries of the world.
- With only 2.4% of the world's land area, 16.7% of the world's human population and 18% livestock, it contributes about 8% of the known global biodiversity, however, putting enormous demands on our natural resources.
- India is home to world's largest wild tigers population and has got unique assemblage of globally important endangered species like Asiatic lion, Asian Elephant, Onehorned Rhinoceros, Gangetic River Dolphin, Snow Leopard, Kashmir Stag, Dugong, Gharial, Great Indian Bustard, Lion Tailed Macaque etc

Protected Area Network in India:

- A National Board for Wildlife (NBWL), chaired by the Prime Minister of India provides for policy framework for wildlife conservation in the country.
- The National Wildlife Action Plan (2002-2016) was adopted in 2002, emphasizing the people's participation and their support for wildlife conservation.
- India's conservation planning is based on the philosophy of identifying and protecting representative wild habitats across all the ecosystems.
- The Indian Constitution entails the subject of forests and wildlife in the Concurrent list.
- The Federal Ministry acts as a guiding torch dealing with the policies and planning on wildlife conservation, while the provincial Forest Departments are vested with the responsibility of implementation of national policies and plans.
- A network of 662 Protected Areas (PAs) has been established, extending over 1,58,508 sq. kms. (4.83% of total geographic area), comprising **104 National Parks, 551 Wildlife Sanctuaries, Conservation Reserves and Community Reserves.**
- **Tiger Reserves and Elephant Reserves** have been designated for species specific management of tiger and elephant habitats.
- UNESCO has designated 5 Protected Areas as World Heritage Sites.
- As the ecosystems and species do not recognise political borders, the concept of Trans-boundary Protected Areas has been initiated for coordinated conservation of ecological units and corridors with bilateral and/or multilateral cooperation of the neighbouring nations.
- There are **4 categories of the Protected Areas viz, National Parks, Sanctuaries, Conservation Reserves and Community Reserves.**

■ WILDLIFE SANCTUARY

- Sanctuary is an area comprised within any reserve forest or the territorial waters, which is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance. The Sanctuary is declared for the purpose of protecting, propagating or developing wildlife or its environment. Certain rights of people living inside the Sanctuary could be permitted. Further during the settlement of claims, before finally notifying the Sanctuary, the Collector may, in consultation with the Chief Wildlife Warden, allow the continuation of any right of any person in or over any land within the limits of the Sanctuary

■ NATIONAL PARK

- It is an area within a Sanctuary or outside having adequate ecological, faunal, floral, geomorphological, natural or zoological significance.
- The National Park is also declared for the purpose of protecting, propagating or developing wildlife or its environment, like that of a Sanctuary.
- The difference between a Sanctuary and a National Park mainly lies in the vesting of rights of people living inside.
- **Unlike a Sanctuary, where certain rights can be allowed, in a National Park, no rights are allowed.**
- **No grazing of any livestock shall also be permitted inside a National Park while in a Sanctuary, the Chief Wildlife Warden may regulate, control or prohibit it.**
- In addition, while any removal or exploitation of wildlife or forest produce from a Sanctuary requires the recommendation of the State Board for Wildlife, removal etc., from a National Park requires recommendation of the National Board for Wildlife.

■ Wildlife sanctuaries and National Park in India

- **Jim Corbett National Park:** Said to be India's most beautiful wildlife reserve, Jim Corbett National Park was established in 1936. Nestled in the foothills of the Himalayas in Uttarakhand, this National Park is spread over an area of 1318.54 sq. km. Home to a rich ecosystem the Jim Corbett consists rolling grasslands interspersed with rivers and valleys. An ideal place for bird watchers and nature lovers this national park in North India is the residing place of the endangered Bengal Tiger. Consisting of a diversified flora and fauna this sanctuary in India is home to about 600 different species of plants, over 650 species of birds and animals which includes gharial, elephant, chital, sambar, wild boar, King Cobra, Indian Pangolin nilgai, muntjac, common musk shrew, and the flying fox.
- **Periyar Wildlife Sanctuary:** Situated in the mighty Western Ghats the Periyar Wildlife Sanctuary is said to be heaven for nature lovers. Set amidst the picturesque surroundings and vast tracts of lush greeneries of Kerala this wildlife sanctuary in South India is the adobe of some of the rarest endangered species in the country. Beautiful as it is this wildlife sanctuary offers enthralling views of nature and includes a host of wildlife attractions like Barking Deer, Dhole or Indian Wild Dog, Deer, Mouse and very rarely, a Tiger. There are also a number of birds that inhabit the Periyar Wildlife Sanctuary which include Darters, Kingfishers, Cormorants and the Malabar Hornbill.
- **Gir National Park:** Spread over an area of 1412 sq km the Gir National Park lies in the Gujarat Peninsular region of India. Known to be the only habitat of the world renowned Asiatic Lion, this wildlife reserve in western India is every nature lovers' dream. Consisting of a seamless blend of valleys, rivers, dense deciduous forests and swampy grasslands this national park is considered as one of the top wildlife habitats in the country. Apart from the Asiatic Lions this wildlife reserve is also famous for species like; Grey Musk Shrew, Flying Fox, Hare, Hedgehog, Small Indian Civet, Indian Pangolin, Ratel, Porcupine, Fox and Jackal. The peafowl is the most important bird found here. Kamleshwar Dam provides a large water body for marsh crocodiles, reptiles and birds.
- **Sariska National Park:** Counted as one of the most frequented wildlife reserves in India, Sariska Wildlife Sanctuary is located in Alwar district of Rajasthan. Extending over 800 sq km of vast green milieu and encompassing certain important historical monuments, dating back to 10 century, within the vicinity of the park this wildlife sanctuary is definitely eye candy to nature and wildlife enthusiasts. The biosphere of this wildlife sanctuary includes rocky landscapes, dry deciduous forests, and hilly cliffs. Sariska is said to be ethereal for bird watchers with some of the rarest feathered species like Grey Partridge, white breasted Kingfisher, golden backed woodpecker and the Sand Grouse. Some of the wildlife that reside in this sanctuary are; Four-horned antelope, hyena rhesus macaque, leopard, langur and the jungle cat.
- **Sunderbans National Park:** Synonymous with wildlife and wildlife sanctuaries in India the Sunderbans National Park is the undisputed gem in the crown of the eastern part of India. It is situated in the world's largest Delta this wildlife reserve in India spreads over an area of 4264 square km of impenetrable mangrove forests. Bestowed with the title of a UNESCO World Heritage Site the

Sunderbans in Eastern India is known to be the largest tiger reserve in the country. Idyllic for bird gazers and nature lovers the Sunderbans is home to species a multitude of species apart from the Royal Bengal Tiger like; Jungle Cat, Flying Fox, Chital, Wild boar and Pangolin.

- **Ranthambore National Park:** When talking about National Parks and wildlife sanctuaries in India Ranthambore National Park needs a definite mention. Ranked as one of the largest and most reputed national park in North India this wildlife sanctuary is situated in Rajasthan. Said to be the once famous hunting ground of the Maharajas of Jaipur this National Park sprawls over 1,334 sq km of terrain. Offering a gamut of flora and fauna and home to species such as the sambar, hyena, sloth bear, leopard, nilgai, dhole and lots more this is a place worth a visit.

■ CONSERVATION RESERVE AND COMMUNITY RESERVES

- Conservation reserves and community reserves in India are terms denoting protected areas of India which typically act as buffer zones to or connectors and migration corridors between established national parks, wildlife sanctuaries and reserved and protected forests of India.
- Such areas are designated as conservation areas if they are uninhabited and completely owned by the Government of India but used for subsistence by communities, and community areas if part of the lands are privately owned.
- Administration of such reserves would be through local people and local agencies like the gram panchayat, as in the case of communal forests.
- Community reserves are the first instances of private land being accorded protection under the Indian legislature. It opens up the possibility of communally owned for-profit wildlife resorts, and also causes privately held areas under non-profit organizations like land trusts to be given protection.
- These protected area categories were first introduced in the Wildlife (Protection) Amendment Act of 2002 – the amendment to the Wildlife Protection Act of 1972.
- These categories were added because of reduced protection in and around existing or proposed protected areas due to private ownership of land, and land use.
- A case in point was the Melghat Tiger Reserve where a large area was left unprotected due to private ownership.
- Amendments to the Wild life protection act in 2003, provided a mechanism for recognition and legal backing to the community initiated efforts in wildlife protection.
- It provides a flexible system to achieve wildlife conservation without compromising community needs.
- Tiruvidaimarudur Conservation Reserve, declared on February 14, 2005, is the First Conservation Reserve to be established in the country. It is an effort of a village community who wanted to protect the birds nesting in their village

INTERNATIONAL ORGANIZATION

- There are various international environmental organizations which are striving hard to address problems such as habitat destruction, poaching, pollution, and global warming.
- Environmental organizations operate around the world in an effort to analyze, track, and conserve the global environment.
- These organizations may be nonprofits, governmental, trusts, or non-governmental.
- Additionally, environmental organizations work at different levels around the world, including international, national, regional, or local.

■ International Geosphere-Biosphere Programme (IGBP)

- IGBP was launched in 1987 to coordinate international research on global-scale and regional-scale interactions between Earth's biological, chemical and physical processes and their interactions with human systems. The vision has three key elements:
 - ▶ The planet
 - ▶ The planet under pressure
 - ▶ Transformation in an era of rapid global change

IGBP is a world-class provider of:

- Earth system expertise
- Communication
- Coordination
- IGBP research is organised around six projects representing the Earth system - land, atmosphere, ocean and where they meet (land-atmosphere, land-ocean, atmosphere-ocean) and two further projects looking at the Earth system as a whole: Past Global Changes (PAGES) which looks at palaeoclimate, and the Analysis, Integration and Modelling of the Earth System (AIMES), which helps set the agenda for Earth system models. Plus four joint projects - carbon, water, human health and food security - with the other three international global-change programmes.

■ World Nature Organization

- Planning for the World Nature Organization began in 2010 by the developing countries which are most threatened by climate change.
- These nations are located around the Pacific Ocean and the Caribbean as well as a few countries in Africa.
- The Preparatory Commission published the WNO Treaty in June of 2012, but lack of interest left the agreement unsigned.
- This organization did not come into effect in May of 2014 as planned. Its goal was to promote economically friendly businesses, technology, energy, and activities.

■ Forest Carbon Partnership Facility (FCPF)

It is a global partnership of governments, businesses, civil society, and Indigenous Peoples focused on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, the sustainable management of forests, and the enhancement of forest carbon stocks in developing countries (activities commonly referred to as REDD+).

The four strategic objectives of the FCPF:

- To assist countries in their REDD+ efforts by providing them with financial and technical assistance in building their capacity to benefit from possible future systems of positive incentives for REDD+.
- To pilot a performance-based payment system for REDD+ activities, with a view to ensuring equitable benefit sharing and promoting future large-scale positive incentives for REDD+.
- Within the approach to REDD+, to test ways to sustain or enhance livelihoods of local communities and to conserve biodiversity.
- To disseminate broadly the knowledge gained in the development of the Facility and the implementation of Readiness Preparation Proposals (RPPs) and Emission Reductions Programs (ERPs).

The FCPF's funding mechanisms:

The FCPF has two separate but complementary funding mechanisms — the Readiness Fund and the Carbon Fund — to achieve its strategic objectives. Both funds are underpinned by a multi-donor fund of governments and non-governmental entities, including private companies that make a minimum financial contribution of \$5 million.

- Contributors to the Readiness Fund are known as Donor Participants.
- Contributors to the Carbon Fund are known as Carbon Fund Participants.
- Developing countries participating in the FCPF (both funds) are known as REDD Country Participants

Governance

- The FCPF currently has 47 REDD Country Participants (18 in Africa, 18 in Latin America and the Caribbean, and 11 in Asia-Pacific).
- The World Bank assumes the functions of trustee and secretariat. The World Bank, the Inter-American Development Bank and United Nations Development Programme are Delivery Partners under the Readiness Fund and responsible for providing REDD+ readiness support services to distinct countries.

■ United Nations Environment Programme (UNEP)

- The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system, and serves as an authoritative advocate for the global environment.
- **Mission** is to provide **leadership and encourage partnership** in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.
- UNEP categorize work into seven broad thematic areas:
 - ▶ climate change,
 - ▶ disasters and conflicts,
 - ▶ ecosystem management,
 - ▶ environmental governance,
 - ▶ chemicals and waste,

- ▶ resource efficiency, and
- ▶ Environment under review.
- Every year, they **honour and celebrate** individuals and institutions that are doing outstanding work on behalf of the environment.

■ The Partnership for Action on Green Economy (PAGE)

- It was launched in 2013 as a response to the call at Rio+20 to support those countries wishing to embark on greener and more inclusive growth trajectories.
 - ▶ PAGE seeks to put sustainability at the heart of economic policies and practices to advance the 2030 Agenda for Sustainable Development and supports nations and regions in reframing economic policies and practices around sustainability to foster economic growth, create income and jobs, reduce poverty and inequality, and strengthen the ecological foundations of their economies.
 - ▶ PAGE brings together five UN agencies – UN Environment, International Labour Organization, UN Development Programme, UN Industrial Development Organization, and UN Institute for Training and Research – whose mandates, expertises and networks combined can offer integrated and holistic support to countries on inclusive green economy, ensuring coherence and avoiding duplication.
 - ▶ PAGE represents a mechanism to coordinate UN action on green economy and to assist countries in achieving and monitoring the emerging Sustainable Development Goals, especially SDG 8: “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.”

■ Climate Action Network

- The Climate Action Network (CAN) is a worldwide network of over 1300 Non-Governmental Organizations (NGOs) in more than 120 countries, working to promote government and individual action to limit human-induced climate change to ecologically sustainable levels.
- CAN members work to achieve this goal through information exchange and the coordinated development of NGO strategy on international, regional, and national climate issues. CAN have regional network hubs that coordinate these efforts around the world.
- CAN members place a high priority on both a healthy environment and development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Commission). CAN’s vision is to protect the atmosphere while allowing for sustainable and equitable development worldwide.

■ Global Alliance for Climate Smart Agriculture (GACSA)

- GACSA is an inclusive, voluntary and action-oriented multi-stakeholder platform on Climate-Smart Agriculture (CSA).
- Its vision is to improve food security, nutrition and resilience in the face of climate change.
- GACSA aims to catalyze and help create transformational partnerships to encourage actions that reflect an integrated approach to the three pillars of CSA.
- GACSA works towards three aspirational outcomes to:
 - ▶ Improve farmers’ agricultural productivity and incomes in a sustainable way;
 - ▶ Build farmers’ resilience to extreme weather and changing climate;
 - ▶ Reduce greenhouse gas emissions associated with agriculture, when possible.

Members:

- GACSA is a **voluntary platform** open to governments, international and regional organizations, institutions, civil society, farmers’ organizations and businesses who agree with its vision and its Framework Document.

- Being a member **does not create** any binding obligations and members determine their particular voluntary actions according to their needs and priorities.
- Individuals cannot be members, but they can join GACSA's Action Groups

■ The Intergovernmental Panel on Climate Change (IPCC)

- Created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), the objective of the IPCC is to provide governments at all levels with scientific information that they can use to develop climate policies.
- **IPCC reports are also a key input into international climate change negotiations.**
- The IPCC is an organization of governments that are members of the United Nations or WMO. The IPCC currently has 195 members. Thousands of people from all over the world contribute to the work of the IPCC. For the assessment reports, IPCC scientists volunteer their time to assess the thousands of scientific papers published each year to provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks.
- **An open and transparent review by experts** and governments around the world is an essential part of the IPCC process, to ensure an objective and complete assessment and to reflect a diverse range of views and expertise.
- **Through its assessments, the IPCC identifies the strength of scientific agreement** in different areas and indicates where further research is needed. The IPCC does not conduct its own research.

■ United Nations Framework Convention on Climate Change (UNFCCC).

- The UNFCCC secretariat (UN Climate Change) was established in 1992 when countries adopted the United Nations Framework Convention on Climate Change (UNFCCC).
- With the subsequent adoption of the Kyoto Protocol in 1997 and the Paris Agreement in 2015, Parties to these three agreements have progressively reaffirmed the secretariat's role as the United Nations entity tasked with supporting the global response to the threat of climate change.
- **Since 1995, the secretariat is located in Bonn, Germany.**

What does the secretariat do?

- Focussing in its early years largely on facilitating the intergovernmental climate change negotiations, the secretariat today supports a complex architecture of bodies that serve to advance the implementation of the Convention, the Kyoto Protocol and the Paris Agreement.
- The secretariat provides technical expertise and assists in the analysis and review of climate change information reported by Parties and in the implementation of the Kyoto mechanisms.
- It also maintains the registry for Nationally Determined Contributions (NDC) established under the Paris Agreement, a key aspect of implementation of the Paris Agreement.
- The secretariat organizes and supports between two and four negotiating sessions each year.
- The largest and most important is the Conference of the Parties, held annually and hosted in different locations around the globe.
- It is the largest annual United Nations conference, attended on average by around 25,000 participants.
- In addition to these major conferences, the secretariat organizes annual sessions of the so-called subsidiary bodies as well as a large number of meetings and workshops throughout the year.
- In recent years, the secretariat also supports the **Marrakech Partnership for Global Climate Action**, agreed by governments to signal that successful climate action requires strong support from a wide range of actors, including regions, cities, business, investors and all parts of civil society.
- At UN Climate Change Conferences, a large number of events demonstrate how non-Party stakeholders are working with governments and the UN system to implement the Paris Agreement.

- Throughout the year, the secretariat strives to keep all stakeholders informed of on the negotiating process and climate action through a variety of communications products, including social media.

■ The International Union for Conservation of Nature

- IUCN is a membership Union composed of both government and civil society organisations.
- It harnesses the experience, resources and reach of its more than 1,300 Member organisations and the input of more than 15,000 experts.
- This diversity and vast expertise makes IUCN the global authority on the status of the natural world and the measures needed to safeguard it.
- Over the past decades, IUCN has widened its focus beyond **conservation ecology** and now **incorporates issues related to sustainable development** in its projects.
- IUCN does not itself aim to mobilize the public in support of nature conservation.
- It tries to **influence the actions of governments, business and other stakeholders by providing information and advice, and through building partnerships**.
- The organization is best known to the wider public **for compiling and publishing the IUCN Red List of Threatened Species**, which assesses the conservation status of species worldwide.
- Its headquarters are in **Gland, Switzerland**.

■ Global Climate Change Alliance (GCCA)

- The GCCA was established by the European Union (EU) in 2007 to strengthen dialogue and cooperation with developing countries, in particular least developed countries (LDCs) and Small Island developing States (SIDS).
- By fostering effective dialogue and cooperation on climate change, the Alliance helps to ensure that poor developing countries most vulnerable to climate change increase their capacities to adapt to the effects of climate change, in support of the achievement of the Millennium Development Goals (MDGs).
- In 2014, a new phase of the GCCA, the GCCA+ flagship initiative, began in line with the European Commission's new Multiannual Financial Framework (2014-2020).
- The GCCA+ aim is to boost the efficiency of its response to the needs of vulnerable countries and groups. Using ambitious and innovative approaches, it will achieve its goals by building on its two mutually reinforcing pillars:
- Under the first pillar, the GCCA+ serves as a platform for dialogue and exchange of experience between the EU and developing countries, focusing on climate policy and bringing renewed attention to the issue of international climate finance. The results feed into negotiations for a new climate deal under the United Nations Framework Convention on Climate Change (UNFCCC).
- Under the second pillar, the GCCA+ acts as a source of technical and financial support for the world's most climate-vulnerable countries, whose populations need climate finance the most. Extra efforts will be made to strengthen the strategically important issues of ecosystems-based adaptation, migration and gender equality.
- The GCCA+ focuses its technical support on three priority areas:
 - ▶ Climate change mainstreaming and poverty reduction
 - ▶ Increasing resilience to climate-related stresses and shocks
 - ▶ Sector-based climate change adaptation and mitigation strategies

■ Green Climate Fund

- The Green Climate Fund (GCF) is the **world's largest dedicated fund** helping developing countries reduce their greenhouse gas emissions and enhance their ability to respond to climate change.
- It was set up by the **United Nations Framework Convention on Climate Change (UNFCCC) in 2010**.

- GCF has a crucial role in serving the **Paris Agreement**, supporting the goal of keeping average global temperature rise well below 2 degrees C.
- It does this by **channeling climate finance to developing countries**, which have joined other nations in committing to climate action.
- Responding to the climate challenge requires collective action from all countries, including by both public and private sectors. Among these concerted efforts, advanced economies have agreed to jointly mobilize significant financial resources.
- Coming from a variety of sources, these resources address the pressing mitigation and adaptation needs of developing countries.
- GCF launched its initial resource mobilisation in 2014, and rapidly gathered pledges worth USD 10.3 billion. These funds come mainly from developed countries, but also from some developing countries, regions, and one city.
- GCF's activities are aligned with the priorities of developing countries through the principle of country ownership, and the Fund has established a direct access modality so that national and sub-national organisations can receive funding directly, rather than only via international intermediaries.
- The Fund pays particular attention to the needs of societies that are highly vulnerable to the effects of climate change, in particular Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African States.
- GCF aims to catalyze a flow of climate finance to invest in low-emission and climate-resilient development, driving a paradigm shift in the global response to climate change.

■ World Wide Fund for Nature

- **The World Wide Fund for Nature (WWF) is an international non-governmental organization** founded in 1961, working in the field of wilderness preservation, and the reduction of human impact on the environment.
- It was formerly named **the World Wildlife Fund**, which remains its official name in Canada and the United States.
- WWF is the world's largest conservation organization with over five million supporters worldwide, working in more than 100 countries, supporting around 3000 conservation and environmental projects.
- They have invested over \$1 billion in more than 12,000 conservation initiatives since 1995.
- WWF is a foundation with 55% of funding from individuals and bequests, 19% from government sources (such as the World Bank, DFID, USAID) and 8% from corporations in 2014.
- WWF aims to "stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature."
- The Living Planet Report has been published every two years by WWF since 1998; it is based on a Living Planet Index and ecological footprint calculation.
- In addition, WWF has launched several notable worldwide campaigns including **Earth Hour and Debt-for-Nature Swap**, and its current work is organized around these six areas: **food, climate, freshwater, wildlife, forests, and oceans**.

■ Global Environment Facility

- The Global Environment Facility (GEF) was established on the eve of the 1992 Rio Earth Summit to help tackle our planet's most pressing environmental problems. Since then, the GEF has provided close to \$20 billion in grants and mobilized an additional \$107 billion in co-financing for more than 4,700 projects in 170 countries. Through its Small Grants Programme, the GEF has provided support to nearly 24,000 civil society and community initiatives in 128 countries.
- The GEF Partnership recently agreed to a new direction in its work to achieve greater results and helps to meet rising challenges. This agreement is set out in the Summary of the Negotiations of the Seventh Replenishment of the GEF. In combination with its traditional investments under the Conventions, the GEF is:

- ▶ Strategically focusing its investments to catalyze transformational change in key systems that are driving major environmental loss, in particular energy, cities and food;
- ▶ Prioritizing integrated projects and programs that address more than one global environmental problem at a time, building on the GEF's unique position and mandate to act on a wide range of global environmental issues; and
- ▶ Implementing new strategies and policies to enhance results, including stronger engagement with the private sector, indigenous peoples, and civil society, and an increased focus on gender equality.





RECENT DEVELOPMENT

■ Namami Gange

- The River Ganga is important not only for its cultural and spiritual significance but also because it hosts more than 40% of the country's population. To translate this vision, the Government launched an integrated Ganga conservation mission called 'Namami Gange' to arrest the pollution of Ganga River and revive the river. The Union Cabinet approved the action plan proposed by Centre to spend Rs 20,000 Crores till 2019-2020 on cleaning the river, increasing the budget by four-fold and with 100% central share – a central sector scheme.
- Recognizing the multi-sectoral, multi-dimensional and multi-stakeholder nature of the Ganga Rejuvenation challenge, efforts have been made to improve the inter-ministerial and centre-state coordination with increased involvement in preparation of action plan and increased monitoring at central and state levels.
- The implementation of the program has been divided into **entry-level activities** (for immediate visible impact), **medium term activities** (to be implemented within 5 years of time frame), and, **long-term activities** (to be implemented within 10 years).
- **Entry-level activities** includes river surface cleaning to address the floating solid wastes; rural sanitation to arrest the pollution (solid & liquid) entering through rural sewage drains and construction of toilets; renovation, modernization, & construction of crematoria that prevents the disposal of un-burnt/ partially burnt bodies in the river; repair, modernization & construction of ghats to improve the human-river connect.
- **Medium-term activities** will focus on arresting the municipal and industrial pollution entering into the river. To address the pollution through municipal sewage, 2500 MLD additional treatment capacity is to be created in next 5 years. Major financial reforms are underway to make the program efficient, accountable, and sustainable in the long term. Hybrid Annuity based Public Private Partnership model for project implementation is currently being considered by the Cabinet. If approved, Special Purpose Vehicle will manage concessionaires in all major cities, market will be developed for treated water, and long term sustainability of assets will be assured.
- For managing the industrial pollution, efforts have been initiated to improve the compliance through better enforcement.
- Grossly Polluting Industries located along Ganga have been directed to reduce the effluent quality & volume or implement zero-liquid discharge. Action plan for the implementation of these directions by Pollution Control Boards are already prepared and timelines have been assigned for each category of industry with detailed consultations. All the industries have to install real-time on-line effluent monitoring stations.
- It is worth mentioning that cleaning river Ganga is extremely complex due to its socio-economic & cultural importance and yet, exploitation for various uses. Never in the world such a complex program has been implemented and will require participation across sectors and each and every citizen of the country.
- There are various ways in which each one of us can contribute to the cause of cleaning river Ganga:
 - ▶ **Contribution of funds:** Restoring the quality of a river with the length and population as large as that of Ganga requires huge investments. Government has already increased the budget

by four-fold but still may not be enough to the requirements. Clean Ganga Fund has been established that provides a platform to all for contributing funds to clean river Ganga.

- ▶ **Reduce, Reuse and Recovery:** Majority of us do not realize that used water and filth of our homes can end up in the rivers if not disposed properly. Sewerage infrastructure is already being constructed by the Government but citizens can reduce the usage of water and generation of waste. Reusing and Recovery of used water and organic waste & plastics can greatly benefit the program.

■ The Recycling of Ships Bill, 2019

Ministry:

Chemicals and Fertilizers

- The Recycling of Ships Bill, 2019 was introduced in Lok Sabha by the Minister of State for Shipping, Mr. Mansukh Mandaviya, on November 25, 2019. The Bill restricts the use of hazardous material on ships and regulates the recycling of ships. Key features of the Bill include:
- **Applicability of the Bill:** The Bill will apply to: (i) any new or existing ship which is registered in India, (ii) ships entering a port or terminal in India, or the territorial waters of India, (iii) any warship, or other ship owned and operated by an administration and used on government non-commercial service, and (iv) ship recycling facilities operating in India.
- **Ship recycling:** The Bill defines ship recycling as the dismantling of a ship at a facility to recover the components and materials for reuse, and taking care of the hazardous material so produced. It includes associated operations such as storage and treatment of materials and components on site.
- **Requirements for ships:** Ships should not use prohibited hazardous materials as notified. The central government may exempt certain categories of ships from this requirement. The National Authority will carry out periodic surveys to verify the prescribed requirements. This Authority will be notified by the central government to administer, supervise and monitor all activities related to ship recycling.
- The owner of every new ship must make an application to the National Authority to obtain a certificate on the inventory of hazardous materials. Existing ship owners must apply for the certificate within five years of the commencement of the Act. The certificate must be renewed every five years. It must be maintained and updated through the life of the ship to reflect any changes in the ship's structure and equipment. The certificate may be suspended for various reasons such as the ship not complying with the particulars of the certificate, or not maintaining the inventory of hazardous materials properly. Using hazardous materials in a ship will be punishable with imprisonment of up to three months, or a fine of up to five lakh rupees, or both.
- These requirements will not apply to: (i) any warship, or other ship owned and operated by an administration and used on government non-commercial service, and (ii) ships with internal volume less than 500 tonne.
- **Recycling facilities:** Ships will be recycled only in authorised recycling facilities. An application to authorise such a facility must be submitted to the Competent Authority (which will be notified by the central government) along with a ship recycling facility management plan, and prescribed fee. Existing facilities must apply for authorisation within 60 days of the commencement of the Act. A facility will be authorised when the Competent Authority is satisfied that it follows the specified standards. The certificate of authorisation will be valid for a period as specified but not exceeding five years. Contravening these provisions will be punishable with imprisonment of up to one year, or a fine of up to Rs 10 lakh, or both.
- Each Ship Recycler must maintain adequate measures for emergency preparedness and response, safety, health, training, and welfare of workers as per the Factories Act, 1948. It must also provide insurance coverage for the regular and temporary workers.
- **Recycling process:** A ship owner must apply to the National Authority for a ready for recycling certificate before recycling his ship. The Ship Recycler must prepare a ship recycling plan which should be approved by the Competent Authority. Each ship will be recycled after obtaining written permission from the Competent Authority. The Authority must grant such permission after physically inspecting the ship.

- Every ship recycler must: (i) ensure safe and environmentally sound removal and management of hazardous materials from a ship, and (ii) comply with the specified environmental regulations. They must also ensure that no environmental damage is caused due to such recycling. On contravening these provisions, the ship recycler will be liable to pay environmental damages and cleanup operation compensation as prescribed. In case of an oil spill, a ship recycler will be punishable with: (i) a fine of up to five lakh rupees in case of no response within 12 hours of issue of the first notice, (ii) a fine of up to Rs 10 lakh in case of no response within 24 hours of issue of the second notice, and (iii) imprisonment of up to three months, and a fine of up to Rs 10 lakh in case of no response within 24 hours of issue of the third notice.
- **Appeals:** Decisions of the Competent Authority may be appealed with the National Authority within 30 days of receiving the decision. Decisions of the National Authority may be appealed with the central government within 30 days of receiving the decision.

■ The Dam Safety Bill, 2019

Ministry:

Water Resources

Highlights of the Bill

- The Bill provides for the surveillance, inspection, operation, and maintenance of all specified dams across the country. These are dams with height more than 15 metres, or height between 10 metres to 15 metres with certain design and structural conditions.
- It constitutes two national bodies: the National Committee on Dam Safety, whose functions include evolving policies and recommending regulations regarding dam safety standards; and the National Dam Safety Authority, whose functions include implementing policies of the National Committee, providing technical assistance to State Dam Safety Organisations (SDSOs), and resolving matters between SDSOs of states or between a SDSO and any dam owner in that state.
- It also constitutes two state bodies: State Committee on Dam Safety, and State Dam Safety Organisation. These bodies will be responsible for the surveillance, inspection, and monitoring the operation and maintenance of dams within their jurisdiction.
- Functions of the national bodies and the State Committees on Dam Safety have been provided in Schedules to the Bill. These Schedules can be amended by a government notification.
- An offence under the Bill can lead to imprisonment of up to two years, or a fine, or both.

Key Issues and Analysis

- The Bill applies to all specified dams in the country. This includes dams built on both inter and intra state rivers. As per the Constitution, states can make laws on water including water storage and water power. However, Parliament may regulate and develop inter-state river valleys if it deems it necessary in public interest. The question is whether Parliament has the jurisdiction to regulate dams on rivers flowing entirely within a state.
- The functions of the National Committee on Dam Safety, the National Dam Safety Authority, and the State Committee on Dam Safety are listed in Schedules to the Bill. These Schedules can be amended by the government through a notification. The question is whether core functions of authorities should be amended through a notification or whether such amendments should be passed by Parliament.

■ The Occupational Safety, Health and Working Conditions Code, 2019

Ministry:

Labour and Employment

Highlights of the Bill

- The Code seeks to regulate health and safety conditions of workers in establishments with 10 or more workers, and in all mines and docks.
- It subsumes and replaces 13 labour laws relating to safety, health and working conditions. These laws include: Factories Act, 1948; Mines Act, 1952; Dock Workers Act, 1986; Contract Labour Act, 1970; and Inter-State Migrant Workers Act, 1979.
- Establishments covered by the Code are required to register with registering officers, appointed by the central or state governments.
- Welfare facilities, working conditions and work hours for different types of establishments and workers will be prescribed by the central or state governments through rules.
- The Code sets up occupational safety boards at the national and state level to advise the central and state governments on the standards, rules, and regulations to be framed under the Code.
- The Code creates special provisions for certain classes of establishments such as factories, mines, dock workers, and constructions workers. These include separate provisions on licenses, safety regulations, and duties of employers.

Key Issues and Analysis

- The Second National Commission on Labour (2002) had recommended consolidation and simplification of existing health and safety laws. However, the Code continues to retain special provisions for various categories of workers such as working journalists and sales promotion employees. The rationale for retaining such provisions is unclear.
- The Code covers workers employed in establishments with at least 10 workers or more. It has been argued that size-based thresholds for applicability of labour laws help in reducing compliance burden for small establishments. On the other hand, it has been argued that occupational health and safety laws should cover all workers, to protect their basic rights.
- The Code bars civil courts from hearing matters under the Code. Therefore, the only judicial recourse for a person aggrieved under the Code is to file a writ petition before the relevant High Court. It can be argued that a bar on civil courts from hearing any matters under the Code may result in the denial of an opportunity to challenge issues before a lower court.

■ The Motor Vehicles (Amendment) Bill, 2019

Ministry:

Road Transport and Highways

- The Motor Vehicles (Amendment) Bill, 2019 was introduced in Lok Sabha on July 15, 2019 by the Minister for Road Transport and Highways, Mr. Nitin Gadkari. The Bill seeks to amend the Motor Vehicles Act, 1988 to provide for road safety. The Act provides for grant of licenses and permits related to motor vehicles, standards for motor vehicles, and penalties for violation of these provisions.
- Compensation for road accident victims: The central government will develop a scheme for cashless treatment of road accident victims during golden hour. The Bill defines golden hour as the time period of up to one hour following a traumatic injury, during which the likelihood of preventing death through prompt medical care is the highest. The central government may also make a scheme for providing interim relief to claimants seeking compensation under third party insurance. The Bill increases the minimum compensation for hit and run cases as follows: (i) in case of death, from Rs 25,000 to two lakh rupees, and (ii) in case of grievous injury, from Rs 12,500 to Rs 50,000.
- Compulsory insurance: The Bill requires the central government to constitute a Motor Vehicle Accident Fund, to provide compulsory insurance cover to all road users in India. It will be utilised for: (i) treatment of persons injured in road accidents as per the golden hour scheme, (ii) compensation to representatives of a person who died in a hit and run accident, (iii) compensation to a person grievously hurt in a hit and run accident, and (iv) compensation to any other persons as prescribed by the central government. This Fund will be credited through: (i) payment of a nature notified by the central government, (ii) a grant or loan made by the central government, (iii) balance of the Solatium Fund (existing fund under the Act to provide compensation for hit and run accidents), or (iv) any other source as prescribed the central government.

- Good samaritans: The Bill defines a good samaritan as a person who renders emergency medical or non-medical assistance to a victim at the scene of an accident. The assistance must have been (i) in good faith, (ii) voluntary, and (iii) without the expectation of any reward. Such a person will not be liable for any civil or criminal action for any injury to or death of an accident victim, caused due to their negligence in providing assistance to the victim.
- Recall of vehicles: The Bill allows the central government to order for recall of motor vehicles if a defect in the vehicle may cause damage to the environment, or the driver, or other road users. The manufacturer of the recalled vehicle will be required to: (i) reimburse the buyers for the full cost of the vehicle, or (ii) replace the defective vehicle with another vehicle with similar or better specifications.
- National Transportation Policy: The central government may develop a National Transportation Policy, in consultation with state governments. The Policy will: (i) establish a planning framework for road transport, (ii) develop a framework for grant of permits, and (iii) specify priorities for the transport system, among other things.
- Road Safety Board: The Bill provides for a National Road Safety Board, to be created by the central government through a notification. The Board will advise the central and state governments on all aspects of road safety and traffic management including: (i) standards of motor vehicles, (ii) registration and licensing of vehicles, (iii) standards for road safety, and (iv) promotion of new vehicle technology.
- Offences and penalties: The Bill increases penalties for several offences under the Act. For example, the maximum penalty for driving under the influence of alcohol or drugs has been increased from Rs 2,000 to Rs 10,000. If a vehicle manufacturer fails to comply with motor vehicle standards, the penalty will be a fine of up to Rs 100 crore, or imprisonment of up to one year, or both. If a contractor fails to comply with road design standards, the penalty will be a fine of up to one lakh rupees. The central government may increase fines mentioned under the Act every year by up to 10%.
- Taxi aggregators: The Bill defines aggregators as digital intermediaries or market places which can be used by passengers to connect with a driver for transportation purposes (taxi services). These aggregators will be issued licenses by state. Further, they must comply with the Information Technology Act, 2000.

■ The Prohibition of Electronic Cigarettes (Production, Manufacture, Import, Export, Transport, Sale, Distribution, Storage and Advertisement) Bill, 2019

The road to your dreams...

Ministry:

Health and Family Welfare

- The Prohibition of Electronic Cigarettes (Production, Manufacture, Import, Export, Transport, Sale, Distribution, Storage, and Advertisement) Bill, 2019 was introduced in Lok Sabha by the Minister of Health and Family Welfare, Dr. Harsh Vardhan. It replaces an Ordinance promulgated in September 2019. The Bill seeks to prohibit the production, trade, storage, and advertisement of electronic cigarettes.
- Electronic cigarettes: The Bill defines electronic cigarettes (e-cigarettes) as electronic devices that heat a substance, which may contain nicotine and other chemicals, to create vapour for inhalation. These e-cigarettes can also contain different flavours and include all forms of electronic nicotine delivery systems, heat-not-burn products, e-hookahs, and other similar devices.
- Banning of e-cigarettes: The Bill prohibits the production, manufacture, import, export, transport, sale, distribution and advertisement of e-cigarettes in India. Any person who contravenes this provision will be punishable with imprisonment of up to one year, or a fine of up to one lakh rupees, or both. For any subsequent offence, the person will be punishable with an imprisonment of up to three years, along with a fine of up to five lakh rupees.
- Storage of e-cigarettes: Under the Bill, no person is allowed to use any place for the storage of any stock of e-cigarettes. If any person stores any stock of e-cigarettes, he will be punishable with an imprisonment of up to six months, or a fine of up to Rs 50,000 or both.

- Once the Bill comes into force, the owners of existing stocks of e-cigarettes will have to declare and deposit these stocks at the nearest office of an authorised officer. Such an authorised officer may be a police officer (at least at the level of a sub-inspector), or any other officer as notified by the central or state government.
- Powers of authorised officers: If an authorised officer believes that any provision of the Bill has been contravened, he can search any place where trade, production, storage or advertising of e-cigarettes is being undertaken. The authorised officer can seize any record or property connected to e-cigarettes found during the search. Further, he may take the person connected with the offence into custody.
- If the property or records found during the search cannot be seized, the authorised officer can make an order to attach such property, stocks or records.

■ The Compensatory Afforestation Fund Bill, 2015

- The Compensatory Afforestation Fund Bill, 2015 was introduced in Lok Sabha by the Minister for Environment, Forest and Climate Change, Mr. Prakash Javadekar on May 8, 2015. **The Bill seeks to establish funds at the national and state level to receive money collected for compensatory afforestation.**
- Compensatory afforestation is defined as afforestation done in lieu of the diversion of forest land for non-forest use under the Forests (Conservation) Act, 1980.
- Creation of Compensatory Afforestation Funds: The Bill seeks to establish a permanent National Compensatory Afforestation Fund under the public account of India. It also allows states to establish State Compensatory Afforestation Funds.
- The National Fund will be under the central government, and managed by a National Compensatory Afforestation Fund Management and Planning Authority (CAMPA). The central government will appoint a State CAMPA in each state. The State CAMPA will be responsible for the management of the State Fund.
- Sources of funds: At present, an ad hoc National CAMPA and ad hoc State CAMPAs, established by government orders, receive money collected for compensatory afforestation. Once the National Fund is created, money collected by state governments which has been placed with the existing National CAMPA will be transferred to the National Fund. Other sources of funds for the National Fund will be: (i) 10% of the funds collected for compensatory afforestation by states each year; and (ii) grants-in-aid/other sums received by, and loans/borrowings taken by the National CAMPA.
- The major sources of funds for the State Fund will be: (i) unspent balances lying with existing State CAMPAs; (ii) money transferred from the National Fund to the State Funds (90% of the money transferred from the existing National CAMPA to the National Fund); (iii) money received for compensatory afforestation; and (iv) grants in-aid/other sums received by, and loans/borrowings taken by the State CAMPA.
- The balance with both funds will be non-lapsable and get interest as per a rate declared by the central government on a yearly basis.
- **Utilization of funds:** The money in the National Fund will be used to meet expenditure for the management of the National CAMPA, and on schemes approved by the National CAMPA.
- The money in the State Fund will be used for the following purposes: (i) site-specific schemes implemented by the state; (ii) artificial regeneration, forest management and wildlife protection; and (iii) protection and conservation activities in protected areas under the Wild Life (Protection) Act, 1972.
- If the diversion of forest land affects multiple states, the National CAMPA may order that money be transferred to one of those states.
- Composition and functions of Authorities: The National CAMPA will consist of a governing body, an executive committee, and a monitoring group, in addition to an administrative support mechanism.
- The governing body will be responsible for formulating the broad policy framework for the functioning of the National CAMPA. The executive committee will be responsible for the approval

of annual plans of State CAMPAs and the formulation and implementation of schemes approved by the governing body. The monitoring group will be responsible for the monitoring and evaluation of works implemented by states and fund utilisation by the CAMPAs.

- The State CAMPA will consist of a governing body, a steering committee, and an executive committee. The governing body, chaired by the Chief Minister of the state, will be responsible for formulating the broad policy framework for the State CAMPA, within the overall framework laid out by the National CAMPA. The executive committee will be responsible for formulating the annual plan of operations, after obtaining the approval of the steering committee. The executive committee will also monitor works funded by the State Fund, and invest the surplus amounts available with the State Fund.



RECENT DEVELOPMENT

■ Yamuna Action Plan

River Yamuna is one of the major rivers in India and also a major tributary to India's largest river - river Ganges.

Riverine water resources, including river Yamuna, are increasingly becoming vulnerable to quantity decline and quality degradation due to human activities, the modified flow regime due to water holding structures or barrages, withdrawal of water for irrigation & drinking purposes and the cumulative discharge of domestic, industrial & agricultural wastewaters has converted the Yamuna into almost an open sewer in the stretch of Delhi and Agra. As a result, the river is impacting the bio-diversity of the ecosystem and endangering public health of the inhabitants. The prevalence of poor sanitation practices also contributes to the proliferation of a number of diseases and an adverse living environment.

Yamuna Action Plan I and II

- In 1977-78, CPCB initiated a study to assess the status of pollution of Yamuna River over its 1200 km course. The study examined the topography of the drainage basin, base flow, population, land use pattern, industries, and agriculture practices and estimated the pollution load from activities in the basin. Study conducted by the CPCB indicated that the major cause of pollution is the discharge of domestic wastewater into the river which is about two-third of the pollution load. The remaining pollution is contributed by industries and agriculture. Based on the findings of this study, the Government of India (GoI) decided to take up water quality restoration measures named as Yamuna Action Plan (YAP) under the mega project of the Ganga Action Plan (GAP) phase-II. The Government of Japan provided loan assistance for implementation of YAP in December-1990. YAP was formally launched in 1993, now called as YAP phase I (YAP I). The main activities covered under YAP were interception and diversion works, pumping stations, STPs, low cost toilet complex, crematorium, plantation, bathing ghat / river front development, public participation and awareness and computer networking system. The limitation of YAP I were:
 - ▶ The STP capacity created remained under-utilised to the extent of 25-45% because of severe limitations in the collection system and power availability.
 - ▶ The strategy in YAP-I did not adequately address non-point sources.
 - ▶ Municipalities and agencies which were responsible for Operation & Maintenance (O&M) of sewerage infrastructure were constrained to maximize the operational efficiency of the system due to a combination of factors related to skills, finance, management systems, power cuts and upstream sewerage infrastructure.
- Subsequently, the work continued with the launch of YAP phase II (YAP II) in the year 2004 with the sanctioned cost of 647 crores. The project was completed in 2008 Under YAP II, emphasis was on the 22-km stretch of Yamuna in Delhi. The Yamuna Action Plan Project Phase II is regarded as the core project under the National River Conservation Plan of Government of India. The project addresses the abatement of severe pollution of the River Yamuna by raising sewage treatment capacity, caused by rapid population growth, industrialization and urbanization. The plan includes building new and expanding capacity of old sewage treatment plants and laying and rehabilitating sewers to enhance the treatment capacity particularly in Delhi and Agra. Public participation and awareness were also a part of project to ensure the residents' recognition of the necessity of water quality conservation

in the River Yamuna, and would establish linkage between the river conservation and their own living environments. But, there had been no concrete results even though Rs.1, 500 crore had been spent through phases one and two of the Yamuna Action Plan. It has been observed that despite of the continuous efforts to minimize the pollution load still the BOD is not decreasing.

- The Yamuna Action Plan Phase - III project for Delhi has been approved by the Ministry in December, 2011 at an estimated cost of Rs 1656 crore with loan assistance from Japan International Cooperation Agency. Besides this, two projects have also been sanctioned by the Ministry in July, 2012 at an estimated cost of Rs. 217.87 crore for taking up works for pollution abatement of river Yamuna in towns of Sonapat and Panipat in Haryana which are located on upstream of Wazirabad in Delhi.

NGT rules related to Yamuna

- As a consequence of present deplorable state of the river, NGT has given directions to take up cleaning of Yamuna under Maily Se Nirmal Yamuna Revitalization Plan, 2017. In pursuance of this direction, the Centre and the Delhi government have come together to launch projects under phase three of the Yamuna Action Plan which will cost Rs. 825 crores. This Yamuna Action Plan-3 will be the first plan to comprehensively help with sewage treatment and solid waste management along with river front development and providing a proper Chhat Ghat for devotees.
- National Green Tribunal (NGT) ordered that every household in Delhi will have to pay a monthly environmental compensation to clean up Yamuna River. According to the direction, the compensation to be paid will be directly proportional to the property or water tax whichever is higher, paid by a particular household. In case of unauthorized colonies households that do not pay property tax or water bill will have to pay an amount that would be between 100 rupees to 500 rupees.
- According to the Tribunal, industrial units within a particular industrial cluster have to pay these amounts on the 'Polluter Pays' Principle, for the pollution already caused by them and even which they are causing presently, as well as to prevent pollution in future on the Precautionary Principle. Major part of such costs, obviously have to be borne by the authorities concerned, let us say 2/3rd, while 1/3rd of the total costs should be borne by the industries.

Way forward

- Effective coordination between State and Central government agencies is required in terms of execution
- It is necessary to reduce the quantity of water being drawn from the river for irrigation. Efficient irrigation methods like sprinklers or drip method should be used.
- Effective check to ensure in situ treatment of effluents is done before discharge from industries.
- Steps must be taken to relocate the existing settlements and encroachments near the floodplains and no further encroachments should be allowed.
- There should be a ban on construction of new barrages
- Since there is shortage of landfill sites in Delhi, most wastes are dumped in the river. Keeping this in mind, immediate action needs to be taken to identify more landfill sites in Delhi.
- Public awareness is most important prevention measure. Effective steps should be taken to enhance public awareness.

■ National Water Mission

- The National Action Plan on Climate Change (NAPCC) describes the features of National Water Mission as under: **"A National Water Mission will be mounted to ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states."** The Mission will take into account the provisions of the National Water Policy and develop a framework to optimize water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing. It will seek to ensure that a considerable share of the water needs of urban areas are met through recycling of waste water, and ensuring that the water requirements of coastal cities with inadequate alternative sources of water are met through adoption of new and appropriate technologies such as low temperature desalination technologies that allow for the use of ocean water.

- The National Water Policy would be revisited in consultation with States to ensure basin level management strategies to deal with variability in rainfall and river flows due to climate change.
- This will include enhanced storage both above and below ground, rainwater harvesting, coupled with equitable and efficient management structures.
- The Mission will seek to develop new regulatory structures, combined with appropriate entitlements and pricing. It will seek to optimize the efficiency of existing irrigation systems, including rehabilitation of systems that have been run down and also expand irrigation, where feasible, with a special effort to increase storage capacity. Incentive structures will be designed to promote water-neutral or water-positive technologies, recharging of underground water sources and adoption of large scale irrigation programmes which rely on sprinklers, drip irrigation and ridge and furrow irrigation."
- The NAPCC also describes the procedure for implementation of the Mission as under: "These National Missions will be institutionalized by respective Ministries and will be organized through Inter-Sectoral Groups which include, in addition to related Ministries, Ministry of Finance and the Planning Commission, experts from industry, academia and civil society. The institutional structure would vary depending on the task to be addressed by the Mission and will include providing the opportunity to compete on the best management model. Each Mission will be tasked to evolve specific objectives spanning the remaining years of the 11th Plan and the 12th Plan period 2012-2013 to 2016-2017. Where the resource requirements of the Mission call for an enhancement of the allocation in the 11th Plan, this will be suitably considered, keeping in mind the overall resources position and the scope for re-prioritization".
- Comprehensive Mission documents detailing objectives, strategies, plan of action, timelines and monitoring and evaluation criteria would be developed and submitted to the Prime Minister's Council on Climate Change by December 2008. The Council will also periodically review the progress of these Missions. Each Mission will report publicly on its annual performance. Building public awareness will be vital in supporting implementation of the NAPCC. This will be achieved through national portals, media engagement, civil society involvement, curricula reform and recognition / awards, details of which will be worked out by an empowered group. The Group will also consider methods of capacity building to support the goals of the National Missions. We will develop appropriate technologies to measure progress in actions being taken in terms of avoided emissions, wherever applicable, with reference to business as usual scenarios. Appropriate indicators will be evolved for assessing adaptation benefits of the actions. These Eight National Missions taken together, with enhancements in current and ongoing programmes included in the Technical Document, would not only assist the country to adapt to climate change, but also, importantly, launch the economy on a path that would progressively and substantially result in mitigation through avoided emissions." The '**Technical Document**' annexed with the NAPCC has identified key areas related to
 - ▶ Studies on management of surface water resources,
 - ▶ Management and regulation of ground water resources,
 - ▶ Upgrading storage structures for fresh and drainage system for wastewater,
 - ▶ Conservation of wetland, and
 - ▶ Development of desalination technologies etc. required to be considered while preparing the comprehensive document for the National Water Mission.

■ Secure Himalaya

- The Government of India and United Nations Development Programme, with support from the Global Environment Facility, are implementing a new programme in the high altitude Himalayas entitled "**SECURE Himalayas - Securing livelihoods, conservation, sustainable use and restoration of high range Himalayan ecosystems**", to ensure conservation of locally and globally significant biodiversity, land and forest resources in the high Himalayan ecosystem, while enhancing the lives and livelihoods of local communities.

Key Components

- Conservation of key biodiversity areas and their effective management to secure long-term ecosystem resilience, habitat connectivity and conservation of snow leopard and other endangered species and their habitats

- Securing sustainable community livelihoods and natural resource management in high range Himalayan ecosystems
- Enhancing enforcement, monitoring and cooperation to reduce wildlife crime and related threats
- Knowledge, advocacy, communication and information systems established

■ World Sparrow Day

- World Sparrow Day is a day designated to raise awareness of the house sparrow and then other common birds to urban environments, and of threats to their populations, **observed on 20 March**.
- It is an international initiative by the Nature Forever Society of India in collaboration with the Eco-Sys Action Foundation (France) and numerous other national and international organisations across the world.
- **The Nature Forever Society was started by Mohammed Dilawar, an Indian conservationist who started his work helping the house sparrow in Nashik, and who was named one of the "Heroes of the Environment" for 2008 by Time for his efforts.**
- The idea of marking World Sparrow Day came up during an informal discussion at the Nature Forever Society's office.
- The idea was to earmark a day for the house sparrow to convey the message of conservation of the house sparrow and other common birds and also mark a day of celebration to appreciate the beauty of the common biodiversity which is taken so much for granted.
- **The first World Sparrow Day was celebrated in 2010 in different parts of the world.**
- The day was celebrated by carrying out different various kinds of activities and events like art competitions, awareness campaigns, and sparrow processions as well as interactions with media.
- World Sparrow Day also has a broader vision to provide a platform where people who are working on the conservation of the house sparrow and other common birds can network, collaborate and exchange conservation ideas which will lead to better science and improved results.
- It aims to provide a meeting ground for people from different parts of the world to come together and form a force that can play an important role in advocacy and in spreading the awareness on the need of conserving common biodiversity or species of lower conservation status.

■ Land Degradation Neutrality (LDN)

- Desertification is threatening the livelihoods of 1 billion people in over 100 countries, and each year 12 million hectares of arable land are lost to drought. The extent and severity of land degradation worldwide, combined with the negative effects of climate change, population growth and an ever-increasing demand for natural resources, requires immediate and assertive action. The economic costs of desertification and land degradation are estimated at USD 490 billion per year. Avoiding land degradation through sustainable land management can generate up to USD 1.4 trillion of economic benefits.
- Policies and programmes to halt and reverse land degradation have long suffered from the absence of a clear overarching goal and quantitative, time-bound targets to guide action and make measurable progress. In October 2015, UNCCD country Parties reached a breakthrough agreement on the land degradation neutrality (LDN) concept.
- **The LDN concept has been developed to encourage implementation of an optimal mix of measures designed to avoid, reduce and/or reverse land degradation in order to achieve a state of no net loss of healthy and productive land.** LDN aims to balance anticipated losses in land-based natural capital and associated ecosystem functions and services with measures that produce alternative gains through approaches such as land restoration and sustainable land management.
- **LDN is a simple idea and a powerful tool.** It means securing enough healthy and productive natural resources by avoiding degradation whenever possible and restoring land that has already been degraded. At its core are better land management practices and better land use planning that will improve economic, social and ecological sustainability for present and future generations.

- Numerous direct links exist between LDN and Sustainable Development Goals (SDG), such as eradicating poverty, ensuring food security, protecting the environment and using natural resources sustainably. LDN serves as a catalyst in achieving these goals.

LDN and climate change

- LDN provides significant benefits in terms of mitigation and adaptation to climate change. Halting and reversing land degradation can transform land from being a source of greenhouse gas emissions to a carbon sink, by increasing carbon stocks in soils and vegetation. Furthermore, LDN plays a key role in strengthening the resilience of rural communities against climate shocks by securing and improving the provision of vital ecosystem services.
- These links between land and climate are reflected in the Intended Nationally Determined Contributions (INDCs) submitted by countries to COP 21 of the UN Framework Convention on Climate Change (UNFCCC) in Paris in 2015. More than 100 of the INDCs included land-based activities for mitigation and adaptation. LDN targets and associated measures contribute to and depend on the implementation of national climate plans and vice versa. Such synergies should be taken into account when developing national plans for LDN and revising and updating the INDCs under the Paris Agreement.

■ Forest-PLUS 2.0

- US Agency for International Development (USAID) and India's Ministry of Environment, Forest and Climate Change (MoEF&CC) officially launched Forest-PLUS 2.0 on September 25, 2019.
- It is a five-year programme initiated in December 2018 that focuses on developing tools and techniques to bolster ecosystem management and harnessing ecosystem services in forest landscape management.
- Tetra Tech ARD, a consulting and engineering company headquartered in the US, was given the contract to implement the programme and IORA Ecological Solutions, a New Delhi-based environmental advisory group, is its implementation partner.
- Forest-PLUS 2.0, the second set of pilot projects, is meant to enhance sustainable forest landscape management after Forest-PLUS completed its five years in 2017.
- The programme's first set focused on capacity building to help India participate in Reducing Emissions from Deforestation and forest Degradation (REDD+). It included four pilot projects in Sikkim, Rampur, Shivamogga and Hoshangabad.
- Under these, field tests, innovative tools and approaches for Indian forest management were developed. Promotion of bio-briquettes in Sikkim, introduction of solar heating systems in Rampur and development of an agro-forestry model in Hoshangabad were some of the achievements of this programme.
- Forest-PLUS 2.0 comprises pilot project in three landscapes — Gaya in Bihar, Thiruvananthapuram in Kerala and Medak in Telangana. The choice of these sites was driven by the contrast in their landscapes – Bihar is a forest deficit area, Telangana is a relatively drier area where there is ample scope for community livelihood enhancement and Kerala is rich in biodiversity.

The targets of this set are –

- 1,20,000 hectares of land under improved management
- New, inclusive economic activity worth \$12 million
- Measurable benefits accrued to 800,000 households
- Three incentive mechanisms demonstrated in managing landscapes for ecosystem services

To achieve these targets, the programme has three focal points of action –

- Developing tools for multiple services in forests management. The tools consists of innovative apps for automating forest planning processes, model forest management plans. These tools are expected to result in enhanced water flow and quality, improved livelihoods and resilience of forest-dependent communities.

- Developing incentive-based instruments for leveraging finance. For example, a payment mechanism where a municipality or industry would pay upstream forest communities to use water flowing down because of improved forest management.
- Unlocking economic opportunities for forest-dependent people by modelling and setting up conservation enterprises and mobilising investment from the private sector.

■ Important International Events to Protect Environment

Earth Day

- The Earth Day is an annual event celebrated across the world on April 22. Its celebration is coordinated globally by the Earth Day Network.
- In 1969, at a UNESCO Conference in San Francisco, the peace activist John McConnell proposed a day to honour Earth and the concept of peace, the first to be celebrated on 21st March 1970, the first day of spring in the Northern Hemisphere.

Earth Hour

- The Earth Hour is a worldwide movement organized by the WWF. The event is held annually, encouraging individuals, communities, households and businesses to turn off their non-essential lights for one hour, from 8:30 to 9:30 p.m., as a symbol for their commitment to the planet. It was started as a lights-off event in Sydney, Australia, in 2007. Since then, it has grown to engage more than 7,000 cities and towns across 172 countries worldwide. Every year, the event begins at Sydney's Opera House and Bridge, Australia.

International Day of Biological Diversity

- The United Nations has proclaimed May 22 as the International Day for Biological Diversity (IDB) to increase understanding and awareness of biodiversity issues. The UN General Assembly adopted May 22 as IDB, to commemorate the adoption of the Convention on Biological Diversity. Earlier, IDB was celebrated on December 29, each year. The IDB was changed because it was difficult for many countries to plan and carry out suitable celebrations on December 29, given the number of holidays that coincide around that time of the year.

World Environment Day

- The World Environment Day (WED) that falls on June 5 every year, is the United Nations' principal vehicle for encouraging worldwide awareness and action for the protection of our environment. First held in 1974, the WED has grown to become a global platform. The WED was designated by the UN General Assembly in 1972 on the first day of United Nations Conference on the Human Environment. Two years later, in 1974 the first WED was held with the theme 'Only One Earth'. Each year, WED has a new theme.

International Day for the Preservation of the Ozone Layer

- In 1994, the UN General Assembly proclaimed September 16 as the International Day for the preservation of the ozone layer, commemorating the date of the signing, in 1987, of the Montreal Protocol on substances that deplete the ozone layer.

International Day of Forests

- The International Day of Forests was established on March 21, by the resolution of the United Nations General Assembly in 2012. Each year, various events celebrate and raise awareness of the importance of all types of forests and trees outside forests, for the benefit of current and future generations. The Secretariat of the United Nations Forum on Forests, in collaboration with the Food and Agriculture Organization, facilitates the implementation of such events in collaboration with governments and various organizations. International Day of Forests was observed for the first time on 21st March 2013.

World Habitat Day

- World Habitat Day is observed every year on the first Monday of October throughout the world. It was officially designated by the United Nations and first celebrated in 1986.





NUTRIENT CYCLES

■ Concept of Bio-Geochemical Cycles

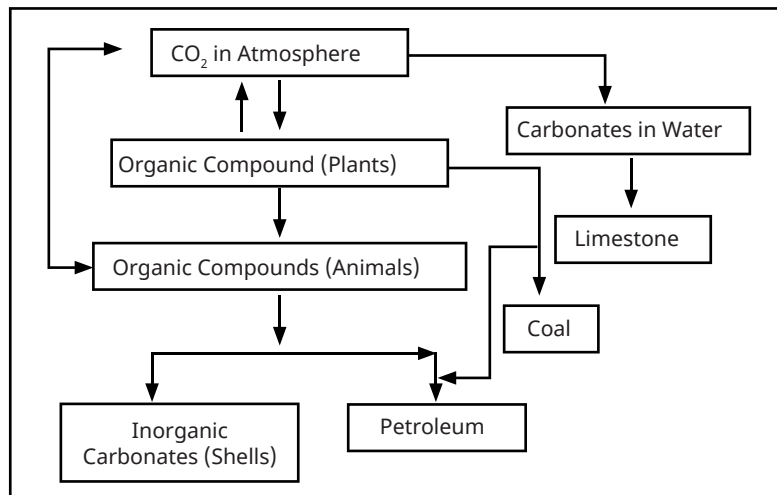
- The cyclical path of elements from abiotic system to the biotic system and back is called **Biogeochemical cycle**.
- The chemical elements, including all the essential elements of life, tend to circulate in the biosphere in characteristic pathways from environment to organisms and back to the environment.
- These more or less circular pathways are known as biogeochemical cycles. In other words, a biogeochemical cycle is a circuit or pathway by which a chemical element or molecule moves through both biotic ("bio-") and abiotic ("geo-") compartments of an ecosystem. In effect, the element is recycled, although in some such cycles there may be places (called sinks) where the element is accumulated or held for a long period of time.
- The movement of these elements and inorganic compounds that are essential to life can be conveniently designated as nutrient cycling.
- The dissipation of energy in some form is always necessary to drive material cycles.
- This cycle contains any of the natural pathways by which essential elements of living matter are circulated.
- **Biogeochemical cycles are named for the cycling of biological, geological and chemical elements through Earth and its atmosphere.**
- The cycles move substances through the biosphere, lithosphere, atmosphere and hydrosphere. **Cycles are gaseous and sedimentary.**
 - **Gaseous cycles includes nitrogen, oxygen, carbon and water.**
 - **Sedimentary cycles includes phosphorus and sulphur**

■ CARBON CYCLE

- Carbon is a constituent of all organic compounds, many of which are essential to life on Earth. Carbon dioxide is an atmospheric constituent that plays several vital roles in the environment.
- It is a greenhouse gas that traps infrared radiation heat in the atmosphere.
- It plays a crucial role in the weathering of rocks. It is the carbon source for plants.
- It is stored in biomass, organic matter in sediments, and in carbonate rocks like limestone.

Steps in Carbon Cycle

- Carbon enters the atmosphere as carbon dioxide from respiration and combustion.
- Carbon dioxide is absorbed by producers to make carbohydrates in photosynthesis.
- Animals feed on the plant passing the carbon compounds along the food chain. Most of the carbon they consume is exhaled as carbon dioxide formed during respiration. The animals and plants eventually die.
- The dead organisms are eaten by decomposers and the carbon in their bodies is returned to the atmosphere as carbon dioxide. In some conditions decomposition is blocked. The plant and animal material may then be available as fossil fuel in the future for combustion.

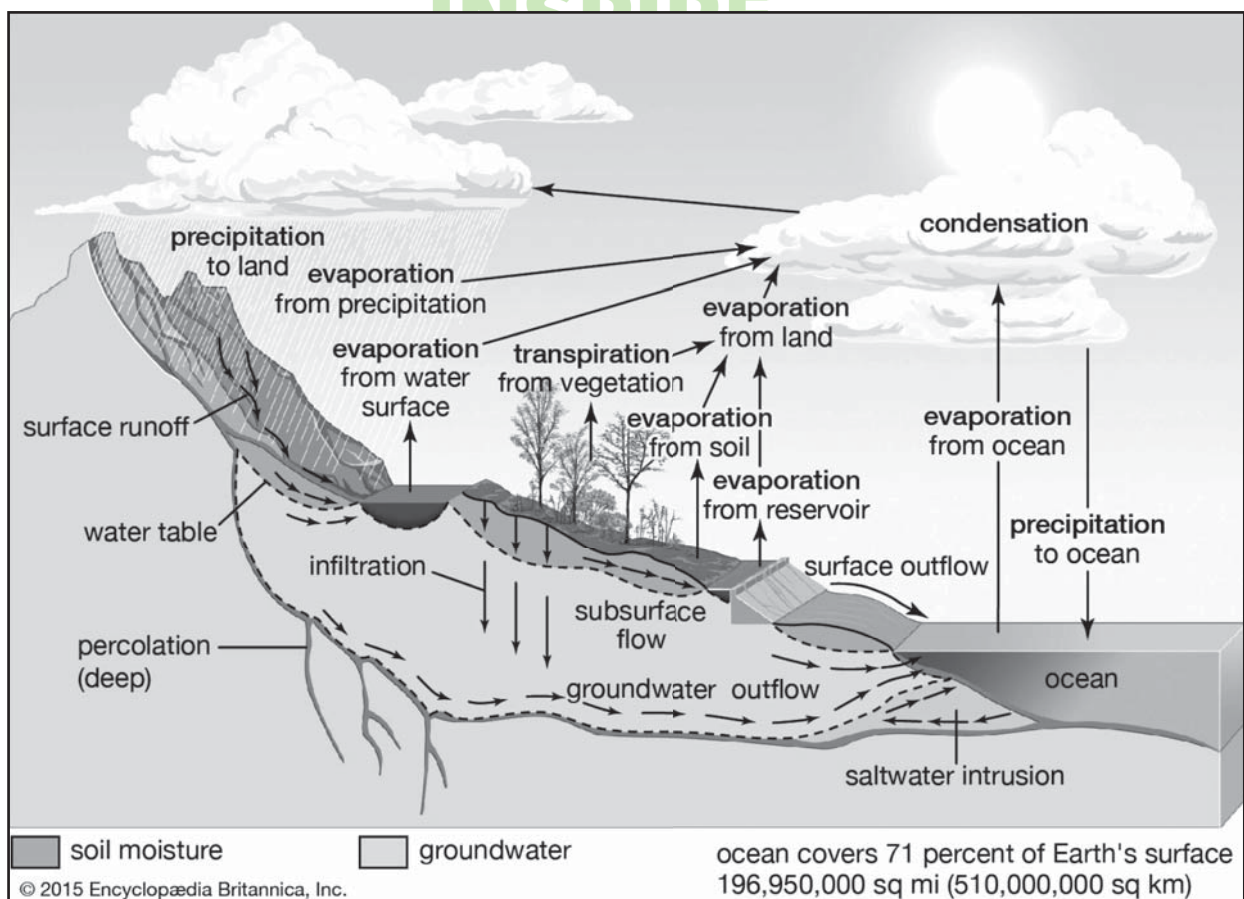


The cycle has four major reservoirs of carbon interconnected by pathways of exchange. The reservoirs are:

- The atmosphere
- The terrestrial biosphere (which usually includes freshwater systems and non-living organic material, such as soil carbon)
- The oceans (which includes dissolved inorganic carbon and living and non-living marine biota).
- The sediments (which includes fossil fuels).

The annual movements of carbon, the carbon exchanges between reservoirs, occur because of various chemical, physical, geological, and biological processes.

■ HYDROLOGICAL CYCLE



Water cycle, also called hydrologic cycle, cycle that involves the continuous circulation of water in the Earth atmosphere system. Of the many processes involved in the water cycle, the most important are evaporation, transpiration, condensation, precipitation, and runoff. Although the total amount of water within the cycle remains essentially constant, its distribution among the various processes is continually changing.

■ Different Steps of the Hydrological Cycle

Evaporation

- Evaporation, one of the major processes in the cycle, is the transfer of water from the surface of the Earth to the atmosphere. By evaporation, water in the liquid state is transferred to the gaseous, or vapour, state.
- This transfer occurs when some molecules in water mass have attained sufficient kinetic energy to eject themselves from the water surface. The main factors affecting evaporation are temperature, humidity, wind speed, and solar radiation.

Transpiration

- When water vapour is also discharged from plant leaves by a process called transpiration.

Sublimation

- Evaporation from snow and ice, the direct conversion from solid to vapor is known as sublimation.

Condensation

- When water vapour rises, it cools slightly and condenses. Generally, the water condenses on dust particles in the air and becomes liquid. Sometimes the water skips the liquid phase and turns directly into a solid - in the form of ice, hail, or snow. In the liquid form the particles collect and form clouds.
- Condensation may take place as soon as the air contains more water vapour than it can receive from a free water surface through evaporation at the prevailing temperature. This condition occurs as the consequence of either cooling or the mixing of air masses of different temperatures. By condensation, water vapour in the atmosphere is released to form precipitation.

Precipitation

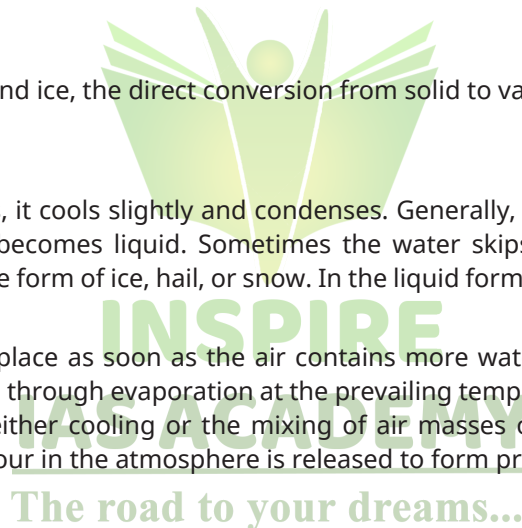
- The condensed water vapor falling to the surface of the Earth is known as precipitation. It occurs in the form of snow, hail and rain.

Infiltration and Percolation

- When precipitation falls on the ground, some of it moves downwards into cracks, joints, and pores in the soil. The entry of water into the subsurface is termed infiltration.
- The process of percolation refers to the subsequent movement of water through subsurface soil pores until it reaches the water table. At this point it becomes groundwater. This is a slow process, which is why more water flows back to the ocean through surface runoff than groundwater discharge

Groundwater Flow

- Groundwater is water that is held in cracks and pore spaces below ground. This water can be tapped by water supply wells or continue moving below the ground until it eventually returns to the surface.
- The process by which groundwater exits the ground is known as groundwater discharge. This groundwater can either discharge directly into oceans, or more commonly, it discharges to surface water (lakes and rivers) and then travels to the ocean as surface runoff.



■ NITROGEN 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

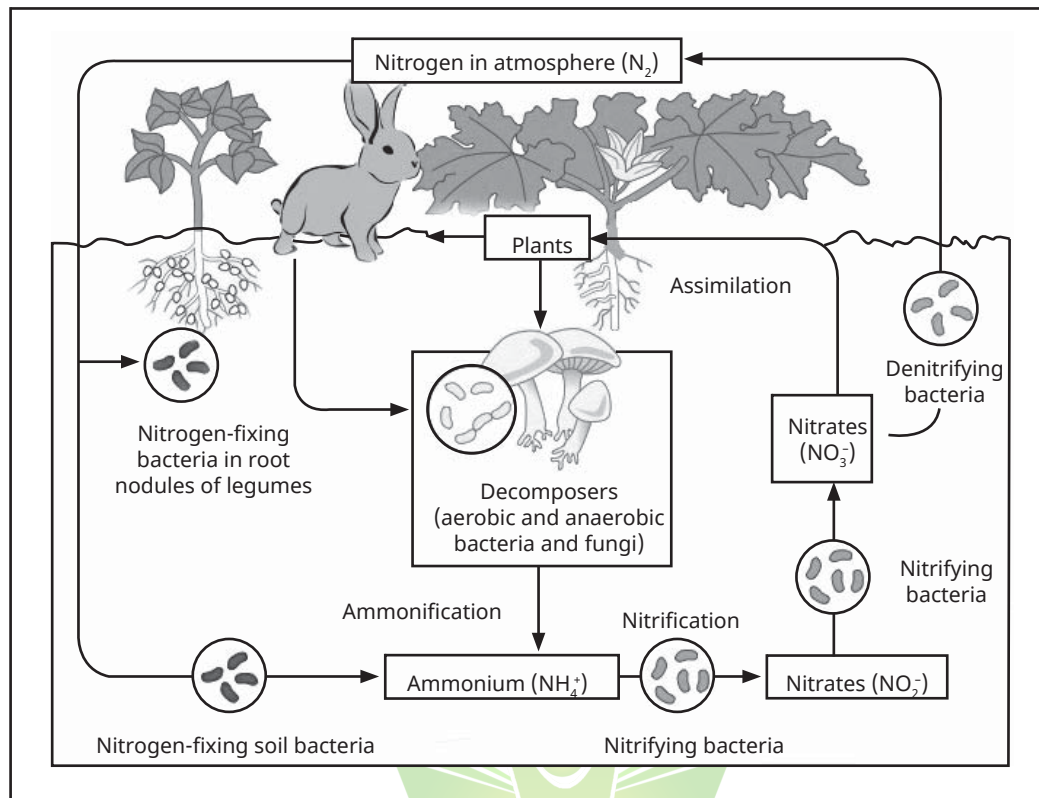
- When plants or animal die organic nitrogen is again released back into the soil. Bacteria or fungi present in the soil convert them back into ammonium. This process is also called as **mineralization**.
- The remains of all living things and their waste products are decomposed by microorganisms in 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 nitrites 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 (N_2) is the ultimate end product of denitrification, but other intermediate gaseous forms of nitrogen exists. Some of these gases, such as nitrous oxide (N_2O), 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.



■ OXYGEN CYCLE

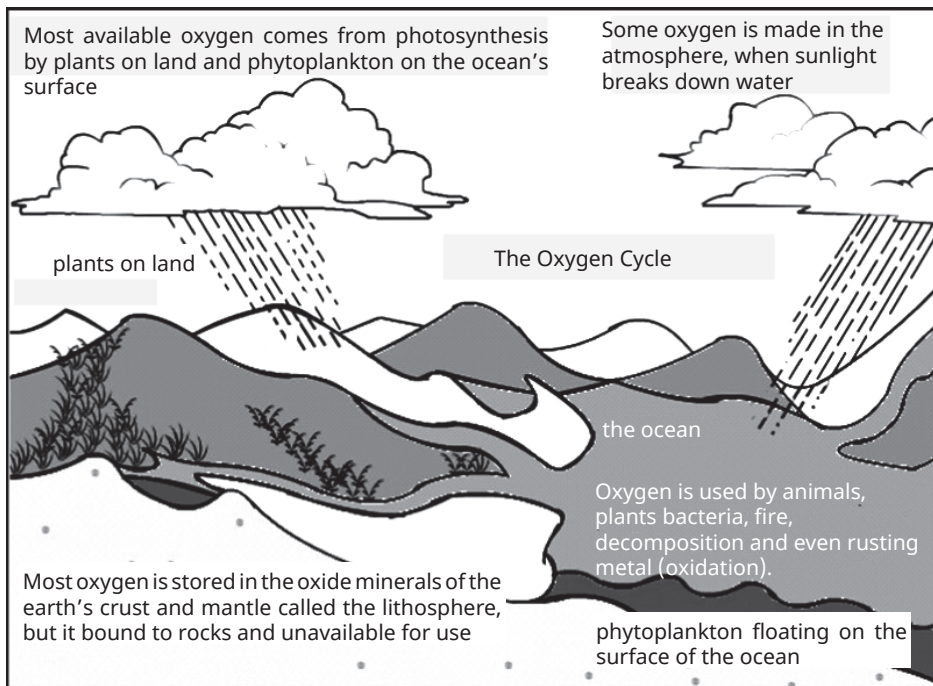
- Oxygen in the atmosphere is about 21%, and it is the second most abundant gas after nitrogen.
- It is mostly utilized by living organisms, especially man and animals in respiration.
- Oxygen is also the most common element of human body. Oxygen is also used during combustion, decomposition, and oxidation.
- 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 give 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:

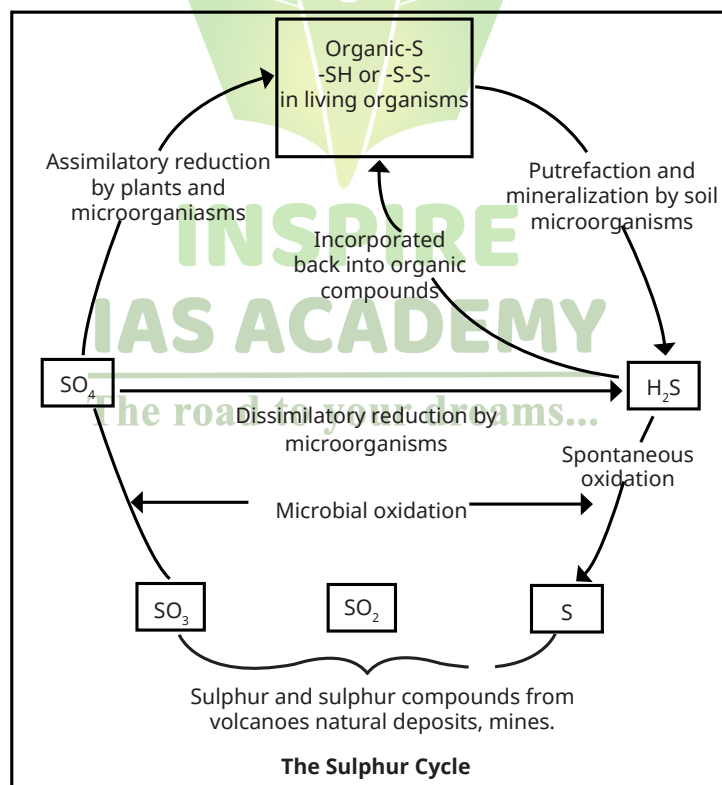
- **Plants** – Plants produce oxygen via photosynthesis
- **Sunlight** – Some oxygen is produced when sunlight reacts with water vapour in the atmosphere.

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 dioxide into the atmosphere.



■ **SULPHUR CYCLE**



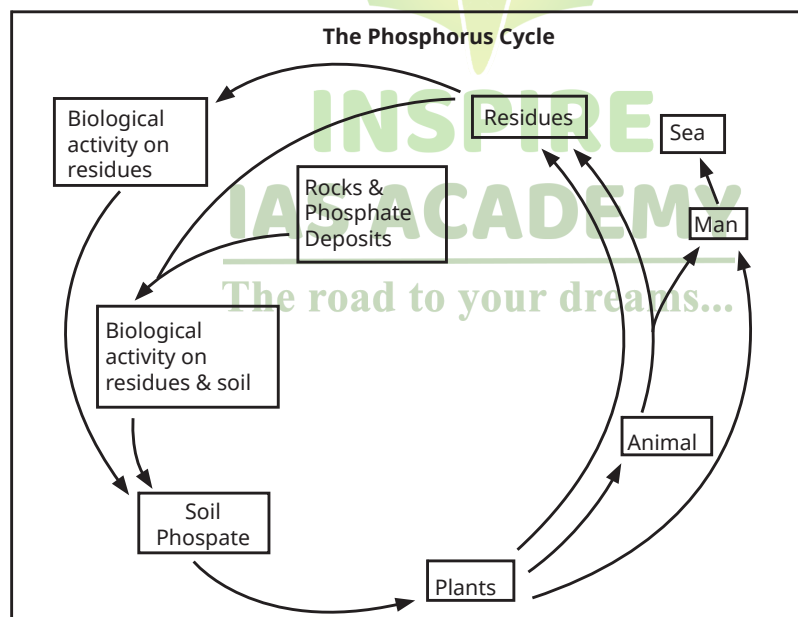
- The sulphur reservoir is in the soil and sediments where it is locked in organic (coal, oil and peat) and inorganic deposits (pyrite rock and sulphur rock) in the form of sulphates, sulphides and organic sulphur.
- It is released by weathering of rocks, erosional runoff and decomposition of organic 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.

■ 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.

Parts of the Cycle



- As shown in the Figure, phosphorus, a necessary constituent of protoplasm, tends to circulate with organic compounds in the form of phosphates (PO_4), which are again available to plants.
- The great reservoir of phosphorus is not the air, however, but in apatite mineral deposits formed in past geological ages (that is, in the lithosphere). Atmospheric dust and aerosols return a large amount of phosphorus (not phosphate) to the land yearly, but phosphate continually returns to the sea, where part of it is deposited in the shallow sediments and part of it is lost to the deep sediments.
- Contrary to popular belief, seabirds play only a limited role in returning phosphorus to the cycle (as shown by the guano deposits located on the coast of Peru). This transfer of phosphorus and other materials by birds from the sea to the land is continuing, likely at the same rate at which it occurred



STATE OF FOREST REPORT 2019

■ Introduction

- The report is published by the Forest Survey of India (FSI) which has been mandated to assess the forest and tree resources of the country including wall-to-wall forest cover mapping in a biennial cycle.
- Starting 1987, 16 assessments have been completed so far. ISFR 2019 is the 16th report in the series.
- India is among few countries in the world where forest cover is consistently increasing.
- The total forest and tree cover of the country is 80.73 million hectare which is 24.56 percent of the geographical area of the country.
- Compared to the assessment of 2017, there is an increase of 5,188 sq. km in the total forest and tree cover of the country.
- Out of this, the increase in the forest cover has been observed as 3,976 sq km and that in tree cover is 1,212 sq. km; Range increase in forest cover has been observed in open forest followed by very dense forest and moderately dense forest and the top three states showing increase in forest cover are Karnataka (1,025 sq. km) followed by Andhra Pradesh (990 sq km) and Kerala (823 sq km)."

Some Major Findings of the report

- Area-wise Madhya Pradesh has the largest forest cover in the country followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra.
- In terms of forest cover as percentage of total geographical area, the top five States are Mizoram (85.41%), Arunachal Pradesh (79.63%), Meghalaya (76.33%), Manipur (75.46%) and Nagaland (75.31%).
- The Mangrove ecosystems are unique & rich in biodiversity and they provide numerous ecological services.
- Mangrove cover has been separately reported in the ISFR 2019 and the total mangrove cover in the country is 4,975 sq km.
- An increase of 54 sq Km in mangrove cover has been observed as compared to the previous assessment of 2017.
- Top three states showing mangrove cover increase are Gujarat (37 sq km) followed by Maharashtra (16 sq km) and Odisha (8 sq km).



- The total growing stock of India's forest and TOF is estimated 5,915.76 million come of which 4,273.47 million come is inside the forests and 1,642.29 million come outside.
- There is an increase of 93.38 million come of total growing stock, as compared to the previous assessment.
- Out of this the increase in growing stock, there is an increase of 55.08 million come inside the forests and 38.30 million come outside the forest areas.
- The extent of bamboo bearing area of the country has been estimated 16.00 million hectare.
- There is an increase of 0.32 million hectare in bamboo bearing area as compared to the last assessment of ISFR 2017.
- The total estimated green weight of bamboo culms is 278 million tonnes, slowly an increase of 88 million tonnes as compared to ISFR 2017.
- Under the current assessment the total carbon stock in country's forest is estimated 7,124.6 million tonnes and there an increase of 42.6 million tonnes in the carbon stock of country as compared to the last assessment of 2017.
- The annual increase in the carbon stock is 21.3 million tonnes, which is 78.2 million tonnes CO₂ eq.
- Wetlands within forest areas form important ecosystems and add richness to the biodiversity in forest areas, both of faunal and floral species. Due to importance of wetlands, FSI has carried out an exercise at the national level to identify wetlands of more than 1 ha within RFA.
- There are 62,466 wetlands covering 3.8% of the area within the RFA/GW of the country



Methodology

- In tune with the Government of India's vision of Digital India, FSI's assessment is largely based on digital data whether it is satellite data, vector boundaries of districts or data processing of field measurements.
- The report provides information on forest cover, tree cover, mangrove cover, growing stock inside and outside the forest areas, carbon stock in India's forests, Forest Types and Biodiversity, Forest Fire monitoring and forest cover in different slopes & altitudes.
- Special thematic information on forest cover such as hill, tribal districts, and north eastern region has also been given separately in the report.
- The biennial assessment of forest cover of the country using mid-resolution Satellite data is based on interpretation of LISS-III data from Indian Remote Sensing satellite data Resourcesat-II.
- This information provides inputs for various global level inventories, reports such as GHG Inventory, Growing Stock, Carbon Stock, Forest Reference Level (FRL) and international reporting to UNFCCC, targets under CCD, Global Forest Resource Assessment (GFRA) done by FAO for planning and scientific management of forests.
- For the first time, Ortho-rectified satellite data has been used for forest cover mapping due to its better positional accuracy as it removes effects of image perspective (tilt) and relief (terrain) and scale distortions in the image to represent features in its true positions for accurate measurement of distances, angles and areas.
- FSI, in a first ever attempt has carried out a rapid assessment of biodiversity for all the States and UTs (except two) and for all the sixteen Forest Type Groups as per Champion & Seth Classification (1968).

- Apart from the number of tree, shrub and herb species as observed in the survey, Shannon Wiener Index which gives species richness along with the relative abundance, has also been calculated for each forest type groups in each State & UT.
- FSI has carried out mapping of forest types of India as per the Champion & Seth Classification (1968), for the first time in the year 2011 based on the base line forest cover data of 2005.

Other Highlights

- A study to assess the dependence of the people living in close proximity to forests for their day to day needs like fuel wood, fodder, small timber and bamboo was undertaken by FSI.
- The present report also gives information on the fire prone forest areas of different severity classes, mapped in the grids of 5km x 5km based on the frequency of forest fires in the last 14 years that would enable the SFDs to manage and control forest fires effectively in the respective States.
- Non Timber Forest Produce (NTFP) are important source of livelihood for many tribal communities and villagers living in the proximity of forests.
- New information has been generated from the national forest inventory data about the top five NTFP species in each State & UT in terms of their availability in forests i.e. relative occurrence.
- Invasive species pose serious threat to the sustainable management of forests. Analysis of NFI data has been done for determining five major invasive species in each State & UT and also an estimate of area affected by them.
- The information given in the report would provide valuable information for policy, planning and sustainable management of forest and tree resources in the country.

India's Forests and Forest Resources in the World

- Global Forest Resource Assessment (FRA) done by FAO once in five years provides information about the forest resources of almost all the countries in the world.
- The latest report of GFRA has been released by FAO in the year 2015.
- Status of the top ten to twelve countries in respect of forest area, change in forest area, growing stock and forest carbon as per the GFRA 2015 are presented as follows.

Forest area for top ten countries in 2015

| S.No. | Country | Forest area (000 ha) | % of country area | % global forest area |
|--------------|----------------------------------|----------------------|-------------------|----------------------|
| 1. | Russian Federation | 8,14,931 | 48 | 20 |
| 2. | Brazil | 4,93,538 | 58 | 12 |
| 3. | Canada | 3,47,069 | 35 | 9 |
| 4. | USA | 3,10,095 | 32 | 8 |
| 5. | China | 2,08,321 | 22 | 5 |
| 6. | Democratic Republic of the Congo | 1,52,578 | 65 | 4 |
| 7. | Australia | 1,24,751 | 16 | 3 |
| 8. | Indonesia | 91,010 | 50 | 2 |
| 9. | Peru | 73,973 | 58 | 2 |
| 10. | India | 70,682 | 22 | 2 |
| Total | | 26,86,948 | | 67 |

Objectives of the Nation-Wide Forest Cover Mapping

- To monitor forest cover and changes therein at the National, State and District levels
- To generate information on forest cover in different density classes and changes therein
- To produce forest cover and other thematic maps derived from it for the whole country
- To provide primary base layer for assessment of different parameters including growing stock, forest carbon etc

- To provide information for international reporting

Limitations of the Forest Cover Mapping

- Since the resolution of the LISS III sensor data is 23.5 m, land cover features having a geometric dimension less than 23.5 m on the ground are not discernible.
- Considerable ground details may sometimes be obscured due to clouds and shadows. Such areas can be discerned to a certain extent with the help of collateral data and image processing techniques, but not always.
- Non-availability of appropriate season data sometimes puts constraints on the interpretation of the features owing to poor reflectance of data and phenological changes in forests.
- Occurrence of weeds like lantana in forest areas and agricultural crops like sugarcane, cotton, etc adjacent to forests, causes mixing of spectral signatures and often make precise forest cover delineation difficult.
- Young plantations and tree species with less chlorophyll or inadequate foliage, many a times are not discernable on satellite images due to inadequate reflectance.
- Haze and other atmospheric distortions pose difficulty in interpretation, especially in the coastal areas.

