



JK Chrome

JK Chrome | Employment Portal



Rated No.1 Job Application of India

Sarkari Naukri
Private Jobs
Employment News
Study Material
Notifications



JOBS



NOTIFICATIONS



G.K



STUDY MATERIAL



JK Chrome

jk chrome
Contains ads



www.jkchrome.com | Email : contact@jkchrome.com

ECOLOGY AND ECOSYSTEM



ECOLOGY AND ECOSYSTEM

TABLE OF CONTENT

1. Ecology
2. Ecosystem
3. Food chain, food web and ecological pyramid.
4. Biogeochemical cycles.
5. Ecosystem services.
6. Forest ecosystem
7. Grassland
8. Wetlands
9. Mangroves



ECOLOGY AND ECOSYSTEM

Man is an important part of the biotic component of the environment. Ecological approach to the study of **man-environment relationships** is based on the **basic principle of ecology** which is the study of **mutual interactions between organisms and physical environment** on the one hand and **interactions among the organism** on the other hand in a given ecosystem.

Ecological school considers man to be most skilled and intelligent, as the leader of all biota and steward of the earth. Therefore, the relationship of man with the natural environment should be **symbiotic and not exploitative or suppressive**. Ecological approach lays emphasis on **wise and restrained use** of natural resources, application of appropriate environmental management programmes, policies and strategies.

The ecological approach lays emphasis on **rational exploitation of resources and optimum utilization through recycling of resources**. Therefore, humans as sentient species have the obligation to ensure **sustainable development** where all the organisms are treated equally and live in harmony.

1. ECOLOGY

1.1 Meaning of Ecology:

Ecology, in a very simple term, is a **science** that studies the **interdependent, mutually reactive and interconnected relationships** between the organisms and their physical environment on the one hand and among the organisms on the other hand. The term '**ecology**' was first coined and used by the German biologist **Ernst Haeckel**.

Darwin's concept of the 'evolution of species' through natural selection involving interactions between biological species and habitat was the **key stone of the formulation of the idea of ecology**. The definition of ecology led to the development of **two approaches** to the study of ecology and its division into two branches:

1. **Autecology**: Ecological relations of individual species in a given ecosystem are studied.
2. **Synecology**: Study of plant communities in relation to their habitats of a given ecosystem.

1.2 Sub-division of Ecology:

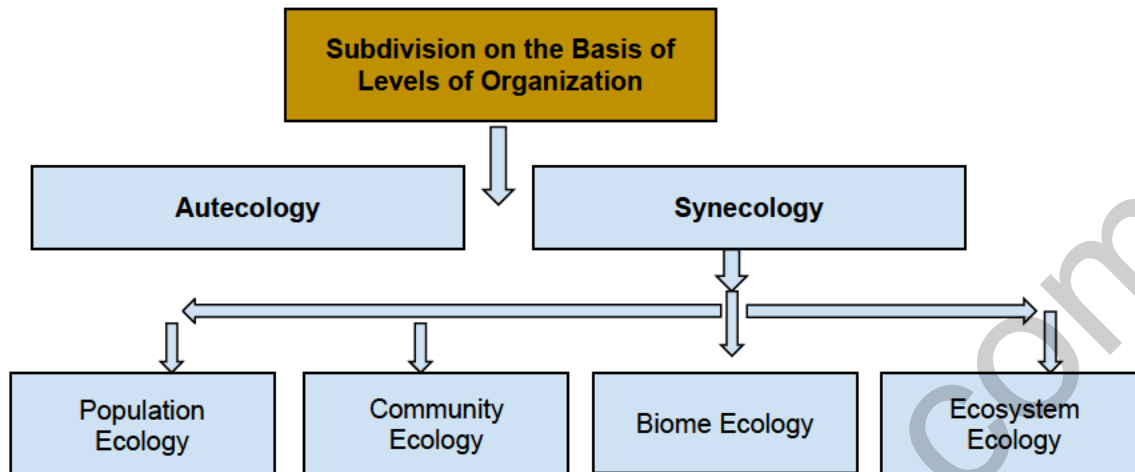
Sub-division based on taxonomic affinities:

- Plant Ecology
- Animal Ecology

Sub-division based on Habitat:

- Forest Ecology
- Grassland Ecology
- Freshwater Ecology
- Estuarine Ecology,
- Marine Ecology, etc.

Sub-division based on Basis of Levels of organization:



The *levels of organization* of biodiversity include ecosystems, species and genes.

- **ecosystem:** An ecosystem is a dynamic complex of plant, animal and microorganism communities and non-living (abiotic) elements, all interacting as a functional unit. An ecosystem's character changes as community members and physical contexts change, sometimes crossing a threshold of tolerance within the system that results in its inability to return to its previous form.
- **Species** are a complete, self-generating, unique ensemble of genetic variation, capable of interbreeding and producing fertile offspring. They (and their subspecies and populations) are generally considered to be the only self-replicating units of genetic diversity that can function independently.
- **Genes** are the working units of heredity; each gene is a segment of the DNA molecule that encodes a single enzyme or structural protein unit. Genetic diversity is the foundation of all biodiversity. Genetic variation permits populations to adapt to changing environments and continue to participate in life's processes.

1.3 Ecological Concepts and Principles:

There are certain basic principles that governs the various aspects of functioning of organisms.

- **Ecosystem is the basic fundamental unit** of ecological study because it comprises both biotic and abiotic components.
- At the largest scale, the whole biosphere becomes an ecosystem.
- Natural hazards adversely affect the biological communities.
- All living organisms and physical environment are mutually reactive.
- 'Nothing actually disappears when we throw it away' because all the materials are rearranged and cycled and recycled through a series of cyclic paths in the natural environment.
- Ecosystem functions through the input of energy mainly solar radiation. **R.L. Lindeman** has formulated principles about the relationship between trophic levels within a natural ecosystem.
 - **Principle 1:** As the distance between the organisms of a given trophic level and the initial source of energy (trophic level one) increases, the probability of the organisms to depend exclusively on the preceding trophic level for energy decreases.

- **Principle 2:** The relative loss of energy due to respiration is progressively greater to higher trophic levels because the species at higher trophic levels are relatively larger in size and have to move and work for getting food and therefore more energy is lost due to respiration.
 - **Principle 3:** Species at progressively higher trophic levels appear to be progressively more efficient in using their available food supply.
 - **Principle 4:** Organisms at higher trophic levels are 'generalists' in their feeding habit and they are most efficient in using their available food supply.
 - **Principle 5:** Food chains tend to be reasonably short. Because loss of energy is progressively higher for higher trophic levels and species at higher levels tends to be less discrete.
- The chemical (inorganic) and organic substances are circulated among the various components of the biosphere through a series of closed systems of cycles collectively known as 'biogeochemical cycles.'
 - The ecosystem productivity (referred to as the rate of growth of organic matter per unit time by autotrophs at trophic level one) depends on two factors:
 1. **Light:** The availability of the amount of solar radiation to the primary producers at trophic level one.
 2. **Photosynthesis ability:** The efficiency of plants to convert solar energy into chemical energy.
 - The 'normal' or 'uneventful' ecosystem attains its stability through 'homeostatic mechanisms' There is inbuilt self-regulating mechanism in a natural ecosystem through which any change caused by external factors in the ecosystem is counterbalanced by the responses of the ecosystem to the change in such a way that ultimately ecosystem or ecological stability is achieved.
 - The ecological concept of diversity/stability has been illustrated in the following manner:
 1. **Impact on food webs:** Increase in the diversity of food webs promote ecosystem stability because the increased food web diversity increases the resilience of the system to outside invasions of exotic organisms and reduced the fluctuations in the population within a given ecosystem. (C.S. Elton)

More complex food web is more stable: The ecosystem stability increases with increase of number of links in the food web because a large number of interacting feeding links provides alternative channels of energy flow and thus is generates a wide variety of adjustment of the population to environmental changes and stresses within the ecosystem. (P.H. MacArthur)

Role of succession: High species diversity of a mature ecosystem representing a 'climax community' is related to more stability of natural ecosystem because as the community succession operates, 'homeostasis' increases due to more protection available to the member of the community against external environmental change. (E.P. Odum)
 - Evolution of species epitomizes the inherently dynamic nature of ecosystem.
 - The concept and principle of succession are very important in ecology as there is successional development of species mainly vegetation communities.
 - Man, being an active agent of environmental change, modifies the ecosystem through the exploitation of natural resources.

- The ultimate goal of ecological study is to preserve ecological resources by maintaining the ecological diversity and ecosystem stability.



Figure: ecological concepts and principles.

1.4 Ecological Succession:

F.E. Clement postulated the concept of Vegetation/Ecological succession which is the process of change in the species structure of an ecological community over time.

- “It is the process of change in the species structure of an ecological community over time. This can done in a decades (for example, after a wildfire), or millions of years after a mass extinction.”
- Ecological succession is the phenomenon or process by which a community (animals/plants) undergoes more or less orderly and predictable changes following a disturbance or the initial colonization of a new habitat.

The development of vegetation community in any ecosystem or habitat is affected and controlled by:

1. Climate
2. Edaphic factors
3. Biotic factors
4. Physiographic factors
5. Fire factors

Phases of biotic succession:

Phases	
Nudation	Creation of bare area devoid of vegetation. Ex. Newly emerged volcanic island
Migration	Arrival of seeds in to the new bare area.
Ecesis	Seeds are germinated.
Reaction:	Competition between plants and physical environment.
Stabilization	Equilibrium condition of populations of plant species.

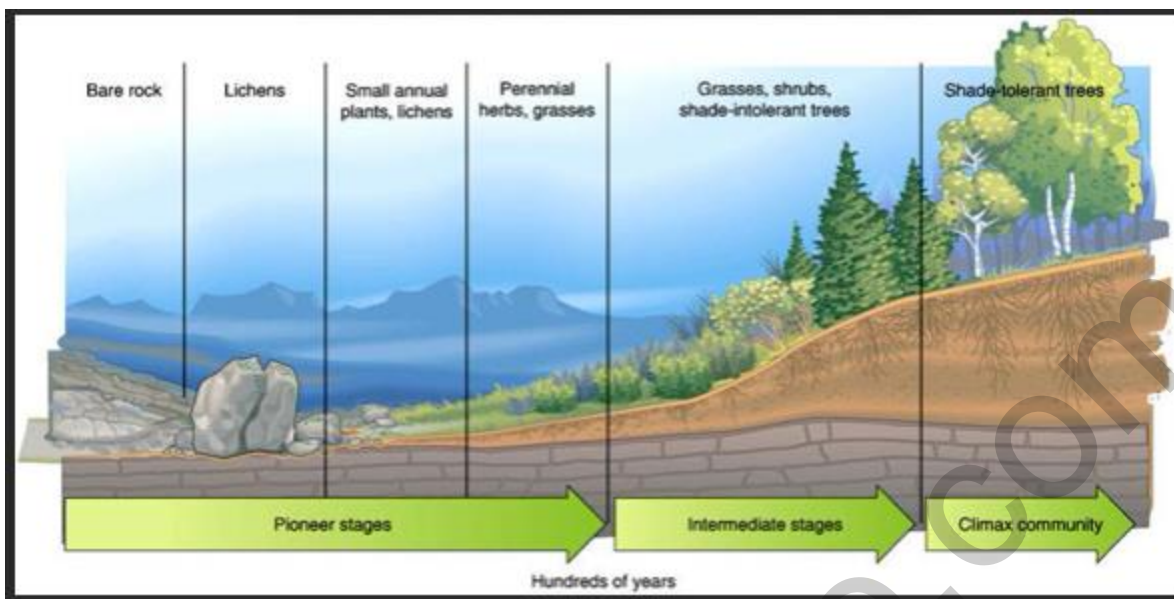


Figure: Stages in Ecological Succession

Characteristics of Ecological Succession:

1. It results from modification of the physical environment of the community. Ex. Development of pioneer species like algae and lichens on bare surface like Krakatoa Island, etc.
2. It is an orderly process of community development.
3. The time required for development of climax vegetation in secondary succession is much less than primary succession.
4. Nutrient variation determines the settlement of new community.
5. Deflected climax due to arresting factors like jhuming cultivation results in plagioclimax.
6. Ecological succession is disrupted in communities like Savanna, Chaparral, etc. by fire.
7. At climax vegetation:
 - Ecosystem is stable and self-perpetuating
 - Biomass increases to maximum
 - Net community production decreases
 - Food chain becomes highly complex changing to food web.

Types of Ecological Succession:

Clements has divided succession in two types:

1. **Primary Succession:** Primary succession refers to developmental sequence of vegetation in those bare areas where there were no vegetation and animals earlier. Ex. Newly emerged sea floor, island of Krakatoa, etc.
2. **Secondary Succession:** Secondary succession refers to the developmental sequences of vegetation in those areas which had vegetation earlier but now have been rendered nude due to destruction by:
 - Natural processes: Lava flow, forest fires, catastrophic floods, etc.
 - Anthropogenic processes: Jhuming cultivation, overgrazing, etc.

Primary Succession	<ul style="list-style-type: none"> ❖ The succession starts from an area where there was no previous living matter. ❖ Pioneer community - lichens produces lichen acids. These lichen acids wither the rock to form the sand. After the soil formation, the lichens are immediately replaced by the mosses.
Secondary Succession	<ul style="list-style-type: none"> ❖ Succession starts from a previously built-up substratum (already existing living matter). ❖ Abrupt changes like fire, snowfall, biotic interventions, cause the disappearance of the existing community. ❖ The area becomes devoid of any living matter due factors like fire or flood. Such areas will be rapidly acquired by new populations, and thus establish a new ecosystem. ❖ This process is a rapid process than the primary succession
Autogenic Succession	<ul style="list-style-type: none"> ❖ After the succession has begun, the communities itself modify its own environment and thus causing its own replacement. ❖ E.g. -collapse of an aquatic ecosystem due to algal bloom
Allogenic Succession	<ul style="list-style-type: none"> ❖ As the succession progresses, the organic matter and energy flow in the ecosystem increase
Heterotrophic Succession	<ul style="list-style-type: none"> ❖ This succession is characterized by an early dominance of heterotrophs such as fungi, bacteria, actinomycetes or animals. ❖ Heterotrophic succession usually starts from a nutrient rich organic environment ❖ As the succession progresses, the organic matter and energy flow in the ecosystem decrease
Hydrarch succession	<ul style="list-style-type: none"> ❖ An ecological succession began from an area where water is abundantly present (such as lake or big pond) is called hydrosere or hydrarch succession. ❖ Pioneer community : phytoplankton. ❖ Climax community: grassland or a forest.
Xerarch succession.	<ul style="list-style-type: none"> ❖ It is an ecological succession starting from an area where water content is very less such as a rock surface. ❖ Pioneer community - lichens
Micro succession	<ul style="list-style-type: none"> ❖ Microsere or is the succession of microorganisms such as bacteria and fungi in a micro habitat ❖ This is also called as Serule.

Climax Vegetation:

The vegetation community developed at the last stage of biotic succession is called climax vegetation which is indicative of a mature ecosystem wherein the dominant vegetation is in equilibrium with the environment.

At climax:

- Ecosystem is stable and self-perpetuating.
- Biomass increases to maximum.
- Net community production decreases.

- Food chain becomes highly complex changing to food web.

Plagioclimax Vegetation:

A Plagioclimax community is an area or habitat in which the influences of the humans have prevented the ecosystem from developing further.

- The ecosystem may have been stopped from reaching its full climatic climax or deflected towards a different climax by activities (arresting factors) such as: jhuming cultivation, large scale afforestation, overgrazing, etc. In each case, human activity has led to a community which is not the climax community expected in such an area.
- It is of two types:
 - a. **Arrested succession:** The natural succession would continue, if the arresting factors are removed. Ex. If cultivation is stopped in Gangetic plains and Great Plains of USA, normal sere of vegetation succession will start.
 - b. **Deflected succession:** Even if the interferences are removed, succession to the original climax community is no longer possible. Ex. Shola forest (Nilgiris), Sahara Desert, Thar Desert, etc.

Fire climax community:

Some landscape never reach a stable climax in the traditional sense because they are characterized by and adapted to periodic fire disruption. Ex. Savanna, chaparral of California, etc.

- **Characteristics of the plants:**
 - a. **Fastre-seeding:** They reseed quickly after fires. Thus, fast growth of ecosystem
 - b. **Least competition:** Many plants require fire to eliminate competition
 - c. To prepare seed-beds for **germination** or to open cones or thick seed coats.

Climax Theories:

Two school of thoughts developed:

One who believed climax

1. **Monoclimax theory:** Clement stated that regional climate is the dominant control factor of climax vegetation.
2. **Polyclimax theory:** Tansley believed in mosaic of climaxes due to fire, topography, climate, drainage, etc. According to this theory, plant community is not always in equilibrium with the climate of that habitat.

One who does not believed climax:

1. Whittaker argued that communities are constantly adjusting in response to the physical environment and therefore no absolute climax.
2. Gleason saw community history to be very unpredictable. He argued that species are individualistic and each getting established according to its ability to colonize and reproduce in an area.

It is perhaps more accurate to say that the rate of succession is so slow in a climax community that, from the perspective of a single human life time, it appears to be unchanging.

1.5 Ecological Niche:

- The term ecological niche was developed by Charles Elton.

- Ecological niche may be defined as ‘the functional role and position (micro-habitat) of species in its ecosystem, including what resources it uses, how and when it uses the resources, and how it interacts with other species.
- The ecosystem stability depends upon the diversity of niche. The greater the niche diversity, the more is ecosystem stability because of larger number of pathways for the flow of energy and less fluctuation of species population.
- Sometimes it becomes difficult for two species to inhabit the same niche. In such cases the ‘Law of Competitive Exclusion’ works.
- In such difficult situations, one species may adopt a few alternative paths i.e.
 - Either one species may migrate to new niche
 - May become extinct
 - May change physiological behaviour for the competition of same resources.
- The process of minimization of competition for resources is called ‘Resource Partition’ which can allow several species to utilize different parts of the same resource and coexist within a single habitat.
- Dominant species occupy extensive and broader ecological niche in comparison to less dominant species.

Types of niche:

Many species perform different functions in the same habitat:

1. Habitat niche—where it lives,
2. Food niche—what it eats or decomposes & what species it competes with,
3. Reproductive niche – how and when it reproduces,
4. Physical & chemical niche—temperature, land shape, land slope, humidity & another requirement.

The competitive exclusion principle: Two species cannot occupy the same ecological niche in a habitat if they are competing for the same resources. If one species is successful, it reduces the competition. If neither evolves to reduce competition, then the species that can more efficiently exploit the resource will win out, and the other species will eventually become extinct.

2. ECOSYSTEM

An ecosystem is a **community of living organisms in conjunction with the nonliving components** of their environment, **interacting as a system**. Its components are linked together through nutrient cycles and energy flows.

2.1 Components of an Ecosystem:

There are three major components of ecosystems:

1. Energy component
2. Abiotic or physical component
3. Biotic component

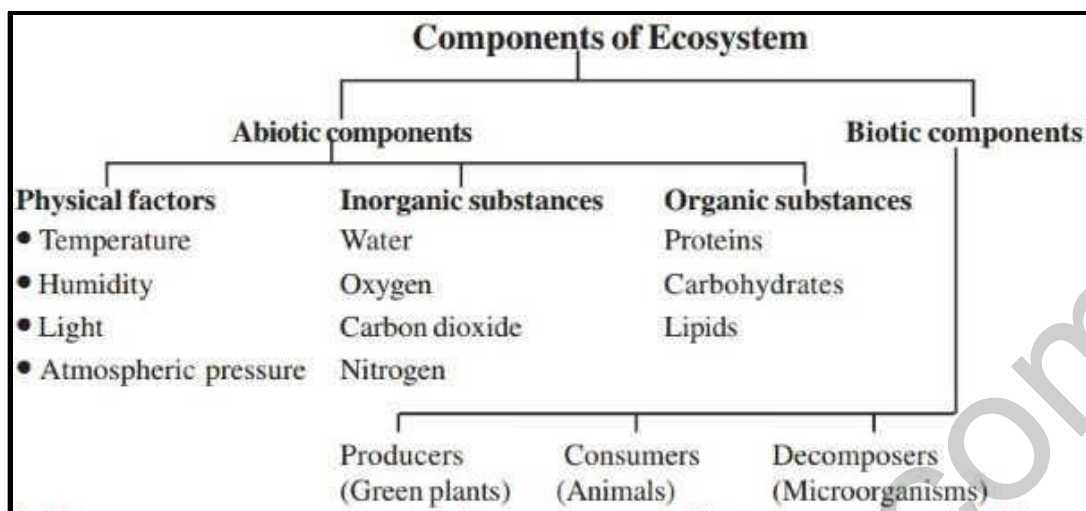


Figure: component of ecosystem

Biotic Components

Producers	<ul style="list-style-type: none"> Plants are the 'producers' in the ecosystem as they manufacture their food by using energy from the sun. In the forest these form communities of plant life. In the sea these include tiny algal forms to large seaweed.
Consumers	<ul style="list-style-type: none"> The herbivorous animals are primary consumers as they live on the producers. <ul style="list-style-type: none"> In a forest, these are the insects, amphibia, reptiles, birds and mammals. In the semiarid areas, there are species such as the chinkara or Indian gazelle. In the sea, there are small fish that live on algae and other plants. At a higher trophic level, there are carnivorous animals, or secondary consumers, which live on herbivorous animals. <ul style="list-style-type: none"> In our forests, the carnivorous animals are tigers, leopards, jackals, foxes and small wild cats. In the sea, carnivorous fish live on other fish and marine animals.
Decomposers	<ul style="list-style-type: none"> Decomposers or detritivores are a group of organisms consisting of small animals like worms, insects, bacteria and fungi, which break down dead organic material into smaller particles and finally into simpler substances that are used by plants as nutrition. Decomposition thus is a vital function in nature, as without this, all the nutrients would be tied up in dead matter and no new life could be produced.

2.2 Classification of Ecosystems:

- Ecosystems are divided into terrestrial or land-based ecosystems, and aquatic ecosystems in water.
- At a sub-global level, this is divided into biogeographical realms.

- Examples:
 - Eurasia called the Palaearctic realm;
 - South and South-East Asia (of which India forms a major part) is the Oriental realm;
 - North America is the Nearctic realm;
 - South America forms the Neotropical realm;
 - Africa the Ethiopian realm; and
 - Australia the Australian realm.
- **Natural ecosystems** include the forests, grasslands, deserts, and aquatic ecosystems such as ponds, rivers, lakes, and the sea.
- **Man modified ecosystems** include agricultural land and urban or industrial land use patterns.

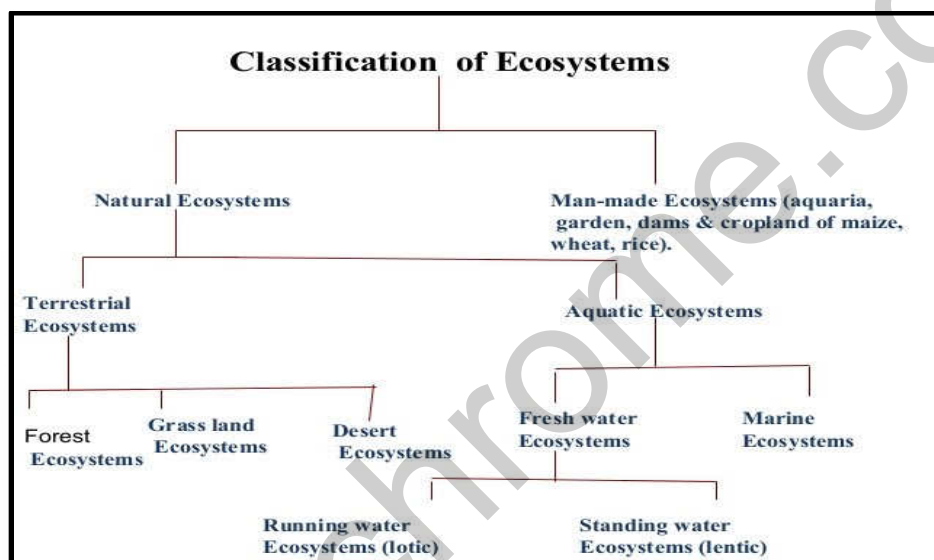


Figure: classification of ecosystem.

2.3 Functioning of Ecosystems:

- The functioning of an ecosystem depends upon the the pattern of energy flow as the living components of an ecosystem depend on energy flow which also helps in the distribution and circulation of organic and inorganic matter within the ecosystem.
- While the energy flow follows unidirectional path the circulation of matter follows cyclic paths.
- The energy pattern and flow are governed by first and second law of thermodynamics.
 - **Law 1:** In any system of constant mass, energy is neither created nor destroyed but it can be transformed from one type to another type.
 - **Law 2:** When work is done, energy is dissipated and the work is done when one form of energy is transformed into another form.

Energy Flow:

- Solar energy is the basic input of energy entering the ecosystem.
- Only a small proportion of radiant energy is used by plants to make food through the process of photosynthesis. The green plants convert solar energy into food/chemical energy.

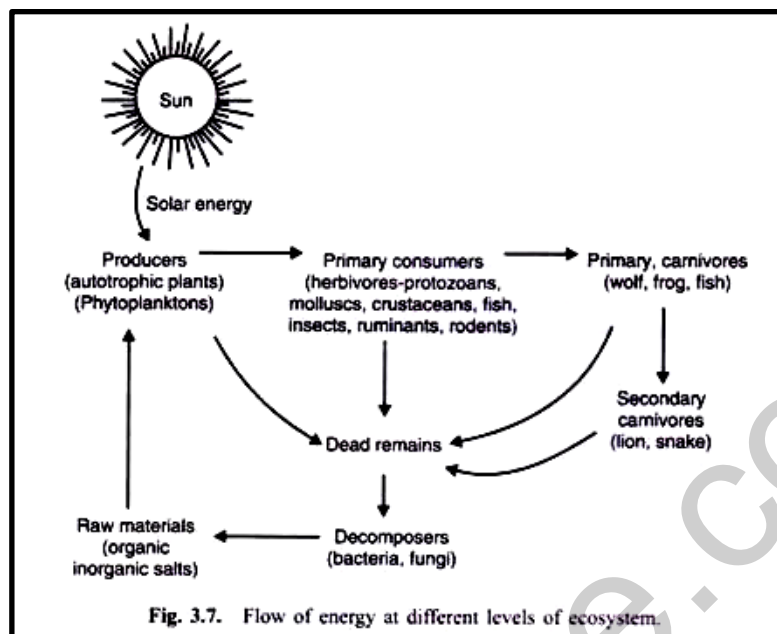


Fig. 3.7. Flow of energy at different levels of ecosystem.

- The chemical energy stored at trophic level one becomes the source of energy to the herbivorous animals at trophic level two of the food chain.
- Some portion of energy is lost from trophic level one through respiration and some portion is transferred to plant eating animals at trophic level two.
- A substantial portion of chemical energy is released by carnivores at trophic level three through respiration because more energy is required for the work to be done by carnivores at trophic level three.
- Some portion of potential chemical energy is transferred from trophic level three to trophic level four or top trophic level represented by omnivores. Some energy is released by omnivores through respiration.
- The remaining energy in the plants and animals is transferred to decomposers when they become dead.

Matter Flow:

- The circulation of elements or matter nutrients (organic and inorganic both) is made possible through energy flow.
- The organic and inorganic substances are moved reversibly in the biosphere, atmosphere, hydrosphere and lithosphere through various closed system of cycles in such a way that the total mass of these substances almost remains the same.
- The materials or nutrients involved within the circulation within an ecosystem are grouped into three categories:
 - **Micro-elements:** oxygen, carbon and hydrogen.
 - **Minor elements:** Nitrogen, phosphorous, potassium, calcium, magnesium and sulphur.
 - **Trace elements:** Iron, zinc, manganese and cobalt.
- Nutrients driven by energy flow pass into various components of biotic communities through the process known as 'biogeochemical cycles'.

2.4 Ecosystem Productivity:

The productivity of ecosystem refers to the rate of growth of energy or organic matter per unit time by autotrophs at trophic level one through the process of photosynthesis with the help of solar energy. Ecosystem Productivity depends upon:

- The availability of the amount of solar radiation to the primary producers at trophic level one.
- The efficiency of plants to convert solar energy into chemical energy.

Primary Production:

- The production of organic matter or energy by autotrophs.
- Primary production is measured in two ways:
- Net Primary Production: It excludes the amount of energy which is lost through respiration by the autotrophs. It represents the usable amount of energy at trophic level one, which is available to higher trophic levels.
- The ecosystem productivity whether gross or net is measured in gram/m²day or year

Secondary Production:

- Secondary production is the rate of generation of heterotrophic biomass, driven by the transfer of organic matter between trophic levels.

Biomass:

- It refers to the quantity or weight of living materials per unit area and is represented in terms of dry weight.

2.5 Difference between Ecology, Environment and Ecosystem:

- **Ecology** = the study of the ecosystems and the environment.
- **Environment** = a group of ecosystems.
- **Ecosystem** = a functional unit of environment (mostly biosphere).
- **Habitat** = Area where an organism lives.
- **Biosphere** = The region on earth that supports life.

3. FOOD CHAIN, FOOD WEB AND ECOLOGICAL PYRAMIDS

3.1 Food Chain:

- The **transfer of energy from the source in plants through a series of organisms by eating and being eaten constitutes food chains.**
- At each transfer, **a large proportion of energy is lost in the form of heat.**
- At each linkage in the chain, a major part of the energy from the food is lost for daily activities.
- Each chain usually has **only four to five such links.** However, **a single species may be linked to a large number of species.**
- **Why food chain:** The most obvious aspect of nature is that **energy must pass from one living organism to another.**
 - When herbivorous animals feed on plants, energy is transferred from plants to animals.

- **Detritus' food chain:** In an ecosystem, some of the animals feed on other living organisms, while some feed on dead organic matter. The latter form the 'detritus' food chain.

3.2 Food Web:

- These food chains are not isolated sequences, but are interconnected with each other. This interlocking pattern is known as the food web.
- Impact of human interference: If the linkages in the chains that make up the web of life are disrupted due to human activities that lead to the loss or extinction of species, the web breaks down.



The arrow points to the eater and shows the transfer of energy.

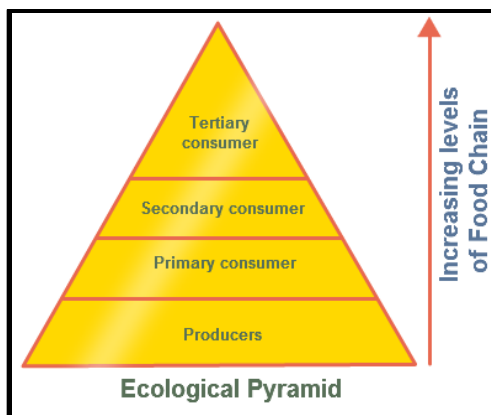
Figure: schematic representation of food web and food chain.

3.3 Ecological Pyramids:

- It is a graphic representation of the relationship between organisms at various trophic levels in a food chain.
- depicts the **number of organisms, biomass and productivity** at each trophic level.
- Basis of an ecological pyramid is = biomass, energy, and number.
- Concept of ecological pyramids = first introduced by Charles Elton, the pioneer British Ecologist.

Features:

- The bottom of an ecological pyramid is the broadest and is occupied by the **Producers**, which form the **first trophic level**.
- In a food chain, the producers are consumed by the primary consumers. In an ecological pyramid, the **next level is occupied by the primary consumers**.
- The next level of the pyramid is occupied by the **secondary consumers** and the last, by the **tertiary consumers**.



Types of Ecological Pyramids:

There are 3 types of ecological pyramids:

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

3.3.1 Pyramid of Number:

- It graphically represents the population (total number of individuals) present at each trophic level.
- This type of pyramid can have two different forms depending on the number of organisms: **upright and inverted**.
 - In an **upright pyramid of number**, the number of organisms generally decreases from the bottom to top. This generally occurs in grassland and pond ecosystems where the **plants** (usually the grasses) occupy the base of the pyramid. The succeeding levels of the pyramid include the consumers.
 - An **inverted pyramid of number** is just the opposite of the former. It is usually observed in tree ecosystems with the trees as the producers and the insects as consumers.
- Issues: Among the three types of ecological pyramids, the **pyramid of number is the least accurate** because it **does not take account the exact number of population** and therefore **cannot completely define the trophic structure in that ecosystem**.

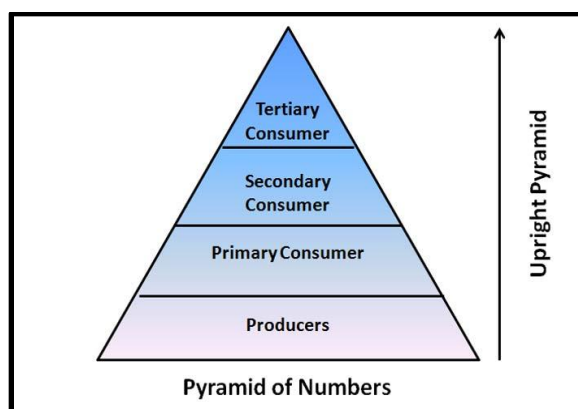


Figure: pyramid of number

3.3.2 Pyramid of Biomass:

- **Biomass** = it refers to the food available for the succeeding trophic level
 - the amount of biomass per unit area product of the living material present in an organism and the total number of organism's present) in a specific trophic level.
- A pyramid of biomass is a **depiction of the amount of food available and how much energy is being passed on at each trophic level.**
- Like the pyramid of numbers, the **pyramid of biomass can either have two forms: upright and inverted.**
- Examples:
 - terrestrial ecosystems = characterized by an upright pyramid of biomass having a larger base (primary producers) with the smaller trophic levels (consumers) located at the top.
 - Aquatic ecosystems = inverted structure of the pyramid; because the phytoplankton producers (with generally smaller biomass) are located at the base while the consumers having larger biomass are located at the top of the pyramid.

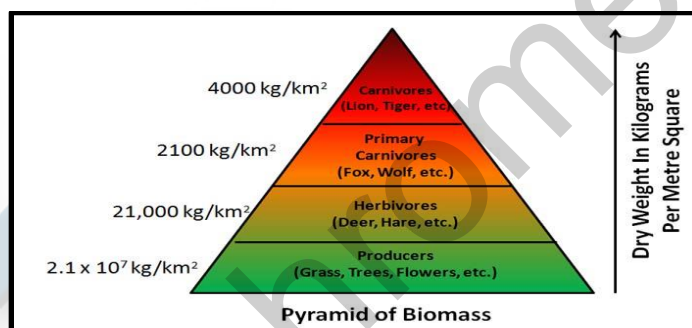


Figure: pyramid of number

3.3.3. Pyramid of Energy (PoE):

- It shows the **overall energy in the ecosystem and how much energy is required by organisms as it flows up the higher trophic levels.**
- The pattern of the energy flow in PoE is **based on the principles of thermodynamics** (energy is neither be created nor destroyed; only transformed into another form.)
- PoE shows that **energy is transferred from lower trophic levels with more amount of energy (producers) to higher ones (consumers) and converted in the biomass.**
 - Therefore, it can be concluded that **organisms found at the highest trophic levels of shorter food chains bear a greater amount of energy than the ones found in longer ones.**
- Unlike the first two ecological pyramids, the pyramid of energy is **always illustrated in an upright position, with the largest energy carriers at the base.**
- **Significance of PoE:** The idea of PoE is very crucial in the idea of **biological magnification** (tendency of toxic substances to increase in amount as we go up the trophic levels)

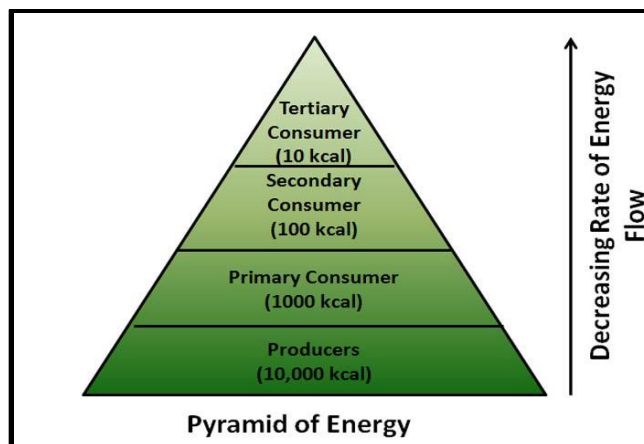


Figure: pyramid of energy

3.3.4 Limitations of Ecological Pyramids:

- These types of pyramids only are applicable in simple food chains (and not food webs), which do not necessarily occur naturally.
- They also do not consider the possible presence of the same species at different trophic levels.
- None of the three ecological pyramids provide any idea related to variations in seasons and climates.
- Other organisms like microorganisms and fungi are not given specific role in the pyramids despite their vital roles in ecosystems.

4. BIOGEOCHEMICAL CYCLES

- There is circulation of chemical nutrients like oxygen, carbon, nitrogen, phosphorus, calcium and water, etc. through the physical and biological world; between atmosphere, hydrosphere, lithosphere and biosphere. These cycles are known as biogeochemical cycles.
- These cycles are natural pathways of circulation of essential elements of life.
- For the survival of the major ecosystem, it is essential that all chemical elements make up the living cells must be recycled.
- As effect of these elements being recycled, in some cycles the elements get accumulated for a long period of time and form reservoirs like ocean or lake.
- Biogeochemical cycles are classed as in which the reservoirs are the air or the oceans via evaporation.

Important biogeochemical cycles includes:

- The Carbon cycle,
- The Nitrogen cycle,
- The Oxygen cycle,
- The Phosphorus cycle,
- The Sulfur cycle,
- The Water cycle,
- The Nutrient cycle and

- The Rock cycle.

Gaseous Cycle:

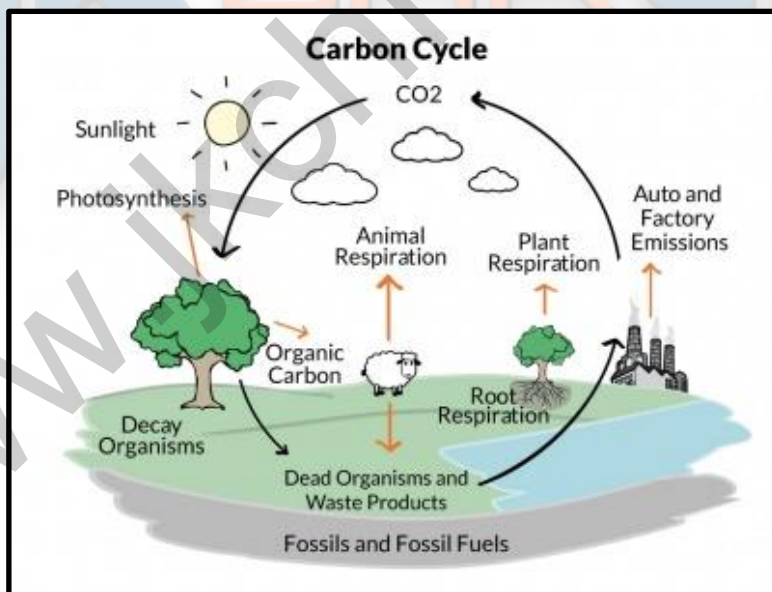
- It includes that of nitrogen, oxygen, carbon and water.
- They move rapidly and adjust more readily to the changes in the biosphere because of the large atmospheric reservoir.
- For example, accumulations of CO₂ are scattered by winds or are absorbed by plants.

Sedimentary Cycle:

- Sedimentary cycle **varies from one another, varies from one element to the other, each cycle consists of a solution and a rock or sediment phase.**
- Weathering of rocks releases minerals in the form of salts which dissolve in water and can pass through a series of organisms and can reach deep sea where they settle out of circulation indefinitely.
- Other salts settle as deposit as sediment and rock in shallow seas.

Carbon Cycle:

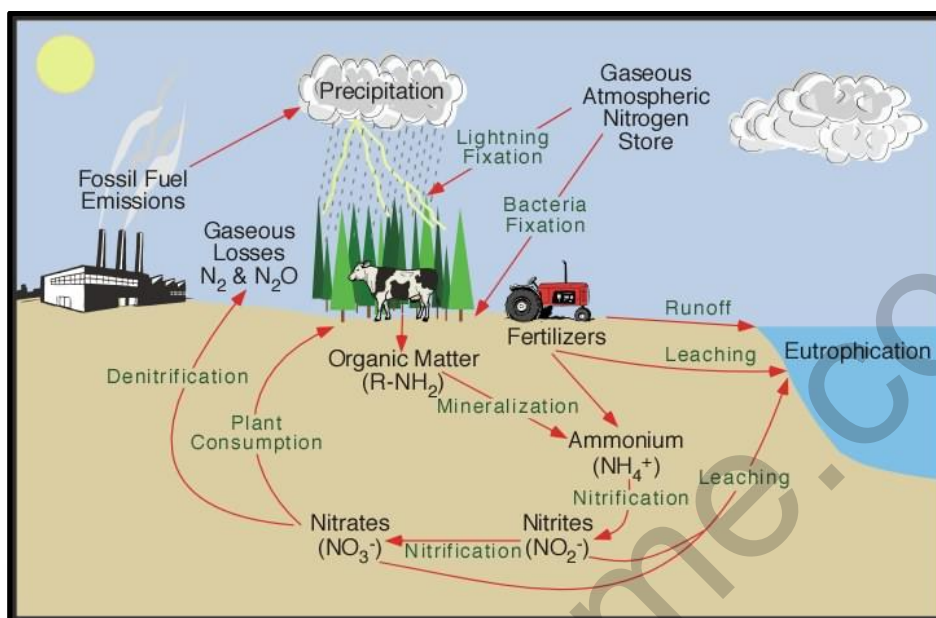
- It is a cycle where there is **exchange of carbon among all the spheres of the ecosystem.**
- It is the **balance of exchange of carbon between carbon reservoirs or between specific spheres; carbon is exchanged among the biosphere, hydrosphere, atmosphere, pedosphere and geosphere as a result of physical, biological, chemical, and geological processes.**



Nitrogen Cycle:

- It is the **transformation between its various chemical forms in both biological and physical processes.**
- Important processes of this cycle is **nitrogen fixation, ammonification, nitrification and denitrification.**

- Atmospheric nitrogen being the largest reservoir of nitrogen is available in limited amounts for biological use.

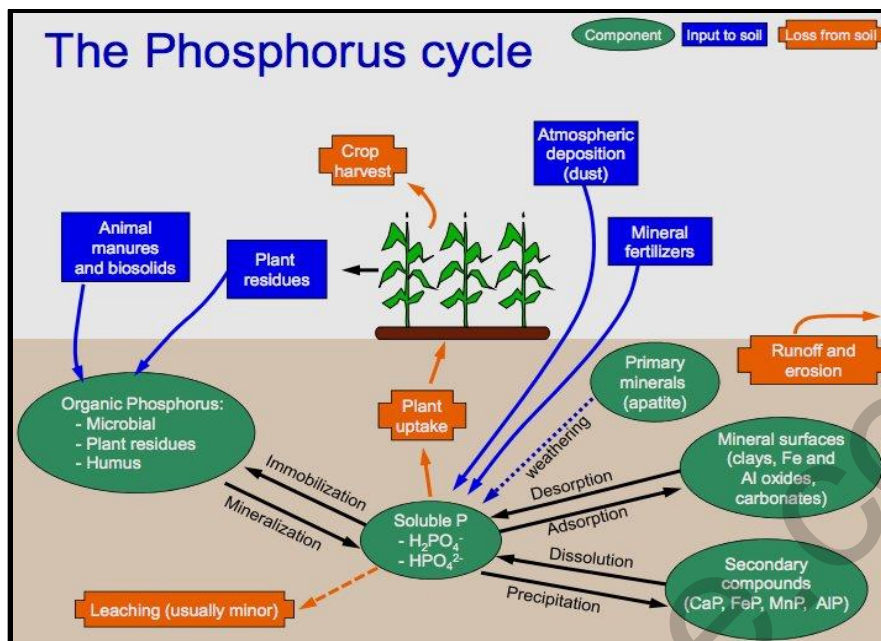


Oxygen Cycle:

- It describes the **movement of oxygen within the atmosphere, biosphere and the lithosphere.**
- Failures of occurrence of oxygen cycle in the hydrosphere => Creation of hypoxic zones.
- Photosynthesis = main factor for the oxygen cycle

Phosphorus Cycle:

- It is the **movement of phosphorus through the lithosphere, hydrosphere and biosphere.**
- In this cycle, the atmosphere does not play a significant role as **phosphorus and phosphorus-based compounds are usually solids at the typical range of temperatures of Earth.**
- Phosphorus has gradually become less available to plants as it is slowly lost in runoff.
- Phosphorus is essential for plant growth and microbial biomass.
- Microorganisms of the soil act as sink and source of phosphorus available in the biogeochemical cycle.

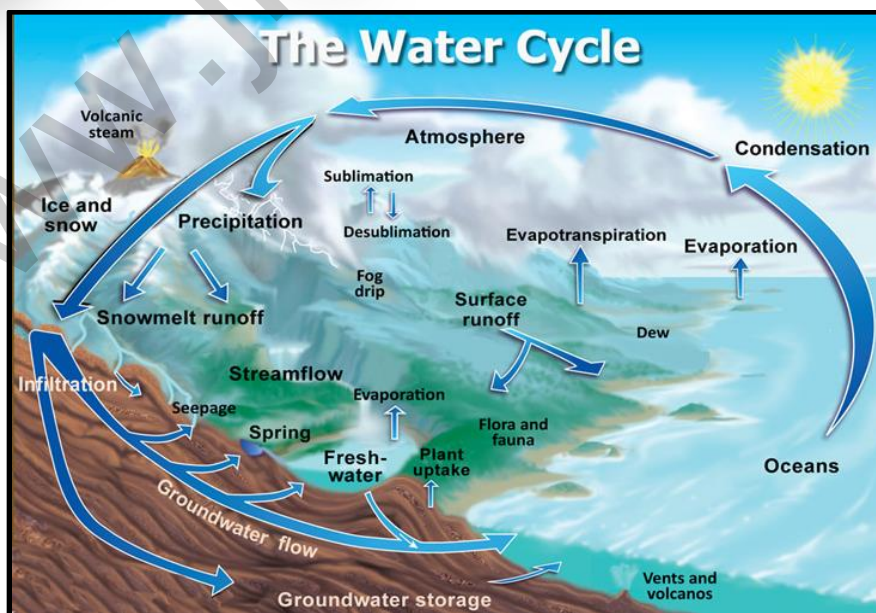


Sulphur Cycle:

- It is the group of processes through which sulphur moves to and from the mineral, waterways and the living systems.
- sulphur is constituent of many proteins and cofactors.

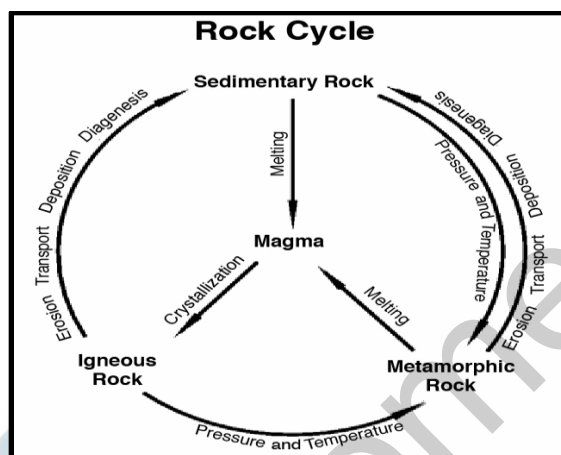
Water Cycle:

- It describes the continuous movement of water on, above, and below the surface of the Earth.
- Water moves from one reservoir to another by physical processes of evaporation, condensation, precipitation, infiltration, runoff and substrate flow.
- Through these processes water undergoes different phases like liquid, solid and gas.



Rock Cycle:

- It describes the dynamic transitions through geologic time among three main rock types sedimentary, metamorphic and igneous.
- In this cycle, each type of rocks is altered or destroyed when it is forced out of equilibrium conditions.
- Due to the forces of the rock cycle, tectonic plates, and water cycle; the rocks do not remain in equilibrium and are forced to change in their new environments.



Nutrient Cycle:

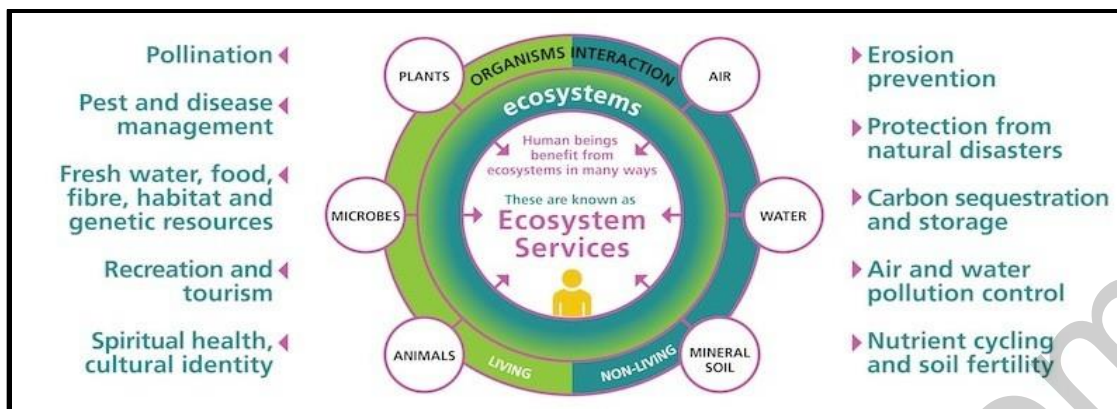
- The nutrient cycle is the movement and exchange of organic and inorganic matter back into the production of living matter.
- This process is regulated by food web pathways and decomposes matter into mineral nutrients.

5. ECOSYSTEM SERVICES

Economic services are the many benefits which society derives from **nature**. They include fresh water; fertile soil; wild plant resources such as foods, fibres, medicinal plants and the wild relatives of crops; wild pollinators and the natural enemies of crop pests; carbon sequestration from the atmosphere; and the important spiritual, aesthetic and recreational values of nature.

According to TEEB, ecosystem services can be categorized in four main types:

- (i) **Provisioning services** are the products obtained from ecosystems such as food, fresh water, wood, fiber, genetic resources and medicines.
- (ii) **Regulating services** are defined as the benefits obtained from the regulation of ecosystem processes such as climate regulation, natural hazard regulation, water purification and waste management, pollination or pest control.
- (iii) **Habitat services** highlight the importance of ecosystems to provide habitat for migratory species and to maintain the viability of gene-pools.
- (iv) **Cultural services** include non-material benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values.



5.1 Ecosystem goods and services:

Direct Values: These are resources that people depend upon directly and are easy to quantify in economic terms.

- a. **Consumptive Use Value**– Non-market value of fruit, fodder, firewood, etc. that are used by people who collect them from their surrounds.
- b. **Productive Use Value** - Commercial value of timber, fish, medicinal plants, etc. that people collect for sale.

Indirect Values: These are uses that do not have easy ways to quantify them in terms of a clearly definable price.

- a. **Non-consumptive use value** - scientific research, bird-watching, ecotourism, etc.
- b. **Option value** - maintaining options for the future, so that by preserving them one could reap economic benefits in the future.
- c. **Existence value** - ethical and emotional aspects of the existence of wildlife and nature

Examples of ecosystem services:

- **Climate regulation** - ecosystems play a vital role in climate regulation. Peat soils contain the largest single store of carbon and in boreal and cool temperate zones. However, the climate regulating function of peatlands depends on land use and intensification (such as drainage and conversion to agriculture)
- and is likely to have profound impacts on the soil capacity to store carbon and on carbon emissions (great quantities of carbon are being emitted from drained peatlands).
- **Water purification.** Both vegetation and soil organisms have profound impacts on water movements: vegetation is a major factor in controlling floods, water flows and quality; vegetation cover in upstream watersheds can affect quantity, quality and variability of water supply; soil micro-organisms are important in water purification; and soil invertebrates influence soil structure, decreasing surface runoff. Forests, wetlands and protected areas with dedicated management actions often provide clean water at a much lower cost than man-made substitutes like water treatment plants.
- **Pests and diseases** are regulated in ecosystems through the actions of predators and parasites as well as by the defence mechanisms of their prey. One example of these regulating services is provided by insectivorous birds in farms that use most of their land for agriculture.
- **Soil biodiversity** supports a range of provisioning services such as food, fiber and fuel provision and is fundamental to soil fertility, being a highly important ecosystem service in India. In addition, a diverse soil community will help prevent loss of crops due to soil-borne pest diseases.
- **Cultural services** provided by ecosystems are also very important to citizens. Evidence can be found in the scale of membership of conservation organizations. E.g. Chipko movement.

5.2 Case Study: Decline in Pollinators:

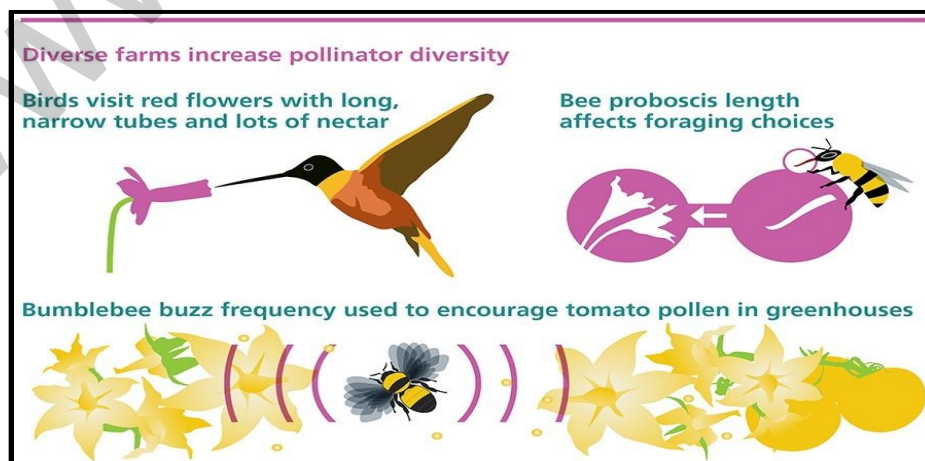
Context: Across India's agrarian plains, plantations and orchards, millions of birds, bats and insects toil to pollinate crops. However, many of these thousands of species may be in dangerous decline.

Pollination	<ul style="list-style-type: none"> ● It is the vital process in flowering plant reproduction ● It involves the transfer of pollen grains from the anther (or male part) to the stigma (or female part) of the same, or another plant of the same species. ● The fertilised egg cells grow into seeds which are then spread in the many fruits and vegetables that are eaten. ● This transfer of pollen can be done by the wind, birds, bats, mammals and insects. Most important of them are the honey bees that pollinate on a huge commercial scale.
Significance of Pollination:	<ul style="list-style-type: none"> ● Pollination is important for the food crops i.e. food security. ● It's also vital for the foraging crops, such as field beans and clover, used to feed the livestock. ● It maintains the genetic diversity of the flowering plants.
Significance of	In 2015, the Intergovernmental Science-Policy Platform on Biodiversity

<p>Pollination for India</p>	<p>and Ecosystem Services (IPBES) found that pollinators lead to huge agricultural economic gains.</p> <ul style="list-style-type: none"> ● Economic gain: The report estimated pollinator contribution in India to be \$0.831-1.5 billion annually for just six vegetable crops. ● Crop dependency: This is an underestimation considering that nearly 70% of tropical crop species are dependent on pollinators for optimal yields. ● Role of Wild pollinators: The wild pollinators now are declining, and their loss will imperil human food supply. Most of our staple food crops (wheat, rice, sorghum, barley and maize etc.) do not require animals for their pollination. However, wild pollinators play a very important role in the production of crops such as some pulses, sunflower seeds, cardamom, coffee, cashew nuts, oranges, mangoes and apples. ● Crop yield decreasing: In the Himalayas, apple yields in recent years have decreased. The decreases have been attributed to reduction in the number of bees, but the exact causes of low yields are not known. In North India, lowering yields of mustard cultivation may be caused by disappearing pollinators.
<p>Reason behind decline of Pollinators:</p>	<p>Anthropogenic Activities: The decline of moths, bees, butterflies, hoverflies and other pollinators is undeniably linked to</p> <p>A. Human activity:</p> <ol style="list-style-type: none"> a. monoculture: Large tracts of natural habitats have been cleared for monoculture cultivation b. use of chemicals: The use of pesticides and fertilisers is pushing out nature's little helpers. Native Indian bees, when exposed to multiple pesticides, suffer from memory and olfactory impairment, lower response rates, and oxidative stress which damages cells. <p>Case studies:</p> <ul style="list-style-type: none"> ■ Between 1964 and 2008, there was a 40-60% growth in relative yields of pollinator-dependent crops, while pollinator-independent crops such as cereals and potatoes saw a corresponding 140% rise in yields. ■ In Kashmir, researchers have pinned lowering yields of apple trees on the declining frequency of bee visits. In north India, lowering yields of mustard cultivation may be caused by disappearing pollinators. <ul style="list-style-type: none"> ● Researchers at the University of Virginia have discovered that air pollution from automobiles and power plants has been inhibiting the ability of pollinators such as bees and butterflies to find the fragrances

	<p>of flowers.</p> <p>B. Natural causes:</p> <ul style="list-style-type: none"> • Rapid transfer of parasites and diseases of pollinator species around the world • Changes in seasonal behaviour due to global warming: In 2014, the Intergovernmental Panel on Climate Change reported that bees, butterflies, and other pollinators faced increased risk of extinction because of global warming due to alterations in the seasonal behaviour of species. Climate change was causing bees to emerge at different times in the year when flowering plants were not available.
<p>Initiatives taken in India to control decline on Pollinators</p>	<ul style="list-style-type: none"> • Shape providing tree: Selected shade trees were planted on coffee and cardamom farms. The temperature control that these trees provide in April help to keep pollinators on-farm between flowering of coffee in March and the flowering of cardamom, which starts in May. • I-LTEO: The Ministry of Environment, Forests and Climate Change has recently launched a programme to establish a network of Indian Long-Term Ecological Observatories (I-LTEO) to monitor the country's ecosystems. The I- LTEO network offers tremendous opportunities to monitor wild pollinators <div style="border: 1px solid black; padding: 10px; text-align: center;"> <p><i>Schefflera venulosa</i> <i>Schefflera wallachiana</i></p> <p>Sequential flowering in plantations keeps pollinators on farm</p> <p>selected shade trees coffee cardamom</p> </div>
<p>International Initiatives to control decline on Pollinators</p>	<ul style="list-style-type: none"> • Pollinator Health Task Force: The U.S. has established a Pollinator Health Task Force (PHTS) and a national strategy that focuses on increasing the monarch butterfly population and planting native species and flowers in more than 28,000 sq. km to attract pollinators. • National Pollinator Strategy: developed by US. • Coalition of the Willing on Pollinators: After the IPBES report, almost 20 countries have joined this coalition. • Pollinators' Initiative by EU. This can provide pointers to India,

	<p>particularly as a policy of direct payment support to farmers to provide buffer strips for pollinators for nectar- and pollen-rich plants.</p>
<p>What needs to be done:</p>	<ul style="list-style-type: none"> • The IPBES report makes a number of recommendations to restore the integrity of pollinators: <ul style="list-style-type: none"> ○ improvements in the science of pollination, ○ strong regulations underlying pesticide use, and ○ restoration and protection of habitats for wild pollinators. • Promote organic farming • Landscape management <ul style="list-style-type: none"> ○ Adoption of The EU Pollinators' Initiative: a policy of direct payment support to farmers to provide buffer strips for pollinators for nectar- and pollen-rich plants. ○ India has millions of hectares of reserve forests, some of which have been converted to pulpwood plantations. • There is an urgent need for monitoring wild pollinators, and for strengthening the governance of natural assets. • Pollinators in urban areas can service and enhance food production in peri-urban areas. Wild biodiversity, including pollinators, must become a significant component of future 'smart cities'. • The IPBES assessment serves notice to government agencies that they must rethink conventional sectoral approaches and narrow disciplinary perspectives. • Pollinators have different tastes, physiologies, and are active at different times of the year. Birds typically visit red flowers with long, narrow tubes and lots of nectar, while bee proboscis length affects the type of foraging, they can do. Accounting for these differences by diversifying crops not only lead to increased agricultural yields: birds can act as natural pest control; bees produce honey; and the buzz frequency of bumblebees actually encourages tomato pollination.



- In general, for the country as a whole, **we have a very poor knowledge of the pollination systems of our animal pollinated crops, and how best we can manage the pollinators for optimal yields.** How are our wild and managed pollinators responding to ongoing loss and fragmentation of natural habitats? What are the effects of widespread pesticide use? Is climate change implicated in the spread of new diseases among honeybee colonies? We need ample research on these.

6. FOREST ECOSYSTEM

Forests are **formed by a community of plants** which is predominantly structurally defined by its trees, shrubs, climbers and ground cover. The forest ecosystem has two parts:

- The **non-living or abiotic aspects of the forest:** The type of forest depends upon the abiotic conditions at the site. Forests on mountains and hills differ from those along river valleys. Vegetation is specific to the amount of rainfall, the local temperature which varies according to latitude and altitude and the type of soil.
- The **living or the biotic aspects of the forest:** The plants and animals form communities that are specific to each forest type. The biotic component includes both the large (macrophytes) and the microscopic plants and animals.
 1. Plants include the trees, shrubs, climbers, grasses, and herbs in the forest. These include species that flower (angiosperms), and non-flowering species (gymnosperms) such as ferns, bryophytes, fungi and algae.
 2. The animals include species of mammals, birds, reptiles, amphibians, fish, insects and other invertebrates and a variety of microscopic animals.

6.1 Forest types in India:

- Forests in India can be broadly divided into **Coniferous forests** and **Broadleaved forests**.
- They can also be classified according to the nature of their tree species – **evergreen, deciduous, xerophytic or thorn trees, mangroves**, etc.
- They can also be classified according to the most abundant species of trees such as **Sal or Teak forests**.

Coniferous forests grow in the Himalayan mountain region, where the temperatures are low.

These forests have tall stately trees with **needle like leaves** and **downward sloping branches** so that the snow can slip off the branches. They have **cones instead of seeds** and are called **gymnosperms**.

Broadleaved forests have several types, such as evergreen forests, deciduous forests, thorn forests, and mangrove forests. Broadleaved forests have **large leaves of various shapes**.

Forest communities:			
Forest type	Plants Examples	Common Animal Examples	Rare Animal Examples
<i>Himalayan Coniferous</i>	Pine, deodar	Wild goats and sheep, Himalayan black bear.	Snow leopard, Hangul, Himalayan brown bear, Musk deer, Himalayan Wolf.
<i>Himalayan Broadleaved</i>	Maple, oak		
<i>Evergreen North-east, Western Ghats, Andaman & Nicobar</i>	Jamun, Ficus, Dipterocarpus	Tiger, Leopard, Sambar, Malabar whistling thrush, Malabar Pied hornbill, tree frogs.	Pigmy Hog, Rhino, Liontailed macaque
<i>Deciduous – Dry</i>	Teak, Ain, Terminalia	Tiger, Chital, Barking deer, Babblers, Flycatchers, Hornbills.	
<i>Moist</i>	Sal		
<i>Thorn and scrub, Semiarid forests</i>	Babul, Ber, Neem	Blackbuck, Chinkara, Fourhorned antelope, Partridge, Monitor lizard.	Wolf, Bustard, Florican, Bustards,
<i>Mangrove Delta Forests</i>	Avicenia	Crocodile, shorebirds – sandpipers, plovers, fish, crustacea.	Water monitor lizard.

6.2 What more need to be done for Conservation of forest ecosystems:

- **Controlled Deforestation:** While deforestation cannot be avoided completely, we must look to control it.
 - Young and immature trees should not be felled as far as possible.
 - avoid large-scale commercial deforestation
 - Adapting practices such as **clear-cutting or selective cutting**
- **Protect against Forest Fires:** Precautions must be taken.
 - Some of the fire suppression techniques are to **develop three-metre-wide five lanes around the periphery of the fire**, back fires, **arrangement of water spray, fire retardant chemicals** should be sprayed from back tank and if possible by helicopters.
 - **clearing out dry leaves and trees**
 - There must be a trained staff of firefighters to control the fire.
- **Reforestation and Afforestation:** any forested land which has been destroyed by fire or mining activities should be reforested. In rugged terrain **aerial seeding** is the method of choice.
 - Besides all this, fresh afforestation programmes should be started. **New plantations will not only increase the forest cover but also help in making up the eco-balance.**
 - For afforestation, **selection of trees should be done according to local geographical conditions**
- **Better Farming Practices:** Control Slash and burn farming, overgrazing by cattle, shifting agriculture
- The natural forests with all their diverse species must be protected as National Parks and Wildlife Sanctuaries where all the plants and animals can be preserved.
- **Check over Forest Clearance for Agricultural and Flabitation Purposes:**

- Most of the present-day agricultural land was once forested and then cleared for the use of agriculture. But now it has reached the stage where further clearance will be dangerous for the entire ecosystem.
- For the conservation of forest, this should be checked and an **alternative system should be suggested** to them.
- Similarly, for the development of villages, towns and cities, forest lands have been cleared and this process continues to this day causing loss of forest cover. This also should be checked and **green belts around cities should be developed**.
- **Protect from forest disease:** There are several forest diseases resulting from parasitic fungi, rusts, mistletoes, viruses and nematodes which cause the destruction of trees. The forests should be protected either by use of chemical spray, antibiotics or by development of disease resistant strains of trees.

7. GRASSLAND ECOSYSTEM

Characteristics of ecosystem

Grasslands are highly dynamic ecosystems that include **vegetation that is mainly dominated by grass or grass-like plants**.

- These can be **in the form of natural and semi-natural pastures, woodlands, scrub and steppe formations** (Intermediate areas between forests and deserts made up of small grasses).
- The UNESCO defines grassland as “land covered with herbaceous plants with less than 10 percent tree and shrub cover” and “wooded grassland as 10-40 percent tree and shrub cover”.

Formation of Grasslands	<ul style="list-style-type: none"> ● Grasslands cover areas where rainfall is usually low and/or the soil depth and quality is poor. ● The low rainfall prevents the growth of a large number of trees and shrubs, but is sufficient to support the growth of grass cover during the monsoon. ● Low rainfall can also trigger droughts and fires that prevent the development of dense forests but grasses can survive fires and heat and their stems can grow again from where they have been burnt off.
Seasonal events in Grassland Ecosystem	<ul style="list-style-type: none"> ● Many of the grasses and other small herbs become dry and the part above the ground dies during the summer months. ● In the next monsoon the grass cover grows back from the rootstock and the seeds of the previous year. This change gives grasslands a highly seasonal appearance with periods of increased growth followed by a dormant phase.
Evolution in Grassland Ecosystem	<ul style="list-style-type: none"> ● A variety of grasses, herbs, and several species of insects, birds and mammals have evolved so that they are adapted to these wide-open grass covered areas. ● These animals are able to live in conditions where food is plentiful after the rains, so that they can store this as fat that they use during the dry period when there is very little to eat. ● Man began to use these grasslands as pastures to feed his livestock when he began to domesticate animals and became a pastoralist in ancient times.

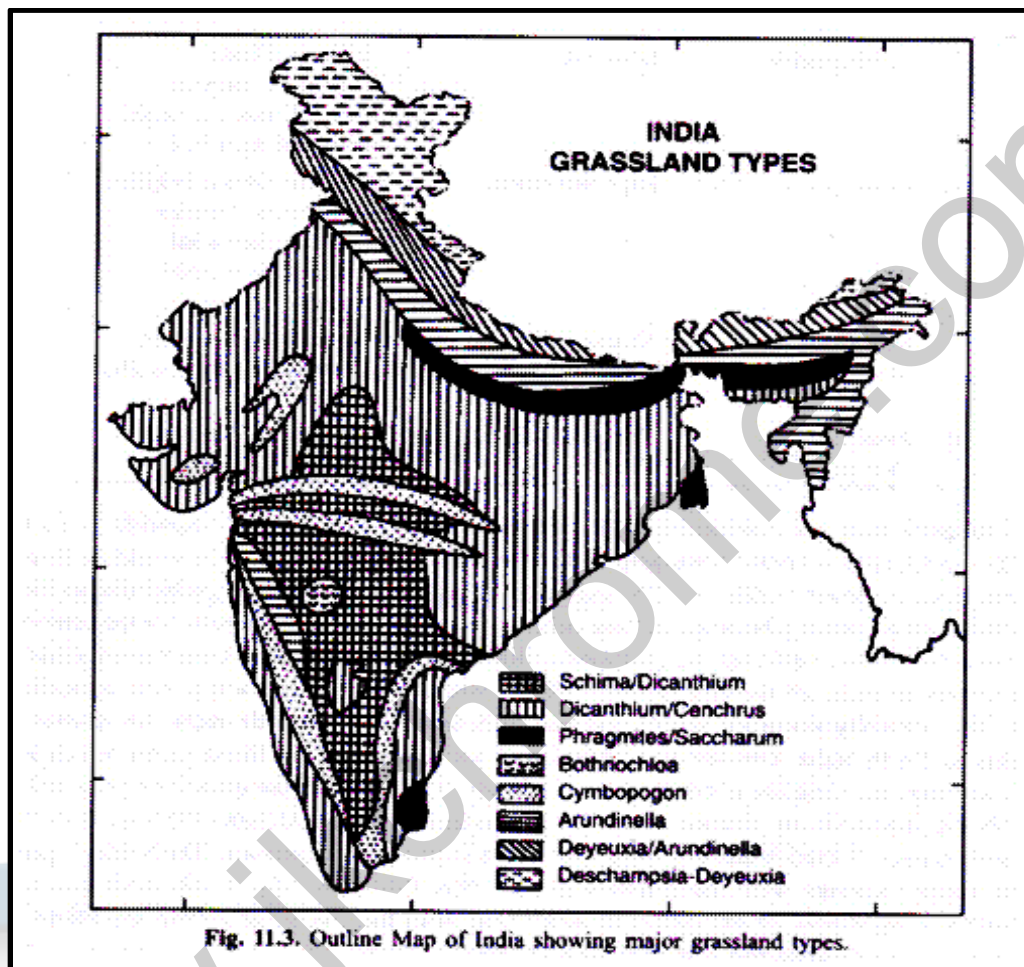
<p>Grasslands of the World</p>	<ul style="list-style-type: none"> ● Grasslands cover about 2/3rd of the landmass of the world and makeup about one-fourth of the earth's surface. Grasslands contain diverse types of grasses numbering to over 10,000 and about 12,000 species of legumes that often grow with grasses. ● Grasslands are usually divided into two categories— <ol style="list-style-type: none"> 1. Tropical (grasslands located near the equator such as those in Africa, southern Asia, Australia and northern South America) and 2. Temperate (grasslands located between the equator and the poles including those in North America, Europe, southern South America, Africa and Australia). ● Some of the typical grasslands found in the world include prairies, savannas, veldts, steppes, llanos, campos, downs, meadows, moors, pamir, pampas, pantanals, patanas, punas, pusztas, and sahel.
<p>Grassland Types in India</p>	<ul style="list-style-type: none"> ● Grasslands occupy nearly 24 percent of the geographical area in India. ● According to Rawat and Adhikari (2015), the major types of grasslands in India are <ul style="list-style-type: none"> ○ the alpine moist meadows of the Greater Himalayas; ○ alpine arid pastures or steppe formations of the trans Himalayas; ○ hillside grasslands in the mid-elevation ranges of the Himalayas; ○ 'Chauris' of the Himalayan foothills; 'Terai' grasslands on the Gangetic and the Brahmaputra floodplains; ○ 'Phumdis' or floating grasslands of Manipur; ○ 'Banni' and 'Vidis' of Gujarat; savannas of western and peninsular India; ○ plateau and valley grasslands in the Satpuras and Maikal hills; ○ dry grasslands of the Andhra Pradesh and Tamil Nadu plains and ○ 'Shola' grasslands of the Western Ghats.
<p>Significance of Grasslands</p>	<ul style="list-style-type: none"> ● Grasslands provide vital ecosystem services such as water and climate regulation that support agriculture, biogeochemical cycling, carbon storage, cultural and recreational services. ● Grasslands are important reservoirs of the crop gene pool and many of the crops like wheat, corn, rice and millets that support human survival have originated from grasslands. ● Grasslands also serve as a critical habitat for a range of plants and animals. ● Significance for the rural economy? <ul style="list-style-type: none"> ○ In India grazing-based livestock husbandry plays an important role in the rural economy. ○ Pasturelands over an area of 12 Mha constitute the main grazing resources that are available. ○ Nearly 30 pastoral communities in hilly or arid/semi-arid regions in the northern and western parts of India, as well as 20 in temperate/hilly regions, depend on grazing-based livestock production.

<p>Threats faced by Grasslands in India</p>	<p>Grassland ecosystems continue to be one of the most neglected ecosystems in the country and are increasingly under threat of being exploited and destroyed for economic gains or being treated as wastelands.</p> <p>Anthropogenic causes:</p> <ul style="list-style-type: none"> ● Many natural grasslands like wet grasslands of Terai and Shola grasslands of the Western Ghats, dry grasslands of Deccan are being converted to plantations even in Protected Areas (PAs). ● Anthropogenic pressures, land-filling, overgrazing, habitat destruction or fragmentation, uncontrolled growth of invasive species and climate change are further increasing the threat to grasslands. ● Overutilization and changes in land use of the ‘common grazing lands’ of rural communities has lead to their degradation. ● conversion of grasslands into irrigated farmlands. <ul style="list-style-type: none"> ○ Case study: In the Deccan, grasslands have been altered to irrigated farms and are now mainly used to grow sugarcane. After continuous irrigation such land becomes saline and useless in a few years. More recently many of these residual grassland tracts have been converted into industrial areas. This provides short-term economic gains but result in long-term economic and ecological losses. ● Grasslands have a limited ability to support domestic animals and wildlife. Increasing this pressure by increasing the number of domestic animals reduces the ‘naturalness’ of the grassland ecosystem leading to its degradation. <p>Natural causes:</p> <ul style="list-style-type: none"> ● Forest Fires: When fires are lit in the grasslands in summer, the burnt grass gets a fresh flush of small green shoots which the domestic animals graze on. If this is done too frequently the grasslands begin to deteriorate. Finally, grasslands become bare, the soil is solidly compacted by trampling, or is washed away during the monsoon by rain and whipped into dust storms during the hot dry summer. The land is degraded, as there is no grass to hold the soil in place. It becomes a wasteland.
<p>Government Initiatives for Regulation and protection of grasslands</p>	<ul style="list-style-type: none"> ● Although grasslands have an important role to play in the rural economy and biodiversity conservation, it is shocking to know that there is still no policy in place to protect grasslands. ● The Task Force Report on Grasslands and Deserts in 2006 submitted to the Planning Commission of India aptly describes the precarious situation the grasslands are in. It states, “Grasslands are not managed by the forest department whose interest lies mainly in trees; not by the agriculture department who are interested in agriculture crops; nor the veterinary department who are concerned with livestock but not the grass on which the livestock is dependent. The grasslands are the ‘common’ lands of the community and are the responsibility of none. They are the most productive

	ecosystems in the subcontinent but they belong to all, are controlled by none, and they have no godfathers.”
<p>What needs to be done to protect Grassland Ecosystem?</p>	<ul style="list-style-type: none"> ● Grassland as critical habitats was first recognised by the National Forest Commission in 2003 and recommended protection of grasslands to protect wildlife and livestock by developing a centrally coordinated and funded scheme. ● The need for a policy on grasslands was identified in the Report of the Task Force on Grasslands and Deserts submitted in 2006 to the Planning Commission of India. The report had suggested special schemes for the conservation of grasslands and made the following recommendations: <ul style="list-style-type: none"> ○ Formulate a National Grazing Policy to ensure the sustainable use of grasslands and biodiversity conservation. ○ Modifications in the Environment Impact Assessment (EIA) guidelines to include grasslands and deserts into ecologically-fragile and environmentally-sensitive areas. ○ Start Integrated Research and Development Programmes in the grasslands to understand the impact of climate change and land use practices on grasslands. ○ Include grasslands and desert ecosystems in Protected Area system. ○ Start a separate division or section to look after grasslands issues. ● Experts feel that a good start would be to update this report and work on its recommendations on an urgent basis. ● Grasslands should not be overgrazed and areas of the grasslands should be closed for grazing. <ul style="list-style-type: none"> ○ It is better to collect grass for stall feeding cattle. ○ A part of the grassland in an area must be closed every year so that a rotational grazing pattern is established. ● Fires must be prevented and rapidly controlled. In hilly areas soil and water management in each micro-catchment helps grasslands to return to a natural highly productive ecosystem. ● To protect the most natural undisturbed grassland ecosystems, Sanctuaries and National Parks must be created. <ul style="list-style-type: none"> ○ Their management should focus on preserving all their unique species of plants and animals. ○ Thus, they should not be converted into plantations of trees. ○ The open grassland is the habitat of its specialised fauna. Planting trees in these areas reduces the natural features of this ecosystem resulting in the destruction of this unique habitat for wildlife. ● We need to create an awareness among people that grasslands are of great value. If we are all concerned about our disappearing grasslands and their wonderful wildlife, the Government will be motivated to protect them.

Location of Grasslands in India:

- Grasslands in India are located in different climatic conditions ranging from near desert conditions, to patches of shola grasslands that occur on hillslopes alongside the extremely moist evergreen forests in South India.



The grasses are successful invaders and are capable of colonization in various habitats due to their following adaptabilities:

- They can grow in both hydrophytic and xerophytic habitats
- Many of the grasses show xeromorphic adaptations
- Their life span is from annual to perennial
- Habit varies from trailing to erect
- Size varies from small to dendroid
- Meristematic activity both apical and intercalary.
- Superficial rooting habit
- High reproductive capacity and capability for both sexual and vegetative reproduction
- They produce light seeds which are easily and quickly dispersed by wind and animals
- Grasses can withstand trampling. Grazing and fire
- Grasses have wide ecological amplitudes

12. Grasses tolerate poor growth conditions
13. They can act as pioneer colonizer in Primary and Secondary successions

8. WETLAND ECOSYSTEM

- A wetland is a place **where the land is covered by water, either salt, fresh or somewhere in between.**
- Wetlands = land area where **soil is saturated with moisture either permanently or seasonally**
- Examples of wetlands: **all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatland, oases, estuaries, delta at the mouth of a river and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans.**
- Wetlands are **transition zones between terrestrial and aquatic ecosystems.** Eg.
 - Mangroves,
 - Lake littorals (marginal areas between highest and lowest water level of the lakes)
 - Floodplains (areas lying adjacent to river channels beyond the natural levees and periodically flooded during high discharge in the river) etc.

8.1 Significance/Functions of Wetlands:

- Mitigation effect : they **acts as carbon sinks.**
- **Water Filtration:** Wetlands aid in water filtration by removing excess nutrients, slowing the water allowing particulates to settle out of the water which can then be absorbed into plant roots.
 - Studies have shown that **up to 92% of phosphorus and 95% of nitrogen can be removed from passing water through a wetland.**
 - Wetlands also **let pollutants settle and stick to soil particles**, up to 70% of sediments in runoff.
 - **Some wetland plants have even been found with accumulations of heavy metals** more than 100,000 times that of the surrounding waters' concentration.
 - Wetlands can even **filter out and absorb harmful bacteria from the water.** Their complex food chain hosts various microbes and bacteria, which invertebrates feed on. These invertebrates can filter up to 90% of bacteria out of the water this way.
- **Water Storage:** Wetlands can store approximately 1-1.5 million gallons of floodwater per acre.
 - By storing and slowing water, wetlands **allow groundwater to be recharged.**
 - And combining the ability of wetlands to **store and slow down water with their ability to filter out sediments**, wetlands serve as strong erosion buffers.
- **Biological Productivity**
 - Through wetlands ability to absorb nutrients, they are able to be **highly biologically productive (able to produce biomass quickly).**
 - Freshwater wetlands are even comparable to tropical rainforests in plant productivity. Their ability to efficiently create biomass may become important to the **development of alternative energy sources.**

- **Wetland as habitat**
 - Wetlands **support a vast and intricate food web** the wetlands are important wildlife habitats. Many species are dependent upon wetlands.
 - They often **support high concentrations of animals**—including mammals, birds, fish and invertebrates—and **serve as nurseries for many of these species**.

Significance for Human:

- Without wetlands, cities have to spend more money to treat water for their citizens, floods are more devastating to nearby communities, storm surges from hurricanes can penetrate farther inland, animals are displaced or die out, and food supplies are disrupted, along with livelihoods.

8.2 Functions, Related Effects of Functions, Corresponding Societal Values, and Relevant Indicators of Functions for Wetlands

<i>Hydrologic Function</i>	<i>Effects</i>	<i>Societal Value</i>	<i>Indicator</i>
Short-term surface water storage	Reduced downstream flood peaks	Reduced damage from floodwaters	Presence of floodplain along river corridor
Long-term surface water storage	Maintenance of base flows, seasonal flow distribution	Maintenance of fish habitat during dry periods	Topographic relief on floodplain
Maintenance of high-water table	Maintenance of hydrophytic community	Maintenance of biodiversity	Presence of hydrophytes

<i>Biogeochemical Function</i>	<i>Effects</i>	<i>Societal Value</i>	<i>Indicator</i>
Transformation, cycling of elements	Maintenance of nutrient stocks within wetland	Wood production	Tree growth
Retention, removal of dissolved substances	Reduced transport of nutrients downstream	Maintenance of water quality	Nutrient outflow lower than inflow
Accumulation of peat	Retention of nutrients, metals, other substances	Maintenance of water quality	Increase in depth of peat
Accumulation of inorganic sediments	Retention of sediments, some nutrients	Maintenance of water quality	Increase in depth of sediment

<i>Habitat and Food Web Support Function</i>	<i>Effects</i>	<i>Societal Value</i>	<i>Indicator</i>
Maintenance of characteristic plant communities	Food, nesting, cover for animals	Support for furbearers, waterfowl	Mature wetland vegetation
Maintenance of characteristic energy flow	Support for populations of vertebrates	Maintenance of biodiversity	High diversity of vertebrates

8.3 Threats faced by Wetlands:

Anthropogenic causes

- Pollutants:** Excessive wastes (Industrial effluents, domestic waste, agricultural runoff etc.) are dumped into wetlands beyond the recycling capacity.
- Reservoirs:** Dams alter the natural flow of water and impact on existing ecosystems.
- Farming:** Conversion of wetlands for agriculture
- Illegal practices: Encroachment** by public and mafia.
- Overfishing and fish farming** (Aquaculture).
- Overgrazing in marshy soils.
- Removal of sand from beds near seas make the wetland vulnerable to wave action and tidal bore.

Natural causes:

- Climate change:** Increases in temperature are causing polar ice to melt and sea levels to rise. This in turn is leading to
- Rising water level:** Shallow wetlands being swamped and some species of mangrove trees being submerged and drowned.
- Drought:** wetlands - estuaries, floodplains, and marshes - are being destroyed through drought.
- erosion and inundation from sea level rise and storms.
- Estuarine wetlands typically protect the coastline from erosion and flooding, but if sea level increases and development prevent inland migration of wetlands, more wetlands will be converted to open water.

8.4 Government Initiatives to Protect Wetlands:

National Wetland Conservation Programme (NWCP)

- Under the programme 115 wetlands have been identified till now by the Ministry which requires urgent conservation and management initiatives.
- **Aim of the Scheme:** Conservation and wise use of wetlands in the country so as to prevent their further degradation.
- **Objectives of the Scheme**
 - to lay down policy guidelines for conservation and management of wetlands in the country;
 - to undertake intensive conservation measures in priority wetlands;
 - to monitor implementation of the programme; and
 - to prepare an inventory of Indian wetlands.

- **Conservation and management of wetlands is primarily vested with the State/UTs, who are in physical possession of the area.**
- **After identification of wetlands under the Scheme, the State/UTs are to submit long-term comprehensive Management Action Plans (MAPs) for a period of 3-5 years, preferably 5 years, coinciding with the Plan period.**
- **The State Governments are advised to define objectives taking into consideration factors responsible for degradation of the wetland.**
- **The MAP should also have short-term objectives to cater to immediate problems confronting wetlands and to go in for immediate rectification measures.**
- **Under the Scheme, Ministry also sponsor multidisciplinary research projects by academic/managerial/ research institutions on various aspects of wetland conservation to supplement execution of MAP in more realistic manner.**

Ramsar Convention on Wetland:

- **The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.**
- **There are presently 158 Contracting Parties to the Convention, with 1758 wetland sites, totaling 161 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.**
- **Ramsar Convention is the only global environment treaty dealing with a particular ecosystem.**
- **In addition, many wetlands are international systems lying across the boundaries of two or more countries, or are part of river basins that include more than one country.**
- **Major obligations of countries which are party to the Convention are:**
 - **Designate wetlands for inclusion in the List of Wetlands of International Importance.**
 - **Promote, as far as possible, the wise use of wetlands in their territory.**
 - **Promote international cooperation especially with regard to transboundary wetlands, shared water systems, and shared species.**
 - **Create wetland reserves.**

Montreux Record:

- **Montreux Record under the Convention is a register of wetland sites on the List of Wetlands of International Importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference.**
- **It is maintained as part of the Ramsar List.**
- **The Montreux Record is employed to identify priority sites for positive national and international conservation attention.**
- **Sites may be added to and removed from the Record only with the approval of the Contracting Parties in which they lie.**

Wetlands (Conservation and Management) Rules, 2017:

Notified by Ministry of Environment, Forests and Climate Change

Salient Features:

- Scope: The rules apply to:
 - wetlands categorised as “wetlands of international importance” under the Ramsar Convention.
 - wetlands as notified by the central and state governments and UT administration.
- Fact: There are at least 115 wetlands that are officially identified by the central government and of those 26 are identified as wetlands of international importance under Ramsar Convention which is an international intergovernmental treaty for conservation of wetlands.
- **Definition of wetland** : Wetlands are defined as an area of marsh, fen, peatland or water.
 - It could be natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt.
 - It includes areas of marine water the depth of which at low tide does not exceed six metres.
- **State Wetlands Authority (SWA):** The new rules stipulate **setting up of a State Wetlands Authority in each State and union territories** that will be **headed by the State’s environment minister** and **include a range of government officials**.
 - They will also include one expert each in the fields of wetland ecology, hydrology, fisheries, landscape planning and socioeconomics to be nominated by the state government.
 - These authorities will need to
 - **develop a comprehensive list of activities to be regulated and permitted within the notified wetlands and their zone of influence, recommend additional prohibited activities for specific wetlands,**
 - **define strategies for conservation and wise use of wetlands, and**
 - **undertake measures for enhancing awareness within stakeholders and local communities on values and functions of wetlands.**
 - **Wise use is defined as the principle of sustainable uses that is compatible with conservation.**
- It is up to the states to decide which wetlands are to be notified.
- Under the new rules, the **powers have been given to the State governments so that protection and conservation work can be done at the local level**. Central government has mainly retained powers regarding monitoring.
- **National Wetlands Committee (NWC):**
 - The rules stipulates for setting up of NWC, headed by MoEFCC Secretary, **to monitor implementation of these rules and oversee work carried out by States.**
 - NCW will also advise Central Government on appropriate policies and action programmes for conservation and wise use of wetlands, recommend designation of wetlands of international importance under Ramsar Convention, advise on collaboration with international agencies on issues related to wetlands etc.
- **Digital inventory of all wetlands:** It is mandatory for **state authorities to prepare list of all wetlands and list of wetlands** to be notified within six months.
 - Based on it, a comprehensive digital inventory of all wetlands will be created and will be updated every ten years.

- **Restrictions:**
 - The rules **prohibit activities like conversion of wetland for non-wetland uses including encroachment of any kind, setting up of any industry and expansion of existing industries, manufacture or handling or storage or disposal of hazardous substances and construction and demolition waste**, solid waste dumping, discharge of untreated wastes and effluents from industries, cities, towns, villages and other human settlements.

Criticism of the Rules: Environmental experts pointed out that

- **Not comprehensive in the context of definitions:** The 2010 Rules included in the definition of wetlands, all inland waters such as lakes, reservoir, tanks, backwaters, lagoon, creeks, estuaries, etc. It also included man-made wetland and the zone of direct influence on wetlands.
 - However, the **2017 Rules are not as comprehensive** as the 2010 rules.
 - It **does not include**
 - **river channels, paddy fields, human-made water bodies/tanks specifically for drinking water purposes, aquaculture, salt production, recreation and irrigation purposes.**
 - **wetlands under forest and coastal regulation zones.**
- Provisions like “central government may consider proposals from the state government or union territory administration for **omitting any of the (prohibited) activities on the recommendation of the authority**” in the new rules can be misused.
- The term ‘**wise use**’ is subjective and could dilute the earlier restrictions.
- There is **no timeline specified for phasing out solid waste and untreated waste from being dumped into wetlands.**
- The restrictions on “any other activity likely to have an adverse impact on the ecosystem of the wetland” are not specified clearly in the Rules.
- As per the 2010 version of the rules, there was a Central Wetlands Regulatory Authority (CWRA) which will now be replaced by a national committee.
- Another major objection is about the **process of appeal against the decisions of wetland authorities.** According to the 2010 rules, anyone aggrieved with the CWRA’s decisions could have filed an appeal with the National Green Tribunal, but the **new 2017 rules are silent on the appeal process.**
- At the outset, the **identification process by the State Wetland Authority does not distinguish between existing wetlands and especially those past wetlands which have been encroached and can be proved through legal documents.** It also **does not take into account the Jagpal Singh judgment of Justice Katju for restoration of encroached wetlands throughout the country.**

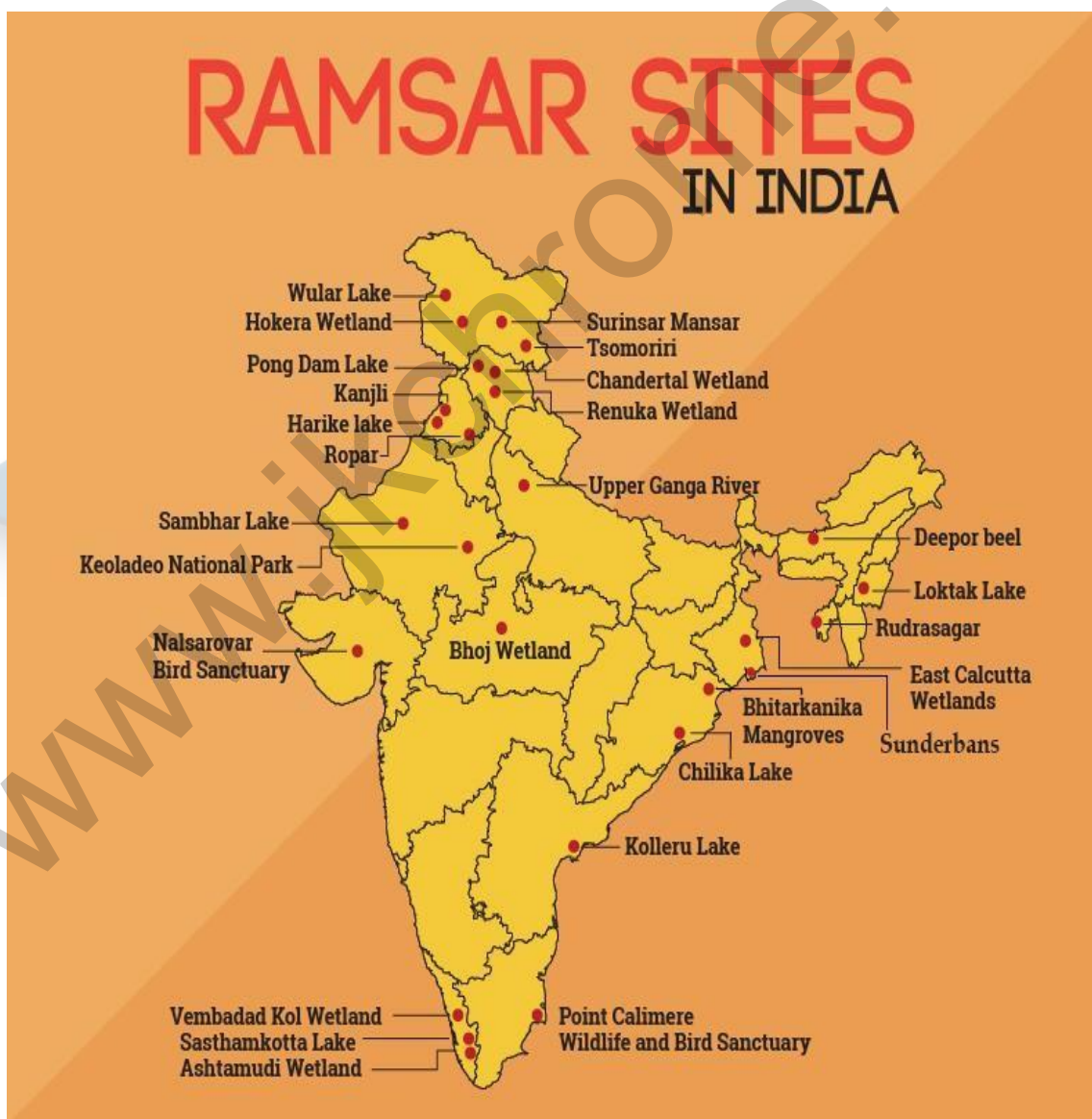
8.5 Wetland Ecosystem and India State of Forest Report (ISFR) 2017

- Forests play a vital role in water conservation and improve the water regime in the area.
- State Forest Departments besides plantation and protection also undertake steps to improve water conservation through different interventions such as building Check dams, vegetation barriers, percolation ponds, contour trenches etc. under various Central & State Government schemes
- As per the latest assessment, water bodies inside forest cover have increased by 2,647 sq. kms during the last decade.

- Maharashtra (432 sq. kms), Gujarat (428 sq. kms), Madhya Pradesh (389 sq. kms) are top three states showing increase in water bodies within forest areas. Overall, almost all the states have shown a positive change in water bodies.

8.6 Steps needed to conserve Wetlands:

- **Demarcation of wetlands** using latest technology
- **Eutrophication abatement** : Processing nutrient rich discharge into the water body.
- **Afforestation, weed control**
- **Preventing invasive species**: stop the introduction of exotic invasive species like water hyacinth
- Treatment of **industrial effluents** and **water from farm lands** before discharging into wetlands.
- Proper enforcement of laws and stringent punishments for violators.
- **Preventing unsustainable aquaculture** and cultivation of shellfish.
- Soil conservation measures + Preventing grazing in peripherals of wetlands.
- Involving local population in the conservation of wetlands.



9. MANGROVE ECOSYSTEM

- Mangroves is a **littoral (near the sea shore) forest ecosystem**.
- These are **mostly evergreen forests** that grow in sheltered low-lying coasts, estuaries, mudflats, tidal creeks backwaters (coastal waters held back on land), marshes and lagoons of tropical and subtropical regions.
- Mangroves are located between the land and sea => they represent the best example of ecotone.

9.1 Features of Mangroves:

- Mangroves are shrubs or small salt tolerant trees (also called **halophytes**) capable of growing in marine intertidal environments; coastal saline or brackish water.
 - They **do not rely on salt water** but are **able to tolerate it**.
 - According to the IUCN, there are 70 species of mangroves, of which 11 are threatened with extinction
- They are adapted to the **low oxygen (anoxic)** conditions of waterlogged mud.
- They produces **pneumatophores (blind roots)** to overcome respiratory problem in the anaerobic soil conditions.
 - **Specialized roots enable mangroves to “breathe” and anchor in soft sediments:** Mangrove habitats are **usually very low in oxygen beneath the surface**, especially in the sediments where microbes deplete available oxygen during metabolizing processes.
 - In order to deal with this non-hostile environment, specialized forms of roots have emerged which enable the tree to breathe oxygen from the air, even when the roots are submerged in water.
- **Long- distance floating mangroves seeds that already grow on the trees:** All mangrove species **use the water to disperse their seeds** but **only some are viviparous** meaning **their seeds already grow to seedlings on the plant** before being released into the water.
 - Advantage: the fully-grown seedling is ready to anchor itself wherever it gets washed up once it's fallen from its mother tree.
 - The already developed plant is capable of photosynthesising and growing straight away instead of being washed back and forth by the incoming tides.

9.2 Growing Areas:

- Mangroves **grow below the high-water level of spring tides**.
- Mangroves occur worldwide in the tropics and subtropics, mainly between latitudes 25° N and 25° S.
 - Mangroves require high solar radiation to filter saline water through their roots.
- Best locations : **where abundant silt is brought down by rivers** or on the backshore of accreting sandy beaches.

9.3 Mangroves in India:

- As per the ISFR 2017 report, the **total area of mangrove cover of India is 4921 km²**, (181 km² positively changed with respect to 2015 mangrove cover assessment) which **contributes 3.3% to the global mangrove cover**.
- The deltas of the Ganges, Mahanadi, Krishna, Godavari, and Kaveri rivers contain mangrove forests.

- Backwaters in Kerala have high density of mangrove forest on the shores.
- Indian mangroves consist of 46 species (4 of which are natural hybrids) belonging to 22 genera and 14 families, representing about 57% of the world's mangrove species.
- **Mangroves of Sundarbans** : the largest single block of tidal halophytic mangroves of the world.
 - The major species of this dense mangrove forest include *Heritiera fomes*, *Rhizophora* spp., *Bruguiera* spp., *Ceriops decandra*, *Sonneratia* spp. and *Avicennia* spp..
 - *Nypa fruticans* are found along the creeks.
 - famous for the Royal Bengal Tiger and crocodiles.
 - Issue faced: Mangrove areas here are being cleared for agricultural use.
- **Bhitarkanika mangroves**: form India's second largest forest, located in the state of Odisha.
 - Bhitarkanika is created by the two river deltas of Brahmani and Baitarani river and one of the important Ramsar Wetland in India.
 - It is also the home of saltwater crocodiles and nesting olive ridley sea turtles.
- **Godavari-Krishna mangroves**: lie in the delta of the Godavari and Krishna rivers in the state of Andhra Pradesh. Mangroves ecoregion is under protection for Calimere Wildlife and Pulicat Lake Bird Sanctuary.
- **Pichavaram mangroves**: hosts the second largest mangrove forests in the world
- **Mumbai mangroves**: has mangroves on its coastline along the west coast of India.
 - These mangroves support a rich diversity of life forms, especially molluscs.
- **Baratang Island mangroves**: are located within the Andaman and Nicobar Islands.
 - The mangrove swamps of Baratang Island are situated between Middle and South Andaman Island.

9.4 Functions of Mangroves:

- Mangroves **enhance and trigger the growth of phytoplankton** (due to the provided nutrients) which in turn supports adjacent fish populations.
- They not only **serve as a source for nutrients**, but also **act as a sink for excess nutrients** and thus play an extremely important ecological role in coastal areas.
 - An intact mangrove forest can substantially impact fishing yields and cleared areas are often followed by a collapse and/or sharp decline in catches
- Mangrove forests are also among the **most carbon-rich habitats on earth**.
 - They play a huge role in *carbon sequestration* (i.e. uptake of carbon from the atmosphere) and can **help counteracting climate change**.
 - **Huge amounts of carbon are stored in the sediments and within the roots and trunks systems of the mangrove trees.**
 - They are thus not only able to **absorb (sequester) CO₂ from the atmosphere but also store it away forming a so-called carbon sink.**
- Mangroves provide food, fire wood, shelter and sustainable tourism opportunities to local people.
- As transition zones between land and sea **they clean land-driven wastewaters and sewage by filtering the water and burying many kinds of toxic substances like heavy metals, dioxin-like compounds and other pollutants.**
- **Mangrove roots cause the water to slow down and enhance sedimentation, which traps colloidal particles in the fine sediments as well.**

- Generally, the water flow through mangroves forests disperses point sources of e.g. industrial waste water and sewage into vast areas and dampens the negative environmental effect.
- **Natural protection from tsunamis and hurricanes:** Mangrove forests act as a natural protection in case of storms and decrease erosion on coastal areas.
 - The huge amount of biomass dissipates the energy of incoming waves and may greatly decrease the impact of hurricanes and tsunamis in coastal areas.
- **Mangroves serve as kindergartens for many species:** The provided habitat enables many species to nurse in the shallow and usually clean waters of mangroves and a large amount of species stays here for a certain period of life to grow while being protected from bigger predators and benefiting from high prey availability.
 - A few examples are shrimps, sharks and reef fish as well as other pelagic predators.

9.5 Threats faced by mangrove forests and their habitats:

Anthropogenic Activities:

- **Clearing:** Mangrove forests have often been cleared to make room for agricultural land, human settlements and infrastructure (such as harbours), and industrial areas.
 - clearing for tourist developments, shrimp aquaculture, and salt farms
- **Overharvesting:** Mangrove trees are used for firewood, construction wood, wood chip and pulp production, charcoal production, and animal fodder. Harvesting in some parts of the world it is no longer sustainable, threatening the future of the forests.
- **River changes: Dams and irrigation reduce the amount of water reaching mangrove forests, changing the salinity level of water in the forest.**
 - If salinity becomes too high, the mangroves cannot survive.
 - Freshwater diversions can also lead to mangroves drying out.
 - In addition, increased erosion due to land deforestation can massively increase the amount of sediment in rivers. This can overcome the mangrove forest's filtering ability, leading to the forest being smothered.
- **Overfishing:** The ecological balance of food chains and mangrove fish communities can also be altered.
- **Pollution:** Fertilizers, pesticides, and other toxic man-made chemicals carried by river systems from sources upstream can kill animals living in mangrove forests, while oil pollution can smother mangrove roots and suffocate the trees.

Natural causes:

- **Destruction of coral reefs:** Coral reefs provide the first barrier against currents and strong waves.
 - When they are destroyed, the stronger-than-normal waves and currents reaching the coast can undermine the fine sediment in which the mangroves grow.
 - This can prevent seedlings from taking root and wash away nutrients essential for mangrove ecosystems.
- **Climate change:** Mangrove forests require stable sea levels for long-term survival. They are therefore extremely sensitive to current rising sea levels caused by global warming and climate change.

9.6 Government Initiatives to Conserve Mangroves:

- **Wetlands (Conservation and Management) Rules, 2017** (already covered under wetland ecosystems)
- **National Wetland Conservation Programme (NWCP)** (already covered under wetland ecosystems)
- **Ramsar Convention on Wetland** (already covered under wetland ecosystems)
- **Montreux Record** (already covered under wetland ecosystems)
- **World Wetland Day** (already covered under wetland ecosystems)
- **Mangroves for the Future (MFF)**
 - is a unique multi- country, multi sectoral, partner- led initiative
 - have two objectives:
 - To strengthen the environmental sustainability of coastal development.
 - To promote the investment of funds and effort in coastal ecosystem management for sustainable development.
 - MFF is being coordinated by International Union for Conservation of Nature, IUCN covering, initially, six Tsunami affected countries namely India, Indonesia, Maldives, Seychelles, Sri Lanka and Thailand. India has agreed to participate in the IUCN- MFF Initiative.

9.7 Mangrove Ecosystem and India State of Forest Report (ISFR) 2017:

- As per ISFR 2017, **mangrove forests have increased by 181 sq kms.**
- Maharashtra (82 sq kms), Andhra Pradesh (37 sq kms) and Gujarat (33 sq kms) are the top three gainers in terms of mangrove cover.
- 7 out of the 12 mangrove states have shown an increase in mangrove cover and none of them show any negative change.
- Mangrove ecosystems are rich in biodiversity and provide a number of ecological services. They also play a major role in protecting coastal areas from erosion, tidal storms and tsunamis.



Figure: Mangroves in India

BIODIVERSITY



BIODIVERSITY

CONTENT

1. Introduction to biodiversity
2. Defining biodiversity
3. Levels of biodiversity.
4. Measuring biodiversity
5. Indian bio-geographical classification.
6. Biodiversity and ecosystem services
7. Loss of biodiversity
8. Current status.
9. Factor affecting biodiversity.
10. Conservation of biodiversity
11. Government intervention.
12. Appendix

BIODIVERSITY

1. INTRODUCTION OF BIODIVERSITY.

- ❖ Biodiversity is the foundation of ecosystem services to which human well-being is intimately linked.
- ❖ Decisions humans make that influence biodiversity affect the well-being of themselves and others.
- ❖ No feature of Earth is more complex, dynamic, and varied than the layer of living organisms that occupy its surfaces and its seas, and no feature is experiencing more dramatic change at the hands of humans than this extraordinary, singularly unique feature of Earth.
- ❖ The layer of living organisms—the biosphere—through the collective metabolic activities of its innumerable plants, animals, and microbes physically and chemically unites the atmosphere, geosphere, and hydrosphere into one environmental system within which millions of species, including humans, have thrived.
- ❖ Breathable air, potable water, fertile soils, productive lands, bountiful seas, the equitable climate of Earth's recent history, and other ecosystem services are manifestations of the workings of life. It follows that large-scale human influences over this biota have tremendous impacts on human well-being.

2. DEFINING BIODIVERSITY

- ❖ Biodiversity is defined 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 part; this includes diversity within species, between species and of ecosystems.”
- ❖ This definition explicitly recognizes that every biota can be characterized by its taxonomic, ecological, and genetic diversity and that the way these dimensions of diversity vary over space and time is a key feature of biodiversity.
- ❖ **E. O. Wilson** heralded the popularity of this concept.
- ❖ Biodiversity includes all ecosystems—managed or unmanaged. Sometimes biodiversity is presumed to be a relevant feature of only unmanaged ecosystems, such as wildlands, nature preserves, or national parks. This is incorrect. Managed systems—be they plantations, farms, croplands, aquaculture sites, rangelands, or even urban parks and urban ecosystems—have their own biodiversity. Given that cultivated systems alone now account for more than 24% of Earth's terrestrial surface, it is critical that any decision concerning biodiversity or ecosystem services address the maintenance of biodiversity in these largely anthropogenic systems

3. LEVELS OF BIODIVERSITY

A. Genetic diversity

<p>Characteristics of Genetic diversity</p>	<ul style="list-style-type: none"> ● Genetic connection: All species on Earth are somewhat related through genetic connections. And the more closer a species is related to another, the more genetic information the two species will share. ● Similarity among organisms: These species will also look more similar. The closest relations of an organism are members of its own species. ● Sharing genes: Genes are the bits of biochemical information that partly determine how an organism looks, behaves, and lives.
--	---

	<ul style="list-style-type: none"> ● Mating behavior: Members of a species share intricate mating behaviors. These behaviors help them to identify each other as potential partners. ● Similar to neighboring species: Virtually every species in an environment has a similar and closely related species in a neighboring environment.
Examples	<p>Western and Eastern gray squirrels are great examples in this case.</p> <ol style="list-style-type: none"> 1) Western gray squirrels, which inhabit the west side of the Rocky Mountains, have more similarities than differences with the eastern gray squirrels. 2) These two types of squirrels don't share a common mating behavior. Even when placed in the same environment, eastern and western squirrels don't mate because they are two different species. <ol style="list-style-type: none"> i) These two species share a more general set of traits of the squirrel family, for example, encompasses chipmunks, prairie dogs, and gray squirrels. ii) These animals share various features such as muscle anatomy, number of teeth, as well as shape and details of the skull <ul style="list-style-type: none"> ● Mammals share characteristics such as hair, three bones in the middle ear, and breastfeeding their young. Likewise, all mammals are distantly related to vertebrates. Vertebrates are animals with backbones. ● Every animal has the same cell structure as fungi, plants, and some microorganisms. Lastly, all organisms have ribonucleic acid (RNA) molecule. Moreover, most of them have deoxyribonucleic acid (DNA). All these imply that species have come from one, common ancestor. <p>However, they diverge and develop distinctive attributes with time, and hence promote biodiversity in their own unique way.</p>

B. Species diversity

Characteristics of Species diversity	<p>A wide variety of species exists in an environment. And that's what is referred to as species diversity.</p> <ol style="list-style-type: none"> 1) Role of species in Bio-diversity: Species are the standard measure of biological diversity in light of the fact that they are the basic units of biological classification. 2) Species Richness: The number of various species in a given ecosystem or environment. 3) Only few species identified: The total number of species in the world is about 10 million. However, only 1.75 million species have been named scientifically to date.
Significance of species diversity	<ol style="list-style-type: none"> 1) Role of species in ecosystem: The composition of species in a given ecosystem is the result of long-lasting evolution. Each species has adapted to its own niche, which is characterized by certain features (e.g. temperature range, availability of food or light) enabling the species to reproduce and thus maintain its population. 2) Impact on environment: Living in an ecosystem, the species interacts with its environment (e.g. mussels take particles out of the water, reed forms root

	<p>systems) and thus performs certain functions (increasing the light availability for plant growth, preventing sediment erosion).</p> <p>3) Loss of species causes imbalance: Any species that will take over the lost species niche will most certainly not replace all of the functions it used to perform. When species get extinct, their services for the global biosphere are lost forever. It is impossible to replace it.</p>
Anthropogenic activities affect species diversity	<p>1) Major threats: Over-exploitation, pollution and habitat conversion. The ever-growing tendencies of tourism, transport, profit-oriented food production (e.g. single-crop agriculture, selective aquaculture), and industry enforce these human activities.</p> <p>2) Impacts: They cause a gradual loss of species on local, regional and global levels.</p> <p>3) Exotic species: The introduction of species into new ecosystems destroys natural balance.</p> <p>4) Climate and population pressure: Global warming and population growth continually increase these pressures on biodiversity. e.g 70-80% global decline in coral population.</p>
Preventive measures	<p>It should have become clear that the loss of species is accompanied by a loss of functionality, some of which directly affect human life in a severe way</p> <p>1) Reduction of commercially used fish stocks, and erosion of soil and sediment are only two examples.</p> <p>2) Scientists have counted and described some 1.7 million living organisms, but the planet's total number is estimated at between 5 and 30 million, with some scientists putting forward figures of 80 million or more. Just as not even the whole inventory of the earth's species has been made, very little is known about the role and the potential that each of them has for increasing the quality of human life.</p> <p>3) It is therefore necessary to prevent the loss of species' diversity in order to avoid the loss of opportunities to gain from it.</p>
Regional specific species	<p>1) Tropical North and South America, for example, have approximately 85,000 flowering plants.</p> <p>2) Tropical and Subtropical Asia have at least 50,000 while tropical and subtropical Africa has about 35,000.</p> <p>3) All of Europe has about 11,300 vascular plants.</p>

C. Ecological diversity

Ecological diversity	<ul style="list-style-type: none"> Ecological or ecosystem diversity is the variety of ecosystems in an area. However, it is difficult to measure ecological diversity because every ecosystem on earth merges into the surrounding ecosystems.
Characteristics of Ecological diversity	<p>1) Species relation with environment: It involves the complex network of various species present in the ecosystems and the dynamic interactions between them.</p> <p>2) Variety of flora and fauna: An ecosystem is made up of organisms from several different species living together in an environment and their connections through the flow of nutrients, energy, and matter.</p> <p>3) Size of ecosystem: An ecosystem can cover a small area, like a pond, or a large area, like an entire forest.</p>

	<p>4) Primary source of energy: In virtually every ecosystem is the sun whose radiant energy is transformed into chemical energy by the plants. Animals eat the plants, allowing the energy to flow through the systems.</p> <p>5) Flow of energy : The animals are, in turn, eaten by other animals. Fungi decompose organisms to obtain energy and, in the process, recycle nutrients back into the soil. Hence, an ecosystem is a collection of living components and non-living components that are connected by energy flow.</p>
--	--

Biodiversity can be measured and monitored at several spatial scales.

- a. **Alpha Diversity:** It refers to the diversity within a particular area or ecosystem usually expressed by the number of species.
- b. **Beta Diversity:** It is a comparison of diversity between ecosystems, usually measured as change in amount of species.
- c. **Gamma Diversity:** It is a measure of the overall diversity for the different ecosystems within a region.

Diversity can be use to describe variation in several forms:

- a. Genetic (species, varieties, etc.)
- b. Life form (grasses, forb, trees, mosses, etc.)
- c. Functional group (deep rooted, nitrogen-fixing, soil crust, evergreen, etc.)

4. MEASURING BIODIVERSITY

Species Richness and Indicators:

- ❖ **In spite of many tools and data sources, biodiversity remains difficult to quantify precisely.**
- ❖ Ideally, to assess the conditions and trends of biodiversity either globally or sub-globally, it is necessary to measure the abundance of all organisms over space and time, using **taxonomy** (such as the number of species), **functional traits** (for example, the ecological type such as nitrogen-fixing plants like legumes versus non-nitrogen-fixing plants), and the **interactions among species** that affect their dynamics and function (predation, parasitism, competition, and facilitation such as pollination, for instance, and how strongly such interactions affect ecosystems).
- ❖ Even more important would be to estimate turnover of biodiversity, not just point estimates in space or time. Currently, it is not possible to do this with much accuracy because the data are lacking.
- ❖ **There are few measures of biodiversity: -**
 1. **Species Evenness:** Proportions of species or functional groups present on a site. The more equal species are in proportion to each other the greater the evenness of the site. A site with low evenness indicates that a few species dominate the site.
 2. **Species richness (the number of species in a given area) represents a single but important metric that is valuable as the common currency of the diversity of life.**
 - These include the species richness of specific taxa, the number of distinct plant functional types (such as grasses, forbs, bushes, or trees), or the diversity of distinct gene sequences in a sample of microbial DNA taken from the soil.
 - Species- or other taxon-based measures of biodiversity, however, rarely capture key attributes such as variability, function, quantity, and distribution—all of which provide insight into the roles of biodiversity.

3. **Ecological indicators** are scientific constructs that use quantitative data to measure aspects of biodiversity, ecosystem condition, services, or drivers of change, but no single ecological indicator captures all the dimensions of biodiversity.
- Ecological indicators form a critical component of monitoring, assessment, and decision-making and are designed to communicate information quickly and easily to policy-makers.
 - In a similar manner, economic indicators such as GDP are highly influential and well understood by decision-makers. Some environmental indicators, such as global mean temperature and atmospheric CO₂ concentrations, are becoming widely accepted as measures of anthropogenic effects on global climate.

Criteria for Effective Ecological Indicators: -

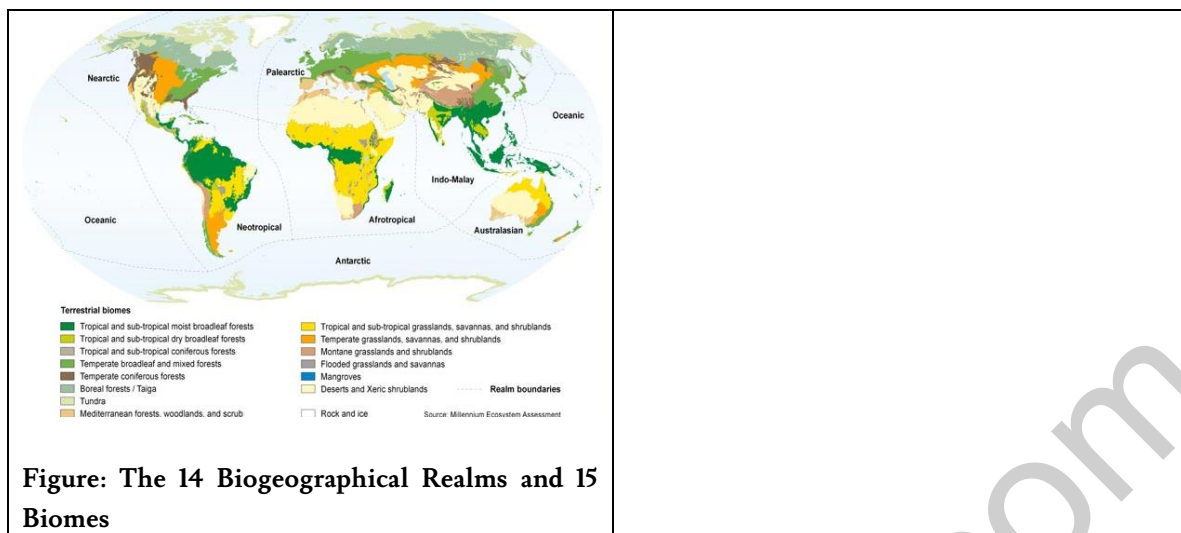
- Provide information about changes in important processes.
- Be sensitive enough to detect important changes but not so sensitive that signals are masked by natural variability.
- Be able to detect changes at the appropriate temporal and spatial scale without being overwhelmed by variability.
- Be based on well-understood and generally accepted conceptual models of the system to which it is applied.
- Be based on reliable data that are available to assess trends and are collected in a relatively straightforward process.
- Be based on data for which monitoring systems are in place.
- Be easily understood by policy-makers.

Where is the biodiversity?

- ❖ **Biodiversity is essentially everywhere, ubiquitous on Earth's surface and in every drop of its bodies of water.**
- ❖ **Documenting spatial patterns in biodiversity is difficult because taxonomic, functional, trophic, genetic, and other dimensions of biodiversity have been relatively poorly quantified.** Even knowledge of taxonomic diversity, the best known dimension of biodiversity, is incomplete and strongly biased toward the species level, megafauna, temperate systems, and components used by people.
- ❖ For these reasons, estimates of the total number of species on Earth range from 5 million to 30 million. Irrespective of actual global species richness, however, it is clear that the 1.7–2 million species that have been formally identified represent only a small portion of total species richness.
- ❖ It can be categorise in two parts: -

<i>Spatial Patterns of Biodiversity</i>	<i>Temporal Patterns of Biodiversity</i>
<p>It includes Hotspots, Biomes, Biogeographic Realms, Ecosystems, and Ecoregions.</p> <p>a. North-temperate regions often have usable data on spatial distributions of many taxa, and some groups (such as birds, mammals, reptiles, plants, butterflies, and dragonflies) are reasonably well documented globally.</p>	<p>It includes Background Rates of Extinction and Biodiversity Loss.</p> <p>a. Knowledge of patterns of biodiversity over time allow for only very approximate estimates of background rates of extinction or of how fast species have become extinct over geological time.</p>

<ul style="list-style-type: none"> b. Biogeographic principles (such as gradients in species richness associated with latitude, temperature, salinity, and water depth) or the use of indicators can supplement available biotic inventories. c. Global and sub-global maps of species richness valuable pictures of the distribution of biodiversity. d. Most macroscopic organisms have small, often clustered geographical ranges, leading to centers of both high diversity and endemism, frequently concentrated in isolated or topographically variable regions (islands, mountains, peninsulas). e. A large proportion of the world's terrestrial biodiversity at the species level is concentrated in a small part of the world, mostly in the tropics. f. Biomes and biogeographic realms provide broad pictures of the distribution of functional diversity. Functional diversity (the variety of different ecological functions in a community independent of its taxonomic diversity) shows patterns of associations (biota typical of wetlands, forests, grasslands, estuaries, and so forth) with geography and climate known as biomes g. ecosystems and ecoregions being smaller divisions within biomes. These can be used to provide first-order approximations of both expected functional diversity as well as possible changes in the distribution of these associations should environmental conditions change. 	<ul style="list-style-type: none"> b. Except for the last 1,000 years, global biodiversity has been relatively constant over most of human history c. The estimated magnitude of background rates of extinction is roughly 0.1–1.0 extinctions per million species per year. d. A mismatch exists between the dynamics of changes in natural systems and human responses to those changes. This mismatch arises from the lags in ecological responses, the complex feedbacks between socioeconomic and ecological systems. e. Multiple impacts (especially the addition of climate change) can cause rapid and dramatic changes in ecosystem function even though the increase in environmental stress has been small and constant over time. f. Shifts to different regimes may cause rapid changes in biodiversity, ecosystem services, and human well-being. E.g. Some regime shifts are essentially irreversible, such as coral reef ecosystems that undergo sudden shifts from coral-dominated to algal-dominated reefs g. The trigger for such phase shifts usually includes increased nutrient inputs leading to eutrophic conditions and removal of herbivorous fishes that maintain the balance between corals and algae. h. Introduced invasive species can act as a trigger for dramatic changes in ecosystem structure, function, and delivery of services. E.g. the introduction of <i>Mnemiopsis leidyi</i> (a jellyfish-like animal) in the Black Sea caused the loss of 26 major fisheries species and has been implicated in the subsequent growth of the oxygen-deprived “dead” zone
---	---



5. INDIAN BIO-GEOGRAPHICAL CLASSIFICATION

5.1. India- a Species-Rich Nation:

- India ranks among the top ten species-rich nations in the world.
- **Biodiversity hotspots:** India has **four global biodiversity hotspots**. They are the **Eastern Himalaya, Indo-Burma region, the Western Ghats, and the Sundarbans**.
- **Factor affecting biodiversity:** The varied edaphic, climatic and topographic conditions and years of geological stability have resulted in a wide range of ecosystems and habitats which include numerous forests, grasslands, wetlands, deserts, and coastal and marine ecosystem.
- **India as Mega Biodiversity:** With 2.4% of the world's land area, India accounts for about 7-8% of recorded species of the world. India is **one of the 17 Mega Biodiversity Nation** in the world.
- **Diverse flora and fauna:** From about 70 per cent of the total geographical area surveyed by the Ministry of Environment and Forests in India, 45,500 plant species (including fungi and lower plants) and 91,000 animal species, representing about seven percent of the world's flora and 6.5 per cent of the world's fauna, respectively, have been described. It has been estimated that **at least 10 percent of the country's recorded wild flora, and ten percent of its wild fauna, are on the threatened list**
- **Medicinal diversity:** The Pride of India lies in its nearly 6,500 native plants which are still used in the indigenous healthcare systems. It is a country with rich biodiversity.

5.2. Biogeographic Zones in India:

India is a country with very typical **geology, terrain conditions, topography, land use, geographic and climatic factors**. Based on these factors, the country can be divided into **eleven recognizable biogeographic zones**.

- i) Trans-Himalayan Region
- ii) Himalayan Zone
- iii) The Alpine and Subalpine Forest
- iv) Indian Desert Zone
- v) Semi-arid Region
- vi) Western Ghats
- vii) Deccan Plateau

- viii) Gangetic Plains
- ix) Coastal Regions
- x) North-East Region
- xi) Andaman and Nicobar Islands.

These zones encompass a variety of ecosystems - mountains, plateaus, rivers, forests, deserts, wetlands, lakes, mangroves, coral reefs, coasts and islands.

<p>Trans-Himalayan Region</p>	<p>Area covered: Trans-Himalayan Region covers about 5.6 per cent of the total geographical area. It includes the high altitude, cold and arid mountain areas of Ladakh, Jammu & Kashmir, North Sikkim, Lahaul and Spiti areas of Himachal Pradesh.</p> <p>Biogeographic Provinces:</p> <ul style="list-style-type: none"> • 1A: Himalaya - Ladakh Mountains (3.3 %) • 2B: Himalaya - Tibetan Plateau (2.2%) • 3C: Trans - Himalaya Sikkim (<0.1 %). <p>Vegetation: This zone has sparse alpine steppe vegetation that harbours several endemic species.</p> <p>Wildlife: It is a favorable habitat for the biggest populations of wild sheep and goat in the world. The other rare fauna includes Snow Leopard (<i>Uncia uncia</i>) and the migratory Black necked Crane (<i>Grus Nigricollis</i>). The cold dry desert of this zone represents an extremely fragile ecosystem.</p>
<p>The Himalayan Zone</p>	<p>Area covered: Himalayan Zone, in the far North is another biogeographic zone. It covers about 6.4 per cent of the total geographical area in India. It includes some of the highest peaks in the world.</p> <p>This zone makes India as one of the richest areas in terms of habitats and species. The steep slopes, unconsolidated soils and intense rainfall render the zone extremely fragile.</p> <p>Biogeographic Provinces:</p> <ul style="list-style-type: none"> • 2A: Himalaya - North West Himalaya (2.1%) • 2B: Himalaya - West Himalaya (1.6%) • 2C: Himalaya - Central Himalaya (0.2%) • 2D: Himalaya - East Himalaya (2.5%) <p>Eastern Himalaya (biodiversity hotspot). Phyto-geographically,</p> <ul style="list-style-type: none"> ➤ Area covered: The Eastern Himalaya forms a distinct floral region and comprises of Nepal, Bhutan, states of East and North-East India, and a contiguous sector of Yunnan province in South-Western China. ➤ Species richness: In the whole of Eastern Himalaya, there are an estimated 9,000 plant species, out of which 3,500 (i.e. 39 per cent) are endemic. In the Indian portion, there occurs some 5,800 plant species, roughly 2,000 (i.e. 36 per cent) of which are endemic. At least 55 flowering plants endemic to this area are recognized as rare, for example, the Pitcher Plant (<i>Nepenthes Khasiana</i>).

<p>The Alpine and subalpine forests</p>	<p>Vegetation: The Alpine and subalpine forests, grassy meadows and moist mixed deciduous forests.</p> <p>Wildlife /Species richness: It provide diverse habitat for endangered species of bovids such as</p> <ul style="list-style-type: none"> ● Bharal (Pseudois nayaur), ● Ibex (Capra ibex), ● Markhor (Capra falconeri), ● Tahr (Hemitragus jemlahicus), and ● Other rare and endangered species restricted to this zone include Hangul (Cervus eldi eldi) and Musk Deer (Moschus moschiferus).
<p>The Indian Desert Zone</p>	<p>Area covered: It covers about 6.6 per cent of the total geographical area. It includes the Thar and the Kutch deserts.</p> <p>Biogeographic Provinces:</p> <ul style="list-style-type: none"> ● 3A: Desert –Thar (5.4%) ● 3B: Desert –Kutch (1.1%). <p>Wildlife/ Species richness: It has large expanses of grassland that supports several endangered species of mammals such as Wolf (Canis lupus), Caracal (Felis caracal), Desert Cat (Felis libyca) and birds of conservation interest viz., Houbara Bustard (Chlamydotis undulata) and the Great Indian Bustard (Ardeotis nigriceps).</p>
<p>The Semi-arid biodiversity Region in India</p>	<p>Area covered: It covers about 16.6 per cent of the total geographical area.</p> <p>Vegetation: It is a transition zone between the desert and the dense forests of Western Ghats. Peninsular India has two large regions, which are climatically semi-arid. This semi-arid region also has several artificial and natural lakes and marshy lands. The dominant grass and palatable shrub layer in this zone support the highest wildlife biomass.</p> <p>Biogeographic Provinces:</p> <ul style="list-style-type: none"> ● 4A: Semi - Arid - Punjab Plains (3.7%) ● 4B: Semi - Arid - Gujarat Rajputana (12.9%). <p>Wildlife/ Species richness: The Cervid species of Sambar (Cervus unicolor) and Chital (Axis axis) are restricted to the better wooded hills and moisture valley areas respectively. The Lion (Leo persica) which is one of the endangered carnivore species is restricted to a small area in Gujarat. The Caracal (Felis caracal), Jackal (Canis aureus) and Wolf (Canis lupus) are some of the endangered species that are characteristic of this region.</p>
<p>The Western Ghats in India</p>	<p>Area covered: It covers about 4.0 per cent of the total geographical area. The zone stretches from the hills to the South of the Tapti River in the North to Kanyakumari in the South. In the West, this zone is bound by the coast</p> <p>Vegetation: It is one of the major tropical evergreen forest regions in India.</p> <p>Biogeographic Provinces</p> <ul style="list-style-type: none"> ● 5A: Western Ghats - Malabar Plains (2.0%) ● 5B: Western Ghats - Western Ghats Mountains (2.0%).

	<p>Species richness: This zone represents one of the biodiversity 'hotspots' with some 15,000 species of higher plants, of which 4,000 (27 per cent) are endemic to the region. The Western Ghats harbour viable populations of most of the vertebrate species found in peninsular India, besides an endemic faunal element of its own. The Travancore Tortoise (<i>Indotestudo forsteni</i>) and Cane turtle (<i>Heosemys silvatica</i>) are two endangered taxa restricted to a small area in central Western Ghats</p> <p>Significant species endemic to this region include</p> <ul style="list-style-type: none"> • Nilgiri Langur (<i>Presbytis johni</i>), • Lion Tailed Macaque (<i>Macaca silenus</i>), • Grizzled Giant Squirrel (<i>Ratufa macroura</i>), • Malabar Civet (<i>Viverricula megaspila</i>), • Nilgiri Tahr (<i>Hemitragus hylocrius</i>) and • Malabar Grey Hornbill (<i>Ocyeros griseus</i>).
<p>The Deccan Plateau</p>	<p>Area covered: It covers about 42 per cent of the total geographical area. These include India's finest forests, particularly in the States of Madhya Pradesh, Maharashtra and Orissa. Majority of the forests are deciduous in nature with regions of greater biological diversity in the hill ranges</p> <p>Vegetation: It is a semi-arid region that falls in the rain shadow area of the Western Ghats. This biogeographic zone of peninsular India is by far the most extensive zone. It consists of deciduous forests, thorn forests and degraded scrubland, all of which support diverse wildlife species</p> <p>Biogeographic Provinces :</p> <ul style="list-style-type: none"> • 6A: Deccan Peninsular - Central Highlands (7.3%) • 6B: Deccan Peninsula - Chota Nagpur (5.4%) • 6C: Deccan Peninsular - Eastern Highlands (6.3%) • 6D: Deccan Peninsular - Central Plateau (12.5%) • 6E: Deccan Peninsular - Deccan South (10.4%). <p>Wildlife/Species richness: such as Chital (<i>Axis axis</i>), Sambar (<i>Cervus unicolor</i>), Nilgai (<i>Boselaphus tragocamelus</i>) and Chousingha (<i>Tetracerus quadricornis</i>) are abundant in this zone. Some other species like Barking deer (<i>Muntiacus muntjak</i>) and Gaur (<i>Antilope cervicapra</i>) are more frequent in, or are restricted to moist areas. They are still found in fairly large numbers. Species with small populations include the Elephant (<i>Elephas Maximus</i>) in Bihar-Orissa and Karnataka-Tamil Nadu belts, Wild Buffalo (<i>Bubalus bubalis</i>) in a small area at the junction of Orissa, Madhya Pradesh and Maharashtra and the hard ground Swamp Deer (<i>Cervus duvauceli</i>), now restricted to a single locality in Madhya Pradesh.</p>
<p>Gangetic Plain</p>	<p>Area covered: It covers about 10.8 per cent of the total geographical area in India. It is a flat alluvial region lying to the North and South of the Ganga River and its major tributaries and in the foothills of the Himalayas.</p> <p>Biogeographic Provinces are:</p> <ul style="list-style-type: none"> • 7A: Gangetic Plain - Upper Gangetic Plains (6.3%) • 7B: Gangetic Plain - Lower Gangetic Plains (4.5%). <p>The Gangetic plain is topographically homogenous for hundreds of kilometers.</p>

	<p>Wildlife/species richness: The characteristic fauna of this region includes Rhino (<i>Rhinoceros unicornis</i>), Elephant (<i>Elephas maximus</i>), Buffalo (<i>Bubalus bubalis</i>), Swamp Deer (<i>Cervus duvauceli</i>), Hog-Deer (<i>Axis porcinus</i>) and Hispid Hare (<i>Caprolagus hispidus</i>).</p>
Indian coastal belts	<p>Area covered: These constitute about 2.5 per cent of the total geographical area. The coastline from Gujarat to Sunderbans is estimated to be 5,423 km long. A total of 25 islets constitute the Lakshadweep, which are of coral origin.</p> <p>Vegetation: This belt includes very vast sandy beaches, mangroves, mud flats, coral reefs and marine angiosperm pastures. The coastal regions are also considered as the wealth and health zones of India. They have a typical reef lagoon system, rich in biodiversity.</p> <p>Biogeographic Provinces:</p> <ul style="list-style-type: none"> ● 8A: Coasts - West Coast (0.6%) ● 8B: Coasts - East Coast (1.9%) ● 8C: Coasts -Lakshadweep (< 0.1%).
The North-East Region	<p>Area covered It covers about 5.2 per cent of the total geographical area, in India. It represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese bio-geographical regions as well as being a meeting point of the Himalayan mountains and peninsular India.</p> <p>Biogeographic Provinces</p> <ul style="list-style-type: none"> ● 9A: North - East - Brahmaputra Valley (2.0%) ● 9B: North - East -North East Hills (3.2%). <p>Species richness: The North-East is thus the biogeographical 'gateway' for much of India's fauna and flora. It is a major biodiversity hotspot. A diverse set of habitats coupled with long term geological stability has allowed the development of significant levels of endemism in all animal and plant groups</p>
The Andaman and Nicobar Islands	<p>Area covered They constituting about 0.3 percent of the total geographical area. The North-South elongated groups of 348 Andaman Islands have a close biogeographical affinity with Myanmar. The Nicobar Islands, lying only 90 kms away from Sumatra have much stronger Indonesian and South-East Asian elements.</p> <p>Vegetation They are one of the three tropical moist evergreen forests zones in India. The islands house an array of flora and fauna which are not found elsewhere. These islands are centres of high endemism. They contain some of India's finest evergreen forests. They support a wide diversity of corals</p> <p>Biogeographic Provinces</p> <ul style="list-style-type: none"> ● 10A: Islands -Andamans (0.2%) ● 10B: Islands -Nicobars (0.1%).

6. BIODIVERSITY AND ECOSYSTEM SERVICES

What is the link between biodiversity and ecosystem services?

- ❖ **Biodiversity plays an important role in ecosystem functions that provide supporting, provisioning, regulating, and cultural services.**
- ❖ These services are essential for human well-being. E.g. Protecting the Catskill watersheds that provide drinking water for New York City is one case where safeguarding ecosystem services paid a dividend of several billion dollars.
- ❖ **Species composition matters as much or more than species richness when it comes to ecosystem services.**
 - Ecosystem functioning, and hence ecosystem services, at any given moment in time is strongly influenced by the ecological characteristics of the most abundant species, not by the number of species.
 - The relative importance of a species to ecosystem functioning is determined by its traits and its relative abundance. For example, the traits of the dominant or most abundant plant species—such as how long they live, how big they are, how fast they assimilate carbon and nutrients, how decomposable their leaves are, or how dense their wood is—are usually the key species drivers of an ecosystem's processing of matter and energy.
 - Thus, conserving or restoring the composition of biological communities, rather than simply maximizing species numbers, is critical to maintaining ecosystem services.
- ❖ **Local or functional extinction, or the reduction of populations to the point that they no longer contribute to ecosystem functioning, can have dramatic impacts on ecosystem services.**
 - Local extinctions (the loss of a species from a local area) and functional extinctions (the reduction of a species such that it no longer plays a significant role in ecosystem function) have received little attention compared with global extinctions (loss of all individuals of a species from its entire range).
 - When the functioning of a local ecosystem has been pushed beyond a certain limit by direct or indirect biodiversity alterations, the ecosystem-service losses may persist for a very long time.
- ❖ **Changes in biotic interactions among species—predation, parasitism, competition, and facilitation—can lead to disproportionately large, irreversible, and often negative alterations of ecosystem processes.**
 - In addition to direct interactions, such as predation, parasitism, or facilitation, the maintenance of ecosystem processes depends on indirect interactions as well, e.g., predator preying on a dominant competitor such that the dominant is suppressed, which permits subordinate species to coexist.
 - Interactions with important consequences for ecosystem services include pollination; links between plants and soil communities, including mycorrhizal fungi and nitrogen-fixing microorganisms; links between plants and herbivores and seed dispersers; interactions involving organisms that modify habitat conditions (beavers that build ponds, for instance, or tussock grasses that increase fire frequency); and indirect interactions involving more than two species (such as top predators, parasites, or pathogens that control herbivores and thus avoid overgrazing of plants or algal communities).
- ❖ **Many changes in ecosystem services are brought about by the removal or introduction of organisms in ecosystems that disrupt biotic interactions or ecosystem processes.**

- This is because the network of interactions among species and the network of linkages among ecosystem processes are complex.
- The impacts of either the removal of existing species or the introduction of new species are difficult to anticipate.

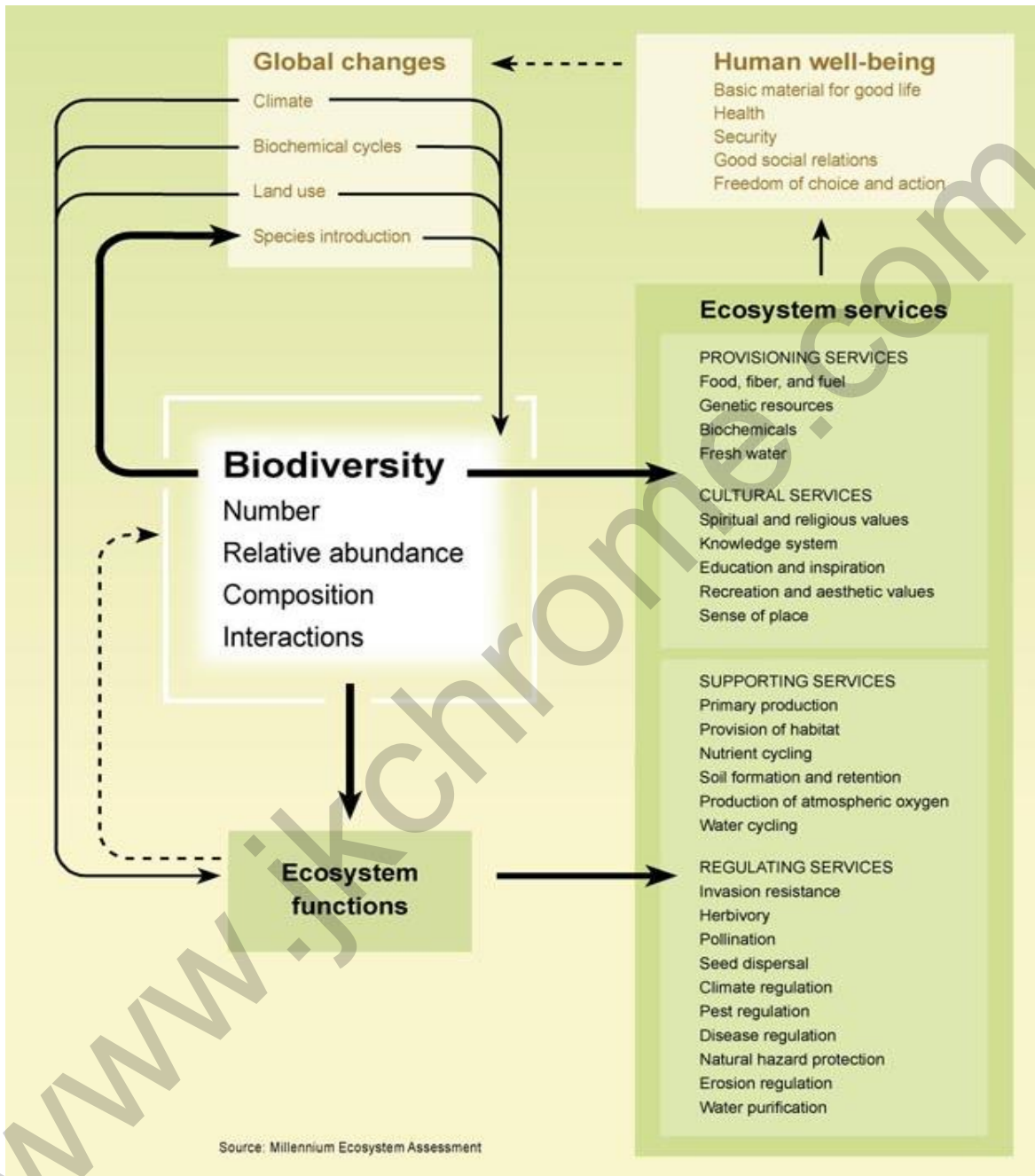


Figure: Biodiversity and ecosystem services

- ❖ As in terrestrial and aquatic communities, the loss of individual species involved in key interactions in marine ecosystems can also influence ecosystem processes and the provisioning of ecological services.
 - For example, coral reefs and the ecosystem services they provide are directly dependent on the maintenance of some key interactions between animals and algae. Coral reefs are responsible for maintaining a vast storehouse of genetic and biological diversity.

- Substantial ecosystem services are provided by coral reefs—such as habitat construction, nurseries, and spawning grounds for fish; nutrient cycling and carbon and nitrogen fixing in nutrient-poor environments; and wave buffering and sediment stabilization.
- The total economic value of reefs and associated services is estimated as hundreds of millions of dollars. Yet all coral reefs are dependent on a single key biotic interaction i.e. Symbiosis with algae. The dramatic effects of climate change and variability (such as El Niño oscillations) on coral reefs are mediated by the disruption of this symbiosis

7. BIODIVERSITY LOSS

Why is biodiversity loss a concern?

- ❖ **Biodiversity** is essential for **ecosystem services** and hence for human **well-being**. Biodiversity goes beyond the provisioning for material welfare and livelihoods to include security, **resiliency**, social relations, **health**, and freedoms and choices.
- ❖ People have benefited over the last century from the conversion of natural **ecosystems** to human-dominated ecosystems and from the exploitation of biodiversity. At the same time, however, these losses in biodiversity and associated changes in ecosystem services have caused other people to experience declining well-being, with some social groups being pushed into **poverty**.
- ❖ What are the main links between biodiversity and human well-being?

Food	<ul style="list-style-type: none"> ❖ Bio-safety Net: Biological diversity is used by many rural communities directly as an insurance and coping mechanism to increase flexibility and spread or reduce risk in the face of increasing uncertainty, shocks, and surprises. ❖ The availability of an ecosystem-based food security net during times when economic entitlements are insufficient to purchase adequate nourishment in the market provides an important insurance program. ❖ Coping mechanisms based on indigenous plants are particularly important for the most vulnerable people, who have little access to formal employment, land, or market opportunities. For example, investigations of two dryland sites in Kenya and Tanzania report local communities using wild indigenous plants to provide alternative sources of food when harvests failed or when sudden expenses had to be met (such as a hospital bill). ❖ Another pathway through which biodiversity can improve food security is the adoption of farming practices that maintain and make use of agricultural biodiversity. <ul style="list-style-type: none"> ➤ Wild relatives of domestic crops provide genetic variability that can be crucial for overcoming outbreaks of pests and pathogens and new environmental stresses. ➤ Many agricultural communities consider increased local diversity a critical factor for the long-term productivity and viability of their agricultural systems. For example, interweaving multiple varieties of rice in the same paddy has been shown to increase productivity by lowering the loss from pests and pathogens
-------------	--

<p>Vulnerability</p>	<p>The world is experiencing an increase in human suffering and economic losses from natural disasters over the past several decades.</p> <ul style="list-style-type: none"> ❖ <u>Mangrove</u> forests and coral reefs—a rich source of biodiversity—are excellent natural buffers against floods and storms. ❖ Over the past four decades, the number of “great” disasters has increased by a factor of four, while economic losses have increased by a factor of ten. During the 1990s, countries low on the Human Development Index experienced about 20% of the hazard events and reported over 50% of the deaths and just 5% of economic losses. But now the index accounted for over 50% of the total economic losses and less than 2% of the deaths. ❖ The sub-global assessments found that diversity of species, food, and landscapes serve as “savings banks” that rural communities use to cope with change and ensure sustainable livelihoods (Peruvian, Portuguese, Costa Rican, and India sub-global assessments).
<p>Health</p>	<ul style="list-style-type: none"> ❖ An important component of <u>health</u> is a balanced diet. <ul style="list-style-type: none"> ➤ About 7,000 <u>species</u> of plants and several hundred species of animals have been used for human food consumption at one time or another. Some indigenous and traditional <u>communities</u> currently consume 200 or more species. ➤ Wild sources of food remain particularly important for the poor and landless to provide a somewhat balanced diet. ➤ Overexploitation of marine fisheries worldwide, and of bushmeat in many areas of the tropics, has led to a reduction in the availability of wild-caught animal protein, with serious consequences in many countries for human health ❖ Human <u>health</u>, particularly risk of exposure to many infectious diseases, may depend on the maintenance of <u>biodiversity</u> in natural <u>ecosystems</u>. <ul style="list-style-type: none"> ➤ On the one hand, a greater <u>diversity</u> of wildlife <u>species</u> might be expected to sustain a greater diversity of pathogens that can infect humans. However, evidence is accumulating that greater wildlife diversity may decrease the spread of many wildlife pathogens to humans. The spread of Lyme disease, the best-studied case, seems to be decreased by the maintenance of the biotic integrity of natural ecosystems
<p>Energy security</p>	<ul style="list-style-type: none"> ❖ Wood fuel provides more than half the energy used in developing countries. <ul style="list-style-type: none"> ➤ Even in industrial countries such as Sweden and the United States, wood supplies 17% and 3% of total energy consumption respectively. ➤ In some African countries, such as Tanzania, Uganda, and Rwanda, wood fuel accounts for 80% of total energy consumption. ➤ Shortage of wood fuel occurs in areas with high population density without access to alternative and affordable energy sources. In some provinces of Zambia where population densities exceed the

	<p>national average of 13.7 persons per square kilometer, the demand for wood has already surpassed local supply.</p> <ul style="list-style-type: none"> ➤ In such areas, people are vulnerable to illness and malnutrition because of the lack of resources to heat homes, cook food, and boil water. ➤ Women and children in rural poor communities are the ones most affected by wood fuel scarcity. They must walk long distances searching for firewood and therefore have less time for tending crops and school
Clean water	<ul style="list-style-type: none"> ❖ The continued loss of cloud forests and the destruction of watersheds reduce the quality and availability of water supplied to household use and agriculture. <ul style="list-style-type: none"> ➤ In one of the best documented cases, New York City took steps to protect the integrity of watersheds in the Catskills to ensure continued provision of clean drinking water to 9 million people. New York City avoided \$6–8 billion in expenses by protecting its watersheds
Social relations	<ul style="list-style-type: none"> ❖ Many cultures attach spiritual and religious values to ecosystems or their components such as a tree, hill, river, or grove. Thus, loss or damage to these components can harm social relations—for example, by impeding religious and social ceremonies that normally bind people. ❖ Damage to ecosystems, highly valued for their aesthetic, recreational, or spiritual values can damage social relations, both by reducing the bonding value of shared experience as well as by causing resentment toward groups that profit from their damage
Freedom of choice and action	<ul style="list-style-type: none"> ❖ Loss of biodiversity often means a loss of choices. <ul style="list-style-type: none"> ➤ Local fishers depend on mangroves as breeding grounds for local fish populations. Loss of mangroves translates to a loss in control over the local fish stock and a livelihood they have been pursuing for many generations and that they value. ➤ Another example is high-diversity agricultural systems. These systems normally produce less cash than monoculture cash crops, but farmers have some control over their entitlements because of spreading risk through diversity. High diversity of genotypes, populations, species, functional types, and spatial patches decreases the negative effects of pests and pathogens on crops and keeps open possibilities for agrarian communities to develop crops suited to future environmental challenges and to increase their resilience to climate variability and market fluctuations (C11). ❖ Another dimension of choices relates to the future. <ul style="list-style-type: none"> ➤ The loss of biodiversity in some instances is irreversible, and the value individuals place on keeping biodiversity for future generations—the option value—can be significant.

	<ul style="list-style-type: none"> ➤ The notion of having choices available irrespective of whether any of them will be actually picked is an essential constituent of the freedom aspect of well-being.
<p>Basic materials for a good life and sustainable livelihoods</p>	<ul style="list-style-type: none"> ❖ Biodiversity offers directly the various goods—often plants, animals, and fungi—that individuals need in order to earn an income and secure sustainable livelihoods. ❖ Biodiversity also contributes to livelihoods through the support it provides for ecosystem services: <ul style="list-style-type: none"> ➤ For example, apples are a major cash crop in the Himalayan region in India, accounting for 60–80% of total household income. The region is also rich in honeybee diversity, which played a significant role in pollinating field crops and wild plants, thereby increasing productivity and sustaining ecosystem functions. ➤ The pollinator populations were also negatively affected by excessive use of pesticides. The result was a reduction in overall apple productivity and the extinction of many natural pollinator species. ❖ Nature-based tourism (“ecotourism”)—one of the fastest-growing segments of tourism worldwide—is a particularly important economic sector in a number of countries and a potential income source for many rural communities. <ul style="list-style-type: none"> ➤ The aggregate revenue generated by nature-based tourism in Southern Africa was estimated to be \$3.6 billion in 2000, roughly 50% of total tourism revenue. ➤ Botswana, Kenya, Namibia, South Africa, Tanzania, Uganda, and Zimbabwe each generated over \$100 million in revenue annually from nature-based tourism in 2000. In Tanzania, tourism contributed 30% of the total GDP of the country. ❖ Biodiversity also contributes to a range of other industries, including pharmaceuticals, cosmetics, and horticulture. <ul style="list-style-type: none"> ➤ Many bioprospecting (it is the systematic search for biochemical and genetic information in nature in order to develop commercially valuable products for pharmaceutical, agricultural, cosmetic and other applications) activities and revenues are expected to increase over the next decades. ❖ Losses of biodiversity can impose substantial costs at local and national scales. <ul style="list-style-type: none"> ➤ For example, the collapse of the Newfoundland cod fishery in the early 1990s cost tens of thousands of jobs, as well as at least \$2 billion in income support and retraining. ➤ Recent evidence suggests that the preservation of the integrity of local biological communities, both in terms of the identity and the number of species, is important for the maintenance of plant and animal productivity, soil fertility, and their stability in the face of a changing environment.

What are the competing goals that can affect biodiversity?

- ❖ **Trade-offs among competing goals:** The value of ecosystem services lost to human society, in the long term, may greatly exceed the short-term economic benefits that are gained from transformative activities.
 - Example: In Sri Lanka, the clearing of tropical forest for agriculture initially reduced the habitat for forest-adapted anopheline mosquito vectors of malaria. But in due course, other vector species occupied the changed habitat, contributing to the resurgence of malaria
- ❖ **To enhance production:** Many of the changes in **biodiversity** and **ecosystems** have been made to enhance the **production** of specific **ecosystem services** such as food production.
 - But only few ecosystem services examined in this assessment have been enhanced such as crops, livestock, **aquaculture**, and **carbon sequestration**.
 - Whereas, most services have been degraded such as, capture **fisheries**, timber production, water supply, waste treatment and detoxification, water purification, natural hazard protection, regulation of air quality, regulation of regional and local climate, regulation of erosion, and many cultural services (the spiritual, aesthetic, recreational, and other benefits of ecosystems).
- ❖ **Modifications to enhance specific services:**
 - For example, while the expansion of agriculture and its increased productivity are a success story of enhanced production of one key ecosystem service, this success has come at high and growing costs in terms of trade-offs with other ecosystem services, both through the direct impact of land cover change and as a result of water withdrawals for irrigation and release of nutrients into rivers.
 - An aquaculture farmer, for instance, may gain material welfare from management practices that increase soil salinization and thereby reduce rice yields and threaten food security for nearby subsistence farmers.

What is the value of biodiversity for human well-being?

- ❖ **The importance of biodiversity and natural processes in producing ecosystem services that people depend on is not captured in financial markets.**
 - Unlike goods bought and sold in markets, many ecosystem services do not have markets or readily observable prices. However, lack of a price does not mean lack of **value**.
 - A substantial body of research on nonmarket valuation is now available for some ecosystem services, including clean drinking water, recreation, or commercially harvested species.
 - Though clear in theory, getting reasonable estimates of option value is difficult in practice. Better quantification of the benefits derived from ecosystems would provide greater impetus for biodiversity protection and create a more transparent picture of the equitability of the distribution of benefits.

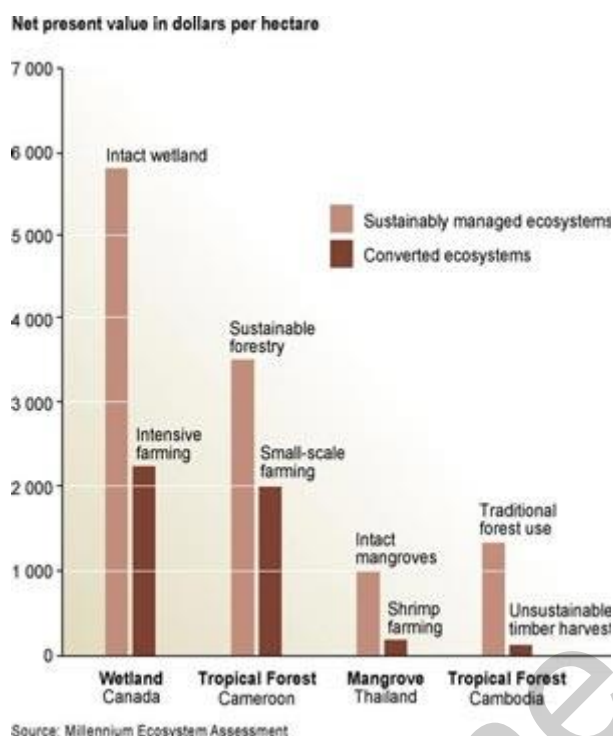


Figure: Economic Costs and Benefits of Ecosystem Conversion

- ❖ **Private and social values of conserving biodiversity and natural systems often differ widely.**
 - The private use value of biodiversity and ecosystem services by individuals will typically ignore the “external” benefits of conservation that accrue to society in general.
 - For example, a farmer may benefit from intensive use of the land but generally does not bear all the consequences caused by leaching of excess nutrients and pesticides into ground or surface water, or the consequences of loss of habitat for native species.
 - If private decision-makers are not given the incentives to value the larger social benefits of conservation, their decisions will often result in inadequate conservation.
- ❖ **The indirect values of biodiversity conservation can be highly significant in comparison with the direct economic values derived from a particular area**
 - In existing economic studies of changes to biodiversity in specific locations (such as the conversion of mangrove forests, degradation of coral reefs, and clear-felling of forests), the costs of ecosystem conversion are often found to be significant and sometimes exceed the benefits of the habitat conversion.
 - In a number of these cases conversion was promoted because the value of the lost ecosystem services—the indirect value of biodiversity conservation—was not internalized. In other instances, subsidies distorted the relative costs and benefits and provided the incentives to destroy biodiversity.
- ❖ **The depletion and degradation of many ecosystem services represents the loss of a capital asset that is poorly reflected in conventional indicators of economic growth or growth in human well-being**

GDP measures the flow of economic benefits from the use of these resources, but the depletion of the capital asset is not reflected

- A country could cut its forests and deplete its fisheries, and this would show only as a positive gain to GDP, despite the loss of the capital asset.
- Moreover, many ecosystem services are available freely to those who use them (fresh water in aquifers, for instance, and the use of the atmosphere as a sink for pollutants) and so again their degradation is not reflected in standard economic measures.
- When changes to these natural capital assets are factored into measures of the inclusive wealth of nations, they significantly change the balance sheet for countries with economies largely dependent on natural resources.

How are the impacts of biodiversity loss distributed geographically?

- ❖ **Biodiversity use, change, and loss have improved well-being for many social groups and individuals. But people with low resilience to ecosystem changes—mainly the disadvantaged—have been the biggest losers and witnessed the biggest increase in not only monetary poverty but also relative, temporary poverty and the depth of poverty.**
- ❖ **Many communities depend on a range of biological products for their material welfare:**
 - the transfer of ownership or use rights to ecosystem services like timber, fishing, and mining to privileged groups by governments have also excluded local communities from the use of these ecosystem services.
 - Provisions for ensuring the equitable distribution of monetary benefits from the use of biological products are an issue of major concern.
- ❖ **Poor people have historically disproportionately lost access to biological products and ecosystem services as demand for those services has grown:**
 - Coastal habitats are often converted to other uses, frequently for aquaculture ponds or cage culturing of highly valued species such as shrimp and salmon.
 - The development of shrimp aquaculture has displaced local fishers who are not able to enter the capital- and technology-intensive shrimp fisheries (for export).
 - Food security and overall well-being is much better in situations where local communities—with particular focus on the poor and the disadvantaged—were involved and made partners in the access, use, and management of biodiversity.

Case study of Vietnam:

Changes in the equity structure of societies can have impacts on ecosystem services.

- The economic liberalization in Vietnam resulted in the development of a class of entrepreneurs with markedly greater access to capital.
- The poorer fishers were unable to enter the capital and technology-intensive shrimp fishery that developed.
- Furthermore, the ecological changes precipitated by the expansion of shrimp aquaculture reduced the capacity of the ecosystem to support the traditional fish stocks, further exacerbating the inequity.

- ❖ **The increase in international trade of biological products has improved the well-being for many social groups and individuals, especially in countries with well-developed markets and trade rules and among people in developing countries who have access to the biological products. However, many groups have not benefited from such trade.**

- Examples include the many indigenous groups and local communities who have relied on these products and the ecosystem services they support for many of the constituents of well-being.
- Weak and inefficient institutional structures that oversee the equitable distribution of benefits are key reasons for the inequitable distribution of benefits at the national and local levels. In addition, structural adjustment programs played a key role in pushing the poor further into destitution and forcing many to have no choice but to further stress ecosystem services.
- ❖ **Conflicts between competing social groups or individuals over access to and use of biological products and ecosystem services have contributed to declines in well-being for some groups and improvements for others.**
 - For example, if mountain communities convert forests into agricultural lands, they may reduce downstream water quality.
 - Some groups improve and other groups decline describes some conflicts that emerged in Chile over the mining industry and local communities.
- ❖ **One of the main reasons some countries, social groups, or individuals—especially the disadvantaged—are more severely affected by biodiversity and ecosystem changes is limited access to substitutes or alternatives.**
 - When the quality of water deteriorates, the rich have the resources to buy personal water filters or imported bottled water that the poor can ill afford.
 - Similarly, urban populations in developing countries have easier access to clean energy sources because of easy access to the electrical grid, while rural communities have fewer choices.
 - Poor farmers often do not have the option of substituting modern methods for services provided by biodiversity because they cannot afford the alternatives. And, substitution of some services may not be sustainable, and may have negative environmental and human health effects.
 - For example, the reliance on toxic and persistent pesticides to control certain pests can have negative effects on the provision of services by the cultivated system and other ecosystems connected to the cultivated system.
 - Many industrial countries maintain **seed banks** in response to the rapid rate of loss of crop genetic diversity and to make existing genetic diversity more readily available to plant breeders. Seed banks could pose a problem when electricity supplies are unreliable, fuel is costly, and there is a lack of human capacity.

8. CURRENT STATUS

What are the current trends in biodiversity?

- ❖ **Across the range of biodiversity measures, current rates of change and loss exceed those of the historical past by several orders of magnitude and show no indication of slowing.**
 - At large scales, across biogeographic realms and ecosystems (biomes), declines in biodiversity are recorded in all parts of the habitable world.
 - Among well-studied groups of species, extinction rates of organisms are high and increasing (medium certainty), and at local levels both populations and habitats are most commonly found to be in decline.

- ❖ Virtually all of Earth's ecosystems have now been dramatically transformed through human actions (according to Millennium Ecosystem Assessment)
 - More land was converted to cropland in the 30 years after 1950 than in the 150 years between 1700 and 1850.
 - Between 1960 and 2000, reservoir storage capacity quadrupled and, as a result, the amount of water stored behind large dams is estimated to be three to six times the amount held by rivers.
 - Some 35% of mangroves have been lost in the last two decades in countries where adequate data are available (encompassing about half of the total mangrove area).
 - Roughly 20% of the world's coral reefs have been destroyed and an additional 20% have been degraded.
 - The biomes with the highest rates of conversion in the last half of the 20th century were temperate, tropical, and flooded grasslands and tropical dry forests (more than 14% lost between 1950 and 1990)
 - Areas of particularly rapid change in terrestrial ecosystems over the past two decades include
 - the Amazon basin and Southeast Asia (deforestation and expansion of croplands);
 - Asia (land degradation in drylands); and
 - Bangladesh, Indus Valley, parts of Middle East and Central Asia, and the Great Lakes region of Eastern Africa.

- ❖ **Habitat conversion to agricultural use has affected all biogeographical realms.**
 - In all realms (except Oceania and Antarctica), at least a quarter of the area had been converted to other land uses by 1950. In the 40 years from 1950 to 1990, habitat conversion has continued in nearly all realms.
 - The Indo-Malayan realm almost half of the natural habitat cover had been converted.
 - The temperate northern realms of the Nearctic and Palearctic are currently extensively cultivated and urbanized; however, the amount of land under cultivation and pasture seems to have stabilized in the Nearctic, with only small increases in the Palearctic in the last 40 years.
 - Within the tropics, rates of land conversion to agricultural use range from very high in the Indo-Malayan realm to moderate in the Neotropics and the Afrotropic, where large increases in cropland area have taken place since the 1950s. Australasia has relatively low levels of cultivation and urbanization, but these have also increased in the last 40 years at a similar rate to those of the Neotropics.

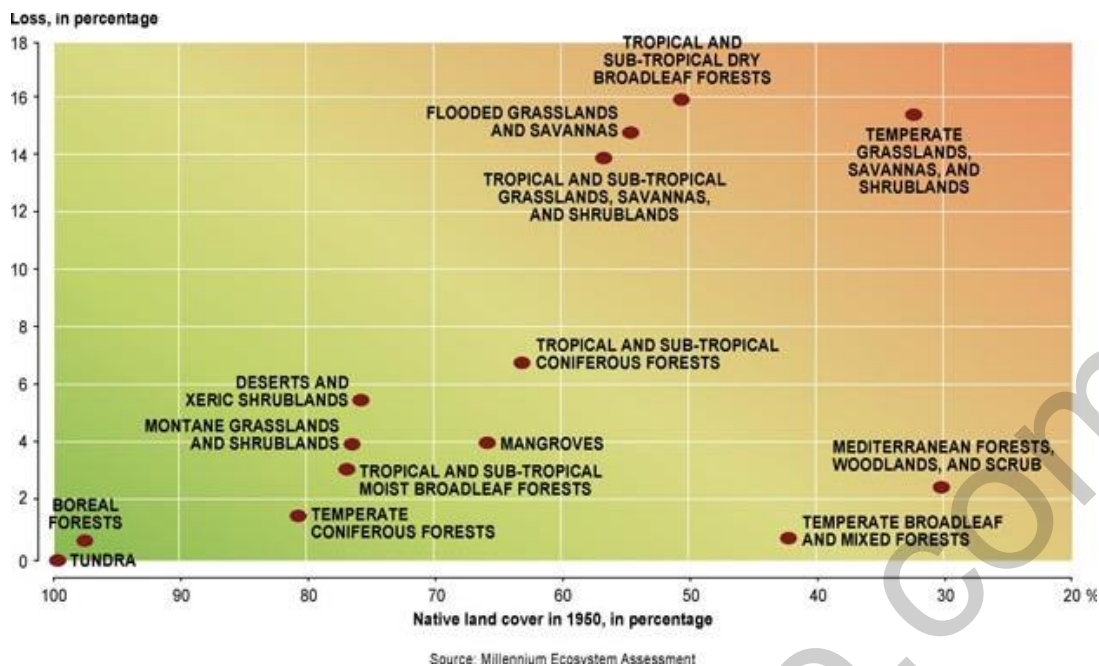


Figure: Native habitat losses

- ❖ The majority of biomes have been greatly modified. Between 20% and 50% of 9 out of 14 global biomes have been transformed to croplands.
 - Tropical dry forests were the most affected by cultivation between 1950 and 1990, although temperate grasslands, temperate broadleaf forests, and Mediterranean forests each experienced 55% or more conversion prior to 1950.
 - Biomes least affected by cultivation include boreal forests and tundra. While cultivated lands provide many provisioning services (such as grains, fruits, and meat), habitat conversion to agriculture typically leads to reductions in local native biodiversity.
- ❖ Rates of human conversion among biomes have remained similar over at least the last century.
 - For example, boreal forests had lost very little native habitat cover up to 1950 and have lost only a small additional percentage since then. In contrast, the temperate grasslands biome had lost nearly 70% of its native cover by 1950 and lost an additional 15.4% since then.
 - Two biomes appear to be exceptions to this pattern: Mediterranean forests and temperate broadleaf forests. Both had lost the majority of their native habitats by 1950 but since then have lost less than 2.5% additional habitat. These biomes contain many of the world's most established cities and most extensive surrounding agricultural development (Europe, the United States, the Mediterranean basin, and China). It is possible that in these biomes the most suitable land for agriculture had already been converted by 1950.

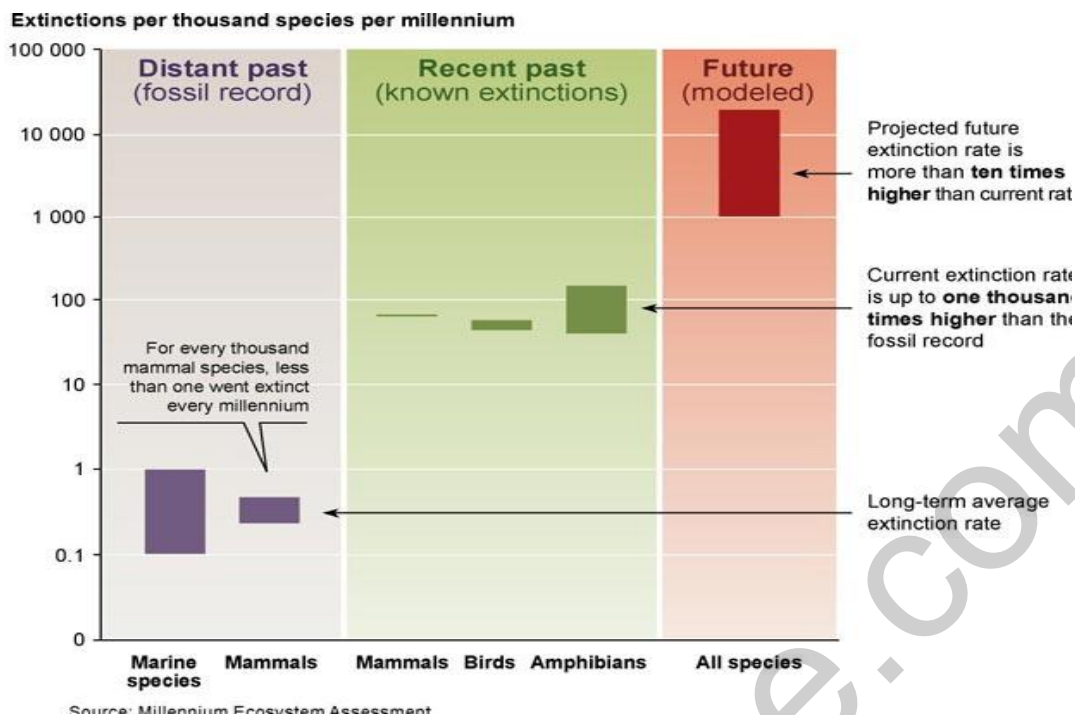


Figure: Extinction rates

- ❖ **Over the past few hundred years, humans have increased the species extinction rate by as much as three orders of magnitude (medium certainty).**
 - The status of many described species is poorly known, it is difficult to document the final disappearance of very rare species, and there are extinction lags between the impact of a threatening process and the resulting extinction.
 - However, the most definite information, based on recorded extinctions of known species over the past 100 years, indicates extinction rates are around 100 times greater than rates characteristic of species in the fossil record.
- ❖ **Between 12% and 52% of species within well-studied higher taxa are threatened with extinction, according to the IUCN Red List.**
 - Less than 10% of named species have been assessed in terms of their conservation status. Of those that have, birds have the lowest percentage of threatened species, at 12%.
 - The patterns of threat are broadly similar for mammals and conifers, which have 23% and 25% of species threatened, respectively.
 - The situation with amphibians looks similar, with 32% threatened, but information is more limited, so this may be an underestimate. Cycads have a much higher proportion of threatened species, with 52% globally threatened.
 - Threatened species show continuing declines in conservation status, and species threat rates tend to be highest in the realms with highest species richness.
- ❖ **Threatened vertebrates are most numerous in the biomes with intermediate levels of habitat conversion.**
 - Low-diversity biomes (such as boreal forest and tundra) have low species richness and low threat rates and have experienced little conversion.

- Very highly converted habitats in the temperate zone had lower richness than tropical biomes, and many species vulnerable to conversion may have gone extinct already. It is in the high-diversity, moderately converted tropical biomes that the greatest number of threatened vertebrates are found.
- ❖ **Among a range of higher taxa, the majority of species are currently in decline.**
 - Studies of amphibians globally, African mammals, birds in agricultural lands, British butterflies, Caribbean corals, water birds, and fishery species show the majority of species to be declining in range or number.
 - An aggregate indicator of trends in species populations—the Living Planet Index—uses published data on trends in natural populations of a variety of wild species to identify overall trends in species abundance.
- ❖ **Genetic diversity has declined globally, particularly among domesticated species.**
 - In cultivated systems, since 1960 there has been a fundamental shift in the pattern of intra-species diversity in farmers' fields and farming systems as a result of the Green Revolution.
 - Intensification of agricultural systems coupled with specialization by plant breeders and the harmonizing effects of globalization have led to a substantial reduction in the genetic diversity of domesticated plants and animals in agricultural systems.
 - The on-farm losses of genetic diversity of crops have been partially offset by the maintenance of genetic diversity in gene banks. A third of the 6,500 breeds of domesticated animals are threatened with extinction due to their very small population sizes.
 - In addition to cultivated systems, the extinction of species and loss of unique populations that has taken place has resulted in the loss of unique genetic diversity contained in those species and populations
- ❖ **Globally, the net rate of conversion of some ecosystems has begun to slow, and in some regions ecosystems are returning to more natural states largely due to reductions in the rate of expansion of cultivated land, though in some instances such trends reflect the fact that little habitat remains for further conversion.**
 - The opportunities for further expansion of cultivation are diminishing in many regions of the world as the finite proportion of land suitable for intensive agriculture continues to decline.
 - Increased agricultural productivity is also lowering pressures for agricultural expansion. Since 1950, cropland areas in North America, Europe, and China have stabilized, and even decreased in Europe and China. Cropland areas in the former Soviet Union have decreased since 1960. Within temperate and boreal zones, forest cover increased by approximately 3 million hectares per year in the 1990s, although about half of this increase consisted of forest plantation.
- ❖ **Rates of change in one biodiversity measure may underestimate or overestimate rates of change in another.**
 - The scaling of biodiversity between measures is not simple, and this is especially significant in the relationship between habitat area and species richness.

- Loss of habitat initially leads to less species loss than might be expected, but depending on how much habitat remains, rates of loss of habitat can underestimate rates of loss of species.

❖ Biotic homogenization

- It is the process whereby species assemblages become increasingly dominated by a small number of widespread species, represents further losses in biodiversity that are often missed when only considering changes in absolute numbers of species.
- The many species that are declining as a result of human activities tend to be replaced by a much smaller number of expanding species that thrive in human-altered environments. The outcome is a more homogenized biosphere with lower species diversity at a global scale.
- One effect is that in some regions where diversity has been low because of isolation, the species diversity may actually increase—a result of invasions of non-native forms (this is true in continental areas such as the Netherlands as well as on oceanic islands).

The patterns of threat and extinction are not evenly distributed among species but tend to be concentrated in particular ecological or taxonomic groups. Ecological traits shared by species facing high extinction risk include high trophic level, low population density, long lifespan, low reproductive rate, and small geographical range size (C4.4.2). The degree of extinction risk also tends to be similar among related species, leading to the likelihood that entire evolutionary radiations can and have been lost. The majority of recorded species extinctions since 1500 have occurred on islands. However, predictions of increasing numbers of future extinctions suggest a significant shift from island to continental areas (C4.4.2).

Causes of species extinction

Why Does Extinction Matters?

- **Role in ecosystem:** Biodiversity - the variety of species and their habitats - plays an **important role in ecosystem function** and in the many services ecosystems provide. These include **nutrient and water cycling, soil formation and retention, resistance against invasive species, plant pollination, climate regulation, and pest and pollution control.**
- **Economic values in ecosystem:** The **monetary value of goods and services** provided by ecosystems is estimated to amount to some **33 trillion dollars per year** – nearly twice the global production resulting from human activities.
- **Medicinal plants:** An estimated 50,000-70,000 plant species are used in **traditional and modern medicine** worldwide.
- **Food security:** About 100 million metric tons of aquatic organisms, including fish, mollusks and crustaceans are taken from the wild every year and represent a **vital contribution to world food security.** Meat from wild animals forms a critical contribution to **food sources and livelihoods** in many countries with high levels of poverty and food insecurity.

Reasons for Species Extinction	
Natural Reasons	<ul style="list-style-type: none"> ● Mass extinctions. Ex. Ordovician, Cretaceous (Dinosaurs), etc. ● Rivalry among species. Ex Competitive Exclusion ● Natural disasters like catastrophic floods, earthquakes, landslides, forest fires, etc.

	<p>Case study on Kaziranga National Park: Assam flood 2017: 70% of the park inundated; 17 rhinoceros, 170 hog deer dead</p> <ul style="list-style-type: none"> • Lack of pollination • Outbreak of diseases. Ex. Christmas island rat got extinct.
<p>Anthropogenic Reasons</p>	<ul style="list-style-type: none"> • Deforestation, population growth and habitat destruction (Swamp deer – critically endangered) • Unregulated hunting and poaching: The number of rhinos poached in South Africa alone has increased by 9,000% since 2007 - from 13 to a record 1,200 in 2014 (WWF). • Over-killing: It has pushed Baleen whale shark to critically endangered status. • Man-induced climate change: Bramble Cay Melomy (Great Barrier Reef) became the first mammal to go extinct due to sea level rise. • Introduction of invasive alien species: Introduction of Burmese Python in Everglade (Florida) and African catfish in Krishna River. • Chemical, nuclear and biological warfare.
<p>Initiatives:</p>	<div> <p>The diagram illustrates the IUCN Red List Categories. It starts with 'All species' which are 'Evaluated'. From 'Evaluated', there are two paths: 'Adequate data' and 'Data Deficient (DD)'. 'Adequate data' leads to 'Extinct (EX)', 'Extinct in the Wild (EW)', 'Critically Endangered (CR)', 'Endangered (EN)', and 'Vulnerable (VU)'. 'Data Deficient (DD)' leads to 'Near Threatened (NT)', 'Least Concern (LC)', and 'Not Evaluated (NE)'. A vertical bar on the right indicates 'Extinction risk' with a color gradient from green (low risk) to red (high risk). The categories CR, EN, and VU are grouped under 'Threatened'.</p> </div> <ol style="list-style-type: none"> 1) Convention on International Trade in Endangered Species of Fauna and Flora (CITES) 2) UNESCO's Man and Biosphere Programme 3) IUCN Red List 4) Convention on the conservation of migratory species (CMS) 5) The wildlife Trade Monitoring Network (TRAFFIC) 6) International Whaling Commission (IWC) 7) Coalition against wildlife trafficking (CAWT) 8) Global Tiger Forum (GTF) 9) Convention on Biological Diversity (CBD) 10) International Tropical Timber Organization (ITTO) 11) United Nations Forum on Forests (UNFF) 12) UNEP
<p>Strategies for Wildlife Conservation</p>	<ol style="list-style-type: none"> 1) Funding: National governments should appropriate optimal funds. Ex. USA = \$200 million annually. 2) Protected area network: Buffer zones (10 km) around Biosphere Reserves, national parks, wildlife sanctuaries should be declared as eco-fragile zones.

	<ul style="list-style-type: none"> ● Case study on Vulture: <ul style="list-style-type: none"> ○ Population of White Backed, Long Billed and Slender Billed vultures have declined by more than 90% due to diclofenac in India. ○ Upgraded from Schedule 4 to Schedule 1 of Wildlife (Protection) Act, 1972. ○ BNHS and Haryana Government: Vulture Captive Care Facility <p>3) Conservation efforts: Projects like Project Tiger (1973), Project Hangul, Integrated development of Wildlife Habitats are in the right direction.</p> <ul style="list-style-type: none"> ● Case study of Kruger Park for protecting Rhinoceros: <ul style="list-style-type: none"> ○ Injecting poison in the horn of rhinoceros ○ Cutting off the horns by authorities ○ Placing spider cameras in the horns <p>4) Community participation: Involvement of local people and tribals in protecting critical habitats.</p> <ul style="list-style-type: none"> ● Case study of Olive Ridley Turtle (IUCN = vulnerable) In Astranga (Odisha), a group of 13 teenagers: <ul style="list-style-type: none"> ○ Created awareness among fishing communities to use hooks to fish instead of nets and trawlers to protect turtles. ○ Initiated a programme to control the population of stray dogs in the area as they ate the eggs of turtles. ○ Prevented the construction of a port. <p>5) Role of media: Efforts of BBC Earth, Animal Planet, Discovery Channel, David Attenborough, etc. should be promoted to full extent.</p> <p>6) Awareness campaign: Involvement of film actors Ex. Leonardo Di Caprio for Climate Change, Amitabh Bachchan for Gujarat Tourism, special chapters in NCERT, making people aware that teeth of elephants and horns of rhinoceros have no medicinal value, prohibiting use of diclofenac and ketoprofen, etc. Ex. Gaj Yatra for protection of elephants.</p> <p>All national governments especially Vietnam, Thailand, China should ban trade in ivory, horns of rhinoceros, tiger skin, etc.</p>
--	---

WILDLIFE DISEASES

Wildlife means feral animals, captive wild animals and wild animals. Feral animal is an animal of a domesticated species that now lives without direct human supervision or control. **Wild animal** is an animal that has a **phenotype** unaffected by human selection and lives independent of direct human supervision or control.

What causes disease in plants and wildlife?

- Most plant diseases are caused by **fungi, bacteria, and viruses**. Although the term disease is usually used only for the destruction of live plants, the action of dry rot and the rotting of

harvested crops in storage or transport is similar to the roots of growing plants; both are caused by bacteria and fungi.

- Wild animals can play a major role in disease transmission and so they are important when addressing certain diseases in domestic animals or humans.
- **Climate change** is expected to lead to substantial changes in wildlife disease patterns and frequency.
- Conflicts between biodiversity conservation, public health and domestic animal health may further intensify as contact between humans, domestic animals and wild animals increases.
- Initiatives that seek to reduce **fragmentation of habitats** or to **improve access to the countryside** may lead to **new infection routes** emerging for plant and animal diseases, both into and out of the natural environment.
- Pests and diseases and their vectors may be native or non-native. There are particular links to aspects of **non-native species** policy and response.

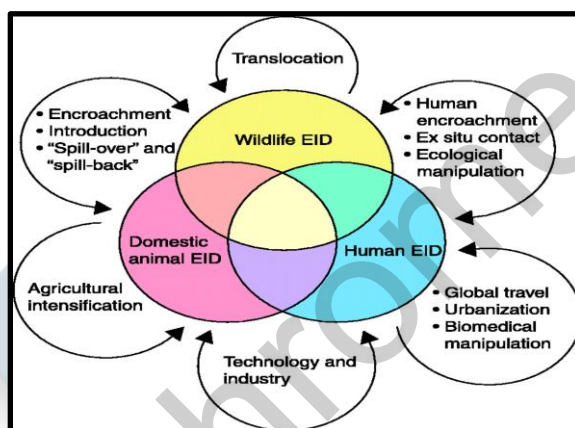
Harmful Diseases Through Animals:

Rabies	It is a viral disease that affects the central nervous system of mammals, including humans.
Ebola	<p>a) Ebola hemorrhagic fever is a severe, often-fatal disease in humans and nonhuman primates (some monkeys, gorillas, and chimpanzees).</p> <p>b) Ebola is considered to be a zoonosis.</p> <p>c) The main natural reservoir is thought to be some species of bats native to tropical forests.</p> <p>d) Large die-offs of endangered species of non-human primates have been linked to infection with Ebola and infected animals can then serve as a source of infection of Ebola in humans.</p> <p>e) Human outbreaks of Ebola virus are most likely linked to hunting and handling of infected wildlife.</p>
Foot and Mouth Disease	<p>a) Wild boar can serve as a reservoir for a number of diseases, including foot and mouth disease, pseudorabies, classical swine fever, African swine fever and brucellosis.</p> <p>b) These diseases can have a critical impact on the domestic swine sector and result in heavy production losses due to high mortality and slaughter for disease control purposes.</p> <p>c) Outbreaks in domestic pigs usually lead to the establishing of trade bans between partners</p>
Case study	<p style="text-align: center;">CANINE DISTEMPER VIRUS ATTACK IN GIR WILDLIFE SANCTUARY</p> <p>Asiatic Lion, one of the most majestic animals of wild, is today restricted to just Gir National Park in Gujarat (India). Once an undisputed king of the wilderness, today, the species suffer the danger of extinction. In the month of September, there have been 23 cases of deaths of Asiatic Lions. The major cause for the death is attributed to the Canine Distemper disease and Babesiosis Infection. Out of 23 deaths, 4 deaths have been caused by Canine Distemper Disease and 17 by Babesiosis Infection.</p> <p>Canine distemper is a contagious and serious disease caused by a virus that attacks the respiratory, gastrointestinal and nervous systems of puppies and dogs.</p> <p>The virus can also be found in wildlife such as foxes, wolves, coyotes, raccoons, skunks, mink and ferrets and has been reported in lions, tigers, leopards and other wild cats as well as seals.</p>

Consequences of Wildlife Diseases

- **Extinction of Species:** Wildlife diseases has the potential to wipe out the entire species. Example: Christmas Island Rat got extinct.
- **Threat to Endemic Species:** The outbreak of diseases can cause heavy losses of endemic species thus pushing them towards the verge of extinction
- **Threat to Agricultural Crops:** Outbreak of diseases in the wildlife can spread to agricultural crops. Destruction of agricultural crops can cause famines like in Ireland. **Infection in potatoes caused severe famine in Ireland.**
- **Threat to Humans:** Recent outbreak of Ebola virus in Liberia, Guinea, etc. has taken numerous lives.
- **Threat to Tourism:** Species extinction and outbreak of diseases can cause immense harm to the tourism industry which are dependent on the biological diversity.

Wildlife Disease Management:



The basic forms of management strategies exist for wildlife disease, which are as follows:

- Prevention of introduction of disease
- Control of existing disease
- Eradication
- **Management of diseases** of wild animals usually requires a change in human activities.
- Most important method is by **restricting translocation** of wild animals to prevent movement of disease.

9. FACTOR AFFECTING BIODIVERSITY

What is a "driver" and how does it affect biodiversity?

- ❖ **Biodiversity change is caused by a range of drivers. A driver is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.**
 - A **direct driver** unequivocally influences ecosystem processes. Important direct drivers affecting biodiversity are habitat change, climate change, invasive species, overexploitation, and pollution
 - An **indirect driver** operates more diffusely, by altering one or more direct drivers.
- ❖ **No single measure or indicator represents the totality of the various drivers.**

- Some direct drivers of change have relatively straightforward indicators, such as fertilizer usage, water consumption, irrigation, and harvests.
 - Indicators for other drivers, including invasion by non-native species, climate change, land cover conversion, and landscape fragmentation, are not as well developed, and data to measure them are not as readily available.
- ❖ **Changes in biodiversity and in ecosystems are almost always caused by multiple, interacting drivers.**
- Changes are driven by combinations of drivers that work over time (such as population and income growth interacting with technological advances that lead to climate change) or level of organization (such as local zoning laws versus international environmental treaties) and that happen intermittently (such as droughts, wars, and economic crises).

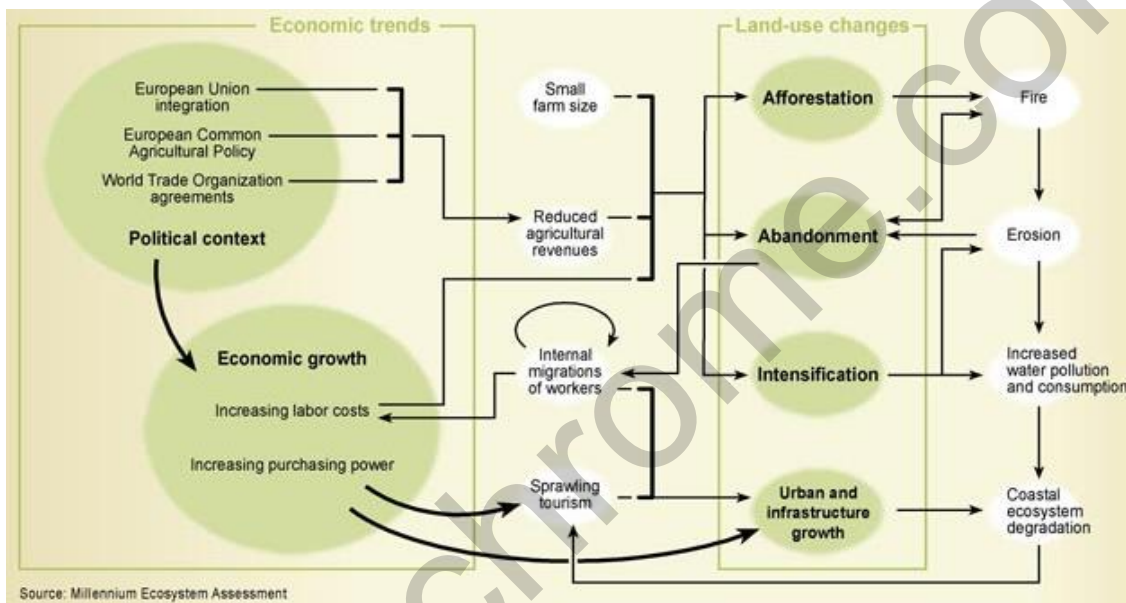


Figure: Feedbacks and Interactions

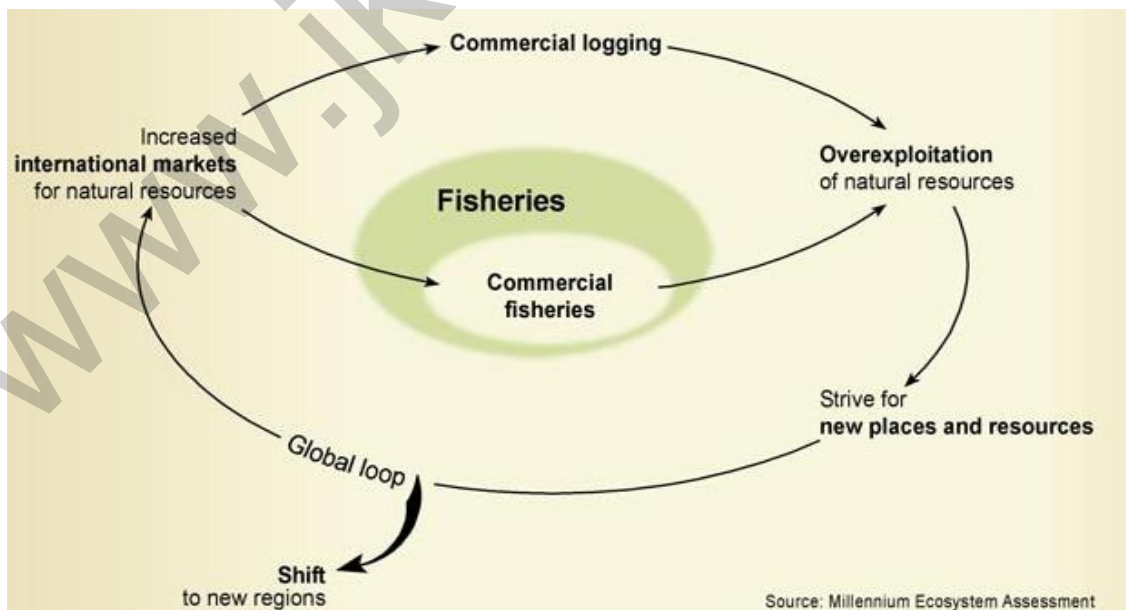


Figure : Overexploitation and interactions between drivers

What are indirect drivers of biodiversity change?

- ❖ **Biodiversity change is most clearly a consequence of the direct drivers. However, these reflect changes in indirect drivers—the root causes of changes in ecosystems.** These can be classified into the following broad categories: change in economic activity, demographic change, sociopolitical factors, cultural and religious factors, and scientific and technological change.
- ❖ Global economic activity increased nearly sevenfold between 1950 and 2000. The many processes of globalization have amplified some driving forces of changes in ecosystem services and attenuated other forces by removing regional barriers, weakening national connections, and increasing the interdependence among people and between nations.
- ❖ Global population doubled in the past 40 years, reaching 7.7 billion in next few years. It is projected to grow to 8.1–9.6 billion by 2050, depending on the scenario. Urbanization influences consumption, generally increasing the demand for food and energy and thereby increasing pressures on ecosystems globally.
- ❖ Culture conditions individuals' perceptions of the world, and by influencing what they consider important, it has implications for conservation and consumer preferences and suggests courses of action that are appropriate and inappropriate. The development and diffusion of scientific knowledge and technologies can on the one hand allow for increased efficiency in resource use and on the other hand can provide the means to increase exploitation of resources.

Which direct drivers are critical in different ecosystems?

- ❖ **Direct drivers vary in their importance within and among systems and in the extent to which they are increasing their impact.**
 - Historically, habitat and land use change have had the biggest impact on biodiversity across biomes.
 - Climate change is projected to increasingly affect all aspects of biodiversity, from individual organisms, through populations and species, to ecosystem composition and function.
 - Pollution, especially the deposition of nitrogen and phosphorus, but also including the impact of other contaminants, is also expected to have an increasing impact, leading to declining biodiversity across biomes.
 - Overexploitation and invasive species have been important as well and continue to be major drivers of changes in biodiversity.
- ❖ **For terrestrial ecosystems, the most important direct driver of change in the past 50 years has been land cover change.**
 - Only biomes relatively unsuited to crop plants, such as deserts, boreal forests, and tundra, are relatively intact. Deforestation and forest degradation are currently more extensive in the tropics than in the rest of the world, although data on boreal forests are especially limited.
 - Approximately 10–20% of drylands are considered degraded, with the majority of these areas in Asia.
- ❖ **Cultivated systems (at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture in any particular year) cover 24% of Earth's surface.**
 - In 1990, around 40% of the cropland is located in Asia; Europe accounts for 16%, and Africa, North America, and South America each account for 13%.

❖ **For marine ecosystems, the most important direct driver of change in the past 50 years, in the aggregate, has been fishing.**

- Fishing is the major direct anthropogenic force affecting the structure, function, and biodiversity of the oceans.
- Fishing pressure is so strong in some marine systems that over much of the world the biomass of fish targeted in fisheries (including that of both the target species and those caught incidentally) has been reduced by 90% relative to levels prior to the onset of industrial fishing.
- Recent studies have demonstrated that global **fisheries landings** peaked in the late 1980s and are now declining despite increasing effort and fishing power, with little evidence of this trend reversing under current practices
- **Destructive fishing** is also a factor in shallower waters; bottom trawling homogenizes three-dimensional benthic habitats and dramatically reduces biodiversity.

Fish landings are defined as the catches of marine fish landed in foreign or domestic ports. Marine capture fisheries landings are subject to changes in market demand and prices as well as the need to rebuild stocks to maximum sustainable yield levels in order to achieve long-term sustainable use of marine resources. This indicator concerns national landings in domestic ports and in foreign ports. It is measured in tonnes and USD.

Destructive fishing practices

1. **Bottom trawling:** Industrial trawlers once avoided coral reefs and other rocky regions of the ocean floor because their nets would snag and tear. But the introduction of rockhopper trawls in the 1980s changed this. The largest, with heavy rollers over 75cm in diameter, are very powerful, capable of moving boulders weighing 25 tonnes. Now, most of the ocean floor can be trawled down to a depth of 2,000m. In heavily fished areas around coral seamounts off southern Australia for example, 90% of the surfaces where coral used to grow are now bare rock. Like removing forest, removing this cover decreases the area available for marine species to live and thrive in.
2. **Cyanide fishing:** In this technique, fishers squirt sodium cyanide into the water to stun fish without killing them, making them easy to catch. Cyanide fishing on coral reefs began in the 1960s to supply the international aquarium trade. But since the early 1980s, supplying live reef fish for the restaurants of Hong Kong, Singapore, and, increasingly, mainland China is a much more profitable business. Some 20,000 tonnes of live fish are eaten annually in the restaurants of Hong Kong - and for every live fish caught using cyanide, a square metre of their coral reef home is killed.
3. **Dynamite fishing:** In this technique, dynamite or other explosives are set off under water. The dead fish floating to the surface are then simply scooped up. The explosives completely destroy the underwater environment, leaving it as rubble. Dynamite fishing has contributed to massive destruction of, for example, Southeast Asian coral reefs over the past 20 years.
4. **Ghost fishing:** Ghost fishing occurs when fishing gear is lost or abandoned at sea. The gear can continue to catch fish, dolphins, whales, turtles, and other creatures as it drifts through the water and after it becomes snagged on the seabed. When driftnets were used on the High Seas, an estimated 1,000km of ghost nets were released each year into the North Pacific Ocean alone.

- ❖ **For freshwater ecosystems, depending on the region, the most important direct drivers of change in the past 50 years include physical changes, modification of water regimes, invasive species, and pollution.**
 - The loss of wetlands worldwide has been speculated to be 50% of those that existed in 1900.
 - Massive changes have been made in water regimes. In Asia, 78% of the total reservoir volume was constructed in the last decade, and in South America almost 60% of all reservoirs were built since the 1980s.
 - Water withdrawals from rivers and lakes for irrigation or urban or industrial use increased six-fold since 1900.
 - Globally, humans now use roughly 10% of the available renewable freshwater supply, although in some regions, such as the Middle East and North Africa, humans use 120% of renewable supplies—the excess is obtained through mining groundwater.
 - The introduction of non-native invasive species is now a major cause of species extinction in freshwater systems. It is well established that the increased discharge of nutrients causes intensive eutrophication and potentially high levels of nitrate in drinking water and that pollution from point sources such as mining has had devastating impacts on the biota of inland waters.

How are specific direct drivers affecting biodiversity?

1. Habitat change

- ❖ **habitats suffer from fragmentation.**
 - Fragmentation is caused by natural disturbance (such as fires or wind) or by land use change and habitat loss, such as the clearing of natural vegetation for agriculture or road construction, which divides previously continuous habitats.
 - Larger remnants, and remnants that are close to other remnants, are less affected by fragmentation. Small fragments of habitat can only support small populations, which tend to be more vulnerable to extinction.
 - Moreover, habitat along the edge of a fragment has a different climate and favors different species to the interior. Small fragments are therefore unfavorable for those species that require interior habitat, and they may lead to the extinction of those species.
 - Species that are specialized to particular habitats and those whose dispersal abilities are weak suffer from fragmentation more than generalist species with good dispersal ability.

2. Invasive alien species

- ❖ **Invasive alien species have been a major cause of extinction, especially on islands and in freshwater habitats, and they continue to be a problem in many areas.**
 - In freshwater habitats, the introduction of alien species is the second leading cause of species extinction, and on islands it is the main cause of extinction over the past 20 years, along with habitat destruction.
 - The rate of introductions continues to be extremely high; for example, in New Zealand plant introductions alone have occurred at a rate of 11 species per year since European settlement in 1840.

INVASIVE ALIEN SPECIES

Definitions:

The understanding and management of invasive alien species (IAS) is an immature, emerging science and its terminology continues to evolve and change. There is currently no convenient glossary of terms that provides a comprehensive set of definitions based on fully understood processes.

Terms such as alien, invasive, weed, feral, exotic and more are sometimes used interchangeably, or to describe the same thing.

- **Alien species** – a species that has been **intentionally or unintentionally** introduced to a location, area, or region where it does not occur naturally.
- **Invasive species** – a species that has established and spread or has the potential to do so outside of its natural distribution range, and which then threatens ecosystems, habitats and/or other species, potentially causing economic and/or environmental damage, or harm to human health.
- **Invasive alien species (IAS)** – An alien species that has established and spread, and which causes, or has the potential to cause, harm to the environment, economies, or human health.
- There are various versions of the IAS definition.
 - For example, the **Convention on Biological Diversity (CBD)** defines “an IAS as an alien species whose establishment and spread threatens ecosystems, habitats or species with economic or environmental harm”.
 - According to the **IUCN** an IAS is an alien species which becomes established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity.



Characteristics Invasive Alien Species (IAS)

1. They are the **second biggest threat to biodiversity** (after habitat destruction).
2. They cause **enormous and often irreversible harm to biodiversity** around the world by displacing native and useful species and changing ecosystems.
3. They are responsible for the extinction or decline of many species and continue to pose a huge threat to many more.
4. They cost economies billions of dollars every year, in lost production, control and mitigation efforts, loss of ecosystem services and many other ways.
5. An alien species is considered invasive only if it **establishes and spreads in its new location**, and has **adverse impacts on the environment**, the economy or human health.
6. IAS are not restricted to plants and mammals, but come from almost every major taxon of organisms.

Many alien populations undergo a lag phase after initial establishment, and may **remain unobtrusive/non-invasive for a long time** before suddenly changing, becoming invasive and spreading rapidly.

The Process of Invasion.

The main phases in the invasion process are:

Phases	Characteristics
Introduction of the species	<ul style="list-style-type: none"> Species coming from another place must survive during and after the journey. Many species fail to survive unless they are cared for (e.g. aquarium fish). However, almost all invasive plants spread as seeds which do not require special care while being transported.
Establishment and reproduction of the introduced species	<ul style="list-style-type: none"> The survivors must persist and reproduce successfully (i.e. there usually needs to be more than one individual) until they establish a self-sustaining population. In certain cases, established populations will multiply rapidly and spread across the landscape.
The lag phases.	<ul style="list-style-type: none"> Some species show no lag phase, and will begin to spread rapidly and uncontrollably as soon as they establish. On the other hand, many IAS have a lag phase, during which they occur at low densities and their impacts are not noticeable. The duration of this lag phase will vary depending on the species, and circumstances, and may be only a few months, or as long as centuries. Once the population starts increasing (explosion phase), the impacts will rapidly become apparent. Following the explosion phase, the growth levels out of the population reaches the carrying capacity of the environment. The variable duration of the lag phase means that one cannot assume that an apparently benign alien species is safe to ignore, as it may change. It is therefore preferable not to allow an alien species to become established, even if there is no immediate indication that it is invasive.
Spread	<ul style="list-style-type: none"> This is the explosion phase and may only happen after a considerable lag phase

Examples of Invasive Alien Species in India:

A. Flora

Needle Bush	<p>Nativity: Tropical South America</p> <p>Distribution in India: Throughout</p> <p>Features: A shrub or small tree. Occasional in thorny scrub and dry degraded forests and often creates close thickets.</p>
Black Wattle	<p>Nativity: South East Australia</p> <p>Distribution in India: Western Ghats</p>

	Features: Introduced for afforestation in Western Ghats. Regenerates rapidly after fire and forms dense thickets. It is distributed in forests and grazing lands in high altitude areas.
Goat Weed	Nativity: Tropical America Distribution in India: Throughout Features: Aggressive colonizer. Troublesome weed in gardens, cultivated fields and forests.
Alternanthera Paronychioides	Nativity: Tropical America Distribution in India: Throughout Features: Occasional weed along edges of tanks, ditches and in marshy lands.
Prickly Poppy	Nativity: Tropical Central & South America Distribution in India: Throughout Features: Aggressive colonizer. Common winter season weed in cultivated fields, scrub lands and fringes of forest.
Blumea Eriantha	Nativity: Tropical America Distribution in India: Throughout Features: Aggressive colonizer. Abundant along railway track, road sides and degraded forests land
Calotropis/ Madar, Swallo	Nativity: Tropical Africa Distribution in India: Throughout Features: Aggressive colonizer. Common in cultivated fields, scrub lands and waste lands.
Wort Palmyra, Toddy Palm	Nativity: Tropical Africa Distribution in India: Throughout Features: Aggressive colonizer. Cultivated and self-sown, occasionally found to be gregarious nearby cultivated fields, scrub lands and waste lands.
Datura, Mad Plant, Thorn Apple	Nativity: Tropical America Distribution in India: Throughout Features: Aggressive colonizer. Occasional weed on disturbed ground.
Water Hyacinth	Nativity: Tropical America Distribution in India: Throughout Features: Aggressive colonizer. Abundant in still or slow floating waters. Nuisance for a aquatic ecosystem.
Impatiens, Balsam	Nativity: Tropical America Distribution in India: Throughout Features: Aggressive colonizer. Common along railway tracks; also runs wild in gardens.
Ipomoea/ the pink morning glory	Nativity: Tropical America Distribution in India: Throughout

	Features: Aggressive colonizer. Common weed of marshy lands and along the edges of tanks and ditches.
Lantana camara/ Lantana, Wild Sage	Nativity: Tropical America Distribution in India: Throughout Features: Aggressive colonizer. Common weed of forests, plantations, habitation, waste lands and scrubs lands.
Black Mimosa	Nativity: Tropical North America Distribution in India: Himalaya, Western Ghats Features: Aggressive colonizer. It invades water courses and seasonally flooded wetlands.
Touch-Me-Not, Sleeping Grass	Nativity: Brazil Distribution in India: Throughout Features: Aggressive colonizer. Common weed of cultivated fields, scrubs lands and degraded forests.
4' O Clock plant	Nativity: Peru Distribution in India: Throughout Features: Aggressive colonizer. Runs wild in gardens and near habitation.
Parthenium/ Congress grass, Parthenium	Nativity: Tropical North America Distribution in India: Throughout Features: Aggressive colonizer. Common weed of cultivated fields, forests, overgrazed pastures, waste lands and gardens.
Prosopis juliflora/Mesquite	Nativity: Mexico Distribution in India: Throughout Features: Aggressive colonizer. Common weed of waste lands, scrub lands and degraded forests.
Townsend grass	Nativity: Tropical West Asia Distribution in India: Throughout Features: Very common along streams and banks of rivers

B. Fauna

African apple snail	: It is most invasive among all alien fauna in India. It is mollusc and was first reported in Andaman and Nicobar Islands. Now it is found all across country and is threatening habitats of several native species.
Papaya Mealy Bug	It is native to Mexico and Central America. It is believed to have destroyed huge crops of papaya in Assam, West Bengal and Tamil Nadu.
Cotton Mealybug	It is native of North America. It has severely affected cotton crops in the Deccan
Amazon sailfin catfish	: It is responsible for destroying fish populations in the wetlands of Kolkata.
Other examples	Giant African Snail, Myna, Pigeon and Donkey

Impacts of Invasive Alien Species

- The number of species that have gone extinct due to IAS is high, and all major taxa are affected. For example, the **island of Guam in the Pacific Ocean** has lost almost all its native forest bird species, two native mammals and nine native reptiles to one IAS, the brown tree snake (*Boiga irregularis*).
- In a different example, although humans probably destroyed much of the endemic palm on Easter island, every single seed found by archaeologists had been gnawed by the introduced **Kiore or Pacific rat** (*Rattus exulans*), undoubtedly contributing to the palm's extinction.
- The introduction of the **predatory Nile perch** to Lake Victoria (in eastern Africa) precipitated a flood of extinctions in the endemic cichlid fish.
- The introduction of alien organisms into a new environment can have **serious negative consequences for the environment and local biodiversity**, for industries and users of natural resources, and also for the health and welfare of those associated with the affected systems.
- While impacts can be direct and indirect, the principal consequences can be grouped into three main categories - **ecological, economic and public health and society**.

SEAWEEDS AND SEAGRASSES

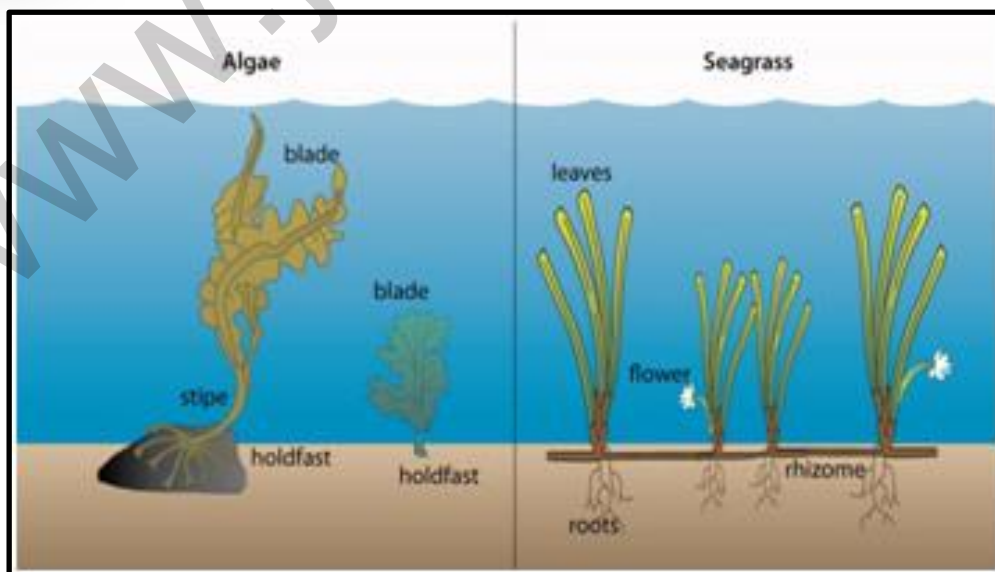
What is seaweed?

Marine macroalgae, or seaweeds, are plant-like organisms that generally live attached to rock or other hard substrata in coastal areas.

Macroalgae (seaweeds) can be classified into three broad groups as **red algae, brown algae and green algae**, based on their pigmentation.

What is Seagrass?

Seagrasses are found in shallow salty and brackish waters in many parts of the world, from the **tropics to the Arctic Circle**. Seagrasses are so-named because most species have **long green, grass-like leaves**. They are often confused with seaweeds, but are actually more closely related to the **flowering plants** that you see on land. **Seagrasses have roots, stems and leaves, and produce flowers and seeds**. They evolved around 100 million years ago, and today there are approximately 72 different seagrass species that belong to four major groups.



Difference between sea grasses and sea weeds

Sea weeds	Sea grasses
a) Seaweeds , are plant-like organisms that generally live attached to rock or other hard substrata in coastal areas.	a) Seagrass can easily be confused with marine macroalgae. While seagrasses are considered vascular plants and have roots, stems and leaves
b) Sea weeds only produces spores	b) Sea grass produces flowers, seeds and fruits
c) Sea weeds does not have roots. It uses 'holdfasts' to anchor itself to other objects.	c) Sea grass has roots.
d) Sea weeds are macroalgae	d) Seagrass is a flowering plant
e) Sea weeds uses extracts nutrients from the water	e) Seagrass uses its roots to extract nutrients from the sediments
f) Sea weeds are threatened by damaging fishing methods and pollution	f) Sea grasses also threatened by damaging fishing methods and pollution
g) There estimated to be between 5000 and 6000 known species of seaweeds	g) The recorded number of species seagrass approximately 60.

Importance of Seaweeds

Seaweed plays an important and vital role in the marine ecosystem, providing food and shelter for a host of creatures such as green sea urchins, lobsters, and young fish. It is also an important **resource for people**. Almost all are algae, which is one of the simplest forms of plant life because they have no roots, stems, leaves, and flowers.

- Seaweeds are potentially excellent sources of **highly bioactive secondary metabolites** that could represent useful leads in the development of new functional ingredients.
- It provides a **food source for coastal birds** and helps to shore up the vital dune system.
- They are used as **animal and fish feed**.
- They can be used as **fuels**.
- They are used in **cosmetic industries**.
- They are integral component of **integrated aquaculture**.
- They help in **removal of toxic metals** from industrial effluents.

Threats to seaweeds

- **Climate change**: In recent years there has been a decline and shift in **distribution of kelps** and other seaweed species.
- **Ocean Acidification**: There is also evidence that the **sea is becoming more acidic**, because it absorbs a large portion of carbon dioxide. Although the long-term effects are unknown, this could be damaging as it may begin to corrode the exterior of some calcified seaweeds.
- **Unchecked fishing**: Bottom trawling fishing also caused destruction of seaweeds.
- **Pollution**: Thermal pollution and oil contamination along the coastline also causes destruction.

Importance of Seagrass

- Seagrasses are flowering plants that are an important part of the **food web**.
- They provide **food for turtles, manatees and a variety of fish** and habitat for filter-feeding organisms and foraging sea life such as sea urchins and sea cucumbers.
- Seagrasses are a **nursery ground** for pink shrimp, lobster, snapper and other sea life and stabilize the ocean bottom by trapping sediments. Seagrasses offer food and habitat for juvenile fish, crustaceans and shellfish.
- They **filter the water of sediments**, release oxygen into the water and **stabilizes the bottom** with their roots.

Threats to Seagrasses

- Seagrasses are related to land-based plants. Like them, they have leaves, stems and flowers, as well as roots. In healthy beds, when leaves are damaged from storms, unusual cold, or overgrazing, seagrasses grow back quickly.
- But prop dredging, causing deep cuts in the ocean floor, causes damage to the root systems of seagrasses.
- These "cuts," most often caused by water jet skis and motorboats, make scars in the seagrass meadows that take years to re-grow.
- These lines are cuts made by prop dredging. In rough weather, vast clouds of calcium carbonate, the limestone that was created from ancient coral beds becomes suspended in the water and severely limits visibility for days.

3. Overexploitation

- ❖ **Overexploitation remains a serious threat to many species and populations.** Among the most commonly overexploited species or groups of species are marine fish and invertebrates, trees, and animals hunted for meat.
- ❖ Most industrial fisheries are either fully or overexploited, and the impacts of overharvesting are coupled to destructive fishing techniques that destroy habitat, as well as associated ecosystems such as estuaries and wetlands. Even recreational and subsistence fishing has contributed to what is known as the "shifting baselines" phenomenon, in which what we consider the norm today is dramatically different from pre-exploitation conditions.
- ❖ Many of the current concerns with overexploitation of bushmeat (wild meat taken from the forests by local people for income or subsistence) are similar to those of fisheries, where sustainable levels of exploitation remain poorly understood and where the offtake is difficult to manage effectively.
- ❖ The trade in wild plants and animals and their derivatives is poorly documented but is estimated at nearly \$160 billion annually. It ranges from live animals for the food and pet trade to ornamental plants and timber. Because the trade in wild animals and plants crosses national borders, the effort to regulate it requires international cooperation to safeguard certain species from overexploitation

4. Nutrient loading (or pollution)

- ❖ **Over the past four decades, nutrient loading has emerged as one of the most important drivers of ecosystem change in terrestrial, freshwater, and coastal ecosystems.**
 - While the introduction of nutrients into ecosystems can have both beneficial and adverse effects, the beneficial effects will eventually reach a threshold as more nutrients are added (for example, additional inputs will not lead to further increases in crop yield), while the harmful effects will continue to grow.

- Synthetic production of nitrogen fertilizer has been the key driver for the remarkable increase in food production of the past 50 years. The total amount of reactive, or biologically available, nitrogen created by human activities increased nine-fold between 1890 and 1990,
- More than half of all the synthetic nitrogen fertilizers ever used on Earth have been used since 1985. Nitrogen application has increased fivefold since 1960, but as much as 50% of the nitrogen fertilizer applied may be lost to the environment.
- Phosphorus application has increased threefold since 1960, with steady increase until 1990, followed by leveling off at a level about equal to applications in 1980. These changes are mirrored by phosphorus accumulation in soils, which can serve as an indicator of eutrophication potential for freshwater lakes and phosphorus-sensitive estuaries.
- Potential consequences include eutrophication of freshwater ecosystems, hypoxia in coastal marine ecosystems, nitrous oxide emissions contributing to global climate change, and air pollution by NO_x in urban areas.

How is climate change affecting biodiversity?

❖ Climate change in the past century has already had a measurable impact on biodiversity:

- Observed recent changes in climate, especially warmer regional temperatures, have already had significant impacts on biodiversity and ecosystems, including causing changes in species distributions, population sizes, the timing of reproduction or migration events, and an increase in the frequency of pest and disease outbreaks.
- Many coral reefs have undergone major bleaching episodes when local sea surface temperatures have increased by 0.5–1 Celsius above the average of the hottest months.
- Precipitation patterns have changed spatially and temporally, and global average sea level rose 0.1–0.2 meters.

❖ Recent studies,

- By using the **climate envelope**/species-area technique, estimated that the projected changes in climate by 2050 could lead to an eventual extinction of 15–52% of the subset of 1,103 endemic species (mammals, birds, frogs, reptiles, butterflies, and plants) analyzed.
- While the growing season in Europe has lengthened over the last 30 years, in some regions of Africa the combination of regional climate changes and anthropogenic stresses has led to decreased cereal crop production since 1970.
- Changes in fish populations have been linked to large-scale climate oscillations; El Niño events, for instance, have affected fisheries off the coasts of South America and Africa, and decadal oscillations in the Pacific have affected fisheries off the west coast of North America.

Climate envelope models

- Climate envelope models are an important tool used in vulnerability assessments to help resource managers understand how plants and animals may respond to a changing climate.
- Climate envelope models describe the climate where a species currently lives (its climate "envelope"), and then map the geographic shift of that envelope under climate change. Because we can't know for certain how climate will change in the future, multiple climate change scenarios are used in these models.

- Well-validated models can provide information for natural resource planning by identifying species most at risk from climate change and highlighting areas of potential future conflict between human activities and conservation priorities.
- The climate envelope modeling project is a partnership among the University of Florida, U.S. Fish and Wildlife Service, U.S. Geological Survey, and National Park Service.

Harm to biodiversity will grow worldwide with increasing rates of change in climate and increasing absolute amounts of change.

- Climate change is projected to exacerbate the loss of biodiversity and increase the risk of extinction for many species, especially those already at risk due to factors such as low population numbers, restricted or patchy habitats, and limited climatic ranges. Water availability and quality are projected to decrease in many arid and semiarid regions. The risk of floods and droughts is projected to increase.
- The reliability of hydropower and biomass production is projected to decrease in some regions.
- The incidence of vector-borne diseases such as malaria and dengue and of waterborne diseases such as cholera is projected to increase in many regions, and so too are heat stress mortality and threats of decreased nutrition in other regions, along with severe weather traumatic injury and death.
- Agricultural productivity is projected to decrease in the tropics and sub-tropics for almost any amount of warming, and there are projected adverse effects on fisheries.

Projected changes in climate during the twenty-first century are very likely to be without precedent during at least the past 10,000 years and, combined with land use change and the spread of exotic or alien species, are likely to limit both the capability of species to migrate and the ability of species to persist in fragmented habitats.

10. PROTECTION AND CONSERVATION OF BIODIVERSITY

What are the key factors of success of conservation actions?

- ❖ Numerous response options exist to improve the benefits from ecosystem services to human societies without undermining biodiversity.
 - The political and social changes now occurring in many parts of the world will have far-reaching consequences for the way ecosystem services and human well-being are managed in the future.
- ❖ A variety of enabling conditions—a combination of instrumental freedoms and institutional frameworks—play critical roles in determining the success or failure of a response strategy.
- ❖ **Spreading Awareness:**
 - Education and communication programs have both informed and changed preferences for biodiversity conservation and have improved implementation of biodiversity responses.
 - Scientific findings and data need to be made available to all of society.
 - The CONABIO initiative in Mexico and INBio in Costa Rica offer examples of successful national models for converting basic taxonomic information into knowledge for biodiversity conservation policies, as well as for other policies relating to ecosystems and biodiversity.

- ❖ **Ecosystem restoration** activities are now common in many countries and include actions to restore almost all types of ecosystems, including wetlands, forests, grasslands, estuaries, coral reefs, and mangroves.
 - Restoration will become an increasingly important response as more ecosystems become degraded and as demands for their services continue to grow.
 - Ecosystem restoration, however, is generally far more expensive an option than protecting the original ecosystem, and it is rare that all the biodiversity and services of a system can be restored.
- ❖ **Acknowledge the trade-offs between conservation and development:**
 - Identifying and then negotiating trade-offs is complex, involving different policy options, different priorities for conservation and development, and different stakeholders.
 - In the case of biodiversity conservation, the challenge is in negotiating these trade-offs, determining Levels of acceptable biodiversity loss, and encouraging stakeholder participation. Better trade-offs from policies that remove perverse incentives or create markets for biodiversity protection can achieve a given level of biodiversity protection (regionally) at lower cost.
 - Example: The Ken-Betwa river-linking project involves diversion of around 6,000 hectares of forests, mostly from the Panna National Park tiger reserve in Madhya Pradesh
- ❖ **The “ecosystem approaches” as developed by the CBD:** The rationale is that the full range of measures is applied in a continuum from strictly protected to human-made ecosystems and that integration can be achieved through both spatial and temporal separation across the landscape, as well as through integration within a site.
- ❖ **More social opportunities:**
 - An area converted to agriculture can lead to loss of biodiversity but can still contribute to regional biodiversity if it contributes certain complementary elements of biodiversity to overall regional biodiversity conservation. E.g. community reserves, Social forestry and compensatory afforestation
 - Formal protected areas are criticized for foreclosing other opportunities for society, but an integrated regional approach can build on the biodiversity protection gains from the surrounding lands, thereby reducing some of the pressure for biodiversity protection in the face of other anticipated uses over the region. E.g. wildlife sanctuaries are allowed controlled human activities

How could important drivers of biodiversity loss be addressed?

Numerous responses that address direct and indirect drivers would be particularly important for biodiversity and ecosystem services:

- ❖ **Elimination of subsidies that promote excessive use of specific ecosystem services.**
 - Public investments in agriculture as a percentage of agricultural GDP has declined from 3.9 per cent in 1980-81 to 2.2 per cent in 2014-15, while input subsidies as a percentage of agricultural GDP have increased from 2.8 per cent to around 8 per cent over the same period.
 - These subsidies lead to overproduction, reduce the profitability of agriculture in developing countries, and promote overuse of fertilizers and pesticides. Similar problems are created by fishery subsidies.

❖ **Promotion of sustainable intensification of agriculture:**

- The expansion of agriculture will continue to be one of the major drivers of biodiversity loss well into the twenty-first century.
- The development, assessment, and diffusion of technologies that could increase the production of food per unit area sustainably, without harmful trade-offs related to excessive consumption of water or use of nutrients or pesticides, would significantly lessen pressure on biodiversity. E.g. GIAHS cities in India: Koraput, Odisha State; Kashmir Valley, Pampore region; and Kuttanad, Kerala
- We can also contribute to agricultural productivity and sustainability through the ecosystem services that biodiversity provides (such as through pest control, pollination, soil fertility, protection of water courses against soil erosion, and the removal of excessive nutrients).

The Global Agricultural Heritage Systems (GIAHS) was started by Food and Agricultural Organization (FAO) for the purpose of creating public awareness and safeguarding the World agricultural heritage sites. There are three regions of India, which has been recognized as the Global Agricultural Heritage Systems (GIAHS) cities in India: Koraput, Odisha State; Kashmir Valley, Pampore region; and Kuttanad. Here, we are giving the list of Global Agricultural Heritage Systems (GIAHS) Sites in India and why these regions are chosen by FAO as GIAHS for general awareness.

❖ **Adapting to climate change**

- An IPCC (Intergovernmental Panel on Climate Change) special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.
- Limiting warming to 1.5°C requires major and immediate transformation.
- According to IPCC, Emissions will need to reach net-zero around mid-century.

❖ **Slowing the global growth in nutrient loading**

- Governments rationalize fertilizers subsidies. E.g. Neem coating urea.
- Technologies already exist for reduction of nutrient pollution at reasonable costs, but new policies are needed for these tools to be applied on a sufficient scale to slow and ultimately reverse the increase in nutrient loading

❖ **Correction of market failures and internalization of environmental externalities that lead to the degradation of ecosystem services.** Because many ecosystem services are not traded in markets, markets fail to provide appropriate signals that might otherwise contribute to the efficient allocation and sustainable use of the services.

❖ **Increased transparency and accountability of government and private-sector performance in decisions that affect ecosystems, including through greater involvement of concerned stakeholders in decision-making.**

❖ **Laws, policies, institutions, and markets that have been shaped through public participation in decision-making are more likely to be effective and perceived as just.** And stakeholder involvement and transparency of decision-making can increase accountability and reduce corruption.

❖ **Increased coordination among multilateral environmental agreements and between environmental agreements and other international economic and social institutions.**

- ❖ Technical capacity for agriculture, forestry, and fisheries management is still limited in many countries, but it is vastly greater than the capacity for effective management for ecosystem services not derived from these sectors.
- ❖ **Addressing unsustainable consumption patterns:** Consumption of ecosystem services and nonrenewable resources affects biodiversity and ecosystems directly and indirectly. Total consumption is a factor of per capita consumption, population, and efficiency of resource use. Slowing biodiversity loss requires that the combined effect of these factors be reduced.

How do protected areas benefit biodiversity and humans?

- ❖ **Protected areas are an extremely important part of programs to conserve biodiversity and ecosystems, especially for sensitive habitats.**
 - Recent assessments have shown that at the global and regional scales, the existence of current PAs, while essential, is not sufficient for conservation of the full range of biodiversity.
 - Protected areas need to be better located, designed, and managed to deal with problems like lack of representativeness, impacts of human settlement within protected areas, illegal harvesting of plants and animals, unsustainable tourism, impacts of invasive alien species, and vulnerability to global change.
 - Marine and freshwater ecosystems are even less well protected than terrestrial systems, leading to increasing efforts to expand PAs in these biomes. However, marine protected area management poses special challenges, as enforcement is difficult and much of the world's oceans lie outside national jurisdictions.
 - The experts concluded that PA design, legal establishment, boundary demarcation, resource inventory, and objective setting were relatively well addressed. But management planning, monitoring and evaluation, and budgets for security and law enforcement were generally weak among the surveyed areas.
 - Moreover, the “paper park” problem remains, whereby geographic areas may be labeled as some category of protected area but not achieve the promised form of management.
- ❖ **Protected areas may contribute to poverty where rural people are excluded from resources that have traditionally supported their well-being.**
 - PAs can contribute to improved livelihoods when they are managed to benefit local people. One possible strategy is to promote the broader use of IUCN protected areas management categories.
 - Success depends on a collaborative management approach between government and stakeholders, an adaptive approach that tests options in the field, comprehensive monitoring that provides information on management success or failure, and empowerment of local communities through an open and transparent system that clarifies access and ownership of resources.
- ❖ **Success of protected areas as a response to biodiversity loss requires better site selection and incorporation of regional trade-offs to avoid some ecosystems from being poorly represented while others are overrepresented.**
 - Success of PAs depends on adequate legislation and management, sufficient resources, better integration with the wider region surrounding protected areas, and expanded stakeholder engagement

- Indicators of percent-area coverage of PAs, as associated with the Sustainable Development Goals and other targets, for example, only provide a broad indication of the actual extent of protection afforded by PA systems, but regional and national-level planning requires targets that take into account trade-offs and synergies with other ecosystem services.
- ❖ **Protected area design and management will need to take into account the impacts of climate change.**
 - The impacts of climate change will increase the risk of extinctions of certain species and change the nature of ecosystems.
 - Today's species conservation plans may incorporate adaptation and mitigation aspects for this threat, drawing on existing tools to help assess species' vulnerability to climate change.
 - Corridors and other habitat design aspects to give flexibility to protected areas are effective precautionary strategies. Improved management of habitat corridors and production ecosystems between protected areas will help biodiversity adapt to changing conditions.

PROTECTED AREA NETWORKS IN INDIA

What is protected Area Network (PAN)

- A protected area is a **clearly defined geographical space**, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term **conservation of nature with associated ecosystem services and cultural values**.
- Protected areas are at the core of efforts towards conserving nature and the services it provides us food, clean water supply, medicines and protection from the impacts of natural disasters.
- Their role in helping **mitigate and adapt to climate change** is also increasingly recognized; it has been estimated that the **global network of protected areas stores at least 15% of terrestrial carbon**.
- Protected areas i.e., national parks, Biosphere Reserve, National Parks, Wildlife Sanctuaries, Coastal Protected Areas, Sacred Grooves, **Biodiversity Hotspots** and so on are a mainstay of biodiversity conservation, while also contributing to people's livelihoods, particularly at the local level.

1) Biosphere Reserves

What is a Biosphere Reserve?

A Biosphere Reserve is a **special ecosystem** or a **specialized environment** with a flora and fauna that require protection and nurturing. These reserves are managed and studied for the conservation of various life forms found here. They are **subjects of scientific and natural interest**.

The **World Network of Biosphere Reserves**, currently comprising 669 sites/regions designated by **UNESCO** in 120 countries since 1976, is a unique global network explicitly linking sustainable development and biodiversity conservation. While the **core area(s)** and sometimes **buffer zone(s)** of all biosphere reserves (BRs) comprise protected areas as recognized by IUCN, the **outer transition area**, where most of the inhabitants of BRs live, cannot be regarded as a protected area as often, these transition areas include towns and cities.

According to UNESCO, "Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located".

- The **Ministry of Environment, Forest and Climate Change**, Government of India defines Biosphere Reserves thus “Biosphere Reserves (BRs) are representative parts of natural and cultural landscapes extending over large area of terrestrial or coastal/marine ecosystems or a combination thereof and representative examples of biogeographic zones/province”.
- The Government of India has established about **18 different Biosphere Reserves** in the country. Of these, **11 are part of the World Network of Biosphere Reserves**, set up under the auspices of the **UNESCO Man and Biosphere (MAB) Programme**.
- Not only are animals protected in the Biosphere Reserves of our country but the natural lifestyle of the indigenous people is also promoted.
- The communities in these regions are encouraged to retain their agrarian lifestyle and **develop harmony with the plants and animals**.
- The Biosphere Reserves of India correspond roughly to the **IUCN Category V Protected Areas** list and are often designed to include one or more national parks and national sanctuaries.
- The **buffer zones** of these Biosphere Reserves are **open to economic activities as well**

The criteria for Biosphere Reserves to get selected under WNBR of MAB.

- It should encompass a mosaic of ecological systems representative of major bio geographical regions, including a graduation of human interventions
- It should be of significance for biological diversity conservation
- It should provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale
- It should have an appropriate size to fulfill the three functions of biosphere reserves (conservation, development, logistic support)
- It should include these functions through appropriate zonation, recognizing core, buffer, and outer transition zones.

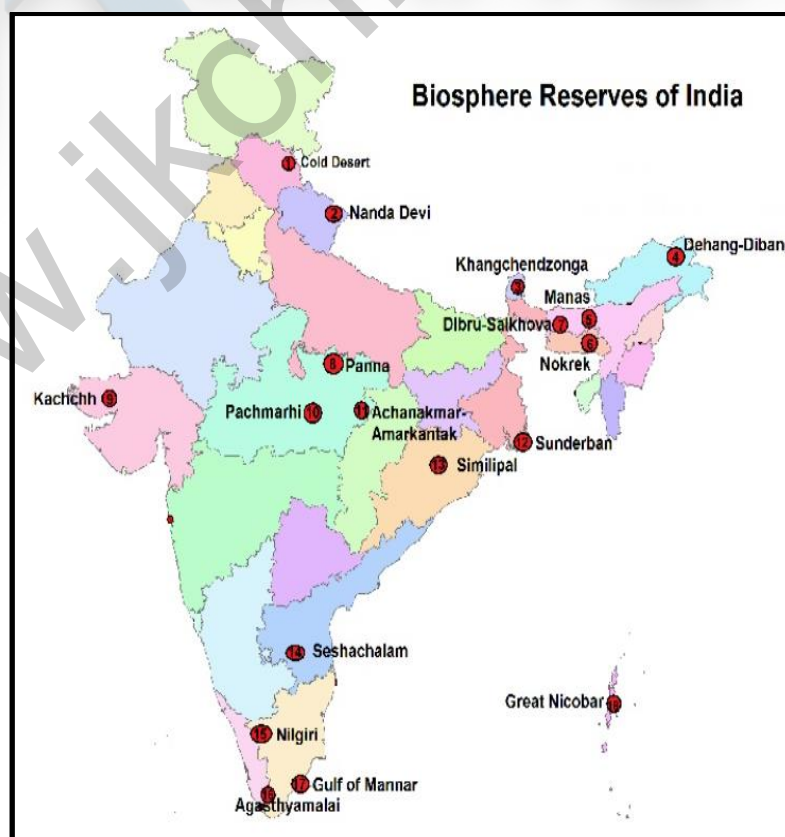


Figure: Biosphere reserves of India

2) National Parks

What is a national park?

An area, whether within a sanctuary or not, **can be notified by the state government** to be constituted as a National Park, by reason of its **ecological, faunal, floral, geomorphological, or zoological association or importance**, needed to for the purpose of protecting & propagating or developing wildlife therein or its environment. **No human activity is permitted inside** the national park **except** for the ones permitted by the **Chief Wildlife Warden of the state** under the conditions given in CHAPTER IV, WPA 1972.

There are 104 existing national parks in India covering an area of 40,501 km², which is 1.23% of the geographical area of the country (**National Wildlife Database, Aug. 2018**). In addition to the above 75 National Parks covering an area of 16,608 km² are proposed in the Protected Area Network Report (Rodgers & Panwar 1988). The network of parks will go up 179 after full implementation of the above report.

3) Wildlife Sanctuaries

What is a wildlife sanctuary?

Sanctuary is an area which is of adequate **ecological, faunal, floral, Geo-morphological, 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.
- A sanctuary is a protected area which is reserved for the conservation of only animal and human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not interfere with well-being of animals.
- **Boundaries of sanctuaries are not well defined** and controlled biotic interference is permitted.

Declaration of area as Sanctuary

- To be included in a sanctuary, the **State Government** shall issue a notification specifying the **limits of the area** which shall be comprised within the sanctuary and declare that the said area shall be sanctuary on and from such date as may be specified in the notification.
- Provided that where any part of the **territorial waters** is to be so included, **prior concurrence of the Central Government** shall be obtained by the State Government.
- Provided further that the **limits of the area of the territorial waters** to be included in the sanctuary shall be determined in consultation with the **Chief Naval Hydrographer of the Central Government** and after taking adequate measures to protect the occupational interests of the local fishermen.

	<i>WILDLIFE SANCTUARY</i>	<i>NATIONAL PARK</i>
Meaning	Wildlife Sanctuary, is a natural habitat, owned by the government or private agency, that safeguards particular species of birds and animals.	National park is the protected area, which are established by the government, to conserve wildlife and also develop them
Objective	To make sure that viable population of the wildlife and their habitats are maintained.	To protect the natural and historic objects and wildlife of an area.

Restriction	Restrictions are less and it is open to public.	Highly restricted, random access to people is not allowed
Boundaries	Not required	Required
Preserves	Animals, birds, insects, reptiles, etc.	Flora, fauna, landscape, historic objects, etc.
Human activity	Allowed but up to a certain extent	Not allowed at all

4) Marine and Coastal Protected Areas

What is Coastal Protected Area?

An area **within or adjacent to the marine environment**, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings.

What are Marine Protected Areas

A marine protected area is **essentially a space in the ocean where human activities are more strictly regulated** than the surrounding waters similar to parks we have on land. These places are given special protections for natural or historic marine resources by local, state, territorial, native, regional, or national authorities.

How to manage

- There are many different types of MPAs with the protection measures ranging from multiple-use to strict protection within 'no-take' or 'no-access' zones.
- Most MPAs tend to be more permissive, often implementing zones or seasonal restrictions that allow certain types of use.
- The IUCN protected area management categories reflect the diverse range of purposes for which marine protected areas are declared.
- IUCN has published specific guidelines on how to apply its protected area management categories to MPAs, aiming to help authorities to maintain consistency in the ways that the management of both terrestrial and marine protected areas is described

5) Sacred Grooves

What is Sacred Groove?

Sacred groves comprise of **patches of forests or natural vegetation** from a few trees to forests of several acres, that are usually **dedicated to local folk deities** (Example: Ayyanar and Amman) or tree spirits (Vanadevatha). These spaces are **protected by local communities** because of their **religious beliefs and traditional rituals** that run through several generations.

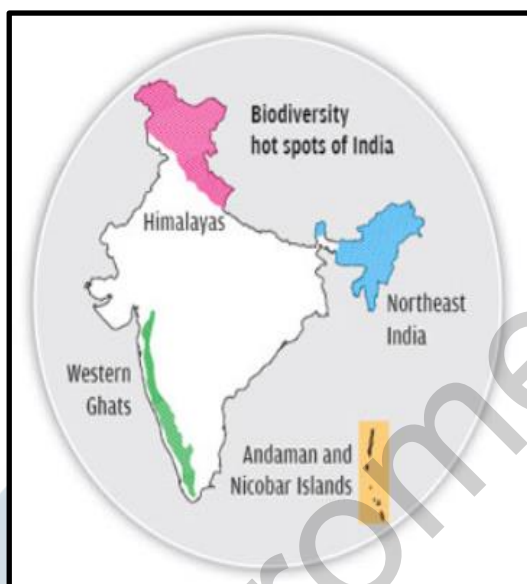
Why sacred Grooves are important?

- Sacred groves are one of the forest ecosystems conserved by local communities reinforced by religious sentiments towards the forests in Western Ghats of India.
- Sacred groves are an **example for positive human intervention** in conserving forests.
- They help in mitigation and adaptation of climate change.
- They protect and conserve the local wildlife diversities.
- They provide important food and economic resources on which local livelihoods are based.

- The contributions of local communities towards the managements of sacred groves are mainly in terms of providing protection and tree enrichment.
- Sacred groves occur in many parts of India viz., Western Ghats, Central India, northeast India, etc.

Types of sacred groves

- **Traditional Sacred Groves** – It is the place where the village deity resides, who is represented by an elementary symbol.
- **Temple Groves** – Here a grove is created around a temple and conserved.



6) Biodiversity Hotspots

What is a biodiversity hotspot?

A biodiversity hotspot is a **biogeographic region** that is both a significant **reservoir of biodiversity** and is **threatened with destruction**.

- The British biologist Norman Myers coined the term "biodiversity hotspot" in 1988 as a biogeographic region characterized both by exceptional levels of plant endemism and by serious levels of habitat loss.
- **Conservation International (CI)** adopted Myers' hotspots as its institutional blueprint in 1989, and in 1996, the organization made the decision to undertake a reassessment of the hotspots concept.
- There are currently **36 recognized biodiversity hotspots**. These are Earth's most biologically rich, yet threatened terrestrial regions.

To qualify as a biodiversity hotspot, an area must meet two strict criteria:

- **Endemic species:** Contain at least 1,500 species of vascular plants found nowhere else on Earth.
- **High Bio-diversity loss:** Have lost at least 70 percent of its primary native vegetation. The loss of vegetation in some hotspots has reached a startling 95 percent.
- **For example:** both the Sundaland Hotspot in Southeast Asia and the Tropical Andes Hotspot in South America have about 15,000 endemic plant species.

Who lives in biodiversity hotspots?

- The 36 biodiversity hotspots are home to around 2 billion people, including some of the world's poorest, many of whom rely directly on healthy ecosystems for their livelihood and well-being.



JK Chrome

JK Chrome | Employment Portal



Rated No.1 Job Application of India

Sarkari Naukri
Private Jobs
Employment News
Study Material
Notifications



JOBS



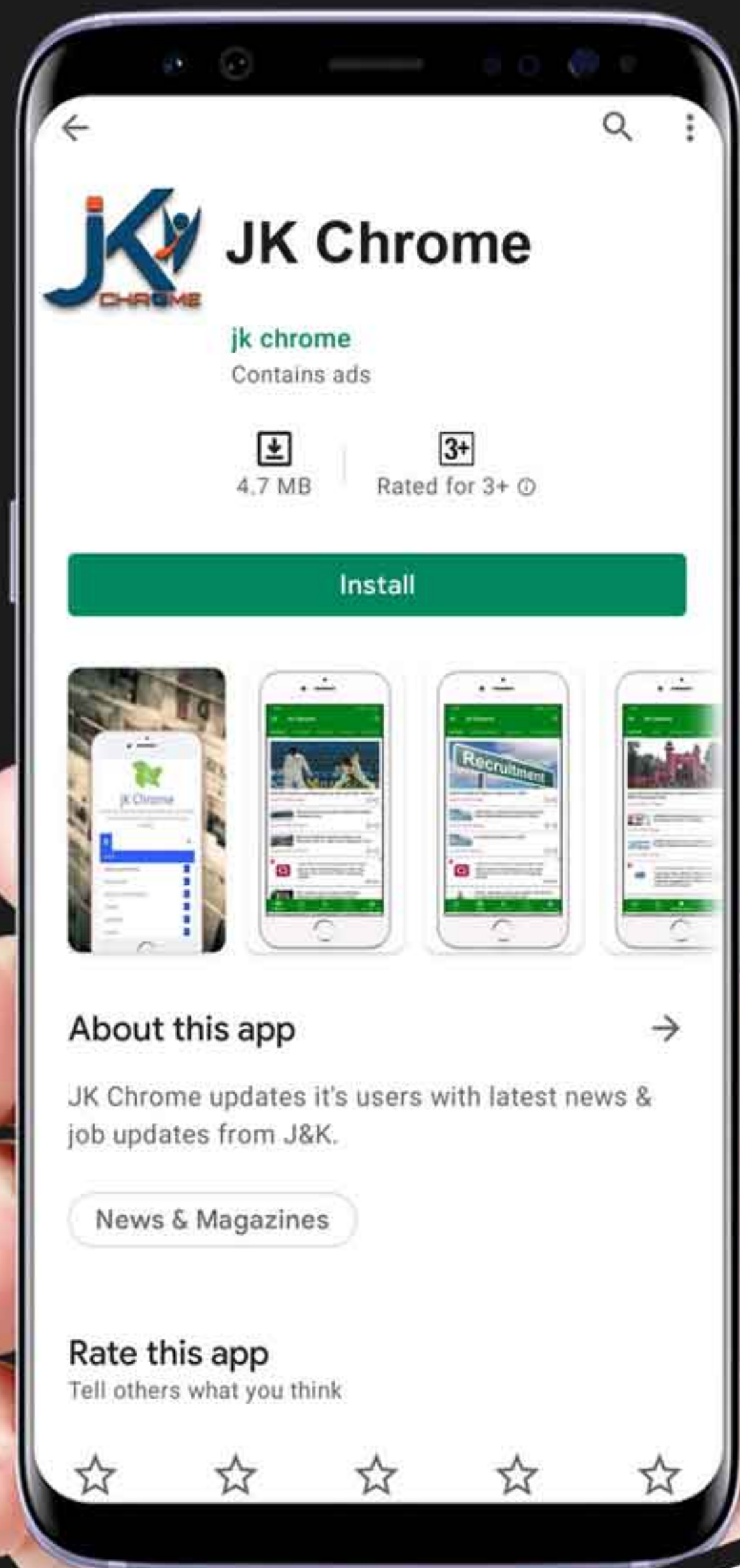
NOTIFICATIONS



G.K



STUDY MATERIAL



JK Chrome

jk chrome
Contains ads



www.jkchrome.com | Email : contact@jkchrome.com

- The hotspots provide crucial ecosystem services for human life, such as provision of clean water, pollination and climate regulation.
- These remarkable regions also hold some of the highest human population densities on the planet, but the relationship between people and biodiversity is not simply one where more people lead to greater impacts on biodiversity.
- Much of human-biodiversity impacts lies not in human density but rather in human activity.
- Conservation in the hotspots promotes sustainable management of these essential natural resources and supports economic growth, which also reduces drivers of violent conflict.
- CEPF works with civil society in the hotspots to protect biodiversity.

How can invasive species be addressed?

❖ Direct management of invasive species

- Control or eradication of an invasive species once it is established is often extremely difficult and costly, while prevention and early intervention have been shown to be more successful and cost-effective.
- Common factors in successful eradication cases include particular biological features of the target species (for example, poor dispersal ability), early detection/response, sufficient economic resources devoted for a sufficient duration, and widespread support from the relevant agencies and the public.
- Successful prevention requires increased efforts in the control and regulation of the transportation of invasive species due to international trade.

❖ Other forms of management of invasive species

- **Chemical and mechanical control of invasive plant species, sometimes combined with mechanical removal like cutting or pruning, has been useful for controlling at least some invasive plants, but has not proved particularly successful in eradication.**
 - In addition to its low efficiency, chemical control can be expensive.
- Biological control of invasive species has also been attempted, but results are mixed.
 - For example, the introduction of a non-native predatory snail to control the giant African snail in Hawaii led to extinction of many native snails.
 - Some 160 species of biological agents, mainly insects and fungi, are registered for controlling invasive species in North America, and many of them appear highly effective. However, at least some of the biological agents used are themselves potential invaders.

❖ Social and economic aspects of the control of invasive species have received less attention, perhaps because of difficulties in estimating these trade-offs.

- The Global Invasive Species Program (GISP) is an international response to address the problem.

GISP was established in 1997 to address global threats caused by Invasive Alien Species (IAS), and to provide support to the implementation of Article 8(h) of the Convention on Biological Diversity (CBD). GISP is in essence an enabling body, focusing on effective information exchange and networking mechanisms among an expanding number of partner organizations.

How do protected areas benefit biodiversity and humans?

❖ Strategies for integrating biodiversity issues in production sectors

- At the national level, integrating biodiversity issues into agriculture, fishery, and forestry management encourages sustainable harvesting and minimizes negative impacts on biodiversity.
- Biodiversity will only be conserved and sustainably used when it becomes a mainstream concern of production sectors.
- Examples:

agriculture	<ul style="list-style-type: none"> ○ Agriculture is directly dependent on biodiversity, but agricultural practices in recent decades have focused on maximizing yields. ○ Effective response strategies include sustainable intensification, which minimizes the need for expanding total area for production, so allowing more area for biodiversity conservation. ○ Practices such as integrated pest management, some forms of organic farming, and protection of field margins, riparian zones, and other non-cultivated habitats within farms can promote synergistic relationships between agriculture, domestic biodiversity, and wild biodiversity.
Tropical forest	<ul style="list-style-type: none"> ○ Tropical deforestation at a local level can be controlled most effectively when the livelihood needs of local inhabitants are addressed within the context of sustainable forestry. ○ Forest management policies should center on existing land and water ownership at the community level. ○ Relevant legal tools include redesigning ownership to small-scale private control of forests, public-private partnerships, direct management of forests by indigenous people, and company-community partnerships.

❖ Contributions of the private sector to biodiversity objectives

- Showing greater **corporate social responsibility**, many companies are now preparing their own biodiversity action plans, managing their own landholdings in ways that are more compatible with biodiversity conservation, supporting certification schemes that promote more sustainable use, working with multiple stakeholders, and accepting their responsibility for addressing biodiversity issues in their operations.
- Further developments are likely to focus on two main areas.
 - First, in addition to assessing the impact of companies on biodiversity and increasing emphasis will be given to ecosystem services and how companies rely on them.
 - Second, greater collaboration is likely to take place between NGOs and business in order to more fully explore ways to reduce harmful trade-offs and identify positive synergies that could lead to more effective sustainable management practices.

II. GOVERNMENT INTERVENTIONS

What governance approaches can promote biodiversity conservation?

- ❖ The principle that biodiversity should be managed at the lowest appropriate level has led to **decentralization** in many parts of the world, with variable results. The key to success is strong institutions at all levels, with security of tenure and authority at the lower levels essential to providing incentives for sustainable management
- ❖ At the same time that management of some ecosystem services is being devolved to lower levels, management approaches are also evolving to deal with large-scale processes with many stakeholders.
- ❖ Problems such as regional water scarcity and conservation of large ecosystems require large-scale management structures.
 - For example, most of the major rivers in Southern Africa flow across international borders, so international water co-management organizations are being designed to share the management of riparian resources and ensure water security for all members.
 - However, political instability in one state may negatively affect others, and power among stakeholders is likely to be uneven.
- ❖ **Multi-layered legal system:** Legal systems in countries are multilayered and, in many countries, local practices or informal institutions may be much stronger than the law on paper.
 - Important customs relate to the local norms and traditions of managing property rights and the ecosystems around them. Since these are embedded in the local societies, changing these customs and customary rights through external incentive and disincentive schemes is very difficult unless the incentives are very carefully designed.
 - Local knowledge, integrated with other scientific knowledge, becomes absolutely critical for addressing ways of managing local ecosystems.
- ❖ **More effort is needed in integrating biodiversity conservation and sustainable use activities within larger macroeconomic decision-making frameworks.**
 - New poverty reduction strategies have been developed in recent years covering a wide range of policies and different scales and actors. However, the integration or mainstreaming of ecosystems and ecosystem services is largely ignored.
 - The focus of such strategies is generally on institutional and macroeconomic stability, the generation of sectoral growth, and the reduction of the number of people living on less than \$1 a day in poor countries
- ❖ **International cooperation:**
 - Multilateral environmental agreements requires increased commitment to implementation of activities that effectively conserve biodiversity and promote sustainable use of biological resources.
 - The Convention on Biological Diversity is the most comprehensive, but numerous others are also relevant, including the World Heritage Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Ramsar Convention on Wetlands, the Convention on Migratory Species, the U.N. Convention to Combat Desertification, the U.N. Framework Convention on Climate Change, and numerous regional agreements. Their impacts at policy and practical levels depend on the will of the contracting parties.
 - Links between biodiversity conventions and other international legal institutions that have significant impacts on biodiversity (such as the World Trade Organization) remain weak. The international agreements with the greatest impact on biodiversity are not in the

environmental field but rather deal with economic and political issues. These typically do not take into account their impact on biodiversity.

- Successful responses will require that these agreements are closely linked with other agreements and that solutions designed for one regime do not lead to problems in other regimes. For example, efforts to sequester carbon under the Kyoto Protocol should seek to enhance biodiversity, not harm it (for example, by planting multiple **species** of native trees rather than monospecific plantations of exotic species).

Bio diversity loss is a global issue

Indirect drivers like globalization and international decisions on trade and economics often have a negative effect on biodiversity and should be addressed at the international level, but the proximate responsibility to detect and act directly on biodiversity loss is at the local and national level.

For threatened endemic species or ecosystems limited to an area within a single country or local administrative unit, the relevant agencies should give high priority to these species or ecosystems, with appropriate support from global, regional, or national support systems

BIODIVERSITY (WILDLIFE) CONSERVATION IN INDIA

National Biodiversity Strategy and Action Plan (NBSAP) Project:

Under this scheme a National Policy and Action Strategy on Biological Diversity (NPASBD) has been formulated with the following objectives:

- Assessment and stocktaking of biodiversity related information at state level including distribution of endemic and endangered species.
- Emphasis on participation of decentralized state level planning sectors.

Species Recovery Programme

The country's flagship and charismatic species face a variety of threats, ranging from habitat destruction and illegal wildlife trade to reduction in forest cover outside protected areas. Significant populations of these species exist outside Protected Areas moving for dispersal from their natal habitats or for seasonal migrations.

The MoEFCC scheme of 'Assistance for the Development of National Parks and Sanctuaries' was reformulated and renamed as 'Integrated Development of Wildlife Habitats (IDWH)' during the 11th Plan period (2007-2012). The MoEFCC, in consultation with Wildlife Institute of India and other scientific institutions/ organizations, identified 16 terrestrial and 7 aquatic species with the objective of saving critically endangered species/ecosystems that to ensure their protection outside Protected Areas, across the wider landscape/seascape.

Under SRP, The Lion and Rhinoceros populations are showing an increasing trend, and the Sangai and Hangul populations are stable; but the populations of the Great Indian bustard and the Nicobar megapode) have recorded declines. Vulture populations had declined. Efforts are underway for developing protocols for monitoring the status and trends of the remaining IDWH species.

1. Asian Wild Buffalo
2. Asiatic Lion
3. Brow-Antlered Deer or Sangai

4. Dugong
5. Edible Nest Swiftlet
6. Gangetic River Dolphin
7. Great Indian Bustard
8. Hangul
9. Indian Rhino or Great One-horned Rhinoceros
10. Jerdon's Courser
11. Malabar Civet
12. Marine Turtles
13. Nicobar Megapode
14. Nilgiri Tahr
15. Snow Leopard
16. Swamp Deer
17. Vultures

- To prepare detailed micro-level action plans at different levels under the framework of CBD.

Wildlife Protection Act 1972

The Wildlife Protection Act, 1972 is a **Central Act of Parliament** providing for the protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with the view to ensuring the ecological and environmental securities of the country.

- It extends to the whole of India **except the state of Jammu and Kashmir**.
- The act provides for the constitution of a **National Board for Wildlife with the Prime Minister as the Chairperson**.
- The National Board shall promote the conservation and development of wildlife and forests by such measures as it thinks fit.
- The act also provides for the constitution of a **State Board for Wildlife** to advise the state government in matters connected with the protection of wildlife.
- The act **regulates the hunting of wild animals and protection of specified plants**.
- It also empowers the State Government to **notify Sanctuaries, National Parks, and Game Reserves**.
- The Act prohibits hunting of animals except with permission of authorized officer when an animal has become dangerous to human life or property or as disabled or deceased as to be beyond recovery.
- It has also set up a **National Tiger Conservation Authority** and regulates trade or commerce in wild animals, animal articles and trophies.
- It has notified **five kinds of protected areas** i.e. National Parks, Sanctuaries, Conservation Reserves, Community Reserves and Tiger Reserves.

Note: For more detail refers a document of environment acts.

Appraisal of Wildlife Protection Act 1972

- The meaning of the wildlife in this Act is very wide and inclusive of all kinds of flora and fauna.
- The Act has failed to maintain balance between the wildlife protection and the forest rights of the indigenous people. Example: Tribal families have been denied the rights of fishing and collecting forest products in Pench Tiger Reserve.
- The Act has ensured that the economic activities like laying of pipes, erection of electricity poles, etc. does not affect the wildlife.

- The Act has restricted illegal trade in animals and their products to some extent. Example: In 2002 the manufacture of Shahtoosh shawls from Chiru or Tibetan Antelope has finally been banned in the state of Jammu and Kashmir.
- Placing many wild animal and plants under Schedule has protected them from going extinct.

Biological Diversity Act, 2002

The Act envisages following goals:

- To **protect and conserve** rich biodiversity of the country.
- To protect the knowledge of **biological communities having high medicinal values** from their use by foreign individuals and organizations.
- To check and **control biopiracy**.
- Setting up of **National Biodiversity Authority (NBA), State Biodiversity Boards (SBB) and Biodiversity Management Committees (BMC)**.
- To promote conservation, sustainable use and **documentation of biodiversity**.

The Act has also made the following provisions for the use of Indian biodiversity:

- **Mandatory permits:** Prior permission for the use of Indian biological resources by foreign individuals and organizations from NBA.
- **Protect indigenous knowledge:** India's biodiversity cannot be used by foreign individuals and organizations without formal permission from NBA.
- It is mandatory for Indian industry to give prior intimation to the concerned SSB about obtaining any biological resource for commercial use.
- **Few exemptions:** Citizens, entities, local people, Vaidyas and hakims are exempted from permission from NBA for the use of biological resources within the country for medicinal purposes.

7.5 Appraisal of Biological Diversity Act, 2002

- Since companies are commercially utilizing biological resources when extracting oil or brewing or distilling alcohol, they should be sharing monetary benefits gained from these activities with the SBB. But in reality, the Act has failed to ensure that the benefits percolate to the indigenous people.
- Another issue with the BD Act is the **absence of provisions to deal with the criminal procedures for search, seizure or arrest**. Juxtaposing this with the Indian Forest Act, 1927 and the Wild Life Protection Act, 1972, which have specific provisions to deal with search, seizure and arrest, indicates the procedural injustice posed by the BD Act.
- Absence of documentation of biodiversity of India has resulted into destruction of biodiversity through mining and quarrying, industrialization, etc.
- Biopiracy has not been restricted up to the desired extent.
- Each day, 333 acres of forest are legally diverted on an average under the provisions of the Forest (Conservation) Act, 1980.

Conservation Projects in India

Wildlife conservation is an activity in which people make conscious efforts to protect earth's biological diversity.

Wildlife conservation activities relate to the protection of plants and animal species, and their habitats. Conservation efforts are made with a goal to **preserve the nature, and the endangered species for the future generations**.

- Wildlife conservation is very important because wildlife and wilderness play an important role in maintaining the ecological balance.
- The World Wildlife Fund is an international organization making worldwide efforts for the conservation of nature, and the protection of endangered species.
- Wildlife conservationists work to identify plant and animal species that require protection.

Wildlife Conservation Efforts in India:

- Project Tiger
- Project Elephant
- Project Snow Leopard
- Vultures

Project Tiger

Project Tiger was launched in the year 1973. The **Wildlife (Protection) Act, 1972** was amended in the year 2006. Since then, the Government has taken several initiatives in the field of tiger conservation. Tiger conservation was given statutory backing. The newly-created **NTCA** was mandated to carry out estimation of population of tiger and its natural prey species and assess status of their habitat.

- The first country-wide tiger census conducted in 1972 estimated the population to comprise a little more than 1,800 individuals, an alarming reduction in tiger population.
- **Project Tiger was launched in Jim Corbett National Park** of Uttarakhand in 1973.
- India has more than 104 national parks and 550 Sanctuaries of which some have been declared as Tiger reserves.
- Tiger reserves are governed by the Project Tiger (1973).
- It is a Centrally Sponsored Scheme of the **Ministry of Environment and Forests**.
- It is administered by the **National Tiger Conservation Authority**.
- **Aim:** Protect tigers from extinction by ensuring a viable population in their natural habitats.
- Government has set up a **Tiger Protection Force** under PT to combat poachers.
- Project Tiger funds relocation of villagers to minimize human-tiger conflicts.

Core Zone	<ul style="list-style-type: none"> • No disturbance: The core area is kept free of biotic disturbances and forestry operations, where collection of minor forest produce, grazing, human disturbances are not allowed within. • Protect STs rights: These areas are required to be kept for the purposes of tiger conservation, without affecting the rights of the Scheduled Tribes or such other forest dwellers. • Notified areas: These areas are notified by the State Government in consultation with an Expert Committee (constituted for that purpose).
Buffer Zone	<ul style="list-style-type: none"> • Definition: The area peripheral to the critical tiger habitat or core area providing supplementary habitat for dispersing tigers, besides offering scope for co-existence of human activity (tribal). • Stakeholders: The limits of such areas are determined with the concerned Gram Sabha and an Expert Committee constituted for the purpose.
Issues with project tiger	<ul style="list-style-type: none"> • Conflict with FRA: The Forest Rights Act passed by the Indian government in 2006 recognizes the rights of some forest dwelling communities in forest areas.

	<p>This has led to controversy over implications of such recognition for tiger conservation.</p> <ul style="list-style-type: none"> • The project overlooks the role of abuse of power by authorities in the tiger crisis.
Tiger Task Force	<ul style="list-style-type: none"> • The implementation of Project Tiger over the years has highlighted the need for a statutory authority with legal backing to ensure tiger conservation. • On the basis of the recommendations of National Board for Wild Life, a Task Force was set up to look into the problems of tiger conservation in the country. • The recommendations of the Task Force include strengthening of Project Tiger by giving it statutory and administrative powers.
NTCA	<ul style="list-style-type: none"> • The National Tiger Conservation Authority was established in December 2005 following a recommendation of the Tiger Task Force. • National Tiger Conservation Authority administers Project Tiger. • Administration of the tiger reserves will be in accordance with guidelines of NTCA. • Tiger reserves in India are administered by field directors as mandated by NTCA. • No alteration in the boundaries of a tiger reserve shall be made except on a recommendation of the NTCA and the approval of the National Board for Wild Life. • No State Government shall de-notify a tiger reserve, except in public interest with the approval of the NTCA and the approval of the National Board for Wild Life.
NTCA members	<ul style="list-style-type: none"> • The Wildlife Protection Amendment Act, 2006 provides for the constitution of the National Tiger Conservation Authority. • NTCA was set up under the Chairmanship of the Minister for Environment and Forests. • The Authority will have • eight experts having qualifications in wildlife conservation and welfare tribals, • 3 MPs, • The Inspector General of Forests, in charge of project Tiger, will be ex-officio Member Secretary • Others
Functions of NTCA	<ul style="list-style-type: none"> • The Authority lays down standards, guidelines for tiger conservation in the Tiger Reserves, National Parks and Sanctuaries. • The Tiger Conservation Authority would be required to prepare an Annual Report, which would be laid in the Parliament along with the Audit Report. • State level Steering Committees will be set up in the Tiger States under the Chairmanship of respective Chief Ministers. • This has been done with a view for ensuring coordination, monitoring and protection of tigers in the States. • A provision has been made for the State Governments to prepare a Tiger Conservation Plan. • Provision will be made for the States to establish a Tiger Conservation Foundation, based on the good practices emanating from some tiger reserves.
Reasons for population decline	<ul style="list-style-type: none"> • Pressure on habitat, Habitat fragmentation and Habitat destruction: Caused due to large-scale development projects such as dams, industry, mines, railway lines etc. • Incessant poaching: Tigers are killed so their body parts can be used for Traditional Chinese Medicine.

	<ul style="list-style-type: none"> ● Invasive species: Destroy the local producers. This has a cascading effect on the food chain. Tigers are the worst hit as they are at the end of the food chain. [Tigers represent an “Umbrella Species” that indicate the health of the ecosystem.]
Initiatives	<p>Legal Steps:</p> <ul style="list-style-type: none"> ● Amendment of the Wild Life (Protection) Act, 1972 to Wild Life (Protection) Act, 2006 for providing enabling provisions towards constituting the National Tiger Conservation Authority and the Tiger and Other Endangered Species Crime Control Bureau. ● Enhancement of punishment in cases of offence relating to a tiger reserve or its core area. <p>Administrative Steps:</p> <ul style="list-style-type: none"> ● Strengthening of ant poaching activities, including special strategy for monsoon patrolling. ● State level Steering Committees under the Chairmanship of Chief Ministers and establishment of Tiger Conservation Foundation. ● Creation of Special Tiger Protection Force (STPF) [Budget 2008] <p>Financial Steps:</p> <ul style="list-style-type: none"> ● Financial and technical help is provided to the States under various Centrally Sponsored Schemes, viz. Project Tiger and Integrated Development of Wildlife Habitats. <p>International Cooperation:</p> <ul style="list-style-type: none"> ● India has a bilateral understanding with Nepal on controlling trans-boundary illegal trade in wildlife ● India has signed a protocol on tiger conservation with China. ● India has signed a with Bangladesh for conservation of the Royal Bengal Tiger. ● A sub-group on tiger/leopard conservation has been constituted for cooperation with the Russian Federation. ● A Global Tiger Forum of Tiger Range Countries has been created for addressing international issues related to tiger conservation. ● India is a party to CITES. CITES’s landmark decision states that ‘tigers should not be bred for trade in their parts and derivatives’. <p>Titbit: There are eight subspecies of tiger: among the eight, at present five subspecies are present in the wild. They are Bengal, South China, Indochinese, Sumatran, and Siberian. Three subspecies of tiger — Caspian, Bali, and Javan — are extinct.</p>
Population estimation	<ul style="list-style-type: none"> ● The process of estimating the number of tigers in a given area is called ‘Tiger census’. ● It is conducted at regular intervals to know the current tiger populations and population trends. ● Besides estimating the number of tigers, the method also helps to gather information on the density of the tiger populations and associated prey. ● The most commonly used technique in the past was ‘Pugmark Census Technique’. ● In this method the imprints of the pugmark of the tiger were recorded and used as a basis for identification of individuals. ● Now it is largely used as one of the indices of tiger occurrence and relative abundance.

	<ul style="list-style-type: none"> Recent methods used to estimate the numbers of tigers are camera trapping and DNA fingerprinting. In camera trapping, the photograph of the tiger is taken and individuals are differentiated on the basis of the stripes on the body. In the latest technique of DNA fingerprinting, tigers can be identified from their scats.
Methods to Conserve Tigers	<p>The Tiger Task Force realized that a major lacuna in tiger conservation was the absence of a credible, scientific national monitoring protocol that will inform policy-makers and wildlife managers on:</p> <ul style="list-style-type: none"> Spatial extent and the size of tiger population in India. Welfare factors in these and neighbouring habitat (prey status, human pressure, other wildlife species, status and habitat conditions); Trends in the population and area occupied over time. Wireless communication systems and outstation patrol camps have been developed within the tiger reserves, due to which poaching has declined considerably. Fire protection is effectively done by suitable preventive and control measures. Voluntary Village relocation has been done in many reserves. Livestock grazing has been controlled to a great extent in the tiger reserves. Various compensatory developmental works have improved the water regime and the ground and field level vegetation. Stringent punishments for violators. GIS based digitized database development to evaluate tiger population

Project Elephant

Project Elephant (PE) was launched by the Government of India in the year **1992** as a Centrally Sponsored Scheme with following objectives:

- To protect elephants, their habitat & corridors
- To address issues of man-animal conflict
- Welfare of captive elephants

Financial and Technical support are being provided to major elephant bearing States in the country. The Project is being mainly implemented in **16 States** / UTs, viz. Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jharkhand, Karnataka, Kerala, Maharashtra, Meghalaya, Nagaland, Orissa, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, West Bengal.

Main activities under the Project are as follows:

- Ecological restoration of existing natural habitats and migratory routes of elephants;
- Development of scientific and planned management for conservation of elephant habitats and viable population of Wild Asiatic elephants in India;
- Promotion of measures for mitigation of man elephant conflict in crucial habitats and moderating pressures of human and domestic stock activities in crucial elephant habitats;
- Strengthening of measures for protection of Wild elephants from poachers and unnatural causes of death;
- Research on Elephant management related issues;
- Public education and awareness programmes;

- Eco-development
- Veterinary care
- Elephant Rehabilitation/Rescue Centers

Objectives	<ol style="list-style-type: none"> 1. To assist states having populations of wild elephants and to ensure long term survival of identified viable populations of elephants in their natural habitats 2. addressing man-animal conflict. 3. Developing scientific and planned management measures for conservation of elephants. 4. Protecting the elephants from poachers, preventing illegal ivory trade and other unnatural causes of death
Elephant corridor	<ul style="list-style-type: none"> • An elephant corridor is defined as a stretch/narrow strips of forested (or otherwise) land that connects larger habitats with elephant populations and forms a conduit for animal movement between the habitats. • This movement helps enhance species survival and birth rate. • There are 88 identified elephant corridors in India. • Out of total 88 corridors, 20 are in south India, 12 in north-western India, 20 in central India, 14 in northern West Bengal and 22 in north-eastern India.
Threats to Elephant Corridors	<ul style="list-style-type: none"> • Habitat loss leading to fragmentation and destruction caused by developmental activities like construction of buildings, roads, railways, holiday resorts and the fixing solar energized electric fencing, etc. • Coal mining and iron ore mining is the two “single biggest threats” to elephant corridors in central India. • Orissa, Jharkhand and Chhattisgarh, are mineral-rich states, but also have the highest number of elephant corridors in the country, which makes them known for elephant-man conflicts. • There is also a serious poaching problem, as elephant ivory from the tusks is extremely valuable. • Elephants need extensive grazing grounds and most reserves cannot accommodate them. If protected areas are not large enough, elephants may search for food elsewhere. This often results in conflicts with humans, due to elephants raiding or destroying crops.
Mitigation	<ul style="list-style-type: none"> • Fusion of the corridors with nearby protected areas wherever feasible; in other cases, declaration as Ecologically Sensitive Areas or conservation reserves to grant protection. • During the process of securing a corridor, monitoring for animal movement have to be carried out; depending on the need, habitat restoration work shall also be done. • Securing the corridors involves sensitizing local communities to the option of voluntarily relocation outside the conflict zones to safer areas. • Preventing further fragmentation of the continuous forest habitat by encroachment from urban areas.
Initiatives	<p>Elephant Reserves:</p> <p>Till now 28 Elephant Reserves (ERs) extending over about 61830.08 sq km have been formally notified by various State Governments. Consent for establishment 2 more ERs – Khasi Elephant Reserve in Meghalaya and Dandeli Elephant Reserve in Karnataka has been accorded by MoEF&CC. Inclusion of Bhadra Wildlife Sanctuary in Mysore</p>

Elephant Reserve has also been approved by the Ministry. The concerned State Governments are yet to notify these ERs.

Monitoring of Illegal Killing of Elephants (MIKE) Programme

- Mandated by **COP resolution of CITES**, MIKE program started in **South Asia** in the year 2003 with following purpose.
- To provide information needed for elephant range States to make appropriate management and enforcement decisions, and to build institutional capacity within the range States for the long-term management of their elephant populations.

The main objectives of the MIKE are:

- To measure levels and trends in the illegal hunting of elephants;
- To determine changes in these trends over time; and
- To determine the factors causing or associated with such changes, and to try and assess in particular to what extent observed trends are a result of any decisions taken by the Conference of the Parties to CITES.
- Under the programme CITES, data are being collected from all sites on monthly basis in specified MIKE patrol form and submitted to Sub Regional Support Office for South Asia Programme located in Delhi who are assisting Ministry in the implementation of the programme.

Mike Sites in India

- Chirang Ripu (Assam)
- Dhang Patki (Assam)
- Eastern Dooars (WB)
- Deomali (Arun Pradesh)
- Garo Hills (Meghalaya)
- Mayurbhanj (Orissa)
- Mysore (Karnataka)
- Nilgiri (T N)
- Shivalik (Uttarakhand)
- Wayanad (Kerala)

Haathi Mere Saathi

- is a campaign launched by the Ministry of environment and forest (MoEF) in partnership with the wildlife trust of India (WTI).
- The campaign was launched at the “Elephant- 8” Ministerial meeting held in Delhi in 2011.
- The E-8 countries comprise of India, Botswana, the Republic of Congo, Indonesia, Kenya, Srilanka, Tanzania, and Thailand.
- This public initiative was aimed at increasing awareness among people and developing friendship, companionship between people and elephants.

Other projects

<p>Rhino Vision 2020</p>	<ul style="list-style-type: none"> ● One horned rhino are poached for their horns. ● Indian rhino vision 2020 implemented by the department of environment and forests, Assam. ● The programme will be supported by WWF — India, the international rhino foundation (IRF), and a number of local NGOs. ● Translocations are the backbone of the IRV 2020 program. ● The goal set was to populate the potential rhino habitat areas identified viz. Manas NP, Dibru Saikhowa WLS, Laokhowa-Bura Chapori WLS with a viable population of rhino through translocations from Kaziranga NP and Pobitora WLS. ● Manas National Park was selected as the first site for translocation of rhinos. ● Ten rhinos have been released into Manas since 2008. Ten more rhinos will be moved from Kaziranga National Park before the end of the year. ● The vision of this program is to increase the total rhino foundation in Assam from about 2000 to 3000 by the year 2020 and to ensure that these rhinos are distributed over at least 7 protected areas (PA) to provide long term viability of the one-horned rhino population. ● Concentrating so many rhinos in a single protected area like Kaziranga exposes the species to risks of calamities (epidemics, floods, massive poaching attempts).
<p>Project snow leopard</p>	<ul style="list-style-type: none"> ● The snow leopard is a globally endangered species. ● Most snow leopard occur in China, followed by Mongolia and India. ● Over 180,000 km² of Snow Leopard range is spread over the five Himalayan states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh, and within most of these states, over a quarter of their area lies within the snow leopard's range. The snow leopard is a globally endangered species about which little is known. ● India is perhaps home to 10% of the global population in less than 5% of its global range, thus having a substantial proportion of its global population. ● The estimated world population of Snow Leopards in the world is 3,500-7,000, out of which about 500 cats are spreading across the States of Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Sikkim and Arunachal Pradesh in India. ● About 600-700 Snow Leopards are reported to be in the zoos around the world including a few individuals that are housed at the Padmaja Naidu Zoological Park, Darjeeling and Nainital Zoo, Uttaranchal. ● The Project Snow Leopard started in 2009 to promote knowledge based and adaptive conservation framework that fully involves the local communities, who share the snow leopard's range, in conservation efforts. <p>Threats posed due to</p> <ul style="list-style-type: none"> ● Human interference, ● competition with livestock – people kill them to save their livestock, ● retreating deeper into mountains due to global warming, and ● poaching.

Why to conserve the high-altitude ecosystem?

- The high altitudes of India (> 3000 m) (including the Himalaya and Trans-Himalaya biogeographic zones) support a unique wildlife assemblage of global conservation importance.
- This includes highly endangered populations of species such as the snow leopard, two species of bears, wolf, red panda, mountain ungulates such as the wild yak, chiru, Tibetan gazelle, Tibetan argali, Ladakh urial, two species of musk deer, the hangul, three species of goral, serow, and takin, etc. High altitude lakes and bogs provide breeding grounds for a variety of avifauna including the black-necked crane, barheaded Geese, brahminy ducks, and brown-headed gulls, etc.
- India has ratified international agreements promoting the conservation of high-altitude wildlife species such as the snow leopard.
- In 2003, the **Convention on Migratory Species** included the snow leopard as a Concerted Action Species under its Appendix I.
- Similarly, in 2003, the Convention on International Trade in Endangered Species (CITES) expanded the scope of the CITES Tiger Enforcement Task Force to include all Asian big cat species including the snow leopard.

Conservation challenges in Himalayas

- The potential habitat of snow leopards across the Greater and Trans-Himalayan landscape, in general, is experiencing drastic socio-economic changes over the past few decades.
- Major changes have been documented in the **Spiti Valley of the Lahaul and Spiti district**, owing to the advent of **green pea** (*Pisum sativum*) cultivation during the mid-1980s.
- The advent of apple cultivation around the same time in Kinnaur district over the past two decades show that the economy of the region has rapidly shifted from traditional agro-pastoralism to market-driven agriculture.
- Consequently, human population growth, agricultural expanse, and excessive livestock grazing have been pervasive in the region.

Conservation Action

- Snow leopards have been given the **highest level of legal protection in India under the Indian Wildlife (Protection) Act, 1972**. Also, India is a signatory to the **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** and **Convention on the Conservation of Migratory Species of Wild Animals (CMS)**, providing additional protection to the snow leopard.
- Improved livestock corral to reduce depredation, livestock insurance program to compensate livestock loss to the local community, and establishing grazing-free reserves to increase wild prey population.
- The most recent forms of participatory local conservation initiatives are those of '**Snow Leopard Enterprise**' (SLE) that focuses on empowering local women by facilitating the production of 'wildlife friendly' wool products, and engagement of snow leopard conservationists with pashmina wool growers to develop sustainable grazing practices for pashmina production and trade.

	<ul style="list-style-type: none"> Over the past decade, the snow leopard range countries have joined hands to develop national and transboundary conservation initiatives in the form of National Snow Leopard Ecosystem Priority Protection (NSLEP), Snow Leopard Survival Strategy (SLSS), and Global Snow Leopard and Ecosystem Protection Program (GSLEP). As part of GSLEP, two large landscapes have been identified in India across Himachal Pradesh, Ladakh (Jammu & Kashmir), and Uttarakhand to secure breeding populations of snow leopard. <p>Several institutions and organizations working towards enhancing knowledge on snow leopard ecology and its conservation in India include (but may not be restricted to) Wildlife Institute of India, Nature Conservation Foundation – Snow Leopard Trust, World Wildlife Fund for Nature – India (WWF), and Snow Leopard Conservancy.</p>
Sea turtle project	<ul style="list-style-type: none"> A significant proportion of world’s Olive Ridley Turtle population migrates every winter to Indian coastal waters for nesting mainly at eastern coast. With the objective of conservation of olive ridley turtles and other endangered marine turtles, MoEF initiated the Sea Turtle Conservation Project in collaboration of UNDP in 1999 with Wildlife Institute of India, Dehradun as the Implementing Agency. The project is being implemented in 10 coastal States of the country with special emphasis in State of Orissa. The project has helped in preparation of inventory map of breeding sites of Sea Turtles, identification of nesting and breeding habitats along the shore line, and migratory routes taken by Sea Turtles, development of guidelines to safeguard and minimize turtle mortality. One of the important achievements have been demonstration of use of Satellite Telemetry to locate the migratory route of Olive Ridley Turtles in the sea and sensitizing the fishermen and State Government for the use of Turtle Exclusion Device (TED) in fishing trawlers to check turtle mortality in fishing net.
Project crocodile	<ul style="list-style-type: none"> The Indian Crocodile Conservation Project has pulled back the once threatened crocodilians from the brink of extinction and place them on a good path of recovery. <p>Objectives</p> <ul style="list-style-type: none"> To protect the remaining population of crocodilians in their natural habitat by creating sanctuaries. To rebuild natural population quickly through ‘grow and release’ or ‘rear and release’ technique. To promote captive breeding, <p>Captive breeding means that members of a wild species are captured, then bred and raised in a special facility under the care of wildlife biologists and other expert. Bringing an animal into captivity may represent the last chance to preserve a species in the wild.</p> <ul style="list-style-type: none"> To take-up research to improve management.

	<ul style="list-style-type: none"> • To build up a level of trained personnel for better continuity of the project through training imparted at project-sites and through the (erstwhile) Central Crocodile Breeding and Management Training Institute, Hyderabad. • To involve the local people in the project intimately • The Indian Crocodile Conservation Project has pulled back the once threatened crocodilians from the brink of extinction and place them on a good path of recovery.
Project hangul	<ul style="list-style-type: none"> • The Kashmir stag also called Hangul is a subspecies of Central Asian Red Deer native to northern India. • It is the state animal of Jammu & Kashmir • In Kashmir, it's found in Dachigam National Park at elevations of 3,035 meters. • These deer once numbered from about 5,000 animals in the beginning of the 20th century. • Unfortunately, they were threatened, due to habitat destruction, over-grazing by domestic livestock and poaching. • This dwindled to as low as 150 animals by 1970. However, the state of Jammu & Kashmir, along with the <u>IUCN</u> and the WWF prepared a project for the protection of these animals. • It became known as Project Hangul. This brought great results and the population increased to over 340 by 1980.
Ganga dolphin	<ul style="list-style-type: none"> • The Ministry of Environment and Forests notified the Ganges River Dolphin as the National Aquatic Animal. • The River Dolphin inhabits the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, and Bangladesh. • It is estimated that their total population is around 2,000 and they are listed in Schedule I of the Wildlife Protection Act (1972). • The Ganges Dolphin is among the four "obligate" freshwater dolphins found in the world — the other three are the 'baiji' found in the Yangtze River (China), the 'bhulan' of the Indus (Pakistan) and the 'boto' of the Amazon River (Latin America). • Although there are several species of marine dolphins whose ranges include some freshwater habitats, these four species live only in rivers and lakes. • The Chinese River Dolphin was declared functionally extinct by a team of international scientists in 2006. • In India, the Ganges River Dolphin is threatened by river water pollution and siltation, accidental entanglement in fishing nets and poaching for their oil. • In addition, alterations to the rivers in the form of barrages and dams are separating populations.
Project Vultures	<p>Why project vulture?</p> <p>In recent times vultures have seen a marked decline of many species. Indiscriminate usage of diclofenac as pain killers in the cattle has caused renal failures in the vultures. Unfortunately, power lines are also a key factor in the loss of many birds. Losses of vultures increases the spread of diseases such as rabies and anthrax which can have devastating effects on other wildlife populations.</p>

Vulture to the environment & ecology

- Vultures are an important ecological component, occurring at the **top of the food chain**.
- Healthy vulture population numbers are a clear indication of a well-balanced environment.
- Vultures also play an important cultural, economic and aesthetic role, and are a symbol of our national heritage.
- The vulture performs a number of important tasks which are vitally beneficial to humans, as well as the environment at large. These tasks include their **“clean-up” properties; ridding the environment of decomposing carcasses**.
- This prevents the spread of diseases such as anthrax, brucellosis and rabies.

Government of India on Conservation of vultures

- **The Ministry of Health and Family Welfare** issued Gazette Notification dated 4.7.2008 prohibiting manufacture of Diclofenac for animal use and later by Gazette Notification dated 17.7.2015 restricting on packaging of multi-dose vials of Diclofenac to single dose.
- The Ministry of Health and Family Welfare had been requested for stopping veterinary use of Diclofenac and later for restriction on packaging of Diclofenac (human formulations) to single dose packaging for human use and to discourage veterinary use of Diclofenac and incentivize the use of Meloxicam.
- A survey conducted by the **Bombay Natural History Society** under a special project sponsored in the year 2000 by the Ministry of Environment, Forest and Climate Change revealed that there has been more than 90 percent decline in the populations of three species of vultures viz, White Backed, Long Billed and Slender Billed in many parts of the country.

The following are the important steps taken by Government for protection of Vultures in the country:

1. Protection status of White backed, Long Billed and Slender Billed Vultures has been upgraded from **Schedule IV to Schedule I of the Wild Life (Protection) Act, 1972**.
2. Two workshops were organized in in consultation with scientists in New Delhi in September 2000 and April, 2004 to work out a comprehensive strategy for conservation of vultures.
3. Bombay Natural History Society in collaboration with the Haryana State Forest Department has taken up a project on conservation breeding of vultures.
4. A **‘Vulture Captive Care facility’** has been established at **Panchkula**.
5. The State Governments have been advised to set up vulture care centres for the conservation of three species of vultures.
6. Government of India has formulated a **National Action Plan (2006) on Vulture Conservation**. The Action Plan provides for strategies, actions for containing the decline of vulture population through ex-situ, in-situ vulture conservation.
7. Department of forests of all states/UTs has been requested to constitute a Monitoring committee for vulture conservation with a view to implement the Action Plan, 2006 and for recovery of existing vulture sites.

	<p>8. Captive breeding centres at Zoos at Bhopal, Bhubaneswar, Junagarh and Hyderabad have also been set up through Central Zoo Authority.</p> <p>9. State of Haryana has established Safe Vulture Zones under Project Jatayu.</p> <p>10. Ministry has also taken initiatives to strengthen the mass education and awareness for vulture conservation.</p>
--	---

APPENDIX

Biosphere Reserves in India.

<i>S. No.</i>	<i>Name</i>	<i>Date of Notification</i>	<i>Area (in km²)</i>	<i>Location (State)</i>
1	Nilgiri	01.09.1986	5520 (Core 1240 & Buffer 4280)	Part of Wayanad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani hills (Tamil Nadu, Kerala and Karnataka).
2	Nanda Devi	18.01.1988	5860.69 (Core 712.12, Buffer 5,148.570) & T. 546.34)	Part of Chamoli, Pithoragarh, and Bageshwar districts (Uttarakhand).
3	Nokrek	01.09.1988	820 (Core 47.48 & Buffer 227.92, Transition Zone 544.60)	Part of Garo hills (Meghalaya).
4	Great Nicobar	06.01.1989	885 (Core 705 & Buffer 180)	Southern most islands of Andaman And Nicobar (A&N Islands).
5	Gulf of Mannar	18.02.1989	10,500 km ² Total Gulf area (area of Islands 5.55 km ²)	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu).
6	Manas	14.03.1989	2837 (Core 391 & Buffer 2,446)	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamrup and Darang districts (Assam)
7	Sunderbans	29.03.1989	9630 (Core 1700 & Buffer 7900)	Part of delta of Ganges and Brahmaputra river system (West Bengal).
8	Simlipal	21.06.1994	4374 (Core 845, Buffer 2129 & Transition 1400)	Part of Mayurbhanj district (Orissa).
9	Dibru-Saikhowa	28.07.1997	765 (Core 340 & Buffer 425)	Part of Dibrugarh and Tinsukia Districts (Assam)
10	Dehang-Dibang	02.09.1998	5111.50 (Core 4094.80 & Buffer 1016.70)	Part of Siang and Dibang Valley in Arunachal Pradesh.

11	Pachmarhi	03.03.1999	4926	Parts of Betul, Hoshangabad and Chindwara districts of Madhya Pradesh.
12	Khangchendzonga	07.02.2000	2619.92 (Core 1819.34 & Buffer 835.92)	Parts of Khangchendzonga hills and Sikkim.
13	Agasthyamalai	12.11.2001	1828	Neyyar, Peppara and Shendurney Wildlife Sanctuaries and their adjoining areas in Kerala.
14	Achanakamar - Amarkantak	30.3.2005	3835.51 (Core 551.55 & Buffer 3283.86)	Covers parts of Anupur and Dindori districts of M.P. and parts of Bilaspur districts of Chhattishgarh State.
15	Kachchh	29.01.2008	12,454 km ²	Part of Kachchh, Rajkot, Surendra Nagar and Patan Civil Districts of Gujarat State
16	Cold Desert	28.08.2009	7770	Pin Valley National Park and surroundings; Chandratal and Sarchu&Kibber Wildlife Sanctuary in Himachal Pradesh
17	Seshachalam Hills	20.09.2010	4755.997	Seshachalam Hill Ranges covering parts of Chittoor and Kadapa districts of Andhra Pradesh
18	Panna	25.08.2011	2998.98	Part of Panna and Chhattarpur districts in Madhya Pradesh

Following biosphere reserves are a part of the World Network of Biosphere Reserves(WNBR), based on the UNESCO Man and the Biosphere (MAB) Programme list.

<i>S.N.</i>	<i>Name</i>	<i>States</i>	<i>Year</i>
1	Nilgiri Biosphere Reserve	Tamil Nadu, Kerala and Karnataka	2000
2	Gulf of Mannar Biosphere Reserve	Tamil Nadu	2001
3	Sundarbans Biosphere Reserve	West Bengal	2001
4	Nanda Devi Biosphere Reserve	Uttarakhand	2004
5	Nokrek Biosphere Reserve	Meghalaya	2009
6	Pachmarhi Biosphere Reserve	Madhya Pradesh	2009
7	Simlipal Biosphere Reserve	Odisha	2009
8	Great Nicobar Biosphere Reserve	Great Nicobar	2013
9	Achanakmar-Amarkantak Biosphere Reserve	Chhattisgarh, Madhya Pradesh	2012
10	Agasthyamalai Biosphere Reserve	Kerala and Tamil Nadu	2016

11	Khangchendzonga National Park	Sikkim	2018
----	-------------------------------	--------	------

List of national parks in India

<i>Name</i>	<i>State</i>	<i>Estd</i>	<i>Notability</i>	<i>Rivers and lakes inside the national park</i>
Anamudi Shola National Park	Kerala	2003		
Anshi National Park	Karnataka	1987	Great hornbill, tiger, leopard, black panther, bear, elephant, deer	Kali River (Karnataka)
Balphakram National Park	Meghalaya	1986	Wild water buffalo, red panda, elephant and eight cat species, including the tiger and marbled cat	
Bandhavgarh National Park	Madhya Pradesh	1982	1336 species of endemic plants	
Bandipur National Park	Karnataka	1974	Chital, Bengal tiger, gray langurs, Indian giant squirrel, gaur, leopard, sambar deer, Indian elephants, honey buzzard, red-headed vulture	Kabini River, Moyar River
Bannerghatta National Park	Karnataka	1986	Tiger, sloth bear, peacock, elephant, sambar deer, mouse deer	
Betla National Park	Jharkhand	1986	Tiger, Indian bison, elephant, hyenas, monkey, Leopard	North Koyal River
Bhitarkanika National Park	Odisha	1988	Mangroves, saltwater crocodile, white crocodile, Indian python, black ibis, wild pigs, rhesus monkeys, olive ridley sea turtle, chital	Brahmani River, Baitarani River, Dhamra River, Pathsala
Bison (Rajbari) National Park	Tripura	2007		
Blackbuck National Park, Velavadar	Gujarat	1976	Hunting cheetahs, Blackbuck Lodge, the endangered Indian grey	

			wolf, the nocturnal striped hyena, Indian fox, golden jackal, jungle cat and many small mammals like hare, gerbil, field mice, mongoose and hedgehog.	
Buxa Tiger Reserve	West Bengal	1992		
Campbell Bay National Park	Andaman and Nicobar Islands	1992		
Chandoli National Park	Maharashtra	2004		
Clouded Leopard National Park	Tripura	2003		
Dachigam National Park	Jammu and Kashmir	1981	Only area where Kashmir stag is found ^[2]	
Desert National Park	Rajasthan	1980	Great Indian bustard	
Dibru-Saikhowa National Park	Assam	1999	Feral horse	Brahmaputra, Lohit River, Dibru
Dudhwa National Park	Uttar Pradesh	1977	Tiger, Sambar deer, hog deer	
Eravikulam National Park	Kerala	1978	Nilgiri tahr, Strobilanthes kunthiana	Pambar River (Kerala)
Galathea National Park	Andaman and Nicobar Islands	1992		
Gangotri National Park	Uttarakhand	1989	Gaumukh Glacier	Ganga
Gir Forest National Park	Gujarat	1975	Asiatic lion	Hiran, Shetrunji River, Datardi, Shingoda, Machhundri, Godavari and Raval
Gorumara National Park	West Bengal	1994	The park is rich in large herbivores including Indian rhinoceros, gaur, Asian elephant, sloth bear, chital, and sambar deer	Jaldhaka, Brahmaputra

Govind Pashu Vihar National Park	Uttarakhand	1990		
Great Himalayan National Park	Himachal Pradesh	1984	UNESCO World Heritage Site	
Gugamal National Park	Maharashtra	1987		
Guindy National Park	Tamil Nadu	1976		
Gulf of Mannar Marine National Park	Tamil Nadu	1980		
Guru Ghasidas (Sanjay) National Park	Chhattisgarh	1981		
Hemis National Park	Jammu and Kashmir	1981	Largest National park in India	
Inderkilla National Park	Himachal Pradesh	2010		
Indra Gandhi Wildlife Sanctuary and National Park	Tamil Nadu	1989		
Indravati National Park	Chhattisgarh	1981	Wild Asian buffalo, tiger reserve, hill mynas	
Jaldapara National Park	West Bengal	2012	Indian rhinoceros	
Jim Corbett National Park	Uttarakhand	1936	First national park in India (established in 1936 as Hailey National Park)	Ramganga
Kalesar National Park	Haryana	2003	On the bank of Yamuna river	
Kanha National Park	Madhya Pradesh	1955		
Kanger Ghati National Park	Chhattisgarh	1982		
Kasu Brahmananda Reddy National Park	Telangana	1994		
Kaziranga National Park	Assam	1974	Highest known tiger density in the world, Indian rhinoceros, UNESCO World Heritage Site	
Keibul Lamjao National Park	Manipur	1977	Only floating park in the world	Loktak Lake
Keoladeo National Park	Rajasthan	1981	UNESCO World Heritage Site	

Khangchendzonga National Park	Sikkim	1977	UNESCO World Heritage Site	
Khirganga National Park	Himachal Pradesh	2010		
Kishtwar National Park	Jammu and Kashmir	1981		
Kudremukh National Park	Karnataka	1987		
Kuno National Park	Madhya Pradesh	2018	Asiatic Lion Reintroduction Project	
Madhav National Park	Madhya Pradesh	1959		
Mahatma Gandhi Marine National Park	Andaman and Nicobar Islands	1983		
Mahavir Harina Vanasthali National Park	Telangana	1994		
Manas National Park	Assam	1990	UNESCO World Heritage Site	
Mandla Plant Fossils National Park	Madhya Pradesh	1983		
Marine National Park, Gulf of Kutch	Gujarat	1980		
Mathikettan Shola National Park	Kerala	2003	elephants	
Middle Button Island National Park	Andaman and Nicobar Islands	1987		
Mollem National Park	Goa	1978		
Mouling National Park	Arunachal Pradesh	1986		
Mount Harriet National Park	Andaman and Nicobar Islands	1987	Important bird area as attributed by BirdLife International	
Mrugavani National Park	Telangana	1994		
Mudumalai National Park	Tamil Nadu	1940		
Mukundra Hills National Park	Rajasthan	2006		
Mukurthi National Park	Tamil Nadu	2001	Nilgiri tahr	
Murlen National Park	Mizoram	1991		

Nagarhole National Park	Karnataka	1988		
Namdapha National Park	Arunachal Pradesh	1974		
Nameri National Park	Assam	1978		
Nanda Devi National Park	Uttarakhand	1982	UNESCO World Heritage Site, UNESCO World Biosphere Reserve	
Navegaon National Park	Maharashtra	1975		
Neora Valley National Park	West Bengal	1986		
Nokrek National Park	Meghalaya	1986	UNESCO World Biosphere Reserve	
North Button Island National Park	Andaman and Nicobar Islands	1979		
Ntangki National Park	Nagaland	1993		
Orang National Park	Assam	1999		
Pambadum Shola National Park	Kerala	2003	Nilgiri marten, Nilgiri wood pigeon, Nilgiri langur, Nilgiri flycatcher, Blue rock-thrush	
Panna National Park	Madhya Pradesh	1981		
Papikonda National Park	Andhra Pradesh	2008	Royal Bengal Tiger, Leopards, rusty-spotted cat, King Cobra	
Pench National Park^[3]	Madhya Pradesh	1977	Rudyard Kipling's 'Jungle Book' was set in this NP.	
Periyar National Park	Kerala	1982	Malabar parakeet, Malabar grey hornbill, Nilgiri laughing thrush, Nilgiri blue robin, great hornbill, Malabar pied hornbill, lion-tailed macaque, hairy-winged bat	
Phawngpui Blue Mountain National Park	Mizoram	1992		

Pin Valley National Park	Himachal Pradesh	1987		
Rajaji National Park	Uttarakhand	1983	Mainly known for elephants, tigers, leopards and several species of birds, reptiles and mammals.	
Rajiv Gandhi (Rameswaram) National Park	Andhra Pradesh	2005		
Rani Jhansi Marine National Park	Andaman and Nicobar Islands	1996		
Ranthambore National Park	Rajasthan	1981	Tiger Reserve.	
Saddle Peak National Park	Andaman and Nicobar Islands	1979		
Salim Ali National Park	Jammu and Kashmir	1992		
Sanjay National Park^[4]	Madhya Pradesh	1981		
Sanjay Gandhi National Park	Maharashtra	1969	Asiatic Lion, Indian Leopard, Rhesus Macaque, Bonnet Macaque, Spotted Deer, Hanuman Langur, Indian Flying Fox, Indian Hare, Barking Deer, Porcupine, Palm Civet, Mouse Deer	
Sariska Tiger Reserve	Rajasthan	1955		
Satpura National Park	Madhya Pradesh	1981		
Silent Valley National Park	Kerala	1980	Indian bison, Travancore flying squirrel, Salim Ali's fruit bat, Stripe-necked mongoose, Blue-winged parakeet, Crimson-backed sunbird	Kunthipuzha River
Simbalbara National Park	Himachal Pradesh	2010		
Sirohi National Park	Manipur	1982		

Simlipal National Park	Odisha	1980	Tiger, leopard, Asian elephant, sambar, barking deer, gaur, jungle cat, wild boar	
Singalila National Park	West Bengal	1986		
South Button Island National Park	Andaman and Nicobar Islands	1987	Dugong, dolphin, water monitor lizard, blue whale and smallest National park in India	
Sri Venkateswara National Park	Andhra Pradesh	1989		
Sultanpur National Park	Haryana	1989		
Sundarbans National Park	West Bengal	1984	UNESCO World Heritage Site	
Tadoba National Park	Maharashtra	1955	Tiger	
Valley of Flowers National Park	Uttarakhand	1982	UNESCO World Heritage Site	
Valmiki National Park	Bihar	1976		
Vansda National Park	Gujarat	1979		
Van Vihar National Park	Madhya Pradesh	1983		

List of Biodiversity Heritage Sites

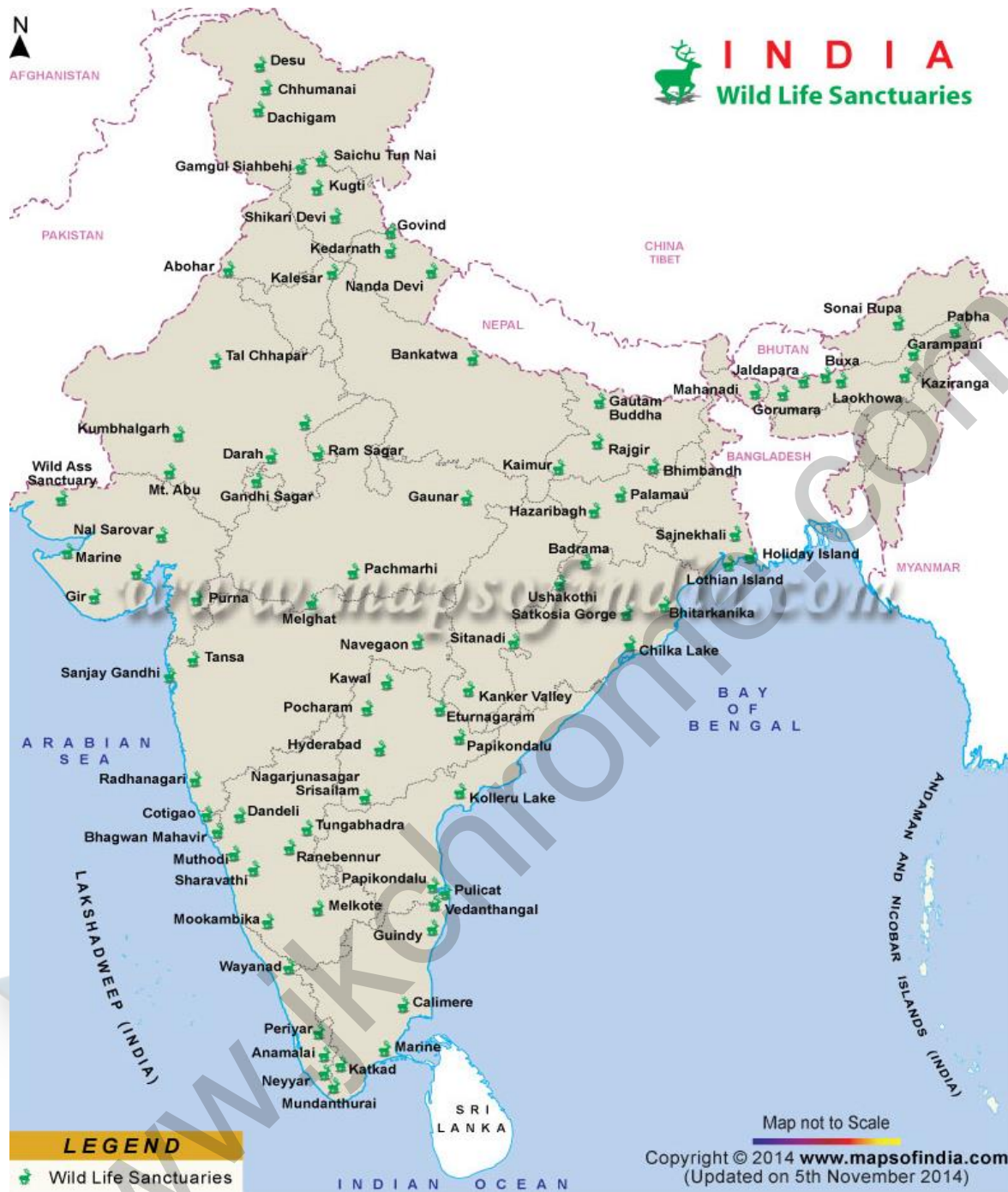
National Biodiversity Authority under Ministry of Environment of India, have declared list of Biodiversity Heritage Sites (BHS)

<i>S. No.</i>	<i>Name of the Site</i>	<i>Name of the District</i>	<i>Area</i>	<i>Importance of the area</i>
1	Nallur Tamarind Grove	Bengaluru	54 acres	It is popularly believed to be a relic of the Chola Dynasty that ruled nearly 800 years ago, is spectacle of awesome wonder and a freakish site. This BHS spread over 54 acres comprising a population of nearly 300 trees, is a picture of dynamic pattern of plant diversity. The significant component of this popular structure is a group of old plants standing like ageless sentinels, firmly rooted to the ground with their gigantic trunks, along with large picturesque crowns spread very high and aloft like open wings.

2	Hogrekan	Chikmagalur	2508.15 acres	The area has unique Shola vegetation and grass land with number of floral species which are unique and having lot of medicinal value. Hogrekan is moderately wooded land and its vegetation is of dry deciduous type and has a link with Bababudanagiri and Kemmangundi, adjoining Bhadra Wildlife Sanctuary and Yemmedode Tiger Reserve and serving as "Wildlife Corridor" between Kudremukha and Bhadra Wildlife Sanctuary.
3	University of Agricultural Sciences, GKVK Campus, Bengaluru	Bengaluru	167 hectares	The GKVK campus is considered one of the greenest areas in Bengaluru. Biological diversity of this campus constitutes a critical repository of various forms of flora and fauna (including 13 sp of mammals, 10 sp of reptiles, 165 sp of birds and 530 sp of plants) which needs to be protected nurtured to posterity.
4	Ambaraguda	Shimoga	3857.12 hectares	It is a revenue land located between Sharavathi Wild Life Sanctuary and Someshwara Wildlife Sanctuary. It has Shola vegetation which is primitive vegetation in the Western Ghat and also has grasslands.
5	Glory of Allapalli	Gadchiroli	6 hectares	It is a reserved forest being preserved as natural forest having biological, ethinical and historical values.
6	Tonglu BHS under the Darjeeling Forest Division	Darjeeling	230 hectares	It is a Medicinal Plant Conservation Areas
7	Dhotrey BHS under the Darjeeling Forest Division	Darjeeling	180 hectares	It is a Medicinal Plant Conservation Areas
8	Dialong Village	Tamenglong	11.35 Sq.km	---
9	Ameenpur lake	Sangareddy	---	---
10	Majuli	Majuli	875 Sq.km	It is an island situated in the Brahmaputra River which is harboring unique Ecological and Cultural Heritage.
11	Ghariyal Rehabilitation Centre	Lucknow	10 Hectares	It is a centre established for conservation and rehabilitation of critically endangered species of Gharial.

12	Chilkigarh Kanak Durga	Jhargram	55.9 Acres (Perimet er Of 1,969 Meters)	Chilkigarh Kanak Durga Sacred Grove is a remnant forest with traditional beliefs and taboos of local inhabitants and rich in biodiversity covering an area of 55.9 acres in Jhargram District of West Bengal.
----	---------------------------	----------	--	---





Can economic incentives benefit biodiversity and local communities?

❖ The impact of market instruments in encouraging and achieving conservation of biodiversity is unclear

- The tradable development rights (TDR) offer the potential to achieve a conservation objective
- Criticism of TDR, for example in a situation could arise in which the most ecologically sensitive land but also the least costly to develop would not be protected.
- To date, the TDR has not been designed to target specific habitat types and properties.

Transferring rights to own and manage ecosystem services to private individuals gives them a stake in conserving those of institutional support. For example, in South Africa, changes in wildlife protection

legislation allowed a shift in landownership and a conversion from cattle and sheep farming to profitable game farming, enabling conservation of indigenous wildlife. On the other hand, the CAMPFIRE program in Zimbabwe, based on sustainable community-managed use of wildlife, has now become an example of how success can turn into failure, with the state repossessing the areas given to individuals and breaking the levels of trust and transparency—a form of instrumental freedom—that are critically needed for these economic responses to work efficiently and equitably.

Payments to local landowners for ecosystem services show promise of improving the allocation of ecosystem services and are applicable to biodiversity conservation. However, compensating mechanisms addressing the distributive and equitable aspects of these economic instruments may need to be designed in support of such efforts. By 2001, more than 280,000 hectares of forests had been incorporated in Costa Rica within reserves, at a cost of about \$30 million per year, with typical annual payments ranging from \$35 to \$45 per hectare for forest conservation (R5 Box 5.3). However, the existence of direct payment initiatives does not guarantee success in achieving conservation and development objectives or benefits for human well-being. Empirical analyses about the distributive impacts across different social groups are rare.

Direct payments are often more effective than indirect incentives. For example, integrated conservation-development projects—an indirect incentive—designed to allow local populations to improve their well-being by capturing international willingness to pay for biodiversity conservation have in practice rarely been integrated into ongoing incentives for conservation. Overall, long-term success for these response strategies depends on meeting the economic and social needs of communities whose well-being already depends to varying degrees on biodiversity products and the ecosystem services biodiversity supports (R5).

However, direct payments have been criticized for requiring ongoing financial commitments to maintain the link between investment and conservation objectives. Furthermore they have led in some instances to inter- and intra-community conflict.

Yet many success stories show the effectiveness of direct payments and the transfer of property rights in providing incentives for local communities to conserve biodiversity. Effectiveness of payments in conserving regional biodiversity may be enhanced by new approaches that target payments based on estimated marginal gains (“complementarity” values) (R5 Box 5.3).

Significant improvements can be made to mitigate biodiversity loss and ecosystem changes by removing or redirecting economic subsidies that cause more harm than good. Agricultural subsidies in industrial countries reduce world prices for many commodities that developing countries produce. Lower prices provide the wrong incentives, encouraging these countries to adopt unsustainable agricultural activities that destroy ecosystems as well as push many poor farmers into poverty. Therefore the removal or redirection of agricultural subsidies is highly likely by itself to produce major improvements in ecosystem services and to check the rate of biodiversity loss (R5).

The promotion of “win-win” outcomes has been politically correct at best and naive at worst. Economic incentives that encourage the conservation and sustainable use of biodiversity show considerable promise. However, trade-offs between biodiversity, economic gains, and social needs have to be more realistically acknowledged. The benefits of biodiversity conservation are often widespread, even global in the case of existence values or carbon sequestration, while the costs of restricting access to biodiversity often are concentrated on groups living near biodiversity-rich areas.

BIOME

- A natural ecosystem is an assemblage of plants and animals which functions as a unit and is capable of maintaining its identity.
- There are two main categories of ecosystems:

A. BIOME (TERRESTRIAL ECOSYSTEM)

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

Biome	Temperature	Rainfall	Vegetation
Desert	Hot (>30°C) in the day Cold (<0°C) at night	Low Precipitation Less than 30cm per year	Xerophytes Adapted to water conservation
Grassland	Warm (20°C-30°C)	Seasonal Droughts Medium amount of rain	Grass with widely spaced trees Fires prevent trees from invading
Shrub land	Moderate (20°C-30°C)	Rainy winters, dry summers	Dry, woody shrubs Regrow quickly
Coniferous Forrest (Taiga)	Cold (0°C-15°C)	Low Precipitation Wet due to lack of evaporation	Epiphytes, tall trees and undergrowth Large diversity in species
Tropical Rainforest	Hot (20°C-30°C)	High Precipitation Over 250cm per year	
Tundra	Freezing (<0°C)	Little Precipitation	Small close to the ground (e.g. mosses) Perennial plants grow in the summer

Figure: types of biome

TUNDRA (Arctic and Alpine Tundra Biome)

- There are two types of tundra – arctic and alpine.
- Alpine tundra occurs at high mountains above the tree line. E.g. High ranges of the Himalayas, Andes, Alps etc.
- There are **no trees** in the tundra (due to **permafrost**).
- The lowest form of vegetation like **mosses**, **lichens** are sparsely found on bare rocks.
- Coastal lowlands **reindeer moss** which provides the only pasturage for reindeers.
- In the summer, birds migrate north to prey on the numerous insects which emerge when the snow thaws.

- Insects have short life cycles which are completed during the favourable period of the year.
- Animals like the reindeer, arctic fox, wolves, musk-ox, polar bear, lemming, arctic hare, arctic willow live in tundra region.
- **Reptiles and amphibians are almost absent.**
- Most of the animals have **long life**, e.g. arctic willow has a life span of 150 to 300 years.
- They are protected from chillness by the presence of **thick cuticle and epidermal hair or fur.**
- Mammals **have a large body size and small tail and ear** to avoid the loss of heat from the surface.

DESERT (Tropical and Mid Latitude Desert Biome)

- The predominant vegetation of both hot and mid-latitude deserts is **xerophytic or drought-resistant.**
- This includes the cacti, thorny bushes, long-rooted wiry grasses and scattered dwarf acacias.
- Most desert shrubs have **long roots and are well spaced out** to gather moisture, and search for ground water.
- Plants have **few or no leaves, and the foliage is either waxy, leathery, hairy or needle-shaped to reduce the loss of water through transpiration.**
- The seeds of many species of grasses and herbs have **thick, tough skins** to protect them while they lie dormant.

FOREST

Taiga or Boreal Biome (Evergreen Coniferous forests)	<ul style="list-style-type: none"> • Boreal forest soils are characterized by thin podzols and are rather poor. This is because: • The weathering of rocks proceeds slowly in cold environments • the litter derived from conifer needle (leaf) is decomposed very slowly and is not rich in nutrients (humus content is low). • conifers do not shed their leaves frequently. • The predominant vegetation is an evergreen coniferous forest with species such as spruce, fir and pine. • The conifers require little moisture are best suited to this type of sub-Arctic climate. • The productivity of boreal forest is lower than those of any other forest ecosystem. • Animals found in this region include Siberian tiger, wolverine, lynx, wolf, bear, red fox, squirrel, and amphibians like Hyla, Rana, etc.
Temperate Deciduous Biome (North Western Europe – British Type Climate)	<ul style="list-style-type: none"> • Soils of temperate forests are podzolic and fairly deep. • The natural vegetation of this climatic type is deciduous. • The trees shed their leaves in the cold season. • This is an adaptation for protecting themselves against the winter snow and frost. • Shedding begins in autumn, the ‘fall’ season. Growth begins in spring. • Some of the common species include oak, elm, ash, birch, beech, and poplar.
Temperate Rainforest Biome	<ul style="list-style-type: none"> • This is a small biome in terms of area covered. The main stretch of this habitat is along the northwestern coast of North America from northern California through southern Alaska.

	<ul style="list-style-type: none"> • There are also small areas in southern Chile, New Zealand, Australia and a few other places around the world. • Big coniferous trees dominate this habitat, including Douglas fir, Western red cedar, Mountain hemlock, Western hemlock, Sitka spruce and Lodgepole pine. • In addition to the trees, mosses and lichens are very common, often growing as epiphytes. • Grizzly bears are the common mammals found in Alaska.
Sub-Tropical Deciduous Biome in Eastern China, South Eastern USA	<ul style="list-style-type: none"> • Supports luxuriant vegetation. • The lowlands carry both evergreen broad-leaved forests and deciduous trees (hardwood). • On the highlands, various species of conifers such as pines and cypresses are important. • Perennial plant growth is not checked by either a dry season or a cold season.
Temperate Deciduous Biome (Mediterranean Climate)	<ul style="list-style-type: none"> • Trees with small broad leaves are widely spaced and never very tall. • Regions with adequate rainfall are inhabited by low, broad-leaved evergreen trees (mostly evergreen oaks). • Fire is an important hazardous factor in this ecosystem, and the adaptation of the plants enable them to regenerate quickly after being burnt. • Plants are in a continuous struggle against heat, dry air, excessive evaporation and prolonged droughts. • They are, in short xerophytic (drought tolerant).
Tropical Deciduous Biome (Monsoon Climate)	<ul style="list-style-type: none"> • Tropical Monsoon Forests are also known as a drought-deciduous forest; dry forest; dry-deciduous forest; tropical deciduous forest. • Teak, neem, bamboos, sal, shisham, sandalwood, khair, mulberry are some of the important species.
Savanna or Tropical Wet and Dry Biome	<ul style="list-style-type: none"> • The savanna landscape is typified by tall grass and short trees. • The trees are deciduous, shedding their leaves in the cool, dry season to prevent excessive loss of water through transpiration, e.g. acacias. • Trees usually have broad trunks, with water-storing devices to survive through the prolonged drought. • Many trees are umbrella shaped, exposing only a narrow edge to the strong winds. • Savanna biome is rich in mammal, bird and reptile diversity.
Tropical Rain Forest Biome	<ul style="list-style-type: none"> • High temperature and abundant rainfall support a luxuriant tropical rain forest. • The equatorial vegetation comprises a multitude of evergreen trees, e.g. mahogany, ebony, dyewoods etc. • In the coastal areas and brackish swamps, mangrove forests thrive. • All plants struggle upwards (most epiphytes) for sunlight resulting in a peculiar layer arrangement (canopy). • Epiphyte (commensalism – epiphyte benefits without troubling the host): An epiphyte is a plant that grows harmlessly upon another plant (such as a tree) and derives its moisture and nutrients from the air, rain, and sometimes from debris accumulating around it.

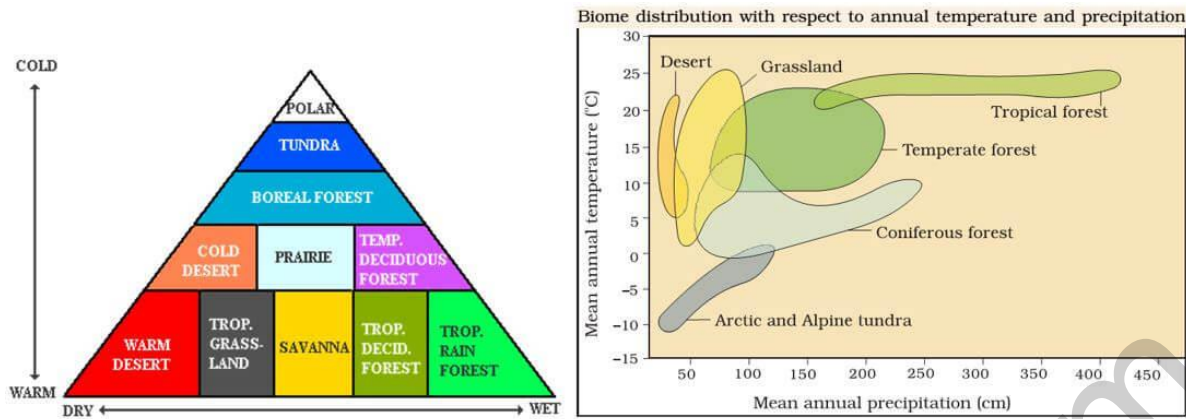


Figure: rainfall pattern in different biome.

B. AQUATIC ECOSYSTEMS

Aquatic ecosystems refer to plant and animal communities occurring in water bodies.

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

AQUATIC ORGANISM

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

LIMITING FACTORS OF THE AQUATIC ECOSYSTEMS

Sunlight and oxygen are the most important limiting factors of the aquatic ecosystems.

Sunlight	<p>Sunlight penetration rapidly diminishes as it passes down the column of water.</p> <ul style="list-style-type: none"> • 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.
Dissolved oxygen	<ul style="list-style-type: none"> • 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. • Oxygen is less soluble in warm water. Warm water also enhances decomposer activity. Therefore, increasing the temperature of a water body increases the rate at which oxygen is depleted from the water. • When the dissolved oxygen level falls below 3-5 ppm, many aquatic organisms are likely to die.
Temperature	<ul style="list-style-type: none"> • 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 organisms when compared to the changes in air temperatures in the terrestrial organisms.

Photic zones

- 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 take place.

Aphotic zone

- The lower layers of the aquatic ecosystems, where light penetration and plant growth are restricted forms 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.

Podzols:

- Podzols are the typical soils of a **coniferous or boreal biome**. The top layer of the soil is very thin and is overlain over sandy or loamy subsurface which has no organic matter (**lost due to leaching of nutrients** to the bottom layers).
- The soils are characterized by low levels of moisture (excessively drained) and nutrients and are loamy or sandy. Others have shallow rooting zones and poor drainage due to subsoil cementation.
- A low pH further compounds issue. The **low pH (acidic)** is due to **excessive leaching of alkaline** matter which if present would neutralise the organic acids of the accumulating litter. Hence, most Podzols are **poor soils for agriculture**. They are mostly used for grazing.



CLIMATE CHANGE



CLIMATE CHANGE, OCEAN ACIDIFICATION AND OZONE DEPLETION

TABLE OF CONTENT:

1. Climate change
2. Ocean acidification
3. Ozone depletion



CLIMATE CHANGE AND IT'S IMPACTS

Variability, in both time and space, is an inherent feature of climate, as the atmosphere is always in the state of turmoil and instability leading to variations in weather and climatic conditions.

What Is Climate? How Is It Different from Weather?

Weather:

- Weather is the **changes we see and feel outside from day to day**. It might rain one day and be sunny the next.
- Weather is dynamic and **changes from place to place**. It is a combination of wind, temperature, cloudiness, precipitation and visibility.

Climate:

- The difference between weather and climate is the measure of time.
- Climate is the **usual weather of a place averaged over some time period (usually 30-50 years)**.

Earth's climate:

- Earth's climate is what you get **when you combine all the climates around the world together**.

What Is Climate Change?

- Global warming and climate change - while closely related and sometimes interchangeably used technically refer to two different things.
- **"Global Warming"** applies to the long-term trend of rising average global surface temperatures.
- **"Climate change"** is a broader term that reflects the fact that carbon pollution does more than just warm our planet. Climate change is a long-term shift in global or regional climate patterns. Often climate change refers specifically to the rise in global temperatures from the mid 20th century to present.
- Carbon pollution is also changing rain and snow patterns and increasing the risk of intense storms and droughts.
- Another distinction between them is that scientists and scholars see global warming mostly as human induced warming whereas climate change, on the other hand, can mean human induced changes or natural ones, such as ice ages or the combination of both.

Is Earth's Climate Changing?

- The planet has experienced climate change before: the Earth's average temperature has fluctuated throughout the planet's 4.54 billion-year history. The planet has experienced long cold periods ("ice ages") and warm periods ("interglacial") on 100,000-year cycles for at least the last million years.
- **Earth's climate is getting warmer**. According to **1.5 Degree Report** of IPCC presented at **CoP 24 in Katowice, Poland**, the world has already warmed 1 degree centigrade, since pre-industrial levels.

The 25th edition of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) or COP25 held in Madrid (Spain).

COP 25: Focus:

- Ambitions for this conference were limited because many countries were focused on narrow technical details such as the workings of the **global carbon markets**.

- It was hoped that countries would resolve to work on more ambitious carbon targets needed to fulfil the goals of the 2015 Paris agreement.

Climate Change Facts:

- Global greenhouse gas emissions of G20 countries are continuing to increase. Between 1990 and 2013, the absolute CO₂ emissions of G20 countries, which account for 3/4ths of global CO₂ emissions, went up by 56%.
- Trends in global CO₂ and total greenhouse gas emissions show that India's emissions have gone up by 4.7% in 2016
- For most major GHG emitters in the world, the emission figures have gone down, barring India and Indonesia
- Nearly 90% of the country's coal-fired power generation capacity is in violation of Sulphur Dioxide (SO₂) emission limits notified two years ago.

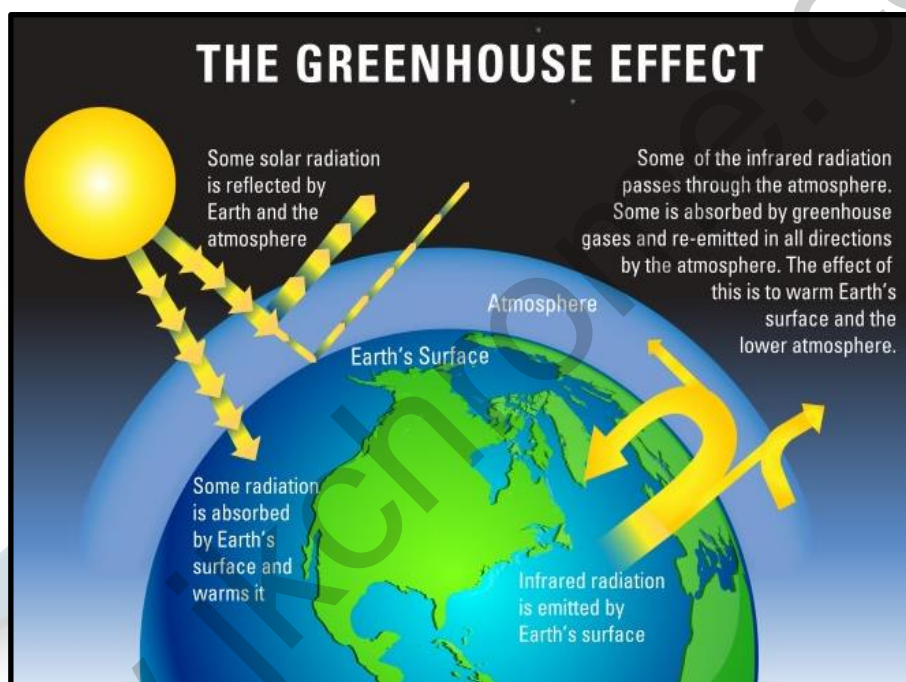


Figure: The Green House effect phenomenon

Greenhouse Effect:

The greenhouse effect refers to the rise in global average temperature of the earth.

The greenhouse effect is a process that occurs when gases in Earth's atmosphere trap the Sun's heat. This process makes Earth much warmer than it would be without an atmosphere. The greenhouse effect is one of the things that makes Earth a comfortable place to live. The process global warming follows given steps:

- **Step 1:** Solar radiation reaches the Earth's atmosphere - some of this is reflected back into space (**shortwave radiations**).
- **Step 2:** The rest of the sun's energy is absorbed by the land and the oceans, heating the Earth.
- **Step 3:** Heat radiates from Earth towards space (**long wave radiation**).
- **Step 4:** Some of this heat is trapped by greenhouse gases in the atmosphere, keeping the Earth warm enough to sustain life.

- **Step 5:** Human activities such as burning fossil fuels, agriculture and land clearing are increasing the amount of greenhouse gases released into the atmosphere.
- **Step 6:** This is trapping extra heat, and causing the Earth's temperature to rise.

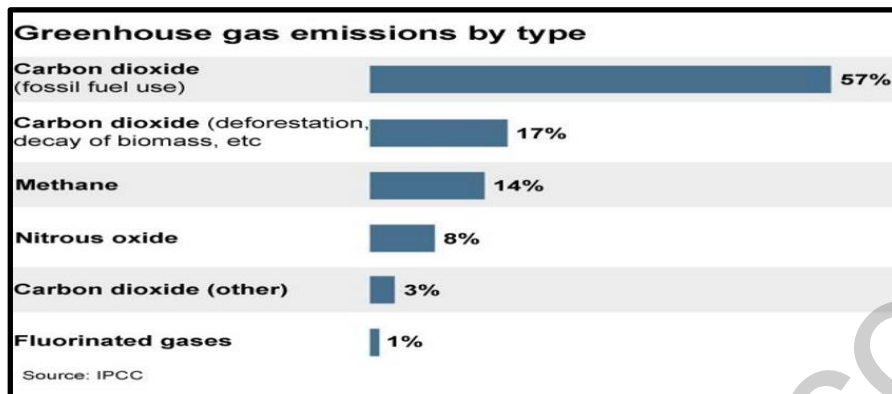


Figure: GHG emission share

Greenhouse Gases:

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.

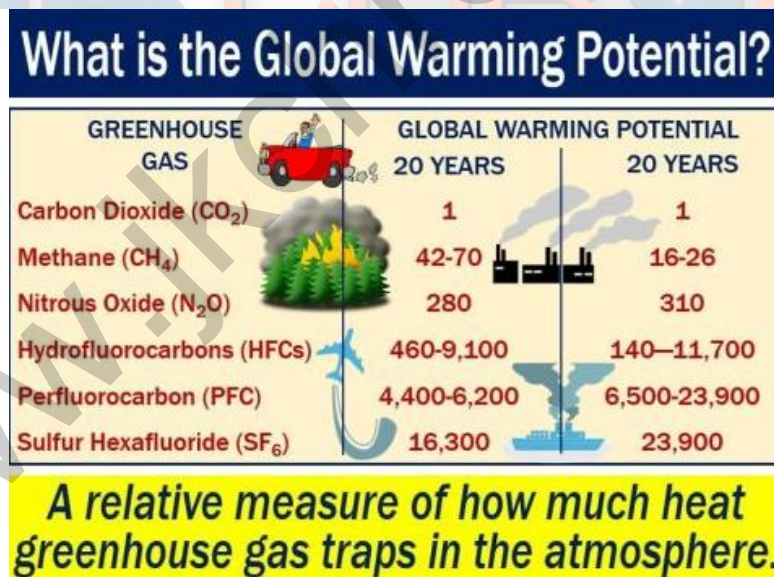


Figure: GWP of GHGs

- **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").
- **GHGs under Kyoto Protocol:**
 - Carbon mono-oxide
 - nitrous oxide
 - methane
 - Sulphur hexafluoride
 - Hydrofluorocarbons
 - Perfluorocarbons

Kyoto Protocol (KP)

In 1997, the Kyoto Protocol (3rd COP) was concluded and established legally binding obligations for developed countries to reduce their greenhouse gas emissions.

- The KP was adopted in Kyoto, Japan, in 1997. The KP came into force in 2005.
- There are currently 192 Parties.
- USA never ratified Kyoto Protocol.
- **Canada withdrew in 2012.**
- **India ratified Kyoto Protocol in 2002.**
- Objective of KP: **Fight global warming by reducing greenhouse gas concentrations** in the atmosphere to “a level that would prevent dangerous anthropogenic interference with the climate system.”
- Kyoto protocol aimed to cut emissions of greenhouse gases across the developed world by about 5 per cent by 2012 compared with 1990 levels.
- The Protocol is based on the principle of **common but differentiated responsibilities**. CBDR puts the obligation to reduce current emissions on **developed countries** on the basis that they are historically responsible for the current levels of greenhouse gases in the atmosphere.
- KP is the **only global treaty with binding limits on GHG emissions**.

IPCC

The Intergovernmental Panel on Climate Change (IPCC) published ‘**The Special Report on the Ocean and Cryosphere in a Changing Climate**’ which focused on the changes taking place in oceans, glaciers, and ice-deposits on land and sea at the United Nations Climate Summit underway in the United States.

❖ IPCC's Assessment Report

- The IPCC prepares comprehensive Assessment Reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place.
- The Assessment Report released by IPCC in 2014 was the 5th in a series of such reports.
- The 6th Assessment Report of IPCC will be released by 2022.

❖ Key Findings of the Report

- Over the 21st century, the ocean is projected to **transition to unprecedented conditions** with increased temperatures, further **ocean acidification**, **marine heatwaves and more frequent extreme El Niño and La Niña events**.

- **Ocean Warming:** Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010. Since 1993, the **rate of ocean warming** and marine heatwaves have very likely **doubled in frequency and intensity**.
- **Global Mean Sea-Level:**
 - a. It has **raised by 16 cm** between 1902 and 2015, and that the rate of increase had doubled of late.
 - b. Between 2006 and 2015, the global mean sea level recorded an average rise of **3.6 mm per year**, which was more than double of 1.4 mm per year recorded in the first 90-year-period of the 20th century.
 - c. Regional differences, within 30 % of global mean sea-level rise, result from land ice loss and variations in ocean warming and circulation
- **The Melting of Glaciers:**
 - a. the **Greenland ice sheet (from 2006 to 2016)** lost ice-mass at an average rate of 278 billion tonnes every year (e.g. **Okjokull glacier of Iceland**), which was enough to result in a global sea-level rise of 0.8 mm per year.
 - b. During the same period, **the Antarctica** lost a mass of 155 billion tonnes on an average every year.
 - c. Snow cover outside these two poles, like the **glaciers in the Himalayas**, together lost an average of 220 billion tonnes of ice every year.
- ❖ Since the mid-20th century, the **shrinking cryosphere** has led to predominantly negative impacts on food security, water resources, water quality, livelihoods, health, and well-being, as well as the culture of human societies, particularly for Indigenous peoples.

CAUSES OF CLIMATE CHANGE

Natural causes:

- **Solar irradiance**
 - Changes in the sun's energy output would cause the climate to change, since the sun is the fundamental source of energy that drives our climate system.
 - Studies show that solar variability has played a role in past climate changes, a decrease in solar activity is thought to have triggered the **Little Ice Age** between approximately 1650 and 1850, when Greenland was largely cut off by ice from 1410 to the 1720s and glaciers advanced in the Alps.
 - But several evidences show that current global warming cannot be explained by changes in energy from the sun:
 - Since 1750, the average amount of energy coming from the sun either remained constant or increased slightly.
 - If the warming were caused by a more active sun, then scientists would expect to see warmer temperatures in all layers of the atmosphere. Instead, they have observed a cooling in the upper atmosphere, and a warming at the surface and in the lower parts of the atmosphere. That's because greenhouse gases are trapping heat in the lower atmosphere.

- Climate models that include solar irradiance changes can't reproduce the observed temperature trend over the past century or more without including a rise in greenhouse gases.
- **Sunspot Cycles:**
 - The increased sunspot activity (increase in the number of sunspots) causes warming of the earth's surface and its atmosphere and vice versa.
 - Sunspots are darker and cooler areas in the photosphere of the sun.

Solar cycles have an average duration of about 11 years. Solar maximum and solar minimum refer to periods of maximum and minimum sunspot counts. Cycles span from one minimum to the next. The cyclical variation in sunspot counts, discovered in 1843 by the German astronomer Samuel Heinrich Schwabe, is called "the Sunspot Cycle"

Sunspots are regions where the solar magnetic field is very strong. In visible light, sunspots appear darker than their surroundings because they are a few thousand degrees cooler than their surroundings. Most of the visible surface of the Sun has a temperature of about 5400 degrees C, but in a big sunspot the temperature can drop to about 4000 degrees C. Sunspots come in sizes between about 2500 km and about 50,000 km.

- **Astronomical Theories**
 - ❖ The **Milankovitch Theory or Milankovitch Oscillations** have tried to explain the causes of climate change through change in the eccentricity of earth's elliptical orbit, obliquity including of the earth's rotational axis and precession of the equinoxes
 - ❖ On the basis of above theory, he tried to explain the advancement and retreat of ice sheets during Pleistocene Ice Age.
- **Atmospheric Dust Hypothesis (mainly volcanic eruptions and dusts)**
 - The atmospheric solid particulate matters include dust particles, salt particles, pollen, smoke and soot, volcanic dusts and ashes, etc.
 - **Black carbon (BC)** is a solid particle or aerosol, not a gas, but it also contributes to warming of the atmosphere.
 - Unlike GHGs, BC can directly absorb incoming and reflected sunlight in addition to absorbing infrared radiation.
 - BC can also be deposited on snow and ice, darkening the surface and thereby increasing the snow's absorption of sunlight and accelerating melt.
 - Sulfates, organic carbon, and other aerosols can **cause cooling by reflecting sunlight**.

Black Carbon

- Black carbon is the sooty black substance emitted from gas and diesel engines, coal-fired power plants, and other sources that burn fossil fuel. It comprises a significant portion of particulate matter or PM, which is an air pollutant.
- Black carbon is a global environmental problem that has negative implications for both human health and our climate. Inhalation of black carbon is associated with health problems including respiratory and cardiovascular disease, cancer, and even birth defects. Black carbon also contributes to climate change causing changes in patterns of rain and clouds.
- As black carbon deposits in the Arctic, the particles cover the snow and ice, decreasing the Earth's ability to reflect the warming rays of the sun, while absorbing heat and hastening melt.

Anthropogenic causes:

- **Burning of fossil fuels:** People drive cars. Heat and cool their houses. People cook food. All those activities take energy.

Burning coal, oil and gas to generate energy Burning these things emits gases into the air. The gases cause the air to heat up. This can change the climate of a place

- In its **5th Assessment Report**, the **Intergovernmental Panel on Climate Change**, a group of 1,300 independent scientific experts from countries all over the world under the auspices of the United Nations, concluded that there's a better than 95 percent probability that human-produced greenhouse gases such as carbon dioxide, methane and nitrous oxide have caused much of the observed increase in Earth's temperatures over the past 50 years.
- **Other causes:** Deforestation, changes in land use, soil erosion and agriculture (including livestock), Industrial revolution and Mining and Quarrying.

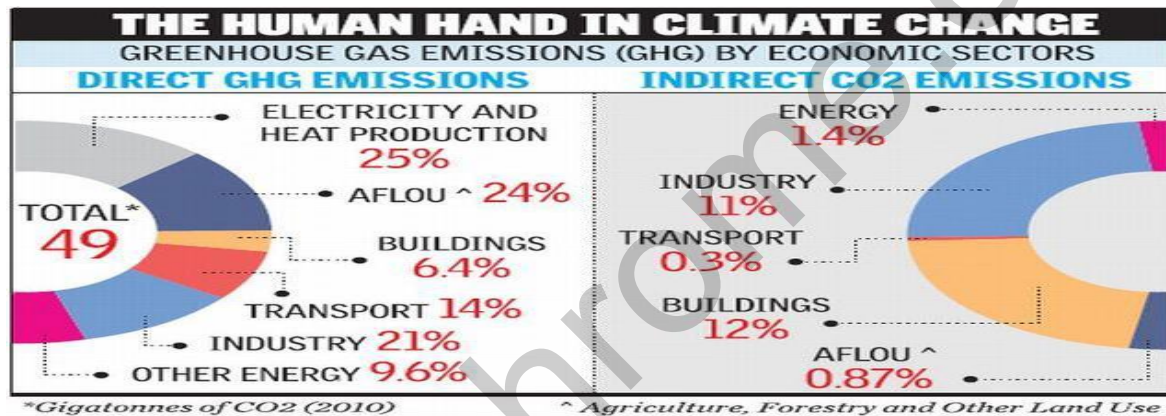


Figure: Direct and Indirect GHG Emission.

Climate Forcing:

- There are a number of natural mechanisms that can upset the global energy balance, for example **fluctuations in the Earth's orbit, variations in ocean circulation and changes in the composition of the Earth's atmosphere.**
- By altering the global energy balance, such mechanisms "force" the climate to change. Consequently, scientists call them "climate forcing" mechanisms.
- **Climate 'forcing'** are factors in the climate that either increase or decrease the effects to the climate system.
- **Positive 'forcing'** such as greenhouse gases warm the earth while the **negative 'forcing'** such as the volcanic eruptions, etc. cools the earth system.
- Examples of forcing include:
 1. Surface reflectivity (albedo)
 2. Human induced changes in greenhouse gases
 3. Atmospheric aerosols (volcanic sulfates, industrial output)
- These examples influence the balance of energy entering and leaving the Earth system.

IMPACTS OF CLIMATE CHANGE

All countries are affected by climate change, they are affected in different ways and to different extents. Especially, developing countries will be particularly badly hit, for three reasons:

- a. Geography (non-temperate latitudes)
- b. Stronger dependence on agriculture
- c. With their fewer resources comes greater vulnerability. E.g. poor and least developing countries.

Impact of Climate Change on Agriculture:

- **Low production:** Rise in coconut yields (with some exceptions); reduced fruit and vegetable production.
- **Negative impacts on livestock:** Livestock of tropical regions would become more prone to infectious and parasitic diseases. Livestock's productivity would decline. Indigenous breeds of India like Rathi, Tharparkar, Red Sindhi, etc. would be at danger.
- **Regional impact:** According to the **Turn Down the Heat: Climate Extremes, Regional Impacts and the Case for Resilience Report** (prepared by World Bank) looks at the likely impacts of 2°C and 4°C warming on agricultural production, water resources, coastal ecosystems and cities across South Asia, Sub-Saharan Africa, and Southeast Asia:
 - By the 2040s, India will see a significant reduction in crop yields because of extreme heat.
 - Reduced water availability due to changes in precipitation levels and falling groundwater tables are likely to aggravate the situation in India, where groundwater resources are already at a critical level and about 15% of the country's groundwater tables are overexploited.
 - In India, more than 60% of the crop area is rain-fed, making it highly vulnerable to climate-induced changes in precipitation patterns.
 - It is estimated that by the 2050s, with a temperature increase of 2°C-2.5°C compared to pre-industrial levels, water for agricultural production in the river basins of the Indus, Ganges and Brahmaputra will reduce further and may impact food adequacy for some 63 million people.
 - **An extreme wet monsoon** that currently has a chance of occurring only once in 100 years is projected to occur every 10 years by the end of the century.
 - Kolkata and Mumbai are 'potential impact hotspots' threatened by extreme river floods, more intense tropical cyclones, rising sea levels and very high temperatures.
 - Substantial reduction in the flow of the Indus and Brahmaputra in late spring and summer.
 - Under 2°C warming by the 2040s, crop production in South Asia may reduce by at least 12%, requiring more than twice the imports to meet per capita demand than is required without climate change.
 - **Decreasing food availability** can also lead to significant health problems, including childhood stunting, which is projected to increase by 35% by 2050 compared to a scenario without climate change.
 - Major rivers such as the Ganges, Indus and Brahmaputra, depend significantly on snow and glacial melt water, which makes them susceptible to climate-change induced glacier melt and reductions in snowfall. **The World Bank report projects a rapid increase in the frequency of low snow years in the future, well before 2°C warming takes place.** This could increase the risk of flooding, threatening agriculture.

Impact of Climate Change on Soil and Land Degradation:

- Land degradation means reduction in the potential of the land to produce benefits from a particular land use under a specified form of land management.
- Changes in climate are recognized as one of the major factors responsible for land degradation affecting sustained development.
- Land degradation encompasses change in chemical, physical and biological property of the soil.
- Soils are also crucial to food security and change in climate has threatened the food security by affecting the soil property.
- The increasing concentration of carbon dioxide in our atmosphere causes the microbes in the soil to work faster to break down organic matter, potentially releasing more carbon dioxide.
- Land exhibited to degradation as a consequence of poor land management could become infertile as a result of climate change.
- The climate change results in the rise of Methane emission due to soil degradation it also results in large scale deforestation.

Impact of Climate Change on Erosional activities:

- Climate change is expected to impact soils through changes in both soil erosion and rainfall.
- Changes in soil surface conditions, such as surface roughness, sealing and crusting, may change with shifts in climate, and hence affect erosion rates.
- Change in erosion can have significant implications for natural assets, agricultural lands and water quality.
- Increased rainfall amounts and intensities will lead to greater rates of erosion unless protection measures are taken.
- Land degradation hazards include wind and water erosion, loss of soil carbon, nutrient decline mass movement, soil structure decline, acid sulphate soils and soil acidification.
- A significant potential impact of climate change on soil erosion and sediment generation is associated with the change from snowfall to rainfall.
- Erosional activities also have a negative impact on biogeochemical cycle.

Climate Change and Groundwater Depletion:

- Groundwater depletion, a term often defined as long-term water-level declines caused by sustained groundwater pumping, is a key issue associated with groundwater use.
- Ground water plays a central part in sustaining ecosystems and enabling human adaptation to climate variability and change.
- Increased variability in precipitation and more extreme weather events caused by climate change can lead to longer periods of droughts and floods, which directly affects availability and dependency on groundwater.
- Groundwater depletion and contamination that will seriously compromise much of the world's agriculturally-grown food supply.
- Sea level rise because of climate change may lead to salt water intrusion into coastal aquifers affecting groundwater quality and contaminating drinking water sources.
- Increasing climate-change-induced storm surges will flood coastal areas, threatening the quality of groundwater supplies and compromising their usability.

Impact of Climate Change on Human health:

- Higher morbidity and mortality from heat stress and vector/water-borne diseases

- Expanded transmission window for malaria as flooding would create opportunities for breeding of mosquitoes.
- The frequency and severity of Heat waves in Pakistan and India would increase.
- Endemic morbidity and mortality due to diarrheal disease primarily associated with floods and droughts are expected to rise in East, South and South-east Asia due to projected changes in hydrological cycles.
- Dengue fever is already in evidence at higher levels of elevation in Latin America and parts of East Asia.

Impact of climate change on the Cryosphere:

CRYOSPHERE

The cryosphere is those portions of Earth's surface **where water is in solid form**, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground (which includes permafrost).

Significance:

In Arctic regions, sea ice provides a home for animals like seals and polar bears, feeding and breeding areas for a variety of migrating species, and hunting grounds for local communities.

Acting like a highly reflective blanket, the cryosphere **protects Earth from getting too warm**. Snow and ice reflect more sunlight than open water or bare ground. Changes in snow and ice cover affect air temperatures, sea levels, ocean currents, and storm patterns all over the world.

- **Melting Ice Causes More Warming:**
 - When solar radiation hits snow and ice approximately 90% of it is reflected back out to space. As global warming causes more snow and ice to melt each summer, the ocean and land that were underneath the ice are exposed at the Earth's surface.
 - Because they are darker in color, the ocean and land absorb more incoming solar radiation, and then release the heat to the atmosphere. This causes more global warming. In this way, melting ice causes more warming and so more ice melts. This is known as a **feedback**.
- **Melting Permafrost Releases Greenhouse Gases:**
 - Global warming is causing soils in the polar regions that have been frozen for as much as 40,000 years to thaw.
 - As they thaw, carbon trapped within the soils is released into the atmosphere as methane, a powerful greenhouse gas.
- **Less Ice on Land Means Sea Level Rises:**
 - Sea level has been rising about 1-2 millimeters each year as the Earth has become warmer.
 - Some of the sea level rise due to melting glaciers and ice sheets which add water to the oceans that was once trapped on land.

Impact of Climate Change on Water Bodies and water insecurity:

Climate change is expected to exacerbate current stresses on water resources. By 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change.

- Warming has resulted in decline in mountain glaciers and snow cover in both hemispheres and this is projected to accelerate throughout the 21st century.

- This will in turn lead to reducing water availability, hydropower potential, and would change the seasonal flow of rivers in regions supplied by meltwater from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes).
- By 2050s freshwater availability in Central South, East and South-East Asia, particularly in large river basins, is projected to decrease.
- A warmer climate will accelerate the hydrologic cycle, altering rainfall, magnitude and timing of runoff.
- **The IPCC Report 2007 states** that the availability of fresh water in India is expected to drop in response to the combined effects of population growth and climate change.
- The IPCC (2007) also suggests that two main drivers of climate change, **higher water temperature and variations in runoff**- are likely to produce adverse changes in water quality affecting human health, ecosystems, and water use.
- Increase in sea-level has serious implications for both human security (increased flood-risks, degraded groundwater quality, etc.) and ecosystems (impact on mangrove forests and coral reefs, etc.), especially so in coastal regions.
- Reduced precipitation and increased evapotranspiration- will reduce recharge and possibly increase groundwater withdrawal rates.
- In coastal areas, sea level rise will exacerbate water resource constraints due to **increased salinization of groundwater supplies**.
- Available records suggest that the Gangotri glacier is retreating about 28 m per year. Glacial melt is expected to increase under changed climate conditions, which would lead to increased summer flows in some river systems
- In the Indo-Gangetic Plain Region in the past whereby different rivers (including Kosi, Ganga, Ghaghara, Son, Indus and its tributaries and Yamuna) changed their course a number of times. => devastating floods in Nepal and Bihar.

Impact of climate change on Sea level rise:

The coastal states of Maharashtra, Goa and Gujarat face a grave risk from the sea level rise, which could flood land (including agricultural land) and cause damage to coastal infrastructure and other property.

- Goa will be the worst hit, losing a large percentage of its total land area, including many Of its famous beaches and tourist infrastructure.
- Flooding will displace a large number of people from the coasts putting a greater pressure on the civic amenities and rapid urbanization.
- Sea water percolation due to inundations can diminish freshwater supplies making water scarcer.
- The salinity also rises with the increased erosion activities.
- The states along the coasts like Orissa will experience worse cyclones. Many species living along the coastline are also threatened.
- The coral reefs that India has in its biosphere reserves are also saline sensitive and thus the rising sea level threatens their existence too, not only the coral reefs but the phytoplankton, the fish stocks and the human lives that are dependent on it are also in grave danger.
- People living in the Ganges Delta share the flood risks associated with rising sea levels.

Impact on Ocean Acidification:

- Ocean acidification is the ongoing decrease in the pH of the Earth's oceans, caused by the uptake of carbon dioxide (CO₂) from the atmosphere.

- Measurements made over the last few decades have demonstrated that ocean carbon dioxide levels have risen in response to increased carbon dioxide in the atmosphere, leading to an increase in acidity of oceans.
- Carbon dioxide absorbed into the ocean from the atmosphere reduces calcification rates in reef-building and reef-associated organisms by altering seawater chemistry through decreases in pH.
- Rising acid levels are likely to have impact on specific categories of ocean life: corals, echinoderms, molluscs, crustaceans and fishes.
- More acidic oceans will interfere with the ability of corals to form the reefs.

Impact of Climate Change on Ecosystem and Biodiversity:

- According to **International World Wildlife Fund (WWF)**
 - species from the tropics to the poles are at risk.
 - Many species may be unable to move to new areas quickly enough to survive changes that rising temperatures will bring to their historic habitats.
 - 1/5th of the world's most vulnerable natural areas may be facing a "catastrophic" loss of species.
- Impact on **Marine Ecosystems:**
 - They will be affected not only by an increase in sea temperature and changes in ocean circulation, but also by ocean acidification; as the concentration of dissolved carbon dioxide (carbonic acid) rises.
 - This is expected to negatively affect shell forming organisms, corals and their dependent ecosystems.
 - The Bramble Cay Melomy is the first mammal to go extinct due to human-induced climate change.
- Impact on **Mangroves:**
 - The ongoing climate change turned out to be a potential threat to the remaining Indian mangroves and other coastal ecosystem.
 - Adverse effects on mangroves extend its serious consequence to the adjoining fragile an ecosystem such as coral reef and seagrass bed.
 - **Impact of climate change on highly diverse and productive mangrove forests will depend upon the rate of sea level rise relative to growth rates and sediments supply and changes in climate-ocean environment.**
 - Climate unsuitability is an important factor responsible for mangrove's change and disappearance.
 - According to **IPCC report**, sea level rise will affect mangroves by eliminating or modifying their present habitats and creating new tidally inundated areas to which some mangrove species may shift.
 - Strict protection, preparation of an action plan for each mangrove area, afforestation in potential areas, plantation of species that fail to adapt to sea level rise, and introducing threatened species at higher latitudes are some of the mitigation and management options.

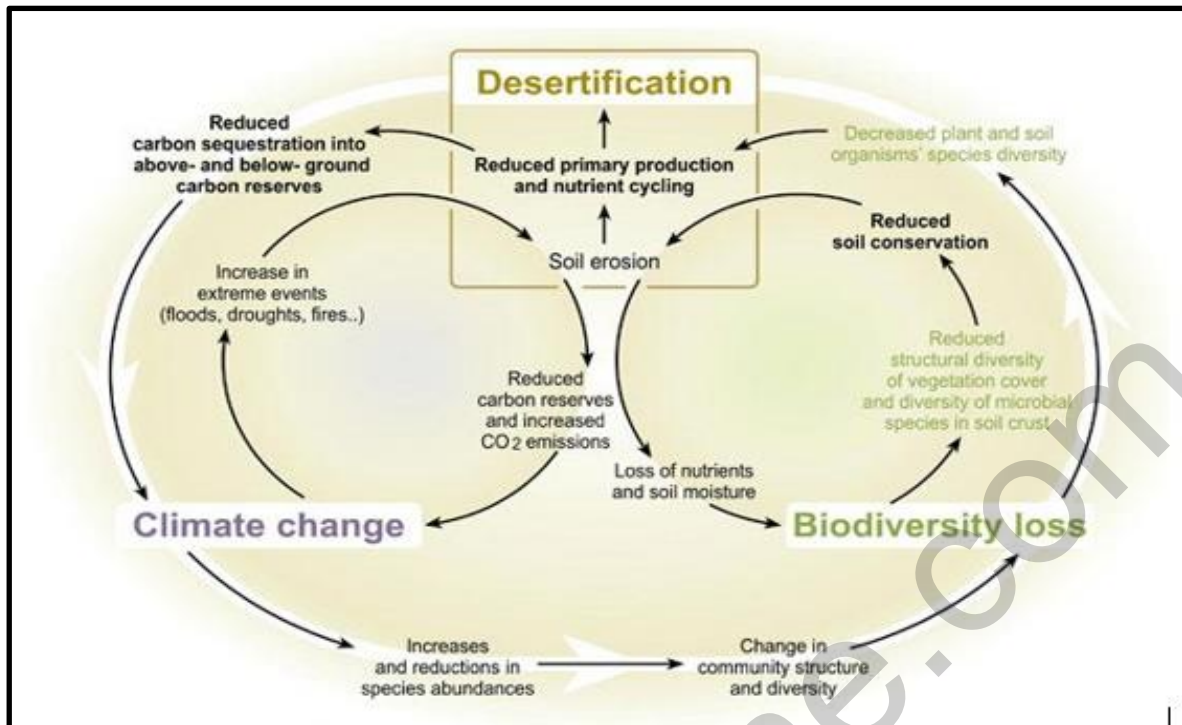


Figure: climate change and desertification

- **Impact on Desert Ecosystem:**
 - According to IPCC, climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.
 - In many dryland areas like Rajasthan and adjoining areas of Punjab and Haryana, the climate has become even more arid and rivers, lakes and underground water sources are drying up. This can have major impacts not only on physical processes (such as the water cycle), but also on ecosystem functions.
 - The UNCCD have recently indicated that: “The climatic effects on land occur at ecosystem and landscape levels”.
 - **Increase in extreme events:**
 - **Frequent floods** will lead to soil erosion and thereby degrading land. It will promote desertification.
 - **Droughts** on the other hand adversely affects the recharge of soil moisture and groundwater table. Soils dry up and become prone to wind erosion. Ex. Vidarbha, Telangana, etc.
 - Forest fires will cause of forest biome. It will expose the top soil for erosion. This may lead to desertification. E.g. Amazon forest fire, Uttarakhand forest fire and Bandipur National park forest fire
 - **Biodiversity loss:** Climate change may adversely affect biodiversity and exacerbate desertification due to increase in evapotranspiration and a likely decrease in rainfall in drylands
 - **Rural-urban migration:** Climate change leads to decline in agricultural productivity which results in rural-urban migration and abandonment of agricultural land and systematic fallowing. In dry conditions and fallowing aggravate soil erosion.

- **Impact of climate change on Mountain Ecosystems:**
 - Mountain ecosystems are hot spots of biodiversity. However, temperature increases and human activities are causing fragmentation and degradation of mountain biodiversity. Example: Snow Leopards.
 - Himalayas is home to the largest number of glaciers after the North and the South Poles. However, climate change is threatening this life giver drastically.
 - It is also predicted that there will be an increase in the phenomenon of **Glacial Lake Outburst Floods (GLOFs)** in the eastern and the central Himalayas, causing catastrophic flooding downstream with serious damage to life, property, forests, farms, and infrastructure.

Impact of Climate change on vulnerable sections.

- **The 2018 report by the IPCC** estimates that “even a 1.5-degree increase in global temperature could push tens of millions of people into poverty.” The report identifies floods and storms (mainly, tropical cyclones) as the primary causes of displacement, leading to millions of displacements.
- **According to the World Food Programme’s 2018 Global Report on Food Crises**, “climate disasters triggered food crises across 23 countries, mostly in Africa, with shocks such as drought leaving more than 39 million people in need of urgent assistance.”
- **According to the 2018 Global Report on Internal Displacement**, “30.6 million new internal displacements associated with conflict and natural disasters were recorded in 2017 across 143 countries and territories.”
- Climate related migration can be found all over the world, displaced by coastal flooding in Dhaka, by hurricane Maria in Puerto Rico, or due to the desertification of Lake Chad in West Africa. **It is estimated that the number of people seeking asylum in the European Union due to climate change would see a 28% increase by 2100.**
- The intensification of existing conflicts and also creates new ones. **The water crisis in Cape Town** began in 2015, and the city continues to live under the threat of becoming the first major city in the world to run out of the water.

Such conflicts and incidences affect the poor the most and further lead to an increase in poverty and displacement, pushing people into a vicious trap across the globe.

In India:

- **India ranks 5th globally for the losses it has experienced due to climate change.** Nearly, 800 million people in the country live in villages and depend on agriculture and natural resources for their livelihoods.
- Around 50% of the farmlands in the country is rainfall dependent, any changes in the pattern of the monsoons will affect their livelihoods the most. Studies reveal that small farmers are aware of the long-term changes in the weather pattern and have changed their practices to deal with the resultant socio-economic changes.
- **The Small farmers also lack access to credit**, which makes them more vulnerable to climate change. Thus, climate change will make the problems such as poverty, malnutrition, and farmer suicides worse.
- **Frequent floods and droughts** caused by climate change lead to food shortages and a rise in food prices in many parts of India. This causes hunger and malnutrition, the effects of which are felt most strongly by the poor.

MITIGATION STRATEGIES

<p>Reduce the use of Fossil Fuels:</p>	<ul style="list-style-type: none"> • Hybrid car that reduce the usage of gasoline. • Promote public transport or carpool. • Recycle can reduce garbage by reusing plastic bags, bottles, papers or glass. • Stop open burning such as burning dry leaves or burning garbage. • Government should reduce deforestation. Trees will help to improve the temperature on earth
<p>Carbon Sequestration</p>	<ul style="list-style-type: none"> • It is the process involved in carbon capture and the long-term storage of atmospheric carbon dioxide or other forms of carbon to mitigate or defer global warming. • Carbon dioxide (CO₂) is naturally captured from the atmosphere through biological, chemical, and physical processes. <p>Types of Sequestration: These can be discussed under three main categories:</p> <ul style="list-style-type: none"> • Geologic Sequestration: Natural pore spaces in geologic formations serve as reservoirs for long-term carbon dioxide storage. Geologic Sequestration is thought to have the highest potential for near-term application. • Terrestrial Sequestration: A large amount of carbon is stored in soils and vegetation, which are our natural carbon sinks. Increasing carbon fixation through photosynthesis, slowing down or reducing decomposition of organic matter, and changing land use practices can enhance carbon uptake in these natural sinks. • Ocean Sequestration: Carbon stored in oceans through direct injection or fertilization. Ocean is a very important carbon sink. Most of the carbon is trapped in the ocean and if a small fraction of this carbon is released the consequences will be disastrous.
<p>Carbon Sink</p>	<ul style="list-style-type: none"> • A carbon sink can be natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period. • The natural sinks are: <ul style="list-style-type: none"> ○ Trees serve as carbon sinks during growing seasons. <ul style="list-style-type: none"> ■ In the case of forests and other woodland areas, carbon sequestration is done through photosynthesis. ○ Absorption of carbon dioxide by the oceans via physio-chemical and biological processes <ul style="list-style-type: none"> ■ Oceans are considered the main natural carbon sinks, as they are capable of absorbing about 50% of the carbon emitted into the atmosphere. ■ In particular, plankton, corals, fish, algae and other photosynthetic bacteria are responsible for this capture. <p>Forests are carbon stores</p> <ul style="list-style-type: none"> • Trees absorb CO₂ during photosynthesis thereby converting atmospheric CO₂ into biomass.

	<ul style="list-style-type: none"> • When this biomass is buried the carbon is trapped forming a carbon sink. When the carbon sink is exposed the biomass decomposes adding methane to the atmosphere and when the biomass is used as fuel (coal and petroleum) it releases CO₂ back into the atmosphere (carbon source). • In Canada's boreal forests as much as 80% of the total carbon is stored in the soils as dead organic matter. • Tropical forests absorb about 18% of all carbon dioxide added by fossil fuels. • In the context of climate change, the most important carbon stores are the natural fossil fuel deposits. But when humans burn coal, oil and natural gas, they turn fossil carbon stores into atmospheric carbon. • The emission of carbon from fossil fuel has caused greenhouse gas (GHG) concentrations in the atmosphere to levels more than 30 per cent higher than at the beginning of the industrial revolution. • The increase in atmospheric carbon, a lot of emphasis and hope has been put into the ability of trees, other plants and the soil to temporarily sink the carbon that fossil fuel burning releases into the atmosphere. • The Kyoto Protocol, the international communities' main instrument for controlling global warming suggests that the absorption of carbon dioxide by trees and the soil is just as valid a means to achieve emission reduction commitments as cutting carbon dioxide emissions from fossil fuels.
Carbon Credit	<ul style="list-style-type: none"> • It is a credit for greenhouse emissions reduced or removed from the atmosphere from an emission reduction project, which can be used, by governments, industry or private individuals to compensate for the emissions they are generating. • Carbon credit is a generic term for any tradable certificate or permit representing the right to emit • E.g.: 1 Tonne of Carbon dioxide or the mass of another greenhouse gas with a carbon dioxide equivalent to one tonne of carbon dioxide.
Carbon Offsetting	<ul style="list-style-type: none"> • While a carbon offset also represents one tonne of carbon dioxide or equivalent greenhouse gas, it is generated by a reduction in emissions made by a voluntary project designed specifically for that purpose. • Carbon offsets are generated by projects with clearly defined objectives, usually outside the confines of a company's own operational sites. • Typical carbon offset projects include building wind turbines or solar farms, supporting methane reduction projects, planting trees or preserving forests.
Carbon Tax	<ul style="list-style-type: none"> • A carbon tax is a tax levied on the carbon content of fuels. • It is a form of carbon pricing. • Revenue obtained via the tax is however not always used to compensate the carbon emissions on which the tax is levied. • Since greenhouse gas emissions caused by the combustion of fossil fuels are closely related to the carbon content of the respective fuels, a tax on these emissions can be levied by taxing the carbon content of fossil fuels at any point in the product cycle of the fuel.

	<ul style="list-style-type: none"> • The objective of a carbon tax is to reduce the harmful and unfavorable levels of carbon dioxide emissions, thereby decelerating climate change and its negative effects on the environment and human health. • It is a tax that increases revenue without significantly altering the economy while simultaneously promoting objectives of climate change policy.
Green Finance	<ul style="list-style-type: none"> • The idea gets its first mention in the UN document at the UN Conference on Sustainable Development (also known as Rio+20), 2012. • There is no universal definition of green finance, though, it mostly refers to financial investments flowing towards sustainable development projects and initiatives that encourage the development of a more sustainable economy. • Initiatives to promote Green Finance: <ul style="list-style-type: none"> ○ The World Bank Group has set up an informal Sustainable Banking Network of banking regulators, led by developing countries, to promote sustainable lending practices. ○ In 2015, green bonds issued by governments, banks, corporate and individual projects amounted to US\$42 billion. ○ At the global level, more than 20 stock exchanges have issued guidelines on environmental disclosure, and many green indices and green ETFs (exchange-traded funds) have been developed.
Green finance and India	<ul style="list-style-type: none"> • Attaining the ambitious solar energy target, development of solar cities, setting up wind power projects, developing smart cities, providing infrastructure which is considered as a green activity and the sanitation drive under the 'Clean India' or 'Swachh Bharat Abhiyan' are all activities needing green finance. • India created a corpus called the NCEF (National Clean Energy Fund) in 2010-II out of the cess on coal produced/imported ('polluter pays' principle) for the purpose of financing and promoting clean energy initiatives and funding research in the area of clean energy.

Issues involved with the mobilization of green finance:

- Green finance **should not be limited only to investment in renewable energy**, as, for a country like India, coal-based power accounts for around 60% of installed capacity.
- **Emphasis should be on greening coal technology:** In fact, green finance for development and transfer of green technology is important as most green technologies in developed countries are in the private sector and are subject to intellectual property rights (IPRs), making them cost prohibitive.
- **Green bonds: GBs** are perceived as new and attach higher risk and their tenure is also shorter. There is a need to reduce risks to make them investment grade.
- **Proper accounting:** There is also a need for an internationally agreed upon definition of green financing as its absence could lead to over-accounting.
- While environmental risk assessment is important, **banks should not overestimate risks while providing green finance.**
- Green finance should also consider unsustainable patterns of consumption as a parameter in deciding finance, particularly conspicuous consumption and unsustainable lifestyles in developed countries.

INITIATIVES TAKEN BY INDIA TO COMBAT CLIMATE CHANGE

India's INDC	<ul style="list-style-type: none"> ● To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation. ● To adopt a climate-friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development. ● To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level. ● To achieve about 40 per cent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, with the help of transfer of technology and low-cost international finance, including from Green Climate Fund. ● To create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030. ● To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management. ● To mobilize domestic and new and additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap. ● To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies.
Himalayan Glaciers Monitoring Programme	<ul style="list-style-type: none"> ● Comprehensive programme to scientifically monitor the Himalayan glaciers – Phase I completed and the Phase II is launched. ● Discussion Paper on State of Himalayan Glaciers released with the help of world bank.
National Policy on Biofuels	<ul style="list-style-type: none"> ● National Policy on Biofuels approved by Cabinet to promote cultivation, production and use of Biofuels for transport and in other applications ● The Policy categorises biofuels as "Basic Biofuels" viz. <ol style="list-style-type: none"> a. First Generation (1G) bioethanol & biodiesel b. Second Generation (2G) ethanol, Municipal Solid Waste (MSW) to drop-in fuels, and "Advanced Biofuels" c. Third Generation (3G) biofuels, bio-CNG etc. to enable extension of appropriate financial and fiscal incentives under each category. ● Sources of biofuel: It expands the scope of raw material for ethanol production by allowing use of sugarcane juice, sugar containing materials like sugar beet, sweet sorghum, starch containing materials like corn, cassava, damaged food grains like wheat, broken rice, rotten potatoes, unfit for human consumption for ethanol production. ● The Policy also allows use of surplus food grains for production of ethanol for blending with petrol with the approval of National Biofuel Coordination Committee. ● With a thrust on Advanced Biofuels, the Policy indicates a viability gap funding scheme for 2G ethanol Bio refineries of Rs.5000 crore in 6 years in

	<p>addition to additional tax incentives, higher purchase price as compared to IG biofuels.</p> <ul style="list-style-type: none"> The Policy encourages setting up of supply chain mechanisms for biodiesel production from non-edible oilseeds, Used Cooking Oil, short gestation crops.
Energy Efficiency Standards for Appliances	<ul style="list-style-type: none"> Energy efficiency ratings made mandatory for 4 key appliances — refrigerators, air conditioners, tube lights and transformers from January 7, 2010 <p>Bureau of Energy Efficiency</p> <ul style="list-style-type: none"> The Government of India set up Bureau of Energy Efficiency (BEE) in 2002 under the provisions of the Energy Conservation Act, 2001. The mission of the Bureau of Energy Efficiency is to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy.
International Solar Alliance	<ul style="list-style-type: none"> India has launched a historic International Solar Alliance (ISA) which is envisaged as a coalition of solar resource-rich countries to address their special energy needs and will provide a platform to collaborate on addressing the identified gaps through a common, agreed approach.
National Adaptation Fund for Climate Change (NAFCC)	<ul style="list-style-type: none"> It has been established with a budget provision of Rs. 1350 crore for the years 2015–16 and 2016–17. It is meant to assist in meeting the cost of national- and state-level adaptation measures in areas that are particularly vulnerable to the adverse effects of climate change. The overall aim of the fund is to support concrete adaptation activities that reduce the adverse effects of climate change facing communities, sectors and states but are not covered under the ongoing schemes of state and central governments.
Coal Cess and the National Clean Energy Fund	<ul style="list-style-type: none"> India is one of the few countries around the world to have a carbon tax in the form of a cess on coal. Not only has India imposed such a cess but it has also been progressively increasing it (from Rs. 50 per tonne of 2010 to Rs. 200 by 2015–16 and Rs. 400 by 2016-17). The NCEF (National Clean Energy Fund) which is supported by the cess on coal was created for the purposes of financing and promoting clean energy initiatives, funding research in the area of clean energy and for any other related activities.

National Action Plan on Climate Change (NAPCC):

Under NAPCC there are 8 missions to cater different problems related to climate change:

National Mission on Enhanced Energy Efficiency	<ul style="list-style-type: none"> Perform Achieve and Trade is part of the National Mission on Enhanced Energy Efficiency The 2010 amendment to the Energy Conservation Act (ECA) provided a legal mandate to PAT. Participation in the scheme is mandatory for Designated Consumers under the ECA.
---	--

	<ul style="list-style-type: none"> • PAT cycle I stretching from 2012-13 to 2014-15, was applicable on eight energy-intensive sectors. There are about 478 numbers of Designated Consumers in these 8 sectors accounting for about 165 million tonnes oil equivalent of energy consumption annually i.e, 33% of India’s primary energy consumption. • PAT cycle II stretching from 2016 to 2018-19 shall include 3 new sectors i.e, petroleum refineries, discoms and railways, along with the previous 8 energy intensive sectors of PAT cycle I. • PAT cycle III stretching from 2017-20 shall include 116 new units under it and have been given a reduction target of 1.06 million tonnes of oil equivalent. • It was introduced as an instrument for reducing specific energy consumption in energy-intensive industries with a market-based mechanism that allowed the trading of ESCerts (energy saving certificates). • The ESCerts, issued by the GoI, are traded through the power exchanges in the country. • To provide adequate amount of investment, the Reserve Bank of India has included renewable energy in the PSL (priority sector lending) for scheduled commercial banks.
National Solar Mission	<ul style="list-style-type: none"> • To achieve the ambitious targets of 100 GW of solar power by 2022. • The target will principally comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale Grid Connected Solar Power Projects.
National Mission on Sustainable Habitat	<p>To promote energy efficiency as a core component of urban planning, the plan calls for:</p> <ul style="list-style-type: none"> • Extending the existing Energy Conservation Building Code; • A greater emphasis on urban waste management and recycling, including power production from waste; • Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of efficient vehicles; and • Incentives for the use of public transportation.
National Water Mission	<ul style="list-style-type: none"> • With water scarcity projected to worsen as a result of climate change, the plan sets a goal of a 20% improvement in water use efficiency through pricing and other measures.
National Mission for Sustaining the Himalayan Ecosystem	<ul style="list-style-type: none"> • The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India’s water supply are projected to recede as a result of global warming.
National Mission for a “Green India”	<ul style="list-style-type: none"> • Goals include the Afforestation and Restoration of 10 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India’s territory. • It acknowledges the influence forests have on environmental amelioration through climate change mitigation, food security, water security, biodiversity conservation and livelihood security of forest-dependent communities.

	<ul style="list-style-type: none"> It hinges on decentralized participatory approach involving grass root level organizations and community in planning, decision making, implementation and monitoring.
National Mission for Sustainable Agriculture	<ul style="list-style-type: none"> The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.
National Mission on Strategic Knowledge for Climate Change	<ul style="list-style-type: none"> To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modelling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

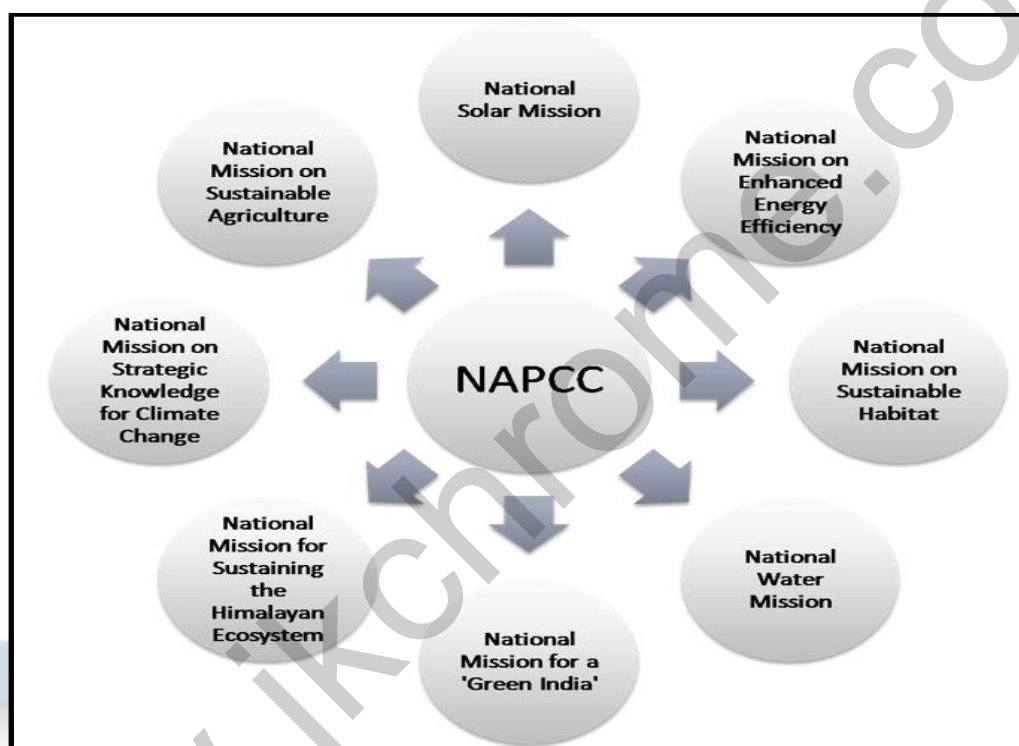


Figure: 8 missions under NAPCC

In 2017-18, the PM's Council on Climate Change (PMCCC) directed the missions under the NAPCC to enhance their ambition in respect of adaptation, mitigation and capacity building and prioritize them, besides recommending the setting up of **some new missions in addition to the existing eight**:

- Considering the adverse impacts that climate change could have on health, a new '**Mission on Climate Change and Health**' is currently under formulation and a National Expert Group on Climate Change and Health has been constituted.
- The proposed '**National Waste-to-Energy Mission**' will incentivize efforts towards harnessing energy from waste and is aimed at lowering India's dependence on coal, oil and gas for power production.
- The '**National Mission on Coastal Areas**' (NMCA) will prepare an integrated coastal resource management plan and map vulnerabilities along the entire (nearly 7000-km-long) shoreline.

- The ‘**National Wind Mission**’ seeks to increase the share of wind energy in the renewable energy mix of India. It is likely to be given an initial target of producing about 50,000–60,000 MW of power by the year 2022.

OTHER MEASURES

National Offshore Wind Energy Policy 2015	<ul style="list-style-type: none"> • A major renewable energy policy initiative. • It aims at helping offshore wind energy development, including setting up of offshore wind power projects and research and development activities in waters, in or adjacent to the country, up to the seaward distance of 200 nautical miles exclusive economic zone (EEZ) of the country from the baseline.
Help-Us-Green	<ul style="list-style-type: none"> • It is an Indian private project which is one of 15 ground-breaking projects from around the world that has won this year’s UN ‘Momentum for Change’ climate action award. • The project collects flowers from temples and mosques across many cities\towns in Uttar Pradesh and recycles them to produce natural incense sticks, organic fertilizers and biodegradable packaging material. <ul style="list-style-type: none"> ○ helps in preventing chemical pesticides from entering into the river through temple waste. • Developed as the world’s first profitable solution to the monumental temple waste problem.
Bureau of Energy Efficiency (BEE):	<ul style="list-style-type: none"> • A statutory body under Ministry of Power created in March 2002 under the provisions of the nation’s 2001 Energy Conservation Act. • To implement policy and programmes in energy efficiency and conservation. • Role of BEE: BEE co-ordinates with designated consumers, designated agencies and other organizations and recognize, identify and utilize the existing resources and infrastructure, in performing the functions assigned to it under the Energy Conservation Act. The Energy Conservation Act provides for regulatory and promotional functions. • Objective of BEE – <ul style="list-style-type: none"> ○ To reduce energy intensity in our country by optimizing energy demand and ○ To reduce emissions of greenhouse gases (GHG), responsible for global warming and climate change.
Energy Conservation Building Code	<ul style="list-style-type: none"> • The Energy Conservation Building Code (ECBC), was launched by Ministry of Power, Government of India in 2007, as a first step towards promoting energy efficiency in the building sector. • It is prepared after extensive consultations with all stakeholders, consisting of architects & experts including building material suppliers and developers. • The code is expected to assist large number of architects and builders who are involved in design and construction of new residential complexes. • It has potential for energy savings to the tune of 125 Billion Units of electricity per year by 2030, equivalent to about 100 million ton of Co2 emission.
Green Good Deeds	<ul style="list-style-type: none"> • It is the societal movement launched by the Ministry for Environment, Forest & Climate Change.

	<ul style="list-style-type: none"> To protect environment and promote good living in the country, has found acceptance by the global community. The BRICS Ministerial on Environment at Durban, South Africa, has agreed to include “Green Good Deeds” in its official agenda in the next Ministerial in Brazil and another meeting in Russia”
Other initiatives	<ul style="list-style-type: none"> National Smart Grid Mission to bring efficiency in power supply GRIHA – Green Rating for Integrated Habitat Assessment – building – energy rating system Zero Effect, Zero Defect (ZED) – quality control and energy efficiency certificate for medium and small industries Smart Cities, AMRUT, HRIDAY – to develop climate resilient urban cities Bharat Stage IV fuel efficient standards to be implemented by April 2016 across the country and now India will move to Bharat Stage VI from April 2020. Mass Rapid Transit System – moving people, instead of moving vehicles

INTERNATIONAL INITIATIVES

Earth Summit 1992 : The outcome of this summit was the following documents:

1. Rio Declaration on Environment and Development
2. Agenda 21
3. Convention on Biological Diversity
4. Forest Principles

UN Framework Convention on Climate Change (UNFCCC).

- It is an **international environmental treaty** negotiated at the **United Nations Conference on Environment and Development (UNCED)**, informally known as the **Earth Summit**, held in Rio de Janeiro from 3 to 14 June 1992.
- It entered into force on 21 March 1994, after a sufficient number of countries had ratified it.
- Objective of UNFCCC : to **stabilize greenhouse gas concentrations** in the atmosphere at a level that would **prevent dangerous anthropogenic interference** with the climate system.
- UNFCCC by itself is **not legally binding**.

United Nations Climate Change conferences

- So far, 23 meetings have taken place.
- The key conventions:
 - COP-3 in 1997 at Kyoto (Japan) : resulted in the **legally binding Kyoto Protocol** on Climate Change
 - COP-7 in 2001 at Marrakech (Morocco) : resulted in **establishment of an Adaptation Fund** for financially supporting developing countries better adapt to climate change.
 - COP-16 in 2010 at Cancún (Mexico) : resulted in an announcement for a **100 billion USD per annum Green Climate Fund** for providing financial support to developing countries on their climate change actions.
 - COP-21 in 2015 in Paris : resulted in **adoption of the Paris Agreement** governing climate change reduction measures **from 2020**.

The Paris Agreement

- The Paris Agreement will enter into force on the 30th day after the date on which **at least 55 countries accounting for at least 55% of the total global greenhouse gas emissions** ratify it.
- The agreement aims to reduce emissions of greenhouse gases, the cause of global warming and consequent climate change, and do it fast enough to **keep the average global temperature from rising above 2°, possibly 1.5°C compared to pre-industrial times.**
- The agreement will come into force 2020 onwards.
- **will replace the Kyoto Protocol**, an existing international agreement on climate change that was finalised in 1997.
- Paris Agreement is ambitious
 - resolves to hold global temperature rise to well below 2°C above pre-industrial levels
 - pursue efforts towards a 1.5° C temp. limit.

Provisions of Paris Agreement

- A **binding obligation** to submit mitigation contributions **every 5 years** and to pursue domestic measures to achieve them.
- For every 5-year cycle, states must put forward contributions **more ambitious than their last.**
- In addition, the agreement envisages a “**global stocktake**” **every 5 years to assess collective progress towards long-term goals.**
 - The global stocktake will also take into account “**equity**” (so CBDR also protected) — thus paving the way for conversation on burden-sharing between nations.
- The Paris Agreement requires **developed countries to raise finances with \$100 billion per year** as the floor by 2020, to help developing nations in both mitigation and adaptation activities, while other nations are encouraged to provide funding voluntarily.
- The first global evaluation of the implementation of the Paris Agreement is to take place in 2023, and thereafter every five years to help all countries.

Bonn Conference (CoP23): The “Rule Book” and Talanoa Dialogue

- The key agenda of the Bonn conference was to **chalk out the Rule Book.**
- If Paris agreement was constitution, the Rule Book would serve as laws and regulations to implement it towards achieving the goal of Paris Agreement i.e. to limit the Earth’s temperature rise to a maximum of 2°C.
- In the Bonn summit, it was decided that the negotiators will keep working for one year and finalize the rule book by December 2018.
- It is expected that the Rule Book shall be adopted at COP-24 at Katowice (Poland) in December, 2018.
- To ensure that this happens, CoP24 host Poland has decided to work with CoP23 host Fiji and past host Morocco. This year long process has been called **Talanoa Dialogue.**
- Thus, Talanoa dialogue is **a year long process that allows countries to assess their progress on past climate actions (stocktaking) and define the way forward** to implement the legally binding Paris Agreement.

Katowice: 24th meeting of the Conference of the Parties (COP24) to the United Nations Framework Convention on Climate Change.

What was expected:

- The summit aimed to **establish guidelines for implementing and reporting on the Paris Agreement.**
- Countries were looking to **establish an enhanced transparency framework to monitor, verify and report** actions taken in a **systematic, standardised manner.**
- Transparency — what would be done to reduce emissions, how countries would measure and report progress, and how much support industrialised countries would provide — was an important aspect of the discussions.
 - This will inform stocktaking of progress on the Paris Agreement and how much more is needed to cut emissions and raise ambition.
- **Funds were also required from rich countries** for the losses and damages borne by poor nations.
- **Technology transfer and capacity building support** are also issues of importance to vulnerable countries and poor, developing countries that need help to transition from high to low carbon economies.

Outcome:

- While there was some progress on **the process by which the Paris Agreement of 2015 would be implemented**, key issues of concern for the poorest and developing nations were diluted or postponed.
- The **1.5 Degree Report**, which was produced by the **Intergovernmental Panel on Climate Change** in October 2018, showed that **the earth is close to a climate catastrophe.**
- There is **little to no finance available for poor and developing nations.**
- **The details on funding and building capacity have been postponed.**
- Article 9 (the provision of financial support to developing countries from industrialised nations) was ignored; instead, there was an **emphasis on carbon markets and insurance mechanisms.**
- In spite of these problems, **a single rulebook for all countries has been produced and will serve as a foundation for more detailed rules and structures.**

Global Alliance to Power Past Coal:

- In the recent Bonn summit, it was **launched by Canada and the UK.**
 - Canada has returned as a proactive nation pushing climate change agenda.
 - With US taking a backseat, Canada might be looking for a leadership role.
- This is a programme to **phase out coal usage in energy production.**
- Immediately, more than 20 countries, including France, Finland, and Mexico have become the part of this initiative.
- It brings together a wide range of businesses and civil society organizations that have united for climate protection.

‘Momentum for Change’ initiative:

- **An initiative spearheaded by the UN Climate Change secretariat** to shine a light on the enormous groundswell of activities underway across the globe that are moving the world toward a highly resilient, low-carbon future.
- It recognizes innovative and transformative solutions that address both climate change and wider economic, social and environmental challenges.

The 25th edition of the **Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)** or COP25 held in **Madrid (Spain)**.

Agenda for COP25

- ❑ The main objective of the COP-25 is to complete the rule-book to the 2015 Paris Agreement that will become effective in 2020 to replace the 1997 Kyoto Protocol (comes to an end in 2020).
- ❑ Finding solution for issues like the creation of new carbon markets, emission reduction targets, country's individual targets, etc. remained unresolved during COP24 at Katowice (Poland) 2019.
- ❑ The COP-25 also discussed the functioning of international emissions trading systems, compensation for poor countries to deal with rising sea levels and other consequences of climate change.
- ❑ It COP also considered the **Emissions Gap Report**, produced by the **UN Environment Programme (UNEP)** and the **series of reports** from the **Intergovernmental Panel on Climate Change (IPCC)**.
 - IPCC reports summarise that the goal of keeping average temperatures within 1.5°C from pre-industrial times is **"on the brink of becoming impossible."** As the **overall emissions are still increasing** worldwide.
- ❑ The processes and methods of reporting information about climate change would be fixed during the summit. Specifically, the **developing countries** will try to ensure that there are greater **appreciation and recognition** of the **issue of loss and damage** due to climate change.

Why CoP25 failed?

- The failure of the talks underlined starkly the massive gap between what scientists say the world's nations need to do on climate change, and what the most powerful political leaders on the planet are prepared to even discuss.
- According to scientist, talks focused on some of the rules for implementing the 2015 Paris agreement, but the overriding issue of how fast the world needs to cut greenhouse gas emissions has received little official attention.
- Countries agreed in Paris in 2015 to revisit their climate pledges by 2020. But many countries were pushing this year for a clear call for all countries to submit more ambitious climate pledges next year.
- But countries such as China and Brazil opposed placing any obligation on countries to submit enhanced pledges next year, arguing it should be each country's own decision. They instead argued the focus should be on pre-2020 action by developing countries to meet their previous pledges
- There was a recognition that tougher carbon targets are needed globally, but few countries came up with any and the resolve to come back next year with more ambitious plans was worded too weakly to satisfy most campaigners.

India's stance:

- India played a mixed role at the recently concluded 25th Conference of Parties (CoP 25) to the United Nations Framework Convention on Climate Change at Madrid.
- On the question of markets, India emphasised the transition of the Clean Development Mechanism (CDM) credits earned under the Kyoto Protocol to the Paris Agreement.
- Pointed out that that excessively cheap emissions reductions enabled by the CDM as well as the possibility of double counting could corrupt the process.

- India played a strong role in critiquing the developed world's continuing poor record on climate action.
- It argued that unless a stocktaking exercise of the fulfilment of various pre-2020 commitments by developed countries, India would not raise its climate ambition for its next round of Paris Agreement targets due in 2020.
- India also took a lead in calling for more finance for developing countries for climate action, (*"not even 2 per cent" of the promised "\$1 trillion in the last 10 years" had been delivered*)

Global Footprint Network (GFN), founded in 2003, is an independent think tank originally based in the United States, Belgium and Switzerland. It was established as a charitable not-for-profit organization in each of those three countries.

Vision and mission: To help end ecological overshoot by making ecological limits central to decision-making. Global Footprint Network develops and promotes tools for advancing sustainability, including the ecological footprint and biocapacity, which measure the amount of resources we use and how much we have.

GFN also calculated Earth Overshoot Day is the day when humanity has exhausted nature's budget for the year. For the rest of the year, society operates in ecological overshoot by drawing down local resource stocks and accumulating carbon dioxide in the atmosphere. The first Earth Overshoot Day was December 19, 1987. In 2014, Earth Overshoot Day was August 19. In 2019, Earth Overshoot Day fell on July 29.

Global Climate Funds:

- **Classification:**
 - Depending on the participating countries, global climate funds can either be multilateral or bilateral depending on.
 - The funds may further be classified according to their area of focus, namely mitigation, adaptation or REDD (reducing emissions from deforestation and forest degradation).
- Currently, the **Green Climate Fund (GCF)** is the largest, with pledges amounting to US\$10.2 billion.
- The second largest is the **Clean Technology Fund (CTF)** with pledges amounting to US\$5.3 billion.
- With the capitalization of the GCF and the sunset clause of the CTF, there is ambiguity about the role of the CTF in the climate finance architecture post-2020.

Green Climate Fund (GCF):

- It was **set up in 2010 under the UNFCCC financial mechanism** to channel funding from developed countries to developing countries to allow them to mitigate climate change and also adapt to disruptions arising from a changing climate.
- The Green Climate Fund will support projects, programmes, policies and other activities in developing country Parties using thematic funding windows. Under **the trusteeship of world bank**.
- It is intended to be the centrepiece of efforts to raise Climate Finance of \$100 billion a year by 2020.
- The Fund will strive to maximize the impact of its funding for adaptation and mitigation, and seek a balance between the two, while promoting environmental, social, economic and development co-benefits and taking a gender-sensitive approach.

The GEF (Global Environment Facility):

- It was established on the eve of the 1992 Rio Earth Summit to help tackle our planet's most pressing environmental problems.
- It is an international partnership of 183 countries, international institutions, civil society organizations and the private sector that addresses global environmental issues.
- GEF funds are available to developing countries and countries with economies in transition to meet the objectives of the international environmental conventions and agreements.
- The World Bank serves as the GEF Trustee, administering the GEF Trust Fund.
- It is a FINANCIAL MECHANISM for five major international environmental conventions:
 1. the Minamata Convention on Mercury,
 2. the Stockholm Convention on Persistent Organic Pollutants (POPs),
 3. the United Nations Convention on Biological Diversity (UNCBD),
 4. the United Nations Convention to Combat Desertification (UNCCD) and
 5. the United Nations Framework Convention on Climate Change (UNFCCC).

FEW CHALLENGES FACED AT INTERNATIONAL COOPERATION (focus through mitigation and adaptation methods):

- Trump has a favour for fossil fuel (coal) based economy. US not being part of any climate change actions may add 0.1 to 0.3° C to global warming by 2100. Some more reluctant countries may also follow the steps of US and quit the climate deal. Example - Brazil.
- Developed nations are not willing to accept the historical role they have played in the emission of GHGs. The international initiatives have failed to make them accountable.
- The \$100 billion figure does not appear in the legally binding part of the Paris Agreement
- Climate change does not affect all countries equally and hence no surety of equal action or concern shown by all participating nations.
 - Low-lying island states face an existential threat from rising sea levels while others, especially countries near the Arctic Circle, may experience greater agricultural output and easier access to natural resources as a result of the thawing of permafrost
- Developing countries, especially in Africa, are still left out or stuck with low-tech options. These nascent markets are seen as too disaggregated and high risk for investors.
- The developed nations are mostly focussing on mitigation approaches and are reluctant to transfer technologies for adaptation approaches.

How can the situation be improved?

- Faced with global ecological limits, focus has to shift from 'environmental risk management' to 'economic growth within ecological limits'.
- It is in responding to this mega-trend that India's climate policy could have been more forward looking. The focus everywhere is shifting from production patterns to consumption patterns.
- Nearly 2/5th of the cumulative emission reductions required by 2050 could come from efficiency improvements.
- Key systems such as the transport, energy, housing and food systems should be transformed.
- India should have integrated its Smart Cities campaign into a plan for low carbon development of cities.
- A greater focus on sharing rather than owning cars would impact the fastest growing emissions..
- Periodic reviews of national contributions should also be undertaken.

- Building state-level profiles of GHG emissions from different sectors can help inform us about different focus areas for each state.
- To fulfill financial needs, India must strategically seek other sources such as the Green Climate Fund and leverage the International Solar Alliance.

International Solar Alliance:

Objectives:

- Promote solar technologies and investment in the solar sector.
- Formulate projects and programme to promote solar applications.
- Develop innovative Financial Mechanisms to reduce cost of capital.
- Build a common Knowledge e-Portal.
- Facilitate capacity building for promotion and absorption of solar technologies and R&D among member countries.

Potential of International Solar Alliance:

- Until December 2015, Germany, China, Japan, the U.S., and Italy accounted for 70 per cent of the 227 GW of solar PV deployed globally.
- Developing countries, especially in Africa have large solar potential. But these nascent markets are seen as too disaggregated and high risk for investors.
- In effect, three factors continue to block the rapid scale-up of solar energy:
 - financing is still too costly for developers;
 - **solar-related plans and policies are often incoherent** and increase risks for developers and investors; and
 - there is **insufficient R&D investment in solar**.
- ISA's vision and mission is to **take solar from the lab (or rich world markets) to (developing country) streets**.
- ISA is being designed as a **platform to bring together countries with rich solar potential** (along with solar innovators, developers, and financiers) **to aggregate demand for solar across member countries, creating a global buyers' market for solar energy, and thereby reducing prices, facilitating the deployment of existing solar technologies at scale, and promoting collaborative solar R&D and capacity**.
- The cost of finance for solar projects in many developing countries is often prohibitively high. ISA envisions that collective measures can facilitate the flow of over \$1 trillion into solar projects.
- ISA hopes to facilitate **collaborative, cross-country R&D**.
- ISA has plans to address related market-limiting factors, by launching **standardised skill training programmes and reducing information asymmetries through a 24x7 knowledge hub**.

Challenges faced by ISA:

- **Funding:** Although alliance talks about developing “innovative financial mechanisms”, it does not address how the capital would be provided.
- **Technology Sharing:** There is need to create a comprehensive framework to share the modern solar technologies at low cost.
- The longer-term danger : whether it devolves into a **bloated bureaucracy**.

- Although conceived as an intergovernmental institution, ISA is not intended to be a typical international bureaucracy.
- A **tight budget** and a **direct link to the private sector** would hold ISA accountable to real action on the ground.

The more proximate danger is that 121 potential member countries get caught up in a battle over legal form, membership rights, and giving precedence to procedure over pragmatism

Climate Change is a natural phenomenon but recent human activities have pushed it to the extent where there is no returning back. The policymakers both at national and international levels need to understand that it is not the earth that is at danger rather it is the humanity which will go extinct. The time demands that humanity must stop seeing humans as their enemies rather see this changing phenomenon as the common enemy. This will save trillions of dollars being diverted towards development of arsenals, which can be effectively used for mitigation and adaptation measures in developing and least developed countries.

The concept of sustainable development shall be followed which states, **Sustainable development** is the organizing principle for meeting human development goals while simultaneously sustaining the ability of natural systems to provide the natural resources and ecosystem services based upon which the economy and society depend. The desired result is a state of society where living conditions and resources are used to continue to meet human needs without undermining the integrity and stability of the natural system. Sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

OCEAN ACIDIFICATION

What is Ocean Acidification?

- When carbon dioxide (CO₂) is absorbed by seawater, chemical reactions occur that **reduces seawater pH**, carbonate ions concentration, and saturation states of biologically important calcium carbonate minerals. These chemical reactions are termed as "ocean acidification".

What is the issue?

- **Ocean acidification** is a direct consequence of increased human-induced carbon dioxide (CO₂) concentrations in the atmosphere. The ocean absorbs over 25% of all anthropogenic emissions from the atmosphere each year.
- As CO₂ dissolves in sea water it forms carbonic acid, thereby decreasing the ocean's pH, leading to a suite of changes collectively known as ocean acidification.
- Ocean acidification is happening in parallel with other climate-related stressors, including ocean warming and deoxygenation. This completes the set of climate change pressures on the marine environment – heat, acidity and oxygen loss – often referred to as the '**deadly trio**'. Interaction between these stressors is often cumulative or even multiplicative, resulting in combined effects that are more severe than the sum of their individual impacts.

Why is it important?

- Present **ocean acidity change** is unprecedented in magnitude, occurring at a rate approximately ten times faster than anything experienced during the last 300 million years. This rapid timeline is **jeopardising the ability of ocean systems to adapt to changes in CO₂** – a process that naturally occurs over millennia.

- Changes in ocean pH levels will persist as long as concentrations of atmospheric CO₂ continue to rise. To avoid significant harm, atmospheric concentrations of CO₂ need to get back to at least the 320-350 ppm range of CO₂ in the atmosphere.
- Compared to other similar events in Earth's history, ocean acidification, over hundreds of years, has been happening very fast. However, its recovery has been very slow due to the inherent time lags in the carbon and ocean cycles.

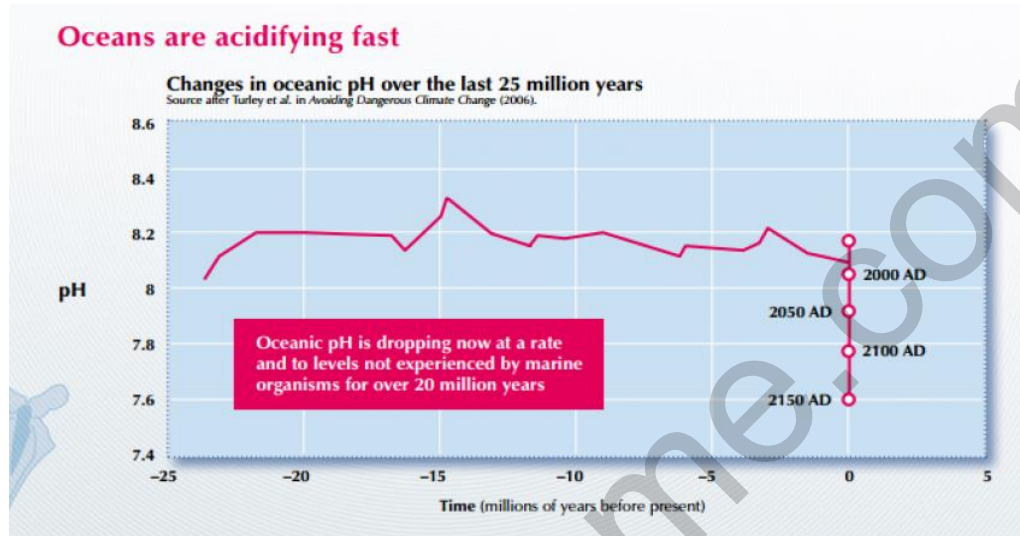


Figure: rate of ocean acidification

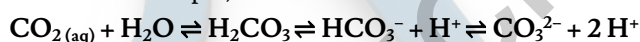
- Ocean acidification has the potential to **change marine ecosystems** and impact many ocean-related benefits to society such as coastal protection or provision of food and income. Although more knowledge on the impacts of ocean acidification on marine life is needed, changes in many ecosystems and the services they provide to society can be extrapolated from current understanding. Some of the strongest evidence of the potential effects of ocean acidification on marine ecosystems stems from experiments on calcifying organisms.
- **Impact of ocean acidification on species:**
 - **Changes in species growth and reproduction**, as well as **structural and functional alterations in ecosystems**, will threaten food security, harm fishing industries and decrease natural shoreline protection.
 - They will also increase the **risk of inundation and erosion** in low-lying areas, thereby hampering climate change adaptation and disaster risk reduction efforts.
- **Increased ocean temperatures** are likely to have direct effects on the **physiology of marine organisms** and influence the **geographical distribution of species**. Some species such as reef-forming corals, already living at their upper tolerance level, will have more difficulties 'moving' fast enough to new areas.
- **Impact of ocean acidification on corals:**
 - Drastic changes in ocean temperature can also lead to **coral bleaching** events, where corals expel the symbiotic algae living in their tissues, causing them to turn completely white.
 - The role of coral reefs in buffering coastal communities from storm waves and erosion, and in supporting income generation (fisheries and tourism) for local communities and commercial businesses, is jeopardised. The potential recovery of such bleaching events is hampered due to the declining calcification rates on reefs caused by ocean acidification.

- **Impact of ocean acidification on cloud formation:**
 - The majority of sulphur in the atmosphere is emitted from the ocean, often in the form of **dimethylsulphide (DMS) produced by phytoplankton**.
 - Some of DMS produced by phytoplankton enters the atmosphere and reacts to make **sulphuric acid**, which clumps into aerosols, or microscopic airborne particles.
 - **Aerosols seed the formation of clouds**, which help cool the Earth by reflecting sunlight.
 - But, in acidified ocean water, **phytoplankton produces less DMS**. This reduction of sulphur may lead to **decreased cloud formation, raising global temperatures**.
- **Impact of ocean acidification on humans:**

Socioeconomic impacts associated with the decline of the following ecosystem services are expected:

 - **Food:** Ocean acidification has the potential to affect food security. Commercially and ecologically important marine species will be impacted, although they may respond in different ways. Molluscs such as oysters and mussels are among the most sensitive groups.
 - **Coastal protection:** Marine ecosystems such as coral reefs protect shorelines from the destructive action of storm surges and cyclones, sheltering the only habitable land for several island nations.
 - **Tourism:** This industry could be severely affected by the impacts of ocean acidification on marine ecosystems (e.g. coral reefs). In Australia, the Great Barrier Reef Marine Park attracts about 1.9 million visits each year and generates more than A\$5.4 billion to the Australian economy.
 - **Carbon storage and climate regulation:** The capacity of the ocean to absorb CO₂ decreases as ocean acidification increases. More acidic oceans are less effective in moderating climate change.

Dissolving CO₂ in seawater increases the hydrogen ion (H⁺) concentration in the ocean, and thus decreases ocean pH, as follows:



- Calcium carbonate minerals are the building blocks for the skeletons and shells of many marine organisms.
- Since the beginning of the Industrial Revolution, the pH of surface ocean waters has **fallen by 0.1 pH units**. Since the pH scale, like the Richter scale, is logarithmic, this change represents approximately a 30% increase in acidity.
- Present ocean acidification is occurring at approximately **ten times faster rate than anything experienced during the last 300 million years, jeopardizing the ability of ocean systems to adapt to changes in ocean chemistry due to CO₂**.
- Ocean acidification has the potential to **change marine ecosystems and impact many ocean-related benefits to society** such as coastal protection or provision of food and income.
- **Increased ocean temperatures and oxygen loss act concurrently with ocean acidification** and constitute the 'deadly trio' of climate change pressures on the marine environment.

Mitigation: Possible responses

1. Reducing the build-up of CO₂ in the atmosphere.
2. Reinvigorate action to reduce stressors, such as overfishing and pollution, on marine ecosystems to increase resilience to ocean acidification.
3. Climate Engineering:

	Types of Climate Engineering-
Ocean fertilization	Ocean fertilization or ocean nourishment is a type of climate engineering based on the purposeful introduction of nutrients to the upper ocean to increase marine food production and to remove carbon dioxide from the atmosphere.
Enhanced weathering	It is a chemical approach to remove carbon dioxide using ocean-based techniques. <ul style="list-style-type: none"> ➤ Ocean-based techniques involve alkalinity enhancement, such as grinding, dispersing, and dissolving olivine, limestone, silicates, or calcium hydroxide to address ocean acidification via CO₂ sequestration.
Iron fertilization	<ul style="list-style-type: none"> ➤ Iron fertilization of the ocean could stimulate photosynthesis in phytoplankton. ➤ The phytoplankton would convert the ocean's dissolved carbon dioxide into carbohydrate and oxygen gas, some of which would sink into the deeper ocean before oxidizing. ➤ Adding iron to the ocean increases photosynthesis in phytoplankton by up to 30 times.
Biological pump	<ul style="list-style-type: none"> ➤ It is the ocean's biologically driven sequestration of carbon from the atmosphere to the ocean interior and seafloor sediments. ➤ It is the part of the oceanic carbon cycle responsible for the cycling of organic matter formed mainly by phytoplankton during photosynthesis (soft-tissue pump), as well as the cycling of calcium carbonate (CaCO₃) formed into shells by certain organisms such as plankton and mollusks (carbonate pump). <div> <p>The diagram, titled "Biological and physical pumps of carbon dioxide", illustrates the oceanic carbon cycle. At the top, CO₂ from the atmosphere enters the ocean. The biological pump shows CO₂ being converted into organic matter (particulate and dissolved) that sinks, eventually leading to sedimentation of organic carbon on the seafloor. The physical pump shows CO₂ being converted into carbonate (CaCO₃) shells that sink, eventually leading to sedimentation of carbonate on the seafloor. The diagram also shows deepwater circulation, upwelling, and cooling.</p> </div>

Issues with the mitigation approaches such as adding chemicals to counter the effects of acidification:

- These processes are likely to be **expensive**,
- **Only partly effective and only at a very local scale**,
- **These processes may pose additional unanticipated risks to the marine environment.**
- **There are lack of proper studies and scalability.**
- There has been very little research on the feasibility and impacts of these approaches. Substantial research is needed before these techniques could be applied.

Steps taken:

- Parties to the **United Nations Framework Convention on Climate Change (UNFCCC)** adopted a target of limiting warming to below 2 °C, relative to the pre-industrial level. Meeting this target would require substantial reductions in anthropogenic CO₂ emissions.
- Limiting global warming to below 2 °C would imply a **reduction in surface ocean pH of 0.16 from pre-industrial levels**. This would represent a substantial decline in surface ocean pH.

Way forward to combat Ocean Acidification: What can be done?

- While climate change is the consequence of a range of greenhouse gas (GHG) emissions, ocean acidification is primarily caused by increased concentrations of atmospheric CO₂ dissolved in sea water.
- It becomes evident, however, that the objective of the United Nations Framework Convention on Climate Change (UNFCCC) to achieve ‘stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’ cannot be encapsulated by a single ‘one-size-fits-all’ climate indicator. **The current emissions targets need significant tightening if they are to tackle the issue of ocean acidification and ocean warming.** Limiting the global average temperature increase to well below 2°C, rather than a lower level, will significantly harm the ocean life on which we all depend in some form or another.
- Other initiatives such as the **Ocean Acidification international Reference User Group (OAIRUG)**, composed of scientists and various stakeholders, need to be engaged as a key means of conveying scientific results. The OAIRUG examines in detail the types of data, analyses and products that are most useful to managers, policy advisers, decision makers and politicians, and ensure an appropriate format and distribution pathways.
- At the IUCN World Conservation Congress 2016, IUCN Members approved a resolution calling for the protection of 30% of the planet’s ocean by 2030.

OZONE DEPLETION

- Ozone gas is formed from di-oxygen by the action of ultraviolet light (UV) and electrical discharges within the Earth's atmosphere.
- The concentration of ozone is high in the stratosphere, which absorbs most of the Sun's ultraviolet (UV) radiation.

WHAT IS OZONE?	ADVERSE HEALTH EFFECTS						
<p>➔ Ground-level ozone is created by a reaction between Nitrogen oxides (emitted by vehicles) and volatile organic compounds, during hot and sunny days.</p> <p>➔ Standards for ozone are set for 1-hour and 8-hour duration. The national standard is 100 ug/m³ for 8-hour average, and 180 ug/m³ for 1 hour average</p>	<p>Breathing ground-level ozone can result in</p> <table border="1"> <tr> <td>Respiratory complications (symptoms: coughing, throat irritation, chest tightness, wheezing, or shortness of breath)</td> <td>function</td> </tr> <tr> <td>Impaired lung</td> <td>Inflammation of airways</td> </tr> <tr> <td></td> <td>In some cases ozone pollution has been known to cause premature death, the elderly being most at risk.</td> </tr> </table>	Respiratory complications (symptoms: coughing, throat irritation, chest tightness, wheezing, or shortness of breath)	function	Impaired lung	Inflammation of airways		In some cases ozone pollution has been known to cause premature death, the elderly being most at risk.
Respiratory complications (symptoms: coughing, throat irritation, chest tightness, wheezing, or shortness of breath)	function						
Impaired lung	Inflammation of airways						
	In some cases ozone pollution has been known to cause premature death, the elderly being most at risk.						

Figure: impact of Ozone

Significance of ozone	<ul style="list-style-type: none"> ● Ozone is a powerful oxidant (far more so than dioxygen) and has many industrial and consumer applications related to oxidation. ● At ground level, it has harmful effects on the respiratory systems of animals. ● However, in upper atmosphere, it creates ozonosphere, which prevents us from the potentially damaging ultraviolet (UV) light from reaching the Earth's surface. ● Ozonosphere is located 10-18 kilometres above Earth's surface.
Variation in thickness of Ozone Layer	<ul style="list-style-type: none"> ● The thickness of the ozone layer varies worldwide and is generally thinner near the equator and thicker near the poles. ● The reasons for these variations are due to atmospheric circulation patterns and solar intensity. ● The majority of ozone is produced over the tropics and is transported towards the poles by stratospheric wind patterns. In the northern hemisphere these patterns are known as the Brewer-Dobson circulation, make the ozone layer thickest in the spring and thinnest in the fall. ● When ozone is produced by solar UV radiation in the tropics, it is done so by circulation lifting ozone-poor air out of the troposphere and into the stratosphere where the sun photolyzes oxygen molecules and turns them into ozone. Then, the ozone-rich air is carried to higher latitudes and drops into lower layers of the atmosphere. ● Research has found that the ozone levels in the United States are highest in the spring months of April and May and lowest in October. ● The total amount of ozone increases moving from the tropics to higher latitudes, the concentrations are greater in high northern latitudes than in high southern latitudes, due to the ozone hole phenomenon. ● The highest amounts of ozone are found over the Arctic during the spring months of March and April, but the Antarctic has their lowest amounts of ozone during their summer months of September and October.
Ozone depletion	<ul style="list-style-type: none"> ● It is the gradual thinning of Earth's ozone layer in the upper atmosphere caused by the release of chemical compounds containing gaseous chlorine or bromine from industry and other human activities. ● The thinning is most pronounced in the polar regions, especially over Antarctica. ● Ozone depletion describes two related events observed since the late 1970s: <ol style="list-style-type: none"> 1. A steady lowering of about four percent in the total amount of ozone in Earth's atmosphere (the ozone layer), and 2. A much larger springtime decreases in stratospheric ozone around Earth's polar regions. This phenomenon is referred to as the ozone hole. ● There are also springtime polar tropospheric ozone depletion events in addition to these stratospheric events.
Causes of Ozone layer depletion	Ozone depleting substances (ODS): <ul style="list-style-type: none"> ● Main cause of ozone depletion and the ozone hole is manufactured chemicals, especially manufactured halocarbon refrigerants, solvents, propellants and foam-blowing agents (chlorofluorocarbons (CFCs), HCFCs, halons), referred to as ozone-depleting substances (ODS).

	<ul style="list-style-type: none"> ○ They are compounds of chlorine, fluorine, and carbon such as CF_3Cl, $CHCl_2F$ etc. ○ These are used as refrigerants in refrigerators, air conditioners, and in cooling plants. ○ These molecules can destroy O_3 molecules and therefore depletion of the O_3 layer. ● Nitrogen oxides (such as nitrous oxide) <ul style="list-style-type: none"> ○ very reactive to O_3 and are also responsible for holes in the ozone layer. ○ released by burning fossil fuels by cars and especially airplanes which fly near the ozone layer.
<p>Process of creation of Ozone Hole</p>	<ul style="list-style-type: none"> ● Ozone-depleting substances are transported into the stratosphere by the winds after being emitted from the surface. ● In the Polar Regions there is much larger variation in sunlight. During the 3 to 6 months of winter there is only dark. Thus, no solar radiation. ● Temperatures reduce around or below $-80^\circ C$ for much of the winter. Extremely low Antarctic temperatures cause cloud formation in the relatively "dry" stratosphere. ● These polar stratospheric clouds (PSCs) are composed of ice crystals that provide surface for reactions, many of which speed up the degradation of ozone molecules. <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> $Cl + O_3 \rightarrow ClO + O_2 \quad \text{(step 1)}$ $ClO + O \rightarrow Cl + O_2 \quad \text{(step 2)}$ $O_3 + O \rightarrow 2O_2 \quad \text{(Overall reaction)}$ </div> <ul style="list-style-type: none"> ● Chemistry + dynamics + radiation = Conditions conducive to significant ozone loss in the Polar Regions. ● The sequence of events leading to the spring time depletion of ozone is initiated of the earth's orbit at about 23.5° causes the polar regions to experience continual darkness during their winter season. <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Catalytic cycle is a series of reactions in which a chemical family or a particular species is depleted, leaving the catalyst unaffected.</p> </div> <ul style="list-style-type: none"> ● The air above the pole cools and a polar vortex is formed that isolates and sets the stage for the rapid depletion of ozone by catalytic cycles. ● Chlorofluorocarbon-bonds (CFCs) themselves are not involved in the catalytic process. Upon reaching the stratosphere, they are subject to higher levels of ultraviolet radiation that decompose the CFCs and release atomic chlorine.
<p>Impact of Ozone layer depletion</p>	<p>Impact of agriculture:</p> <ul style="list-style-type: none"> ● An increase of UV radiation would be expected to affect crops. <ul style="list-style-type: none"> ○ A number of economically important species of plants, such as rice, depend on Cyanobacteria residing on their roots for the retention of nitrogen. ○ Cyanobacteria are sensitive to UV radiation and would be affected by its increase.

	<ul style="list-style-type: none"> ○ Several of the world's major crop species are particularly vulnerable to increased UV, resulting in reduced growth, photosynthesis and flowering. <p>Impact on humans:</p> <ul style="list-style-type: none"> ● Skin cancers, sunburns and premature aging of the skin <ul style="list-style-type: none"> ○ Basal and squamous cell carcinomas: the most common forms of skin cancer in humans ○ Malignant melanoma, a form of skin cancer ● Cortical cataracts: UV radiation can damage several parts of the eye, including the lens, cornea, retina and conjunctiva ● Weakening of the human immune system. ● UV rays can also led to Genetic mutation. <p>Impact on ocean organism:</p> <ul style="list-style-type: none"> ● Planktons are threatened by increased UV radiations.
<p>Why Ozone hole mainly in Antarctica not in Arctic pole?</p>	<ul style="list-style-type: none"> ● Southern polar region is colder and more isolated than north. Antarctica favors the formation of polar stratospheric clouds (PSCs) which in turn serve as platforms for catalytic ozone breakdown ● As a consequence of having less land, the circulation over the Antarctic is more persistent and vortex-like, which favours PSCs. ● Air inside the vortex is prevented from mixing with warmer, ozone-rich air from lower latitudes (This vortex is not a feature of the Arctic).
<p>Intervention to mitigate Ozone Layer Depletion</p>	<p>The Montreal Protocol on Substances that Deplete the Ozone Layer</p> <ul style="list-style-type: none"> ● The original Montreal Protocol was agreed on 16 September 1987 and entered into force on 1 January 1989. ● It was conceived after the detection of a large hole in earth's ozone layer over Antarctica. ● Aim: The main aim of this treaty was the elimination of Chlorofluorocarbons (CFCs) and HCFCs. As a replacement HFCs were proposed ● Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere-chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform-are to be phased out by 2000 (2005 for methyl chloroform). <p>Kigali Conference:</p> <ul style="list-style-type: none"> ● Meeting of Parties (MoP) to the Montreal Protocol of the Vienna Convention for Protection of Ozone Layer took place in October, 2016, in Kigali (Rwanda). ● The negotiations at Kigali were aimed at including Hydrofluorocarbons (HFCs) in the list of chemicals under the Montreal Protocol with a view to regulate their production and consumption and phase them down over a period of time with financial assistance from the Multilateral Fund created under the Montreal Protocol. ● What are HFCs? <ul style="list-style-type: none"> ○ HFCs are refrigerant gases used for commercial, residential and automotive purposes (and in other applications) but are hundreds to thousands of times more potent than carbon dioxide.

	<ul style="list-style-type: none">○ They were meant to replace HCFCs (hydrochlorofluorocarbons) in order to protect the ozone layer but their global warming potential (GWP) has increasingly become a matter of concern in climate negotiations.● During negotiations held at Kigali India successfully negotiated the baseline years and freeze years which will allow sufficient room for the growth of the concerned sectors using refrigerants being manufactured domestically thus ensuring unhindered growth with least additional cost and maximum climate benefits.● Outcome of Kigali Conference:<ul style="list-style-type: none">○ there would be two set of baselines or peak years for developing countries○ India will have baseline years of 2024, 2025, 2026.<ul style="list-style-type: none">■ This decision gives additional HCFC allowance of 65% that will be added to the Indian baseline consumption and production.○ The freeze year for India will be 2028, with a condition that there will be a technology review in 2024/2025 and, if the growth in the sectors using refrigerants is above certain agreed threshold, India can defer its freeze up to 2030.○ On the other hand, developed countries will reduce production and consumption of HFCs by 70% in 2029.○ India will complete its phase down in 4 steps from 2032 onwards with cumulative reduction of 10% in 2032, 20% in 2037, 30% in 2042 and 85% in 2047.● Significance of Kigali<ul style="list-style-type: none">○ The Kigali Amendment is one that could avoid global warming by up to 0.5° C○ India & China are the only countries in the world today that manufacture HFCs. So, why India has been given a later freeze year?<ul style="list-style-type: none">■ Because China's air conditioner market is bigger in size meaning its production of HFCs is also larger than India.■ India's HFC consumption picks up only after 2025 while China will witness rapid emissions of HFCs from 2015-2030○ The Kigali amendments to the Montreal Protocol will, for the first time, incentivise improvement in energy efficiency in case of use of new refrigerant and technology. Funding for R&D and servicing sector in developing countries has also been included in the agreed solutions on finance.
--	--

Facts for Prelims:

- **The International Day for Preservation of Ozone Layer (aka World Ozone Day) is observed every year on September 16** for the preservation of the Ozone Layer. The Montreal Protocol was signed on 16 September, 1987 on substances that deplete the Ozone Layer and marks the International Day for the Preservation of the Ozone Layer.
- **The theme for 2018: 'Keep Cool and Carry On: The Montreal Protocol'**.
- **The theme of World Ozone Day 2019: '32 years and Healing'**.





ENVIRONMENTAL ORGANIZATION

ENVIRONMENTAL ORGANISATIONS AND CONVENTION

ORGANISATIONS

1. International Union for Conservation of Nature
2. The Intergovernmental Panel on Climate Change
3. The United Nations Environment Programme
4. World Meteorological Organisation
5. The Convention on International Trade in Endangered Species of Wild Fauna and Flora
6. The Convention on the Conservation of Migratory Species of Wild Animals
7. The World Wide Fund for Nature
8. The Nature Conservancy
9. Birdlife International
10. Conservancy International

CONVENTIONS

1. UNCBD
2. UNCCD
3. RAMSAR CONVENTION
4. BASEL CONVENTION
5. ROTTERDAM CONVENTION
6. STOCKHOLMS CONVENTION

ORGANISATIONS

I. INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN)

- IUCN has become the global authority on the status of the natural world and the measures needed to safeguard it. The knowledge and the tools IUCN provide are critical for ensuring that human progress, economic development and nature conservation take place together.
 - IUCN, International Union for Conservation of Nature, was established on 5 October 1948 in the French town of Fontainebleau. It changed its name to the International Union for Conservation of Nature and Natural Resources (IUCN) in 1956 and was also known as the **World Conservation Union**.
 - The IUCN is the world's oldest global environmental organization.
 - Its headquarters are in Gland, Switzerland.
 - As the first global environmental union, it brought together governments and civil society organisations with a shared goal to protect nature. Its aim was to encourage international cooperation and provide scientific knowledge and tools to guide conservation action.
 - IUCN also played a fundamental role in the creation of key international conventions, including the Ramsar Convention on Wetlands (1971), the World Heritage Convention (1972), the Convention on International Trade in Endangered Species, (1974) and the Convention on Biological Diversity (1992).
 - In 1980, IUCN – in partnership with the UN Environment Programme (UNEP) and the World Wildlife Fund (WWF) – published the World Conservation Strategy, a groundbreaking document which helped define the concept of 'sustainable development' and shaped the global conservation and sustainable development agenda.
 - A subsequent version of the strategy, caring for the Earth, was published by the three organisations in the run-up to the 1992 Earth Summit. It served as the basis for international environmental policy and guided the creation of the Rio Conventions on biodiversity (CBD), climate change (UNFCCC) and desertification (UNCCD).
 - In the early 2000s, IUCN developed its business engagement strategy. Prioritising sectors with a significant impact on nature and livelihoods, such as mining and oil and gas, its aim is to ensure that any use of natural resources is equitable and ecologically sustainable.
 - Later in the 2000s, IUCN pioneered 'nature-based solutions' – actions to conserve nature which also address global challenges, such as food and water security, climate change and poverty reduction.
 - Today, with the expertise and reach of its more than 1,300 Members – including States, government agencies, NGOs and Indigenous Peoples' Organisations – and over 10,000 international experts, IUCN is the world's largest and most diverse environmental network. It continues to champion nature-based solutions as key to the implementation of international agreements such as the Paris climate change agreement and the 2030 Sustainable Development Goals.

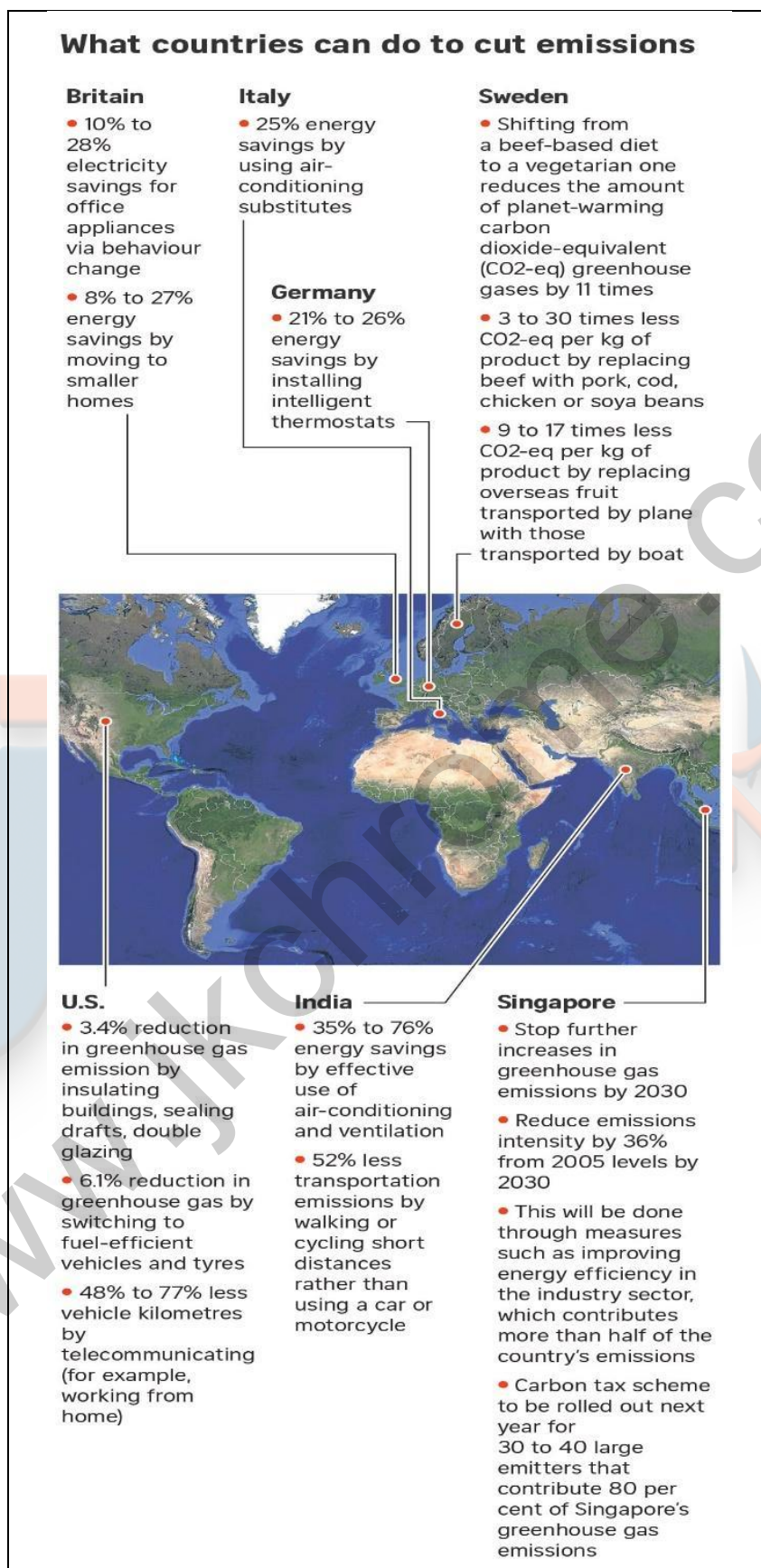


Figure: emission cuts of various countries

There are various programs and initiatives of IUCN are given below: -

1.1. IUCN Red Data List

- Established in 1964, the International Union for Conservation of Nature’s Red List of Threatened Species has evolved to become the world’s most comprehensive information source on the global conservation status of animal, fungi and plant species.
- The IUCN Red List is a critical indicator of the health of the world’s biodiversity. It provides information about range, population size, habitat and ecology, use and/or trade, threats, and conservation actions that will help inform necessary conservation decisions.
- The IUCN Red List is used by government agencies, wildlife departments, conservation-related non-governmental organizations (NGOs), natural resource planners, educational organizations, students, and the business community.
- The Red List process has become a massive enterprise involving the IUCN Global Species Program, the IUCN Species Survival Commission and partner networks who compile the species information to make The IUCN Red List the indispensable product it is today.
- Currently there are more than 105,700 species on The IUCN Red List, with more than 28,000 species threatened with extinction, including 40% of amphibians, 34% of conifers, 33% of reef building corals, 25% of mammals and 14% of birds.

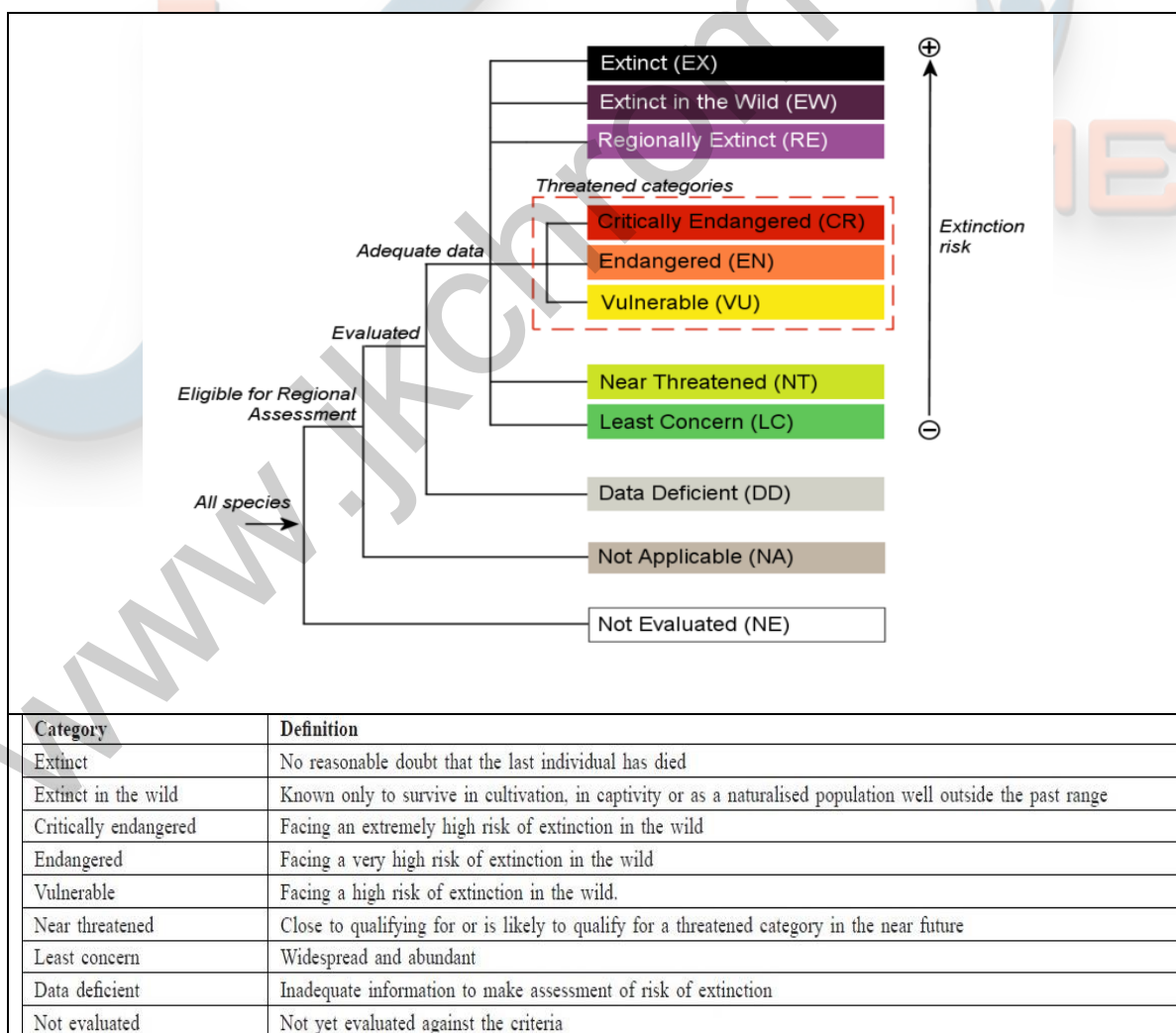


Figure: IUCN criteria under Red List

1.2. Ecosystem Management Programme

The well-being of people all over the world depends on the various goods and services provided by ecosystems, including food, fuel, construction materials, clean water and air, and protection from natural hazards. Ecosystems, however, are under increasing pressure from unsustainable use and other threats including outright conversion. To address this concern, IUCN promotes the sound management of ecosystems through the wider application of the Ecosystem Approach – a strategy for the integrated management of land, water and living resources that places human needs at its centre, through the Ecosystem Management Programme.

The Ecosystem Management Programme works on five key programmatic areas for IUCN:

- **Red List of Ecosystems**, compiles information on the state of the world's ecosystems at different geographic scales. Its central objective is to assess the risk of ecosystem collapse.
- **Ecosystem based Adaptation**, where the Initiative aims to include biodiversity concerns in adaptation and mitigation policies and practice, as well as furthering natural resource management strategies that help biodiversity and people to adapt to the impacts of climate change. The Initiative coordinates Climate Change work across IUCN's programmes, regions, Commissions and member organizations.
- **Disaster Risk Reduction**, where the programme aims to promote integration of ecosystem management, livelihoods, community vulnerability and climate change adaptation to disaster management.
- **Drylands**, where the programme demonstrates the high value of ecosystem services and shows how to adapt development and conservation approaches to the unique challenges of aridity and climatic uncertainty.
- **Global Island Partnership**, this is a voluntary partnership for all islands, regardless of size or political status, to take bold steps to build resilient and sustainable island communities through innovative partnerships.

In addition, the Programme provides technical input on integrating wider ecosystem-scale biodiversity issues into IUCN's programmes globally, regionally and nationally.

1.3. Red List of Ecosystems

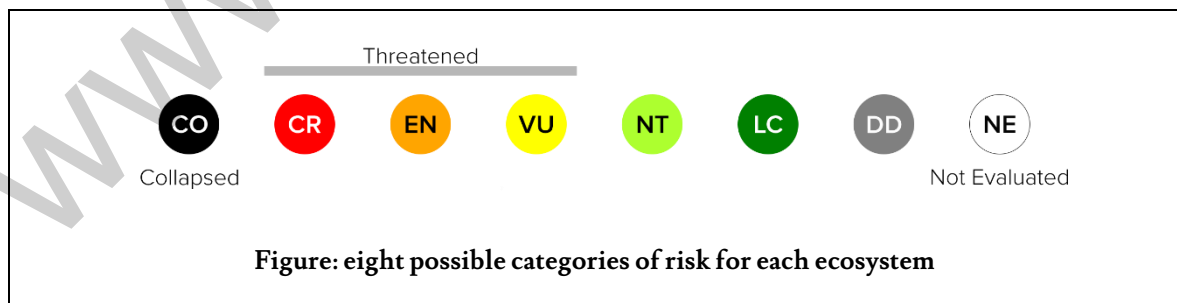
The Red List of Ecosystems evaluates whether ecosystems have reached the final stage of degradation, whether they are threatened at Critically Endangered, Endangered or Vulnerable levels, or if they are not currently facing significant risk of collapse (Least Concern). It is based on a set of rules, or criteria, for performing evidence-based, scientific assessments of the risk of ecosystem collapse, as measured by reductions in geographical distribution or degradation of the key processes and components of ecosystems.

- The Red List of Ecosystems will be of great value to a number of different sectors, including:
 - **Conservation**: to help prioritize investments in ecosystem management and restoration, reform resource use practices, and reward good and improved ecosystem management.
 - **Natural resource management**: to illustrate ecosystem risks under different land use/development scenarios, and offer insights into ecosystems that provide services such as clean water, soil productivity and the availability of natural products.
 - **Macro-economic planning**: to highlight both the economic costs of reduced ecosystem services and potential economic benefits of improved ecosystem management.
 - **Improvement of governance and livelihoods**: to inform development of governance systems that improve ecosystem management, livelihood security and social outcomes.
 - **Global environmental reporting**: to inform governments and the global community on progress towards achieving international environmental targets.

- **Private sector:** to assess potential environmental and social benefits and costs of alternative designs of future development projects, as well as monitor and report on environmental impacts.
- **Public sector:** to inform the public about the current state of ecosystems and their future prognosis.
- **Red List of Ecosystems objectives and goals**
 1. A global assessment of the ecosystems of the world by 2025.
 2. Technical support will be provided for stakeholders to carry out finer scale assessments at national and regional levels. These may be led by government agencies, NGOs, academic institutions, IUCN national and regional offices and their networks of collaborators.
 3. The Red List criteria may be applied to assess individual ecosystems of particular interest to stakeholders.
- Ecosystem red lists have the potential to complement the policy successes of species red lists in several ways.
 1. Ecosystems may more effectively represent biological diversity as a whole than individual species.
 2. The eco-systemic scale includes fundamental abiotic components that are only indirectly included in species assessments.
 3. Decline in ecosystem status may be more apparent than extinctions of individual species.
 4. Ecosystem-level assessments may be less time consuming than species-by-species assessments.
 5. Red lists of ecosystems may suggest areas in which extirpations are likely to result from extinction debt in response to loss and fragmentation of species' habitats, because decline in the extent and status of an ecosystem may precede the loss of its species.
- **Red List of Ecosystems Categories and Criteria**

The IUCN Red List of Ecosystems protocol includes five criteria for assessing the risk of ecosystem collapse:

 1. Reduction in geographic distribution
 2. Restricted geographic distribution
 3. Environmental degradation
 4. Disruption of biotic processes or interactions
 5. Quantitative analysis that estimates the probability of ecosystem collapse



1.4. Global Drylands Initiative

- Drylands are found in tropical and temperate latitudes and account for 41.3% of the global terrestrial area.

- They can be classified into four types - dry sub-humid, semi-arid, arid and hyper-arid lands - encompassing a variety of ecosystems.
- The goal of the Global Drylands Initiative is to restore, sustainably manage and protect dryland ecosystems for multiple environmental, economic and social benefits.
- The Initiative supports countries to adapt ecosystem management policy and practice to the unique conditions of the drylands and to the evolving challenges that the drylands face
- The Global Drylands Initiative aims to:
 - **Generate evidence for targeting and monitoring** of dryland conditions and trends through adapted assessment approaches that operationalize current understanding on non-equilibrium dryland ecology.
 - **Strengthen governance for sustainable land management** by strengthening of resource rights, establishment of institutional mechanisms for ecosystem management, and development of enabling conditions for policy implementation and revision.
 - **Promote policy implementation for dryland ecosystem management** by enhancing the knowledge and capacity of various stakeholders to adapt policies and investments to the unique conditions of the drylands.

1.5. Mangroves for the Future

- MFF is a unique partner-led initiative to promote investment in coastal ecosystem conservation for sustainable development.
- Co-chaired by **IUCN and UNDP**.
- MFF provides a platform for collaboration among the many different agencies, sectors and countries which are addressing challenges to coastal ecosystem and livelihood issues.
- The goal is to promote an integrated ocean-wide approach to coastal management and to building the resilience of ecosystem-dependent coastal communities.
- MFF builds on a history of **coastal management interventions** before and after the 2004 Indian Ocean tsunami. It initially focused on the countries that were worst affected by the tsunami -- India, Indonesia, Maldives, Seychelles, Sri Lanka and Thailand. More recently it has expanded to include Bangladesh, Cambodia, Myanmar, Pakistan and Vietnam.
- Mangroves are the flagship of the initiative, but **MFF is inclusive** of all types of coastal ecosystem, such as coral reefs, estuaries, lagoons, sandy beaches, seagrasses and wetlands.
- **Each country manages its own MFF programme** through a National Coordinating Body which includes representation from government, NGOs and the private sector. MFF addresses priorities for long-term sustainable coastal ecosystem management which include, among others: climate change adaptation and mitigation, disaster risk reduction, promotion of ecosystem health, development of sustainable livelihoods, and active engagement of the private sector in developing sustainable business practices.
- The emphasis is on generating knowledge, **empowering local communities** and advocating for policy solutions that will support best practice in integrated coastal management.
- MFF will increasingly focus on building resilience of ecosystem-dependent coastal communities by promoting **nature-based solutions** and by showcasing the climate change adaptation and mitigation benefits that can be achieved with healthy mangrove forests and other types of coastal vegetation.

1.6. The Restoration Initiative (TRI)

The Restoration Initiative unites 10 Asian and African countries and three Global Environment Facility agencies – IUCN, the Food and Agriculture Organization of the UN, and the UN Environment Program – in

working to overcome existing barriers to restoration and restore degraded landscapes at scale, and in support of the Bonn Challenge.

A growing global movement of political and community leaders, farmers, scientists, businesses and investors is taking action to restore degraded landscapes. One significant outcome of this support is the **Bonn Challenge** – a global effort to bring 150 million hectares of deforested and degraded land into restoration by 2020, and 350 million hectares by 2030. To date, 57 governments and private sector entities have pledged 170 million hectares towards the Bonn Challenge target.

For each partnering country, project interventions will include work in four key areas:

1. **Policy development and integration** enhancing the in-country enabling environment for FLR;
2. **Implementation of restoration programmes and complementary initiatives** providing direct support for implementation of integrated landscape restoration work, and providing scalable models for wider uptake;
3. **Capacity building and finance mobilisation** supporting efforts to unlock and mobilise additional funding for FLR, and to strengthen and enhance the abilities of countries, institutions, and people to plan and manage FLR; and
4. **Knowledge sharing and partnerships** providing support for the capture and sharing of innovative experiences and best practices, raising awareness of FLR needs and opportunities, and developing and strengthening critical partnerships.

1.7. The Bonn Challenge

- The Bonn Challenge is a global effort to bring 150 million hectares of degraded and deforested land into restoration by 2020 and 350 million by 2030.
- The 2020 target was launched at a high level event in Bonn in 2011 organised by the Government of Germany and IUCN, and was later endorsed and extended to 2030 by the New York Declaration on Forests of the 2014 UN Climate Summit. To date, 56 governments, private associations and companies have pledged over 168 million hectares to the Challenge.
- The Bonn Challenge is an implementation vehicle for national priorities such as water and food security and rural development while simultaneously helping countries contribute to the achievement of international climate change, biodiversity and land degradation commitments.
- The restoration of 150 million hectares of degraded and deforested lands in biomes around the world – in line with the forest landscape restoration (FLR) approach – will create approximately US\$ 84 billion per year in net benefits that could bring direct additional income opportunities for rural communities.
- About 90% of this value is potentially tradable, meaning that it encompasses market-related benefits. Achieving the 350-million-hectare goal will generate about US\$ 170 billion per year in net benefits from watershed protection, improved crop yields and forest products, and could sequester up to 1.7 gigatons of carbon dioxide equivalent annually.

Further, as the IUCN Focal Point to the United Nations Convention to Combat Desertification, the Global Drylands Initiative leads IUCN's efforts to influence the global discourse on Land Degradation and Sustainable Land Management. In this case, the Initiative supports countries to implement their commitments to the Convention by demonstrating good practices on the ground, influencing the science-policy interaction of the Convention itself and working with other stakeholders to achieve Land Degradation Neutrality.

2. THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

- The IPCC was created to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options.
- IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC).
- 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.
- The IPCC is an organization of governments that are members of the United Nations or WMO. The IPCC currently has 195 members.
- 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.
- The 2007 Nobel Peace Prize was shared between the IPCC and Al Gore.
- Besides **the Sixth Assessment Report**, to be completed by 2022. The IPCC released the Special Report on Global Warming of 1.5 °C in October 2018, **the Special Report on Climate Change and Land (SRCCL)**, published on 7 August 2019, and **the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)**, released on 25 September 2019

1.8. Key points of IPCC report

- **Unprecedented Scale**
 - The Intergovernmental Panel on Climate Change (IPCC) says the 1.5 deg. C goal is technically and economically feasible, but depends on political leadership to become reality.
 - The panel says capping global warming at 1.5 deg. C above pre-industrial levels will require "rapid, far-reaching and unprecedented changes in all aspects of society".
 - Earth's average surface temperature has already gone up 1 deg. C - enough to unleash a surge of deadly extreme weather - and is on track to rise another two or three degrees unless there is a sharp and sustained reduction in carbon pollution.
 - At current levels of greenhouse gas emissions, the planet could pass the 1.5 deg. C marker as early as 2030, and no later than mid-century.
 - Emissions of carbon dioxide (CO₂) - the main greenhouse gas - should peak no later than 2020 and curve sharply downwards from there, according to scenarios in the report.
 - Limiting global warming to 1.5 deg. C will require investing about US\$2.4 trillion in the global energy system every year between 2016 and 2035, or about 2.5 per cent of world gross domestic product. This price tag, however, must be weighed against the even steeper cost of inaction, the report says.
- **1.5 deg. c versus 2 deg. c**
 - The 2 deg. C was long considered the temperature guardrail for a climate-safe world.
 - Some tropical fisheries may collapse between the 1.5 deg. C and 2 deg. C. Staple food crops will decline in yield and nutritional value by an extra 10 per cent to 15 per cent. Coral reefs will mostly perish. Species loss will accelerate substantially.

- Temperature thresholds between 1.5 deg. C and 2 deg. C could push Arctic sea ice, methane-laden permafrost and melting polar ice sheets past a point of no return.

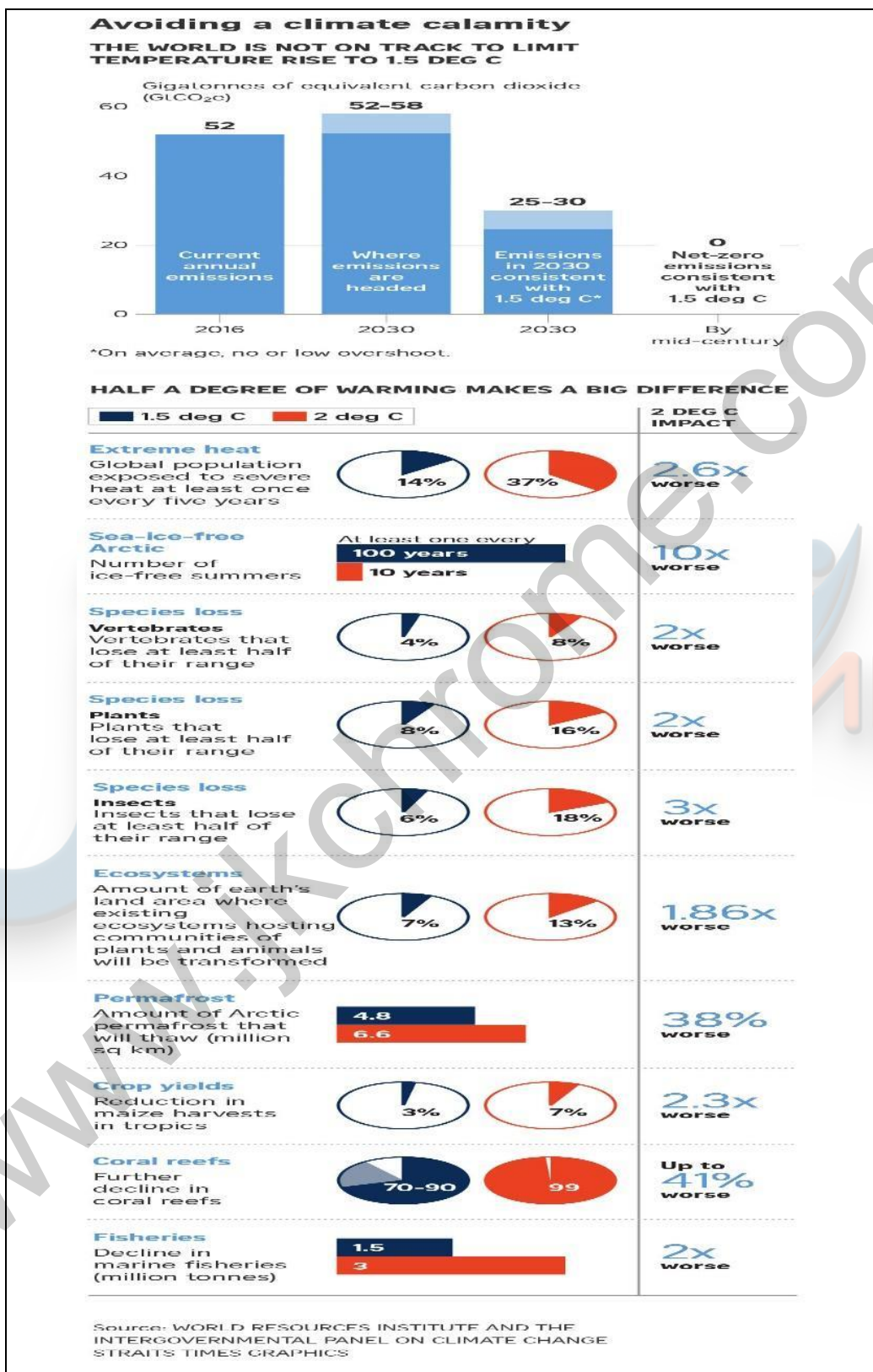


Figure: rise of temperature

3. THE 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.
- It was founded by Maurice Strong as a result of the United Nations Conference on the Human Environment (Stockholm Conference) in June 1972.
- It has played a significant role in developing international environmental conventions, promoting environmental science and information and illustrating the way those can be implemented in conjunction with policy, working on the development and implementation of policy with national governments, regional institutions in conjunction with environmental non-governmental organizations (NGOs).
- UNEP has also been active in funding and implementing environment related development projects.
- UN Environment has aided in the formulation of guidelines and treaties on issues such as the international trade in potentially harmful chemicals, transboundary air pollution, and contamination of international waterways. Relevant documents, including scientific papers, are available via the UNEP Document Repository.
- The World Meteorological Organization and UN Environment established the Intergovernmental Panel on Climate Change (IPCC) in 1988. UN Environment is also one of several Implementing Agencies for the Global Environment Facility (GEF) and the Multilateral Fund for the Implementation of the Montreal Protocol, and it is also a member of the United Nations Development Group.
- UNEP publishes the **Global Environment Outlook (GEO)** assessment is a comprehensive report on environment, development and human well-being, providing analysis and information for policy makers and the concerned public.
- **Emissions Gap Report**
 - The annual UN Environment Emissions Gap Report presents an assessment of current national mitigation efforts and the ambitions countries have presented in their Nationally Determined Contributions, which form the foundation of the Paris Agreement.
 - Scientists agree that to get on track to limit global temperature rise to 1.5°C, emissions must drop rapidly to 25 gigatons by 2030.
 - Collectively, if commitments, policies and action can deliver a 7.6% emissions reduction every year between 2020 and 2030
- **Campaigns and Awards by UNEP**

Clean Seas	UN Environment launched Clean Seas (#CleanSeas on social media) in February 2017, with the aim of engaging governments, the general public and the private sector in the fight against marine plastic pollution. The campaign contributes to the goals of the Global Partnership on Marine Litter, a voluntary open-ended partnership for international agencies, governments, businesses, academia, local authorities and non-governmental organizations hosted by UN Environment.
UN Decade of Ecosystem Restoration	The United Nations General Assembly has proclaimed 2021–2030 as the Decade on Ecosystem Restoration, following a proposal for action by over 70 countries from all latitudes. The UN Decade positions the restoration of ecosystems as a major nature-

	<p>based solution towards meeting a wide range of global development goals and national priorities.</p> <p>The UN Decade on Ecosystem Restoration aims to:</p> <ul style="list-style-type: none"> • Showcase successful government-led and private initiatives to halt ecosystem degradation, restore those ecosystems that have already been degraded • Enhance knowledge exchange on what works and why (policy, economics and biophysical aspects), and how to implement restoration at scale • Connect initiatives working in the same landscape, region, or topic, to increase efficiency and impact • Create links between ecosystem restoration opportunities and initiatives with businesses interested in building a solid portfolio of sustainable production and impact investment • Bring a wider spectrum of actors on board, especially from sectors that are not traditionally involved, by demonstrating the importance of ecosystem restoration to conservation as well as generation of social and economic benefits.
World Environment Day	<p>World Environment Day (5th june) is the United Nations day for encouraging worldwide awareness and action to protect our environment. Since it began in 1974, the event has grown to become a global platform for public outreach that is widely celebrated in over 100 countries.</p> <p>The theme for 2019 is “Air pollution”.</p>
Champions of The Earth	<p>The UN Environment Programme’s Champions of the Earth award is the world’s flagship environmental honour. Since 2005, we have recognized heroes who inspire, encourage others to join them, and defend a cleaner future.</p> <p>Champions of the Earth are celebrated in four categories:</p> <ul style="list-style-type: none"> • Policy leadership – individuals or organizations in the public sector leading global or national action for the environment. They shape dialogue, lead commitments and act for the good of the planet. • Inspiration and action – individuals or organizations taking bold steps to inspire positive change to protect our world. They lead by example, challenge behavior and inspire millions. • Entrepreneurial vision – individuals or organizations challenging the status quo to build a cleaner future. They build systems, create new technology and spearhead a groundbreaking vision. • Science and innovation – individuals or organizations who push the boundaries of technology for profound environmental benefit. They invent possibilities for a more sustainable world.

4. THE WORLD METEOROLOGICAL ORGANIZATION (WMO)

- ❖ It is an intergovernmental organization with a membership of 193 Member States and Territories.
- ❖ WMO originated from the International Meteorological Organization (IMO), which was founded in 1873 to facilitate the exchange of weather information across national borders.
- ❖ Established in 1950, the WMO became a specialized agency of the United Nations in 1951.

- ❖ Its mandate is in the areas of meteorology (weather and climate), operational hydrology and related geophysical sciences.
- ❖ WMO has played a unique and powerful role in contributing to the safety and welfare of humanity. It has fostered collaboration between the National Meteorological and Hydrological Services of its Members and furthered the application of meteorology in many areas.
- ❖ WMO assists Members with technology transfer, training for capacity development, collaboration on research and the application of meteorology to public weather services, agriculture, the energy sector, the environment, health, transport (aviation and shipping), the management of water resources, disaster risk reduction and many more.
- ❖ The Organization also contributes to policy formulation in areas related to weather, climate and water at national and international levels.
- ❖ The World Meteorological Day is held annually on 23 March. the **theme** “The Sun, the Earth and the weather”.
- The **Global Atmosphere Watch (GAW)** Programme of WMO focuses on building a single coordinated global understanding of atmospheric composition, its change, and helps to improve the understanding of interactions between the atmosphere, the oceans and the biosphere. The GAW Programme operates according to the GAW Implementation Plan 2016-2023.
 - Global Atmosphere Watch data are used in the following assessments:
 - a) WMO/UNEP Scientific Assessment of Ozone Depletion
 - b) Global Precipitation Chemistry Assessment
 - c) WMO Arctic and Antarctic ozone bulletins
 - d) Greenhouse gas bulletins
 - e) Aerosol bulletins
- The **Global Climate Observing System (GCOS)** is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO), the United Nations Environment Programme (UN Environment), and the International Science Council (ISC). It regularly assesses the status of global climate observations of the atmosphere, land and ocean and produces guidance for its improvement.

5. CITES (THE 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.
- ❖ CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union). The text of the Convention was finally agreed at a meeting of representatives of 80 countries in **Washington, D.C.**, the United States of America, on **3 March 1973, and on 1 July 1975 CITES entered in force**. This is also known as **Washington convention**
- ❖ CITES is an international agreement to which States and regional economic integration organizations adhere voluntarily. States that have agreed to be bound by the Convention ('joined' CITES) are known as Parties.

- ❖ For many years CITES has been among the conservation agreements with the largest membership, with now 183 Parties.
- ❖ Although CITES is **legally binding on the Parties** – in other words they have to implement the Convention – it does not take the place of national laws. Rather it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level.
- ❖ **International wildlife trade:**
 1. Estimated to be worth billions of dollars and to include hundreds of millions of plant and animal specimens.
 2. 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.
 3. 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.
 4. 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.
- ❖ The species covered by CITES are listed in three Appendices, according to the degree of protection they need.
 1. **Appendix I:** It includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. E.g. gorillas, sea turtles, lady slipper orchids and giant pandas
 2. **Appendix II:** It includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. E.g. paddlefish, lions, American alligators, mahogany and many corals
 3. **Appendix III:** This Appendix contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade. E.g. map turtles, walrus and Cape stag beetles

A specimen of a CITES-listed species may be imported into or exported (or re-exported) from a State party to the Convention only if the appropriate document has been obtained and presented for clearance at the port of entry or exit.

6. CMS (CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES OF WILD ANIMALS)

- ❖ It is an environmental treaty under the aegis of the **United Nations Environment Programme**, 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.
- ❖ CMS signed in 1979 in Bonn, Germany, the Convention entered into force in 1983.

- ❖ 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.
- ❖ 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.
- ❖ 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 Convention on Migratory Species has 130 Parties.

What is the CMS SGP?

The CMS Small Grants Programme (SGP) was established in 1994 by the Fourth Meeting of the Conference of the Parties as a grassroots tool that has served as a catalyst for further action to conserve migratory species and their habitats, funding projects in more than 30 countries since its inception.

The SGP has played an important role in strengthening the implementation of the Convention through supporting CMS conservation initiatives for a number of migratory taxa, with a strong focus on implementation in developing countries.

Migratory Species in India

- ❖ The **Indian sub-continent is also part of** the major bird flyway network, i.e, the **Central Asian Flyway (CAF)** that covers areas between the Arctic and Indian Oceans, and covers at least 279 populations of 182 migratory waterbird species, including 29 globally threatened species.
- ❖ **India is a temporary home to several migratory animals and birds.** The important among these include **Amur Falcons, Bar-headed Geese, Black-necked cranes, Marine turtles, Dugongs, Humpbacked Whales, etc.**
- ❖ India has also launched the National Action Plan for the conservation of migratory species under the Central Asian Flyway.

7. WWF (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 1,300 conservation and environmental projects.
- ❖ 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 is 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.

World Wide Fund for Nature-India (WWF India) was founded with the express objective of ensuring the conservation of the country's wildlife and natural habitats. It was set up as a Charitable Public Trust on 27 November 1969. It was then known as the World Wildlife Fund India, much before the terms 'wildlife' and 'environment' had caught the attention of the government or the public.

Earth Hour is a global movement organized by the World Wide Fund for Nature (WWF). The event is held annually encouraging individuals, communities, and businesses to switching-off non-essential electric lights, for one hour, **from 8:30 to 9:30 p.m.** on a specific day towards the end of March, as a symbol of commitment to the planet. It was started as a lights-off event in **Sydney, Australia, in 2007**

8. THE NATURE CONSERVANCY

- ❖ It is a global environmental non-profit working to create a world where people and nature can thrive.
- ❖ The Nature Conservancy (TNC), **headquartered in Arlington, Virginia, United States.**
- ❖ **Founded at its grassroots in the United States in 1951**, The Nature Conservancy has grown to become one of the most effective and wide-reaching environmental organizations in the world.
- ❖ The Nature Conservancy's **Plant a Billion Trees campaign** is an effort to restore 2,500,000 acres (10,100 km²) of land and plant one billion trees by 2025 in the Atlantic Forest of Brazil.

The Nature Conservancy in India:

1. Restoring Wetlands in Chennai

To develop and implement a science-led lake restoration plan and piloting efforts on Sembakkam lake in Chennai.

Partners: Care Earth Trust & Indian Institute of Technology, Chennai

2. Enhancing Drought Resilience for People and Nature

To develop a comprehensive science-led drought resilience plan for the Devnadi watershed in the Nashik district of Maharashtra.

Partners: Yuva Mitra

3. Ending Crop Residue Burning in Northwest India

Working with partners to promote the use of an agricultural technology – the **Happy Seeder** – which enables utilisation of rice residue in the field itself and eliminates the need to burn. It is a win-win for farmers and the environment as it is known to improve farm yield and soil health, while also reducing water use. Working with farmers in selected districts of Punjab, Haryana and western Uttar Pradesh to address behavioural and financial barriers to the uptake of the Happy Seeder, and increase its use from a mere 2000 in a year to at least 50,000 units by 2022.

Partners: The International Maize and Wheat Improvement Center (CIMMYT), Borlaug Institute of South Asia (BISA), Council on Energy, Environment and Water (CEEW), and Tata Trusts.

4. Establishing India's First Water Fund

TNC-India launch India's first such initiative in the Ghod river basin in the Pune district of Maharashtra. The Ghod river originates in the Bhima Shankar Wildlife Sanctuary – home to the endemic giant Malabar squirrel – and is the main source of water for more than 4.5 million people and 200 industries.

Partners: ITC Ltd.

5. Renewable Energy (RE) and Reforestation by Design

To enhance a decision-support tool – DARPAN – already being used by planners to site RE projects, by adding socio-ecological criteria to the selection of RE sites. This will enable planners to avoid lands with high conservation and social values and select degraded lands for setting up RE projects.

Partners: Center for Study of Science, Technology and Policy (C-STEP); and Foundation for Ecological Services (FES)

6. Restoring River Ganga

To develop a framework for evaluating the consequences and trade-off of alternative river management actions on the health of the middle Ganga (Haridwar to Varanasi). With the right commitment and partnerships, and promoting solutions inspired by sound science, India can aspire towards a healthy Ganga.

Partners: Center for Ganga River Basin Management and Studies (CGRBMS), Wildlife Institute of India (WII), National Mission for Clean Ganga (NMCG), WWF-India.

9. BIRDLIFE INTERNATIONAL

- ❖ Birdlife International is a global partnership of conservation organisations (NGOs) that strives to conserve birds, their habitats and global biodiversity, working with people towards sustainability in the use of natural resources.
 - There are 121 Birdlife Partners worldwide – one per country or territory – and growing. Birdlife is widely recognised as the world leader in bird conservation. Rigorous science informed by practical feedback from projects on the ground in important sites and habitats enables us to implement successful conservation programmes for birds and all nature. Our actions are providing both practical and sustainable solutions significantly benefiting nature and people.
 - Each Birdlife Partner is an independent environmental or wildlife not-for-profit, non-governmental organisation (NGO). This **allows each Partner to maintain its individual national identity within the Global Partnership.**
 - **Headquarters:** Cambridge, United Kingdom
 - **Founded:** 1922

- ❖ **Important Bird & Biodiversity Areas (IBAs)** are the sites of international significance for the conservation of the world's birds and other nature as identified by BirdLife. These sites are also all Key Biodiversity Areas, sites that contribute significantly to the global persistence of biodiversity. Initially, IBAs were identified only for terrestrial and freshwater environments, but over the past decade, the IBA process and method has been adapted and applied in the marine realm.

IBAs are:

- Places of international significance for the conservation of birds and other biodiversity
- Recognised world-wide as practical tools for conservation
- Distinct areas amenable to practical conservation action
- Identified using robust, standardised criteria
- Sites that together form part of a wider integrated approach to the conservation and sustainable use of the natural environment

Threats the most threatened IBAs:

This includes shifting cultivation (the main threat), illegal logging, hunting and exploitation of fuel wood. Impoverished local communities depend on forest products for resource. The forests are an important source of products such as firewood, charcoal, construction materials and lianas. Loss and degradation of forests therefore has major implications for livelihoods.

BirdLife supported the development by IUCN of the Key Biodiversity Area (KBA) Standard for identifying sites that contribute significantly to the global persistence of biodiversity: the world's most important sites for nature in terrestrial, freshwater and marine environments

Sites qualify as global KBAs if they meet one or more of 11 criteria, clustered into five categories: threatened biodiversity; geographically restricted biodiversity; ecological integrity; biological processes; and, irreplaceability.

Few important KBA Partnership comprises partners:

- IUCN**
- Conservation International**
- Critical Ecosystem Partnership Fund**
- Global Environment Facility**
- Global Wildlife Conservation**
- WWF**
- BirdLife International**

BNHS

- The Bombay Natural History Society, founded in 1883. Its headquarter situated in Mumbai, India.
- It is one of the largest non-governmental organisations in India engaged in conservation and biodiversity research.
- The BNHS logo is the great hornbill, inspired by a great hornbill named William, who lived on the premises of the Society.
- The BNHS is the partner of BirdLife International in India.

Function of BNHS

- It organizes and conducts nature trails and camps for the general public.
- It has been designated as a 'Scientific and Industrial Research Organisation' by the Department of Science and Technology.
- It sponsors studies in Indian wildlife and conservation, and publishes a four-monthly journal, Journal of the Bombay Natural History Society (JBNHS), as well as a quarterly magazine, Hornbill.

2. CONSERVATION INTERNATIONAL (CI)

- CI is an American non-profit environmental organization headquartered **in Arlington, Virginia**, 1987. Its goal is to protect nature as a source of food, fresh water, livelihoods and a stable climate.
- **Mission:** Building upon a strong foundation of science, partnership and field demonstration, Conservation International empowers societies to responsibly and sustainably care for nature, our global biodiversity, for the well-being of humanity.
- **Vision:** A healthy, prosperous world in which societies are forever committed to caring for and valuing nature, for the long-term benefit of people and all life on Earth.

www.jkchrome.com

CONVENTIONS

I. THE CONVENTION ON BIOLOGICAL DIVERSITY

The Earth's biological resources are vital to humanity's economic and social development. Thus, there is a growing recognition that biological diversity is a global asset of tremendous value to present and future generations. At the same time, the threat to species and ecosystems has never been so great as it is today. Species extinction caused by human activities continues at an alarming rate.

- ❖ In response, the United Nations Environment Programme (UNEP) convened the Ad Hoc Working Group of Experts on Biological Diversity in November 1988 to explore the need for an international convention on biological diversity.
- ❖ By February 1991, the Ad Hoc Working Group had become known as the Intergovernmental Negotiating Committee. Its work culminated on 22 May 1992 with the Nairobi Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity.
- ❖ The Convention was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development (the Rio "Earth Summit").
- ❖ The first session of the Conference of the Parties was scheduled for 28 November – 9 December 1994 in the Bahamas.

The Convention on Biological Diversity was inspired by the world community's growing commitment to sustainable development. It represents a dramatic step forward in 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.

How the Convention on Biological Diversity promotes nature and human well-being?

a) Biodiversity - The Web of Life

- It is the combination of life forms and their interactions with each other and with the rest of the environment that has made Earth a uniquely habitable place for humans. Biodiversity provides a large number of goods and services that sustain our lives.
- Biodiversity also includes genetic differences within each species - for example, between varieties of crops and breeds of livestock. Chromosomes, genes, and DNA-the building blocks of life-determine the uniqueness of each individual and each species.
- Yet another aspect of biodiversity is the variety of ecosystems such as those that occur in deserts, forests, wetlands, mountains, lakes, rivers, and agricultural landscapes. In each ecosystem, living creatures, including humans, form a community, interacting with one another and with the air, water, and soil around them.
- At the 1992 Earth Summit in Rio de Janeiro:
 - The World leaders agreed on a comprehensive strategy for "sustainable development" -- meeting our needs while ensuring that we leave a healthy and viable world for future generations.
 - One of the key agreements adopted at Rio was the Convention on Biological Diversity.

b) An Agreement for Action

- In 1972, the United Nations Conference on the Human Environment (Stockholm) resolved to establish the United Nations Environment Programme (UNEP). Governments signed a number of regional and international agreements to tackle specific issues, such as protecting

wetlands and regulating the international trade in endangered species. For example, an international ban and restrictions on the taking and selling of certain animals and plants have helped to reduce over-harvesting and poaching.

- In addition, many endangered species survive in zoos and botanical gardens, and key ecosystems are preserved through the adoption of protective measures. This means that humans have to learn how to use biological resources in a way that minimizes their depletion. The challenge is to find economic policies that motivate conservation and sustainable use by creating financial incentives for those who would otherwise over-use or damage the resource.
- In 1987, the World Commission on Environment and Development (the Brundtland Commission) concluded that economic development must become less ecologically destructive. In its landmark report, *Our Common Future*, it said that: "Humanity has the ability to make development sustainable-to ensure that it meets needs of the present without compromising the ability of future generations to meet their own needs"
- In 1992, the largest-ever meeting of world leaders took place at the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. An historic set of agreements was signed at the "Earth Summit", including two binding agreements,
 - a. The Convention on Climate Change, which targets industrial and other emissions of greenhouse gases such as carbon dioxide.
 - b. The Convention on Biological Diversity, the first global agreement on the conservation and sustainable use of biological diversity. The biodiversity treaty gained rapid and widespread acceptance. Over 150 governments signed the document at the Rio conference, and since then more than 196 Parties (168 Signatures) to the agreement.
- **The Convention has three main goals:**
 - a. The conservation of biodiversity,
 - b. Sustainable use of the components of biodiversity, and
 - c. Sharing the benefits arising from the commercial and other utilization of genetic resources in a fair and equitable way
- **Few important issues dealt with under the CBD.**
 - It recognizes-for the first time-that the conservation of biological diversity is "a common concern of humankind" and is an integral part of the development process.
 - The agreement covers all ecosystems, species, and genetic resources.
 - It links traditional conservation efforts to the economic goal of using biological resources sustainably.
 - It sets principles for the fair and equitable sharing of the benefits arising from the use of genetic resources, notably those destined for commercial use.
 - It also covers the rapidly expanding field of biotechnology, addressing technology development and transfer, benefit-sharing and biosafety.
 - Importantly, the Convention is legally binding; countries that join it are obliged to implement its provisions.
 - The Convention recognizes that ecosystems, species and genes must be used for the benefit of humans. However, this should be done in a way and at a rate that does not lead to the long-term decline of biological diversity.



JK Chrome

JK Chrome | Employment Portal



Rated No.1 Job Application of India

Sarkari Naukri
Private Jobs
Employment News
Study Material
Notifications



JOBS



NOTIFICATIONS



G.K



STUDY MATERIAL



JK Chrome

jk chrome
Contains ads



www.jkchrome.com | Email : contact@jkchrome.com

- The Convention also offers decision-makers guidance based on the precautionary principle that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat.
- The Convention acknowledges that substantial investments are required to conserve biological diversity. It argues, however, that conservation will bring us significant environmental, economic and social benefits in return.

c) International Action

- The Convention's ultimate authority is the Conference of the Parties (COP), consisting of all governments (and regional economic integration organizations) that have ratified the treaty. The COP can also make amendments to the Convention, create expert advisory bodies, review progress reports by member nations, and collaborate with other international organizations and agreements.
- The Conference of the Parties can rely on expertise and support from several other bodies that are established by the Convention:
 - **The Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA):** The SBSTTA is a committee composed of experts from member governments competent in relevant fields. It plays a key role in making recommendations to the COP on scientific and technical issues.
 - **The Clearing House Mechanism:** This Internet-based network promotes technical and scientific cooperation and the exchange of information.
 - **The Secretariat.** Based in Montreal, it is linked to United Nations Environment Programme. Its main functions are to organize meetings, draft documents, assist member governments in the implementation of the programme of work, coordinate with other international organizations, and collect and disseminate information.
 - In addition, the COP establishes ad hoc committees or mechanisms as it sees fit. For example, it created a Working Group on Biosafety that met from 1996 to 1999 and a Working Group on the knowledge of indigenous and local communities.

Convention-related activities by developing countries are eligible for support from the financial mechanism of the Convention: The Global Environment Facility (GEF). GEF projects, supported by the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP) and the World Bank, help forge international cooperation and finance actions to address four critical threats to the global environment: biodiversity loss, climate change, depletion of the ozone layer and degradation of international waters.

Conference of The Parties (CoP) under CBD

- The convention on biological diversity provides a global legal framework for action on biodiversity. It brings together the Parties in the Conference of the Parties (COP) which is the Convention's governing body that meets every two years, or as needed, to review progress in the implementation of the Convention, to adopt programmes of work, to achieve its objectives, and provide policy guidance.
- The COP is assisted by the Subsidiary Body on Scientific, Technical, and Technological Advice (SBSTTA), which is made up of government representatives with expertise in relevant fields, as well as observers from non-Party governments, the scientific community, and other relevant

organizations. SBSTTA is responsible for providing recommendations to the COP on the technical aspects of the implementation of the

- Few important Working Groups are:
 - The Working Group on Access and Benefit-Sharing (ABS) is currently the forum for negotiating an international regime on access and benefit sharing;
 - The Working Group on Protected Areas is guiding and monitoring implementation of the programme of work on protected areas;
 - Open-ended Ad Hoc Intergovernmental Committee (ICNP) for the Nagoya Protocol on ABS was established as an interim governing body for the Nagoya Protocol until the first meeting of the Parties to the Protocol at which time it will cease to exist.

<i>COP</i>	Places and years
1.	Nassau, Bahamas, 1994
2.	Jakarta, Indonesia, 1995
3.	Buenos Aires, Argentina 1996
4.	Bratislava, Slovakia 1998
5.	Nairobi, Kenya 2000
6.	The Hague, Netherlands 2002
7.	Kuala Lumpur, Malaysia 2004
8.	Curitiba, Brazil 2006
9.	Bonn, Germany 2008
10.	Nagoya, Aichi Prefecture 2010
11.	Hyderabad, India 2012
12.	PyeongChang, Republic of Korea 2014
13.	Cancun, Mexico 2016

Figure: list of COPs

Meetings of the Conference of the Parties

- The Fourteenth meeting of the Conference of the Parties (COP 14) will be held in Sharm El-Sheikh, Egypt, 17 - 29 November 2018.
- Important decisions at COP-14:
 - a. Parties adopted the Voluntary Guidelines for the design and effective implementation of ecosystem-based approaches to climate change adaptation and disaster risk reduction.
 - b. Governments also agreed to accelerate action to achieve the Aichi Biodiversity Targets, agreed in 2010, from now until 2020. Work to achieve these targets will take place at the global, regional, national and subnational levels.

Protocols under CBD

I. Nagoya protocol

- What is the Nagoya Protocol and what is its objective?
 - The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity is a supplementary agreement to the Convention on Biological Diversity.

- It provides a transparent legal framework for the effective implementation of one of the three objectives of the CBD: the fair and equitable sharing of benefits arising out of the utilization of genetic resources.
- The Nagoya Protocol on ABS was adopted on 29 October 2010 in Nagoya, Japan and entered into force on 12 October 2014.

- Why is the Nagoya Protocol important?
 - The Nagoya Protocol will create greater legal certainty and transparency for both providers and users of genetic resources by
 - Establishing more predictable conditions for access to genetic resources.
 - Helping to ensure benefit-sharing when genetic resources leave the country providing the genetic resources

- What does the Nagoya Protocol cover?
 - The Nagoya Protocol applies to genetic resources that are covered by the CBD, and to the benefits arising from their utilization.
 - The Nagoya Protocol also covers traditional knowledge (TK) associated with genetic resources that are covered by the CBD and the benefits arising from its utilization.

- What are the core obligations of the Nagoya Protocol with respect to genetic resources?
 - The Nagoya Protocol sets out core obligations for its contracting Parties to take measures in relation to access to genetic resources, benefit-sharing and compliance.
 - **Access obligations**
 - Domestic-level access measures are to:
 - Create legal certainty, clarity and transparency
 - Provide fair and non-arbitrary rules and procedures
 - Establish clear rules and procedures for prior informed consent and mutually agreed terms
 - Provide for issuance of a permit or equivalent when access is granted
 - Create conditions to promote and encourage research contributing to biodiversity conservation and sustainable use
 - Pay due regard to cases of present or imminent emergencies that threaten human, animal or plant health
 - Consider the importance of genetic resources for food and agriculture for food security
 - **Benefit-sharing obligations**
 - Domestic-level benefit-sharing measures are to provide for the fair and equitable sharing of benefits arising from the utilization of genetic resources with the contracting party providing genetic resources.
 - Utilization includes research and development on the genetic or biochemical composition of genetic resources, as well as subsequent applications and commercialization.
 - Sharing is subject to mutually agreed terms. Benefits may be monetary or non-monetary such as royalties and the sharing of research results.

➤ **Compliance obligations**

Contracting Parties are to:

- Take measures providing that genetic resources utilized within their jurisdiction have been accessed in accordance with prior informed consent, and that mutually agreed terms have been established, as required by another contracting party
 - Cooperate in cases of alleged violation of another contracting party's requirements
 - Encourage contractual provisions on dispute resolution in mutually agreed terms
 - Ensure an opportunity is available to seek recourse under their legal systems when disputes arise from mutually agreed terms
 - Take measures regarding access to justice
 - Take measures to monitor the utilization of genetic resources after they leave a country including by designating effective checkpoints at any stage of the value-chain: research, development, innovation, pre-commercialization or commercialization
- How does the Nagoya Protocol address traditional knowledge associated with genetic resources and genetic resources held by indigenous and local communities?
 - The Nagoya Protocol addresses traditional knowledge associated with genetic resources with provisions on access, benefit-sharing and compliance.
 - It also addresses genetic resources where indigenous and local communities have the established right to grant access to them.
 - Contracting Parties are to take measures to ensure these communities' prior informed consent, and fair and equitable benefit-sharing, keeping in mind community laws and procedures as well as customary use and exchange.

Note: States and regional economic integration organizations that are Parties to the Convention on Biological Diversity are eligible to become a Party to the Nagoya Protocol.

II. The Cartagena Protocol

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international treaty governing the movements of living modified organisms (LMOs) resulting from modern biotechnology from one country to another. It was adopted on 29 January 2000 as a supplementary agreement to the Convention on Biological Diversity and entered into force on 11 September 2003.

- The Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology.
- It establishes an advance informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory.
- The Protocol also establishes a Biosafety Clearing-House to facilitate the exchange of information on living modified organisms and to assist countries in the implementation of the Protocol.
- The ICCP Process: The Intergovernmental Committee for the Cartagena Protocol on Biosafety (ICCP) was established in adopting the Cartagena Protocol on Biosafety, to undertake the preparations necessary for the first meeting of the Parties to the Protocol.

International Day for 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.
- When first created by the Second Committee of the UN General Assembly in late 1993, 29 December (the date of entry into force of the Convention of Biological Diversity), was designated The International Day for Biological Diversity.
- In December 2000, the UN General Assembly adopted 22 May as IDB, to commemorate the adoption of the text of the Convention on 22 May 1992 by the Nairobi Final Act of the Conference
- Themes
 - a. **2019 - Our Biodiversity, Our Food, Our Health**
 - b. **2018 - Celebrating 25 Years of Action for Biodiversity**

Strategic Goals and The Aichi Biodiversity Targets

The new plan consists of five strategic goals, including twenty Aichi Biodiversity Targets.

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use.

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services.

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

Aichi Biodiversity			SDG	Aichi Biodiversity			SDG
Goal	Target		score	Goal	Target		score
A. Addressing the underlying causes of loss	1 Understand values		😊	C. Improve the status	11 Protected areas		😞
	2 Mainstream biodiversity		😊		12 Prevent extinctions		😟
	3 Address incentives		😟		13 Conserve gene pool		😊
	4 Sustainable production		😊		14 Restore ecosystems		😊
B. Reduce the direct pressures	5 Halve rate of loss		😟	D. Enhance the benefits	15 Enhance resilience		😊
	6 Sustainable fisheries		😟		16 Nagoya Protocol		😊
	7 Manage within limits		😊		17 Revise NBSAPs		😞
	8 Reduce pollution		😊	E. Enhance implementation	18 Traditional knowledge		😟
	9 Invasive species		😊		19 Improve knowledge		😊
	10 Minimise reef loss		😊		20 Mobilise resources		😊

Figure: Aichi Goals and Targets

To build support and create momentum for this urgent task, the United Nations General Assembly at its 65th session declared the period 2011-2020 to be the “United Nations Decade on Biodiversity, with a view to contributing to the implementation of the Strategic Plan for Biodiversity for the period 2011-2020”

National Biodiversity Strategies and Action Plans (NBSAPs)

According to Article 6 of the Convention on General Measures for Conservation and Sustainable Use states that each Contracting Party shall, in accordance with its particular conditions and capabilities:

- (a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned.
- (b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

2. UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD)

- The United Nations Convention to Combat Desertification (UNCCD) is the sole legally binding international agreement linking environment and development to sustainable land management.
- **Established in 1994**
- **Location:** Paris, France; New York, United States.
- The UNCCD published the **Global Land Outlook (GLO)**:
 - The premise of the Global Land Outlook (GLO) is that land, and its associated resources such as soil, water, and biodiversity, comprise a relatively fixed stock of natural capital.
 - The GLO focus on a positive narrative and provide a clear set of responses to optimize land use, management, and planning, and thereby create synergies among different sectors in the provision of land-based goods and services.
- The new UNCCD 2018-2030 Strategic Framework is the most comprehensive global commitment to achieve Land Degradation Neutrality (LDN) in order to restore the productivity of vast expanses of degraded land, improve the livelihoods of more than 1.3 billion people, and reduce the impacts of drought on vulnerable populations.
- The Convention addresses specifically the arid, semi-arid and dry sub-humid areas, known as the drylands, where some of the most vulnerable ecosystems and peoples can be found.
- The Convention's 197 parties work together to improve the living conditions for people in drylands, to maintain and restore land and soil productivity, and to mitigate the effects of drought.
- The UNCCD is particularly committed to a bottom-up approach, encouraging the participation of local people in combating desertification and land degradation.

As the dynamics of land, climate and biodiversity are intimately connected, the UNCCD collaborates closely with the other two Rio Conventions; the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC), to meet these complex challenges with an integrated approach and the best possible use of natural resources.

2.1. COP

- The COP was established by the Convention as the supreme decision-making body; it comprises ratifying governments and regional economic integration organizations, such as the European Union.

- One of the main functions of the COP is to review reports submitted by the Parties detailing how they are carrying out their commitments; the COP makes recommendations on the basis of these reports

2.2. Land Degradation Neutrality

- Land Degradation Neutrality (LDN) has been defined by the Parties to the Convention as:
- **A state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems.**
- It is a unique approach that counterbalances the expected loss of productive land with the recovery of degraded areas. It strategically places the measures to conserve, sustainably manage and restore land in the context of land use planning.
- The land is fixed in quantity, there is ever-increasing competition to control land resources and capitalize on the flows of goods and services from the land. This has the potential to cause social and political instability, fueling poverty, conflict and migration. For that reason, the implementation of LDN requires multi-stakeholder engagement and planning across scales and sectors, supported by national-scale coordination that utilizes existing local and regional governance structures.
- UNCCD and the UN Environment Programme (UN Environment) came together to mark the United Nations General Assembly adoption of the "2030 Agenda for Sustainable Development".
- India will restore 26 million hectares of degraded land by 2030, more than its earlier target of 21 million hectares, Prime Minister Narendra Modi said at a UN conference to combat desertification.

In 2007, the UN General Assembly declared 2010-2020 **The United Nations Decade for Deserts and the fight against Desertification**. The purpose of the Decade is to mobilize global action to fight land degradation, promote sustainable management of land resources and ensure long-term ability of drylands to support the livelihoods of local populations.

The **World Day to Combat Desertification (WDCD)** is observed every year on 17 June to promote public awareness of international efforts to combat desertification. The day is a unique moment to remind everyone that land degradation neutrality (LDN) is achievable through problem solving, strong community involvement and co-operation at all levels. The Day was declared by the United Nations General Assembly in 1995.

COP14: 2-13 September New Delhi, India

The Conference adopted the Delhi Declaration in which parties expressed commitment for a range of issues, including gender and health, ecosystem restoration, taking action on climate change, private sector engagement, Peace Forest Initiative and recovery of 26 million hectares of degraded land in India.

The New Delhi Declaration: Investing in Land and Unlocking Opportunities

1. Encourage the development of community-driven transformative projects and programmes that are gender-responsive, at local, national and regional level, to drive the implementation of the Convention;
2. Also encourage, in the context of projects aimed at combating desertification/land degradation and drought and achieving land degradation neutrality and resilience-building, inter alia and as appropriate, the transition and increased access to energy in rural and urban communities, within the scope of the UNCCD;

3. Promote opportunities that support, as appropriate and applicable, the long-term goals of the Paris Agreement and the development of an ambitious post-2020 global biodiversity framework, taking into consideration land-based solutions for climate action and biodiversity conservation and the mutually supportive implementation of the three Rio conventions;
4. Welcome the United Nations Decade on Ecosystem Restoration (2021–2030), commit to adopting an integrated, best-practice approach to land restoration based on scientific evidence and traditional knowledge that offers hope to vulnerable communities and invite Parties, observers and other relevant UNCCD stakeholders, including the private sector, to accelerate and scale up relevant initiatives at all levels;
5. Take note of the benefits brought to participating countries by the accelerated implementation of initiatives that support a transformative narrative in the Sahel through, inter alia, the Great Green Wall of the Sahara and the Sahel Initiative and the Initiative on Sustainability, Stability and Security;
6. Also take note of the launch of the Peace Forest Initiative and its potential contribution to increasing cooperation on land degradation neutrality, including land restoration and reforestation in transborder areas in participating countries, where appropriate;
7. Reaffirm the relevance of the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security for better access, control and stewardship over land and equitable tenure security, in accordance with relevant national legislation, for the implementation of the Convention and the promotion of sustainable land management;
8. Encourage local governments to adopt integrated land use management and enhanced land governance to rehabilitate the natural resource base that makes cities sustainable, taking into consideration the New Urban Agenda, including by reducing rates of land consumption and soil sealing along with biodiversity and ecosystem loss;

2.3. The Drought Initiative

The Conference of the Parties (COP) at its thirteenth Meeting (COP13) in Ordos China, requested the Secretariat and appropriate UNCCD institutions and bodies including the Science-Policy Interface to implement the Drought Initiative during the 2018-19 biennium. The new initiative focuses on:

- Drought preparedness systems
- Regional efforts to reduce drought vulnerability and risk; and
- A toolbox to boost the resilience of people and ecosystems to drought

Indian efforts to mitigate concerns over desertification, land degradation and drought problems.

- **Rashtriya Krishi Vikas Yojana' (Ministry of Agriculture)**
- **Pradhan Mantri Krishi Sinchayee Yojana' (Ministry of Water Resources)**
- **Deen Dayal Antyodaya Yojana - National Rural Livelihoods Mission (Ministry of Rural Development).**
- **Deen Dayal Upadhyay Grameen Kaushalya Yojana**
- **Integrated Watershed Management Programme (Ministry of Rural Development),**
- **Swacchh Bharat Mission.**
- **National Mission for a Green India.**
- **National Afforestation Programme (Ministry of Environment, Forest and Climate Change)**

2.4. The Land for Life Programme

Tackling the land issue can help achieve many Sustainable Development Goals (SDGs). Globally, nearly two billion hectares of land – twice the size of China – can be restored and rehabilitated. To restore degraded land to its productive state, significant attention must be drawn to achieving land degradation neutrality (LDN). The Land for Life Programme was launched at the tenth UNCCD Conference of the Parties (COP10) in 2011 in the Republic of Korea as part of the Changwon Initiative. The Programme seeks to address the challenges of land degradation, desertification and mitigation of drought.

The Changwon Initiative intends to complement activities being undertaken in line with The Strategy and in accordance with COP 10 decisions.

The main components of the Changwon Initiative include:

1. enhancing the scientific process of the UNCCD,
2. mobilizing additional resources and facilitating partnership arrangements, and
3. supporting a global framework for the promotion of best practices.

The Land for Life Programme is involved in a variety of awareness-raising and knowledge support activities to provide information and sensitize the public about the importance of land for their life and for achieving the SDGs by 2030. These activities include:

- Promoting LDN
- Highlighting SLM success stories and the achievements of Land for Life Award winners
- Promoting public outreach activities such as:
 - Producing educational videos
 - Holding photo contests
 - Sharing and disseminating knowledge
 - Conducting media trainings
 - Organizing campaigns and e-Forums

3. THE RAMSAR CONVENTION

The Convention on Wetlands, called the Ramsar Convention, is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources.

- The Convention was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975. Since then, almost 90% of UN member states, from all the world's geographic regions, have acceded to become "Contracting Parties".

Wetlands are among the most diverse and productive ecosystems. They provide essential services and supply all our fresh water. However, they continue to be degraded and converted to other uses.

- The Convention uses a broad definition of wetlands. It includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans.
- Under the "three pillars" of the Convention, the Contracting Parties commit to:
 - a. work towards the wise use of all their wetlands;
 - b. designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and ensure their effective management;
 - c. cooperate internationally on transboundary wetlands, shared wetland systems and shared species.

World Wetlands Day is celebrated every year on 2 February. This day marks the date of the adoption of the Convention on Wetlands on 2 February 1971, in the Iranian city of Ramsar on the shores of the Caspian Sea.

The Montreux Record

- It is a register of wetland sites on the List of Ramsar wetlands of international importance where ecological changes occurred, or are likely to occur as a result of technological developments, pollution or other man-made interference.
- It is a voluntary process to highlight specific wetlands of international importance that are facing immediate challenges.
- In India, there are two sites in Montreux record:
 1. Loktak lake, Manipur.
 2. Keoladeo national park, Rajasthan.

Wetlands for The Future

Since 1997, the Secretariat of the Convention on Wetlands (Ramsar, Iran, 1971), the United States State Department, and the United States Fish and Wildlife Service have operated a special initiative, the Wetlands for the Future (WFF) training programme, to benefit Latin American and the Caribbean institutions and individuals through capacity building and training in the conservation and wise use of wetlands.

This initiative promotes the implementation of the concept of "wise use" of wetlands through strengthening the capacity of countries to manage their wetland resources in perpetuity and contributing to integrate wetland conservation and management with the development process.



Figure: List of the wetlands in India

4. BASEL CONVENTION

- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 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.
- 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.
- Its adoption was to combat the “toxic trade”. 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

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

Few key provisions.

- In all cases where transboundary movement is not, prohibited, it may take place only if it represents an environmentally sound solution.
- Based on the concept of prior informed consent, it requires that, before an export may take place, the authorities of the State of export notify the authorities of the prospective States of import and transit, providing them with detailed information on the intended movement.
- The movement may only proceed if and when all States concerned have given their written consent. The Basel Convention also provides for cooperation between parties, ranging from exchange of information on issues relevant to the implementation of the Convention to technical assistance, particularly to developing countries.
- The Convention also provides for the establishment of regional or sub-regional centres for training and technology transfers regarding the management of hazardous wastes and other wastes and the minimization of their generation to cater to the specific needs of different regions and subregions.

The **Cartagena Declaration** on the Prevention, Minimization and Recovery of Hazardous Wastes and Other Wastes, adopted on the occasion of the tenth meeting of the Conference of the Parties, sets forth a strong commitment by the Parties to the Basel Convention to promote the prevention and minimization of the generation of hazardous and other wastes.

5. ROTTERDAM CONVENTION

The Rotterdam Convention was adopted on 10 September 1998 in Rotterdam, the Netherlands. The Convention entered into force on 24 February 2004.

It is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans.

The objectives of the Convention are:

- a. To promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm.
- b. To contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

The Mechanisms

To achieve its objectives the Convention includes two key provisions, namely the Prior Informed Consent (PIC) Procedure and Information Exchange.

1. **The Prior Informed Consent (PIC) procedure** – The PIC procedure is a mechanism for formally obtaining and disseminating the decisions of importing Parties as to whether they wish to receive future shipments of those chemicals listed in Annex III of the Convention and for ensuring compliance with these decisions by exporting Parties.
2. **Information Exchange** - The Convention facilitates information exchange among Parties for a very broad range of potentially hazardous chemicals. The Convention requires each Party to notify the Secretariat when taking a domestic regulatory action to ban or severely restrict a chemical.

Few key provisions:

- The chemicals listed in Annex III include pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by two or more Parties and which the Conference of the Parties has decided to subject to the PIC procedure.
- There is a total of 52 chemicals listed in Annex III, 35 pesticides (including 3 severely hazardous pesticide formulations), 16 industrial chemicals, and 1 chemical in both the pesticide and the industrial chemical categories.
- Once a chemical is included in Annex III, a "decision guidance document" (DGD) containing information concerning the chemical and the regulatory decisions to ban or severely restrict the chemical for health or environmental reasons, is circulated to all Parties.
- Parties have nine months to prepare a response concerning the future import of the chemical. The response can consist of either a final decision (to allow import of the chemical, not to allow import, or to allow import subject to specified conditions) or an interim response. Decisions by an importing country must be trade neutral (that is, decisions must apply equally to domestic production for domestic use as well as to imports from any source).

6. STOCKHOLM CONVENTION

The Stockholm Convention on Persistent Organic Pollutants was adopted by the Conference of Plenipotentiaries on 22 May 2001 in Stockholm, Sweden. The Convention entered into force on 17 May 2004.

- The Stockholm Convention on Persistent Organic Pollutants is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of humans and wildlife, and have harmful impacts on human health or on the environment.
- Exposure to Persistent Organic Pollutants (POPs) can lead to serious health effects including certain cancers, birth defects, dysfunctional immune and reproductive systems, greater susceptibility to disease and damages to the central and peripheral nervous systems.

Persistent Organic Pollutants (POPs) are organic chemical substances, that is, they are carbon-based. They possess a particular combination of physical and chemical properties such that, once released into the environment, they:

- remain intact for exceptionally long periods of time (many years);
- become widely distributed throughout the environment as a result of natural processes involving soil, water and, most notably, air;
- accumulate in the fatty tissue of living organisms including humans, and are found at higher concentrations at higher levels in the food chain; and
- are toxic to both humans and wildlife.

Main provisions

- a. Prohibit and/or eliminate the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex A to the Convention.
- b. **Annex A** allows for the registration of specific exemptions for the production or use of listed POPs.
- c. The import and export of chemicals listed in Annex A can take place under specific restrictive conditions.
- d. Restrict the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex B to the Convention
- e. Annex B allows for the registration of acceptable purposes for the production and use of the listed POPs, in accordance with that Annex, and for the registration of specific exemptions for the production and use of the listed POPs.
- f. Reduce or eliminate releases from unintentionally produced POPs that are listed in Annex C to the Convention.
- g. The Convention promotes the use of best available techniques and best environmental practices for preventing releases of POPs into the environment.
- h. Ensure that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner
- i. The Convention requires that such stockpiles and wastes be identified and managed to reduce or eliminate POPs releases from these sources. The Convention also requires that wastes containing POPs are transported across international boundaries taking into account relevant international rules, standards and guidelines.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

TABLE OF CONTENT 1. Introduction 2. Kyoto protocol 3. COPs	Syllabus: Environment GS-III
--	---

I. INTRODUCTION

- The UNFCCC entered into force on 21 March 1994. The 195 countries that have ratified the Convention are called Parties to the Convention (Almost universal Membership).
- The UNFCCC is a "Rio Convention", one of three adopted at the "Rio Earth Summit" in 1992. Others are the UN Convention on Biological Diversity and the Convention to Combat Desertification.
- Objective of UNFCCC: The ultimate objective of the Convention is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."
- the COP-1 was held in Berlin, COP-2 in Geneva, and the COP-3 was held in Kyoto to adopt "Kyoto Protocol", which implemented the objective of the UNFCCC to fight global warming by reducing greenhouse gas concentrations in the atmosphere to 'a level that would prevent dangerous anthropogenic interference with the climate system'

2. KYOTO PROTOCOL

Kyoto Protocol: The Kyoto Protocol commits its signatories by setting internationally binding emission reduction targets.

- The Kyoto Protocol was adopted in Kyoto, Japan, in 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords."
- Its first commitment period started in 2008 and ended in 2012.
- Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."
- When no Protocol exists, the global CO₂ emission in 2010 will increase by 24% compared with 1990. When the Protocol is enforced in 2000, the global CO₂ emission in 2010 will reduce by 5.2% compared with 1990.

Parties to the Kyoto protocol are classified as:

Annex I	Parties to the UNFCCC listed in Annex I of the Convention. These are the industrialized (developed) countries and "economies in transition" (EITs). EITs are the former centrally-planned (Soviet) economies of Russia and Eastern Europe. The European Union-15 (EU-15) is also an Annex I Party.
----------------	--

Annex II	<p>Parties to the UNFCCC listed in Annex II of the Convention. Annex II Parties are made up of members of the Organization for Economic Cooperation and Development (OECD). Annex II Parties are required to provide financial and technical support to the EITs and developing countries to assist them in reducing their greenhouse gas emissions (climate change mitigation) and manage the impacts of climate change (climate change adaptation).</p> <p>Annex B: Parties listed in Annex B of the Kyoto Protocol are Annex I Parties with first or second round Kyoto greenhouse gas emissions targets.</p> <p>Non-Annex I: Parties to the UNFCCC not listed in Annex I of the Convention are mostly low-income developing countries. Developing countries may volunteer to become Annex I countries when they are sufficiently developed.</p> <p>Least-developed countries (LDCs): 49 Parties are LDCs, and are given special status under the treaty in view of their limited capacity to adapt to the effects of climate change.</p>
-----------------	--

- Industrialized countries (Annex I) have to report regularly on their climate change policies and measures, including issues governed by the Kyoto Protocol (for countries which have ratified it).
- They must also submit an annual inventory of their greenhouse gas emissions, including data for their base year (1990) and all the years since
- **Developing countries (Non-Annex I Parties)** report in more general terms on their actions both to address climate change and to adapt to its impacts - but less regularly than Annex I Parties do, and their reporting is contingent on their getting funding for the preparation of the reports, particularly in the case of the Least Developed Countries.

2.1. Kyoto Mechanisms

- **Emission Trading:** Emissions Trading-mechanism allows parties to the Kyoto Protocol to buy 'Kyoto units' (emission permits for greenhouse gas) from other countries to help meet their domestic emission reduction targets.
- **Joint Implementation:** Any Annex I country can invest in emission reduction projects (referred to as "Joint Implementation Projects") in any other Annex I country as an alternative to reducing emissions domestically.
- **Clean Development Mechanism (CDM):** Countries can meet their domestic emission reduction targets by buying greenhouse gas reduction units from (projects in) non-Annex I countries to the Kyoto protocol.
- **Kyoto Units:** The emissions trading can be international or domestic. Under the International Emissions Trading (IET), the countries can trade in the international carbon credit market to cover their shortfall in Assigned amount units. Countries with surplus units can sell them to countries that are exceeding their emission targets under Annex B of the Kyoto Protocol.

Certified Emission Reductions (CERs): Certified Emission Reductions are one of the types of the Kyoto Units. They are issued under the Clean Development Mechanism. The Annex-I countries can use the CERs to comply with their emission limitation targets or by operators of installations covered by the European Union Emission Trading Scheme (EU ETS) in order to comply with their obligations to surrender EU Allowances, CERs or Emission Reduction Units (ERUs) for the CO₂ emissions of their installations. The Government and Private entities can hold the CERs on electronic accounts with the UN.

Doha Amendment to the Kyoto Protocol

In Doha, Qatar, on 8 December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020.
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period.
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.
 - In Durban (2011), the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) was established to develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention, applicable to all Parties. The ADP is to complete its work as early as possible, but no later than 2015, in order to adopt this protocol, legal instrument or agreed outcome with legal force at the twenty-first session of the Conference of the Parties and for it to come into effect and be implemented from 2020.

3. CONFERENCE OF PARTIES

Conference of parties to the Kyoto Protocol

<i>Conferences</i>	<i>Outcome/Breakthrough</i>
COP 16: 16th session of the Conference of the Parties (COP 16) to the UNFCCC and the 6th session of the CMP 6 to the Kyoto Protocol was held in Cancun, Mexico in 2010.	<ul style="list-style-type: none"> • Called for a large "Green Climate Fund", and a "Climate Technology Centre" and network. • It looked forward to a second commitment period for the Kyoto Protocol. • The agreement recognizes that climate change represents an urgent and potentially irreversible threat to human societies and the planet, which needs to be urgently addressed by all parties.
COP 17: 17th session of the Conference of the Parties (COP 17) to the UNFCCC and the 7th session of the CMP 7 to the Kyoto Protocol was held in Durban, South Africa in 2011.	<ul style="list-style-type: none"> • The conference led to agreement on a management framework for a future Green Climate Fund. The fund is to distribute US\$100bn per year to help poor countries adapt to climate impacts. • The design of the new Green Climate Fund for developing countries was completed through a decision on its governance and other practical arrangements. This opens the way for the Fund to become operational in 2012. • The conference decided that the second commitment period will start on 1 January 2013 and run until 2017 or 2020. The end date and the emission targets for developed countries taking part will be fixed at the UN climate conference to be held at the end of 2012 in Qatar.
COP 18: 18th session of the Conference of the Parties (COP 18) to the UNFCCC and the 8th	<ul style="list-style-type: none"> • Doha finalised details of the second Kyoto period and agreed a work plan for negotiations on the new global agreement and on raising ambition under the Durban Platform.

<p>session of the CMP 8 to the Kyoto Protocol was held at the Qatar National Convention Centre in Doha in 2012.</p>	<ul style="list-style-type: none"> the Technology Mechanism established in Cancun by agreeing the governance arrangements for the Technology Executive Committee and a Climate Technology Centre and Network;
<p>COP 19: 19th session of the Conference of the Parties (COP 19) to the UNFCCC and the 9th session of the CMP 9 to the Kyoto Protocol was held in Warsaw, Poland in 2013</p>	<ul style="list-style-type: none"> The Warsaw conference agreed a time plan for countries to table their contributions to reducing or limiting greenhouse gas emissions under the new global climate agreement in 2015. It also agreed ways to accelerate efforts to deepen emission cuts over the rest of this decade, and to set up a mechanism to address losses and damage caused by climate change in vulnerable developing countries. The conference agreed decisions which enhance the implementation of a range of measures already agreed, including climate finance, REDD+, and transparency of reporting on emissions.
<p>COP-20, Lima, Peru</p>	<ul style="list-style-type: none"> Nations concluded by elaborating the elements of the new agreement, scheduled to be agreed in Paris in late 2015, while also agreeing the ground rules on how all countries can submit contributions to the new agreement during the first quarter of next year. These Intended Nationally Determined Contributions (INDCs) will form the foundation for climate action post 2020 when the new agreement is set to come into effect. Pledges were made by both developed and developing countries prior to and during the COP that took the capitalization of the new Green Climate Fund (GCF) past an initial \$10 billion target. Levels of transparency and confidence-building reached new heights as several industrialized countries submitted themselves to questioning about their emissions targets under a new process called a Multilateral Assessment The Lima Ministerial Declaration on Education and Awareness-raising calls on governments to put climate change into school curricula and climate awareness into national development plans.

THE PARIS AGREEMENT COP-21

- The Paris Agreement will enter into force on the 30th day after the date on which **at least 55 countries accounting for at least 55% of the total global greenhouse gas emissions** ratify it.
- The agreement aims to reduce emissions of greenhouse gases, the cause of global warming and consequent climate change, and do it fast enough to **keep the average global temperature from rising above 2°, possibly 1.5°C compared to pre-industrial times.**
- The agreement will come into force 2020 onwards.
- will replace the Kyoto Protocol**, an existing international agreement on climate change that was finalised in 1997.

- Paris Agreement is ambitious
 - resolves to hold global temperature rise to well below 2°C above pre-industrial levels
 - pursue efforts towards a 1.5° C temp. limit.

Provisions of Paris Agreement

- A **binding obligation** to submit mitigation contributions **every 5 years** and to pursue domestic measures to achieve them.
- For every 5-year cycle, states must put forward contributions **more ambitious than their last**.
- In addition, the agreement envisages a “**global stocktake**” **every 5 years to assess collective progress towards long-term goals**.
 - The global stocktake will also take into account “**equity**” (so CBDR also protected) — thus paving the way for conversation on burden-sharing between nations.
- The Paris Agreement requires **developed countries to raise finances with \$100 billion per year** as the floor by 2020, to help developing nations in both mitigation and adaptation activities, while other nations are encouraged to provide funding voluntarily.
- The first global evaluation of the implementation of the Paris Agreement is to take place in 2023, and thereafter every five years to help all countries.

BONN CONFERENCE (COP23): The “Rule Book” and Talanoa Dialogue

- The key agenda of the Bonn conference was to **chalk out the Rule Book**.
- If Paris agreement was constitution, the Rule Book would serve as laws and regulations to implement it towards achieving the goal of Paris Agreement i.e. to limit the Earth’s temperature rise to a maximum of 2°C.
- In the Bonn summit, it was decided that the negotiators will keep working for one year and finalize the rule book by December 2018.
- It is expected that the Rule Book shall be adopted at COP-24 at Katowice (Poland) in December, 2018.
- To ensure that this happens, CoP24 host Poland has decided to work with CoP23 host Fiji and past host Morocco. This year long process has been called **Talanoa Dialogue**.
- Thus, Talanoa dialogue is a **year long process that allows countries to assess their progress on past climate actions** (stocktaking) and **define the way forward** to implement the legally binding Paris Agreement.

KATOWICE: 24TH MEETING OF THE CONFERENCE OF THE PARTIES (COP24) TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE.

What was expected:

- The summit aimed to **establish guidelines for implementing and reporting on the Paris Agreement**.
- Countries were looking to **establish an enhanced transparency framework to monitor, verify and report** actions taken in a **systematic, standardised manner**.
- Transparency — what would be done to reduce emissions, how countries would measure and report progress, and how much support industrialised countries would provide — was an important aspect of the discussions.
 - This will inform stocktaking of progress on the Paris Agreement and how much more is needed to cut emissions and raise ambition.
- **Funds were also required from rich countries** for the losses and damages borne by poor nations.

- **Technology transfer and capacity building support** are also issues of importance to vulnerable countries and poor, developing countries that need help to transition from high to low carbon economies.

Outcome:

- While there was some progress on **the process by which the Paris Agreement of 2015 would be implemented**, key issues of concern for the poorest and developing nations were diluted or postponed.
- The **1.5 Degree Report**, which was produced by the **Intergovernmental Panel on Climate Change** in October 2018, showed that the **earth is close to a climate catastrophe**.
- There is **little to no finance available for poor and developing nations**.
- The **details on funding and building capacity have been postponed**.
- Article 9 (the provision of financial support to developing countries from industrialised nations) was ignored; instead, there was an **emphasis on carbon markets and insurance mechanisms**.
- In spite of these problems, **a single rulebook for all countries has been produced and will serve as a foundation for more detailed rules and structures**.

Global Alliance to Power Past Coal:

- In the recent Bonn summit, it was **launched by Canada and the UK**.
 - Canada has returned as a proactive nation pushing climate change agenda.
 - With US taking a backseat, Canada might be looking for a leadership role.
- This is a programme to **phase out coal usage in energy production**.
- Immediately, more than 20 countries, including France, Finland, and Mexico have become the part of this initiative.
- It brings together a wide range of businesses and civil society organizations that have united for climate protection.

'Momentum for Change' initiative:

- **An initiative spearheaded by the UN Climate Change secretariat** to shine a light on the enormous groundswell of activities underway across the globe that are moving the world toward a highly resilient, low-carbon future.
- It recognizes innovative and transformative solutions that address both climate change and wider economic, social and environmental challenges.

The 25th edition of the **Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)** or COP25 held in **Madrid (Spain)**.

Agenda for COP25

- The main objective of the COP-25 is to complete the rule-book to the 2015 Paris Agreement that will become effective in 2020 to replace the 1997 Kyoto Protocol (comes to an end in 2020).
- Finding solution for issues like the creation of new carbon markets, emission reduction targets, country's individual targets, etc. remained unresolved during COP24 at Katowice (Poland) 2019.
- The COP-25 also discussed the functioning of international emissions trading systems, compensation for poor countries to deal with rising sea levels and other consequences of climate change.

- ❑ It COP also considered the **Emissions Gap Report**, produced by the **UN Environment Programme (UNEP)** and the **series of reports from the Intergovernmental Panel on Climate Change (IPCC)**.
 - IPCC reports summarise that the goal of keeping average temperatures within 1.5°C from pre-industrial times is “**on the brink of becoming impossible.**” As the **overall emissions are still increasing** worldwide.
- ❑ The processes and methods of reporting information about climate change would be fixed during the summit. Specifically, the **developing countries** will try to ensure that there are greater **appreciation and recognition** of the **issue of loss and damage** due to climate change.

Why CoP25 failed?

- The failure of the talks underlined starkly the massive gap between what scientists say the world’s nations need to do on climate change, and what the most powerful political leaders on the planet are prepared to even discuss.
- According to scientist, talks focused on some of the rules for implementing the 2015 Paris agreement, but the overriding issue of how fast the world needs to cut greenhouse gas emissions has received little official attention.
- Countries agreed in Paris in 2015 to revisit their climate pledges by 2020. But many countries were pushing this year for a clear call for all countries to submit more ambitious climate pledges next year.
- But countries such as China and Brazil opposed placing any obligation on countries to submit enhanced pledges next year, arguing it should be each country’s own decision. They instead argued the focus should be on pre-2020 action by developing countries to meet their previous pledges
- There was a recognition that tougher carbon targets are needed globally, but few countries came up with any and the resolve to come back next year with more ambitious plans was worded too weakly to satisfy most campaigners.

India’s stance:

- India played a mixed role at the recently concluded 25th Conference of Parties (CoP 25) to the United Nations Framework Convention on Climate Change at Madrid.
- On the question of markets, India emphasised the transition of the Clean Development Mechanism (CDM) credits earned under the Kyoto Protocol to the Paris Agreement.
- Pointed out that that excessively cheap emissions reductions enabled by the CDM as well as the possibility of double counting could corrupt the process.
- India played a strong role in critiquing the developed world’s continuing poor record on climate action.
- It argued that unless a stocktaking exercise of the fulfilment of various pre-2020 commitments by developed countries, India would not raise its climate ambition for its next round of Paris Agreement targets due in 2020.
- India also took a lead in calling for more finance for developing countries for climate action, (*“not even 2 per cent” of the promised “\$1 trillion in the last 10 years” had been delivered*)

ENVIRONMENTAL LAWS



ENVIRONMENT RELATED LAWS

INDEX

1. **Wildlife (Protection) Act, 1972**
2. **Water (Prevention and Control of Pollution) Act, 1974**
3. **Forests (Conservation) Act, 1980**
4. **Air (Prevention and Control of Pollution) Act, 1981**
5. **Environment Protection Act, 1986**
6. **Biodiversity Act, 2002**

1. WILDLIFE (PROTECTION) ACT, 1972

Wildlife Act, a landmark in the history, was enacted for providing protection to wild animals and birds.

From State to Concurrent subject: Wildlife was transferred from State list to concurrent list in 1976, thus giving powers to the Central government to enact legislation.

Salient features of WPA-1972.

1. **Clear definitions:**
It clearly defines the wild-life related terminology.
2. **Appointments:**
It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.
3. **Exhaustive list of Indian wildlife:**
The endangered wild life species was done for the first time and prohibition of hunting of the endangered species was mentioned.
 - ❖ some endangered plants like Beddome cycad, Blue Vanda, Ladies Slipper Orchid, Pitcher plant etc
 - ❖ some animals are – Tiger, Sangai deer, Dugong, great Indian bustard.
4. **Institutions**
 - ❖ The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.
 - ❖ The constitution of Central Zoo Authority.
 - ❖ The Act also provides the constitution of Indian Board of Wildlife (IBWL)
 - ❖ It also sets up **National Tiger Conservation Authority**.
5. **Wildlife trade and protection**
 - ❖ There are few provisions for trade and commerce in some wildlife species with license for sale, possession, transfer etc.
 - ❖ The Act imposes a ban on the trade or commerce in scheduled animals.
 - ❖ It provides for legal powers to officers and punishment to offenders.
 - ❖ It provides for captive breeding programme for endangered species.

Why was this act passed?

- ❖ The rapid decline of India's wildlife population needs legal protection from activities such as poaching, smuggling, etc which is cause of grave concern.

- ❖ The Wild Birds and Animals Protection Act, 1935 had become completely outdated.
- ❖ The existing laws not only had become outdated but also provide punishments, which were not commensurate with the offence and financial benefits that occurred from poaching and trade in wildlife produce.

Five kinds of protected areas can be notified in the Act. These are:

- **Sanctuaries:**
 - The State or Central Government may by notification declare its intention to constitute any area as a sanctuary for protecting wildlife and the environment.
 - The government determines the nature and extent of rights of persons in or over the land within the sanctuary.
- **National Parks:**
 - The State or Central Government may declare an area, whether inside a sanctuary or not, as a national park for the purpose of protecting and developing wildlife and its environment.
 - The State Government **cannot** alter the boundaries of a national park except on the recommendation of the National Board for Wildlife.
 - **No grazing or any other human activities** is allowed inside a national park.

National parks in India:

- Protected under category II of IUCN.
- India's first national park was established in 1936 as Hailey National Park (Jim Corbett National Park), Uttarakhand.
- In 1970, there are only five national parks.
- After 1972, India enacted the Wildlife Protection Act and Project Tiger to safeguard the habitats of conservation reliant species
- At present, there are 104 NPs in India
- Kuno NP is the newest one

Project Tiger and National Tiger Conservation Authority (NTCA)

- **Project Tiger was launched in 1973** with 9 tiger reserves for conserving our national animal, the tiger. Currently, the **Project Tiger coverage has increased to 50**, spread out in 18 tiger range states.
- Environment Minister is the Chairman of the NTCA.
- Jim Corbett National Park is the oldest national park in India and was established in 1936 as Hailey National Park to protect the endangered Bengal tiger. It became the tiger in 1973.
- The TRs in India are Orang (Assam) and Kamlang (Arunachal Pradesh).
- The tiger reserves are constituted on a **core/buffer strategy**. The **core areas have the legal status** of a national park or a sanctuary, whereas the buffer or peripheral areas are a mix of forest and non-forest land, managed as a multiple use area.
- It is an ongoing Centrally Sponsored Scheme of the Ministry of Environment, Forests and Climate Change providing central assistance to the tiger States for tiger conservation in designated tiger reserves.

- The National Tiger Conservation Authority (NTCA) is a statutory body of the Ministry, with an overarching supervisory/coordination role, performing functions as provided in the Wildlife (Protection) Act, 1972.
- The NTCA was launched in 2005, following the recommendations of the Tiger Task Force. It was given statutory status by 2006 amendment of Wildlife (Protection) Act, 1972.

M-STrIPES (Monitoring System for Tigers - Intensive Protection and Ecological Status) is an app-based monitoring system. The system would enable field officers to assist intensity and spatial coverage of patrols in a geographic information system (GIS) domain.

- All provisions applicable to a sanctuary are also applicable to a national park.
- **Tiger reserves**
 - These areas were reserved for protection tiger in the country.
 - The **State Government** on the recommendation of the Tiger Conservation Authority may notify an area as a tiger reserve, for which it has to prepare a Tiger Conservation Plan.

Conservation reserves and community reserves

- These protected areas act as buffer zones and migration corridors between established national parks, wildlife sanctuaries and reserved and protected forests of India.
- These protected area categories were first introduced in the Wildlife (Protection) Amendment Act of 2003.

<i>Conservation reserves</i>	<i>Community Reserves</i>
<ul style="list-style-type: none"> ➤ The State Government after consultations with local communities can declare any area owned by the Government, especially areas adjacent to national parks or sanctuaries, as conservation reserves. ➤ The government can constitute conservation reserve Management Committee to manage and conserve the conservation reserve. ➤ 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. ➤ Such reserves administered through local people and local agencies like the <i>gram panchayat</i>. 	<ul style="list-style-type: none"> ➤ The State Government after having consultation with the community or an individual who have volunteered to conserve wildlife declare any private or community land as community reserve. ➤ A Community Reserve Management Committee shall be constituted by State Government for conserving and managing the reserve. ➤ 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.

Schedules in WPA-1972

- ❖ **Schedule I and II** - these are the most vital sections of the act.
 - This section covers animals which are in the category of endangered species.
 - The sections in this schedule give absolute protection to certain species and these cannot be infringed on any account.
 - The animals can only be hunted if they are dangerous to human or diseased or disabled.
 - Any violation is a punishable offence, the famous actor Salman Khan was sentenced to 5 years rigorous imprisonment for shooting a black buck in Rajasthan.
 - The case is under appeal in the high court. In addition, 16 persons have been convicted and sentenced to various terms of prison up to 7 years for killing a tiger.
- ❖ **Schedule III and IV.**
 - These also have roughly the same provisions of Section I and II, but cover animals that are not in danger of becoming extinct or endangered, required equal protection.
 - The penalties under this section are also less than Schedule I and II.
- ❖ **Schedule V**
 - This include the list of vermin animals-mice, common crow, monkey, pigs, bats, etc
 - For this purpose, the hunter has to apply for a license to the District Forest Officer who will allow a hunter to shoot during a specific season and restricted area. Any infringement can lead to cancellation of the hunting license.
- ❖ **Schedule VI**
 - It concerns with the cultivation and plant life and gives teeth to setting up more protected animal parks.

What are Vermins?

- Vermin means wild mammals and birds which are harmful to crops, farm animals or which carry disease.
- In India, wild animals can be declared as vermin if they have become (i) dangerous to human life or property (including standing crops on any land). (ii) become disabled or diseased as to be beyond recovery.
- The Central Government through notification may declare any wild animal other than those specified in Schedule I and part II of Schedule H of the law to be vermin for any area for a given period of time.
- The hunted wildlife is declared as government property and it imposes restrictions on how these carcasses must be disposed of.
- Currently, some animals like the common crow, fruit bats, mice and rats have been listed as vermin in Schedule V of WPA.
- The Union Ministry of Environment, Forest and Climate Change (MoEFCC) has declared Wild Pig as vermin in Uttarakhand and the Monkey as Vermin in Himachal Pradesh for the period of one year for a year.

Drawbacks of the Wildlife (Protection) Act, 1972:

- ❖ It seems that the Act has been enacted just as a fallout of Stockholm Conference held in 1972.
- ❖ **Loop holes:** e.g. The personal ownership certificates for animal articles (tiger, leopard skins etc.) are permissible which very often serve as a tool for illegal trading.
- ❖ **J&K exception:** The Wildlife traders in Jammu and Kashmir easily get illegal furs and skins from other states which after being made into caps, belts etc. are sold to other countries. This is so happening because J and K has its own Wildlife Act and it does not follow the Central Wildlife Act. Moreover,

hunting and trading of several endangered species prohibited in other states are allowed in J and K, thereby opening avenues for illegal trading in such animals.

- ❖ **Bias towards fauna** There is little emphasis on protection of plant genetic resources.
- ❖ **Poor deterrence :**
 - The offender of the Act is not subject to very harsh penalties. It is just up to 3 years imprisonment or a fine of Rs. 25000 or both.
 - Conviction rate is as low as of 2% for crime related to wildlife.
 - Lack of control mechanism in international border and transport facility.
- ❖ **Lack of skilled people**
 - Due to lack of specialization, police and customs officers are not able to recognize tiger bones, which are exported with a different label.
 - Authorities are not highly sensitive towards animal welfare and the seriousness of the crime.

<i>Schedule-I Mammals</i>			
1. Binturong	12. Hoolock gibbon	23. Marbled cat	33. Snow leopard
2. Black Duck	13. Indian lion	24. Markhor	34. Spotted linsang
3. Brow-antlered deer	14. Indian Wild Ass	25. Musk deer	35. Swamp deer
4. Caracal	15. Indian Wolf	26. Ovis Ammon or Nyan	36. Mishmi Takin
5. Cheetah	16. Kashmir Stage	27. Pallas's cat	37. Tibetan Gazelle
6. Clouded leopard	17. Leopard cat	28. Pangolin	38. Tibetan Wild Ass
7. Dugong	18. Lesser or Red panda	29. Pygmy hog	39. Tiger
8. Fishing Cat	19. Lion-tailed macaque	30. Rhinoceros	40. Urial or Shapu
9. Golden Cat	20. Loris	31. Rusty spotted cat	41. Wild buffalo
10. Golden langur	21. Lynx	32. Slow Loris	
11. Hispid hare	22. Malabar Civet		

<i>Before WPA-1972</i>	<i>After WPA-1972</i>
<ul style="list-style-type: none"> ❖ Number of rhinoceros only 75 in 1905. ❖ Only 5 national parks. ❖ In 1971, 1800 tigers were present in Indian subcontinent (in 1971 Delhi High court banned tiger hunting). 	<ul style="list-style-type: none"> ❖ Now it is 3550 in India and Nepal. ❖ Today it has grown to 110 (July, 2018). ❖ The number of tigers was 2,226 in 2014.

2. WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

The Act defined terms like pollution, sewage effluent, trade effluent, stream and boards.

The salient features and provisions of the Act are summed up as follows:

- The Act provides for maintenance and restoration of quality of all types of surface and ground water.
- **Controlling bodies:** It provides for the establishment of Central and State Boards for pollution control.
- **Functions:** The Act assigns powers and functions to these Boards to control pollution.
- **Authority to board:** The Central and State Pollution Control Boards are given comprehensive powers to advise, coordinate and provide technical assistance for prevention and control of water pollution.
- **Audit:** The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards.

- **Prohibition:** The Act prohibits disposal of any poisonous, noxious or polluting matter to the flow of water in a stream. However, dumping of any material into a stream for the purpose of reclamation of land is not considered an offence.
- **Penalties:** The Act provides for severe and deterrent punishments for violation of the Act which includes fine and imprisonment.

The Water (Prevention and Control of Pollution) Cess Act, 1977:

- To empowers the Central Water Board to collect cess on water consumed by persons, industries, etc.
- The cess and the consent fees from the major sources of revenue to run the Central and State Water Boards.
- The Act has been amended in 1991 to provide rebate to the industries for complying with the consumption and effluent quality standard.

Technical Difficulties in Controlling Water Pollution:

- The Water Cess Act was passed to meet the expenses of the Central and State Boards yet the Water Board has no power to take direct action against the erring party.
- The procedures are time consuming often prevent quick and preventive action thereby defeating the sole purpose of the Act.

Functions of Central Pollution Control Board (CPCB):

- **Advisory body:** CPCB advises the Central government in matters related to prevention and control of water pollution.
- **Assist State boards:** Coordinates activities of State Pollution Control Boards and provides them technical assistance and guidance.
- **Awareness:** Organizes comprehensive programmes on pollution related issues through mass media.
- **Quality measures:** Lays down standards for water quality parameters.
- **Information dissemination:** Collects, compiles and publishes technical and statistical data related to pollution.
- **Guidelines:** Prepares manuals for treatment and disposal of sewage and trade effluents.
- **Labs:** Establishes laboratories for analysis of water, sewage or trade effluent samples.

National Air Quality Index (AQI)

The AQI values and corresponding ambient concentrations (health breakpoints) as well as associated likely health impacts for the identified eight pollutants are as follows:

Ambient Air Quality Standards in India

The Air (Prevention and Control of Pollution) Act 1981 was enacted by the Central Government with the objective of arresting the deterioration of air quality.

The current National Ambient Air Quality Standards were notified on 18 November 2009 by the Central Pollution Control Board.

Air Quality Index (AQI)

Launched by the Environment Ministry, under 'Swachh Bharat'

- ❖ **Colour coded:** AQI act as 'One Number-One Colour-One Description' to judge the Air Quality for Common Man to judge the air quality within his vicinity
- ❖ Central Pollution Control Board along with State Pollution Control Boards has been operating National Air Monitoring Program (NAMP) covering 240 cities of the country.

<p>List of 12 pollutants</p> <ul style="list-style-type: none"> ● Particulate Matter (size less than 10 μm) or (PM_{10}), ● Particulate Matter (size less than 2.5 μm) or ($\text{PM}_{2.5}$), ● Nitrogen Dioxide (NO_2), ● Sulphur Dioxide (SO_2), ● Carbon Monoxide (CO), ● Ozone (O_3), ● Ammonia (NH_3), and ● Lead (Pb) ● Benzene - C_6H_6 ● Benzo(a)Pyrene (BaP) ● Arsenic (As) ● Nickel (Ni) 	<ul style="list-style-type: none"> ❖ Real time monitoring: Continuous monitoring systems that provide data on near real-time basis are also installed in a few cities. ❖ AQI categories: There are six AQI categories- Good, Satisfactory, Moderately polluted, Poor, Very Poor, and Severe. ❖ List of 8 pollutants: for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed. <ul style="list-style-type: none"> ● Particulate Matter (size less than 10 μm) or (PM_{10}), ● Particulate Matter (size less than 2.5 μm) or ($\text{PM}_{2.5}$), ● Nitrogen Dioxide (NO_2), ● Sulphur Dioxide (SO_2), ● Carbon Monoxide (CO), ● Ozone (O_3), ● Ammonia (NH_3), and ● Lead (Pb)
--	---

3. FORESTS (CONSERVATION) ACT, 1980

Features:

Forest (Conservation) Act was enacted for providing a higher level of protection to forests and to regulate diversion of forest lands for non-forestry purposes.

- **Clear Definition:** The term “forest land” mentioned in the Act refers to reserved forest, protected forest or any area recorded as forest in the government records. The term “tree” will have the same meaning as defined in the Indian Forest Act 1927.
- **Wide coverage:** The act extends to whole of India except state of Jammu and Kashmir (J&K).
- **Strong Regulation:** As per the Forest (Conservation) Act, 1980 Prior permission of the Central Government is essential for De-reservation/ Diversion of forest land for non-forestry purposes.
- **Control deforestation:** The Act has made ample provisions to check deforestation and encourage afforestation of non-forest areas.
- **Promote afforestation:** This act put certain conditions on user(s) that need to deposit required amount to undertake compensatory afforestation for mitigate negative impact of forest land diversion.

The amended Act (1988) prohibits lease of forest land to anybody other than the government. It enhances conservation, plantation and increase of forest cover to an average of 30%.

Amended Forest Act, 1992:

- **Infrastructure is allowed:** The Act made provision for allowing some non-forest activities in forests without cutting trees with prior approval of Central government. These activities include setting of transmission lines, seismic surveys, exploration, drilling and hydroelectric projects.
- **Total ban deforestation:** Wildlife sanctuaries, National Parks etc. are totally prohibited for any exploration or survey without prior approval of Central government even if no tree felling is involved.
- **More crops under NFA:** Cultivation of tea, coffee, spices, rubber, mulberry for rearing silk worms and cash crops are included under non-forestry activities and are not allowed in reserve forests.
- **Mining:** Mining is a non-forestry activity and prior approval of Central government is mandatory.
- Environmental Impact Statement.

Even cultivation of fruit bearing trees, oil yielding plants or medicinal plants in the forest area need to be first approved to maintain the balance in the ecology of the forest.

Drawbacks of the Forest (Conservation) Act:

- This Act has just transferred the powers from States to Centres to decide the conversion of reserve forest lands to non-forest areas. Thus, powers have been centralized at the top.
- The Act has failed to attract public support because it has infringed upon the human rights of the poor native people.
- Very marginal participation of the poor community in the Act remains one of the major drawbacks which affects proper execution of the Act.
- Forest dwelling tribal communities have a rich knowledge about the forest resources, their values and conservation. But their role and contribution are neither acknowledged nor honoured
- Efforts are now being made to make up for gaps in laws by introducing the principles of Public trust or Human rights protection.

4. AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

Air pollution is defined as the presence of any liquid or gaseous substances in the atmosphere in such a concentration which tends to be injurious to man, animals, plants or environment.

The Air Act was passed under Article 253 of the Constitution of India and in pursuance of decisions of Stockholm Conference.

- **Objective:** to provide means for the prevention, control and abatement of air pollution in order to preserve the quality of air.
- **Define terms:** such as air pollution, air pollutants, vehicular exhausts and industrial plants etc.
- The Act also includes automobiles, diesel vehicles, transport, railways and domestic fuels.
- **Demarcate high pollution areas:** The Act provides the declaration of certain heavily polluted areas as Air pollution control area and no industrial plant shall be operated in these areas without prior consent of the State Pollution Control Board.
- **Pollution boards duties :** The Central and State Water Boards have been entrusted with the task of controlling and preventing air pollution. The State Boards have to lay down and enforce standards for prevention and control of air pollution.

- **Emission control:** The State Government and the respective Board(s) may give instructions to the concerned Authority in-charge for Registrations under the Motor Vehicles Act, 1939, to ensure emission standards for automobiles. Failure to comply with the conditions prescribed for this purpose is punishable with fine and imprisonment.
- **Penalty on polluter:** The State Boards have powers to sue a polluter in a court of law to punish him for polluting the air and the expenses incurred by the Board will be recovered from the polluter.
- **Noise as pollution :** The Act also includes noise under the category of air pollutants in 1987.

5. ENVIRONMENT PROTECTION ACT, 1986

The Act empowers the Central Government to make following rules for the first time for:

- Standard of quality of air, water and soil for various areas and for various purposes.
- Maximum permissible limits of concentration for various environmental pollutants (including noise) for different areas.
- Procedures and safeguards for handling of hazardous substances.
- Prohibition and restrictions on the location of industries and carrying out operations.
- Procedures and safeguards for prevention of accidents which may cause environmental pollution and
- Providing for remedial measures in case of accidents.

The Environment Protection Act, 1986 was enacted as per the spirit of the Stockholm Conference (1972), to take appropriate steps for the protection and improvement of the environment and to prevent hazards to human beings, living creatures and property.

Salient Features of the Act:

- EPA provide a single focus in the country for the protection of environment and to plug the loop holes in the earlier laws.
- The Act ensures enforcement of several Acts/Regulations concerning pollution control.
- EPA is an umbrella legislation which provides a framework for the coordination of Central and State Governments and authorities established under Water and Air Acts.

This Act confers powers to the Central Government to:

- Take measures that are necessary for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution.
- Issue directions for:
 - the closure, prohibition or regulation of any industry, operation and process and,
 - the stoppage or regulation of the supply of water, power or any other service even without obtaining court orders.
- Empower any person to enter, inspect, take samples and test.
- Establish environmental laboratories and appoint Government analysts.
- Prohibit industrial emission or discharge of environmental pollutants over and above the limits stipulated by the relevant standards.
- Any person can make a complaint of violation of provisions of the Act to the Central Government or authority or officer authorised for this purpose.

- The Act prescribes stringent penalties to the defaulters for violation of the provisions of the Act.
- The jurisdiction of Civil Court is barred under the Act. Every State has to set up Green Bench Courts to attend to Public Interest Litigation (PIL) cases concerning environmental hazards affecting the quality of life of citizens.

EPA, Rules:

1. Environmental Impact Assessment:

- Under the Environment (Protection) Rules, EIA of 29 specified projects falling under sectors such as Industries, Mining, Irrigation, Power, Transport, Tourism etc., require clearance from Central Government before establishment.
- The project proponent has to provide EIA report, risk analysis report, NOC from State Pollution Control Board, project report, technical information for environmental appraisal of the project, availability of water and electricity and comprehensive rehabilitation plan etc.

2. Biomedical and Hazardous Wastes:

Under the EPA, 1986, the Central Government has also made Biomedical and Hazardous Waste (Management and Handling) Rules, 1989.

3. Environmental Audit:

Every person carrying on any industry or operation requiring consent under the Water Act, 1974 or Air Act, 1981 or hazardous waste rules, 1989 issued under EPA, 1986 shall submit an environmental audit report for each financial year ending 31st March in a prescribed form to the State Pollution Control Board.

The National Forest Policy of 1988

Aim: to ensuring environmental stability and maintenance of ecological balance, which is essential for the sustenance of all life forms - plant, animal, and human.

OBJECTIVES

- Maintenance and restoration of the ecological balance.
- **Protect genetic diversity:** Conservation of the natural heritage and protection of remaining flora and fauna
- **Soil and water conservation:** Checking soil erosion and denudation in the catchment areas of rivers, lakes, reservoirs in the interest of soil and water conservation.
- **Desert conservation:** Checking the extension of sand-dunes in the desert areas of Rajasthan and along the coastal tracts.
- **Green cover:** Increasing the forest/tree cover through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
- **Minor forest produces:** Meeting the requirements of fuel-wood, fodder, minor forest produce, and small timber of rural and tribal populations.
- **Sustainable resource utilisations:** Encouraging the efficient utilization of forest produce and maximizing the substitution of wood. Increasing the productivity of forests to meet the essential national needs.
- **Mass awareness:** Creating a massive people's movement with the involvement of women in achieving these objectives and to minimize the pressure of population on existing forests.

6. BIODIVERSITY ACT, 2002

By following the ideals of, India enacted the Biological Diversity Act in 2002, and notified Biological Diversity Rules in 2004, to give effect to the provisions of this Convention.

- **Three-tiered institutional structure-** at the national, state and local levels.

A. National Biodiversity Authority

Head Office	The National Biodiversity Authority (NBA) has been set up in October, 2003 in Chennai.
Structure	The NBA consists of a Chairperson, five non-official and ten ex-officio members to be appointed by the Central Government to represent various Ministries
Vision of NBA	Conservation and sustainable use of India's rich biodiversity and associated knowledge with people's participation, ensuring the process of benefit sharing for well-being of present and future generations.
Mission of NBA	To ensure effective implementation of Biological Diversity Act, 2002 and the Biological Diversity Rules 2004 for conservation of biodiversity, sustainable use of its components and fair and equitable sharing of benefits arising out of utilization of genetic resources
Powers and Functions of NBA	<ol style="list-style-type: none"> 1. It shall be the duty of the National Biodiversity Authority to regulate activities and by regulations issue guidelines for access to biological resources and for fair and equitable benefit sharing. 2. The National Biodiversity Authority may grant approval for undertaking any activity. 3. The National Biodiversity Authority may advise the Central Government on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of benefits arising out of the utilization of biological resources. 4. The National Biodiversity Authority may advise the State Governments in the selection of areas of biodiversity importance to be notified as heritage sites and measures for the management of such heritage sites. 5. The National Biodiversity Authority may perform such other functions as may be necessary to carry out the provisions of this Act. 6. The National Biodiversity Authority may, on behalf of the Central Government, take any measures necessary to oppose the grant of intellectual property rights in any country outside India on any biological resource obtained from India or knowledge associated with such biological resource which is derived from India.
National Biodiversity Fund	<ol style="list-style-type: none"> 1. Any grants and loans made to the National Biodiversity Authority. 2. All charges and royalties received by the National Biodiversity Authority. 3. All sums received by the National Biodiversity Authority from such other sources as may be decided upon by the Central Government.

B. State Biodiversity Boards

	The State Biodiversity Boards (SBBs) constituted by the State Governments deal with all matters relating to access by Indians for commercial purposes.
Function	<ol style="list-style-type: none"> 1. The State Biodiversity Boards (SBB'S) have the function of advising the State Government on matters of biodiversity and its equitable distribution 2. To the guidelines of the Central Government but more importantly to regulate granting of approvals or requests for commercial utilization of biological resources. 3. The State Boards require a prior intimation for obtaining biological resources only from Indian citizens or corporate associations or organizations registered in India. 4. This power of the State Biodiversity Boards which is applicable only on Indian citizens or organizations can be easily exploited by vested interests of commercial giants which have substantial overseas shareholders.
State Biodiversity Board	<p>The Biodiversity Act provides for payment of a prescribed fee to the Biodiversity Management Committees established at the Municipal or Panchayat level under "Access and Benefit Sharing "by companies who are using biological resources or use traditionally available knowledge which is often a bone of contention between companies and these Boards as they possess the power to grant them access to bio-resources of the State.</p> <p>Since the grant of approval by the State Boards is only restricted to Indian companies and organizations the tactic of employing commission agents to get this approval is widely used for commercial exploitation as approval from the National Biodiversity Authority implies a cumbersome process requiring strict adherence to established regulations.</p>
State Biodiversity Fund	<p>Constitution of State Biodiversity Fund:</p> <ol style="list-style-type: none"> 1. There shall be constituted a Fund to be called the State Biodiversity Fund and there shall be credited to- 2. Any grants or loans made by the National Biodiversity Authority; 3. All sums received by the State Biodiversity Board from such other sources as may be decided upon by the State Government.

C. Biodiversity Management Committee

	The local bodies are required to set up Biodiversity Management Committees (BMCs) in their respective areas for conservation, sustainable use, documentation of biodiversity and chronicling of knowledge related to biodiversity.
Structure	<p>The BMC will be constituted by :</p> <ul style="list-style-type: none"> ● PRIs/ULBs ● members of the Participatory forest/natural resources management committees' members,

	<ul style="list-style-type: none"> members of horticulture/foot botanists/tribal heads, etc., based on the local conditions.
Functions of BMCs	<ol style="list-style-type: none"> Conservation and sustainable utilization of biological resources. Eco-restoration of the local biodiversity. Proper feedback to the SBB in the matter of IPR, Traditional Knowledge and local Biodiversity issues, wherever feasible and essential feedback to be provided to the NBA. Management of Heritage Sites including Heritage Trees, Animals/Microorganisms etc., and Sacred Groves and Sacred Water bodies. Regulation of access to the biological resources and/ or associated Traditional Knowledge, for commercial and research purposes. Sharing of usufructs arising out of commercial use of bio-resources. Conservation of traditional varieties/breeds of economically important plants/animals. Biodiversity Education and Awareness building. Documentation, enable procedure to develop bio-cultural protocols. Sustainable Use and Benefit Sharing. Protection of Traditional Knowledge.
People's Biodiversity Register (PBR)	This shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them.

ENVIRONMENTAL POLLUTION



ENVIRONMENTAL POLLUTION

- **Environmental pollution** means reduction of environmental quality in a region caused exclusively by human activities, for example, piling up garbage in hill station areas whereas **environmental degradation** means lowering of environmental quality at local, regional and global scales by both natural processes and human activities, for example, Plastic wastes rising in Pacific Ocean.
- Since environmental pollution has now become of global concern and there is a growing realization that pollution also creates 'vicious cycle' of poverty. As it causes reduced capacity to earn and diseases which affects the productivity of a person thus causing people to get stuck in the vicious circle of poverty.
- Therefore, a **comprehensive study** of types of pollution, types of pollutants, sources of pollution, causes and processes of pollution, environmental and ecological effects of pollution, measures to deal with them etc. has become necessary for planning futuristic strategies and **comprehensive environmental management plans**.
- It is commonly accepted that pollution is without a doubt, the outcome of urban-industrial, technological revolution and hasty exploitation of natural resources, increased rate of exchange of matter and energy and ever-increasing industrial wastes, urban effluents and apathetic/mismanaged disposal of consumer goods.

A. POLLUTANTS

A pollutant is defined as any form of energy, or matter or action that causes state of disequilibrium from the state of equilibrium in any existing natural ecosystem. Pollutants are those unnecessary materials which are barely degradable and causes harmful effects to the environment.

TYPES OF POLLUTANTS

On the basis of source of genesis	On the basis of visibility	On the basis of their state
<ul style="list-style-type: none"> ● Natural Pollutants e.g.- CO₂, OZONE ● Man-Made Pollutants- NO_x, SO_x, PAN peroxy acetal nitrate etc. 	<ul style="list-style-type: none"> ● Visible Pollutants e.g. E-waste. ● Invisible Pollutants e.g. Suspended Particulate matter, Fine particles of ash, other harmful gases etc. 	<ul style="list-style-type: none"> ● Solid Particulate e.g. Plastic pollution ● Gaseous Particulate- CO₂, NO₂ etc. ● Liquid Particulate- Waste water, chemicals etc.

B. SOURCES OF POLLUTANTS

<p>Natural sources of pollution: This includes volcanic ashes and dusts, undesirable substances brought to the surface due to seismic activities, flood water, etc.</p>	<p>Anthropogenic sources of pollution: This includes</p> <ul style="list-style-type: none"> ● Industrial Source: Industries emits gaseous pollutants like methane, carbon monoxide, sulphur, etc. solid pollutants, waste water, etc.
--	--

	<ul style="list-style-type: none"> • Urban Source: It includes sewage water, plastics, e-waste, solid wastes, etc. • Agricultural Source: This pollution is related to fertilizers, pesticides and insecticides. • Population Source: On an average increase in population of a nation has been positively correlated with pollution.
--	---

C. TYPES OF POLLUTION

On the basis of location of Pollution

<p>Point Pollution: Point pollution is always visible and hence can be easily identified.</p> <p>Example: Discharge of effluents from a drain or pipe into river channel.</p>	<p>Nonpoint Pollution: Pollution of the area from unspecified location. It occurs mostly from agricultural practices. Nonpoint pollution is seldom visible.</p> <p>Example: Chemical fertilizers and pesticides and insecticides used in the agricultural fields.</p>
--	--

I. AIR POLLUTION

- According to the WHO, air pollution is defined as limited to situations in which the outdoor ambient atmosphere contains materials in concentration, which are harmful to the environment and his/her surrounding environment.
- The **nature, dimensions and magnitude of air pollution** depends on a variety of factors such as residence time of pollutants in the atmosphere, sources of pollutants, nature of pollutants, amount of pollutants, etc.
- The **time of pollutants** for which it stays in the atmosphere vary considerably depending upon the **nature of the pollutant**, on **meteorological factors** (amount of moisture, cloudiness, etc.) and on **sink mechanism** (vegetation, water bodies, etc.)

AIR POLLUTANTS	Air pollutant is a material in the air that can have adverse effects on humans and the ecosystem.
Pollutants are classified as	<p>According to their existence in nature,</p> <ul style="list-style-type: none"> • Quantitative Pollutants: These occur in nature and become pollutants when their concentration reaches beyond a threshold level. Example: Carbon dioxide, Nitrogen oxide. • Qualitative Pollutants: These do not occur in nature and are man-made. Example: fungicides, herbicides, DDT etc. <p>According to the form in which they persist after release into the environment</p> <ul style="list-style-type: none"> • Primary pollutants: These persist in the form in which they are added to the environment. Examples: ash from a volcanic eruption,

	<p>carbon monoxide gas from motor vehicle exhausts, Sulphur dioxide released from factories.</p> <ul style="list-style-type: none"> ● Secondary pollutants: These are formed by interaction and reaction among the primary pollutants. They are not emitted directly. Examples: peroxyacetyl nitrate (PAN) is formed by the interaction of nitrogen oxides and hydrocarbons; ground level ozone, etc.
--	---

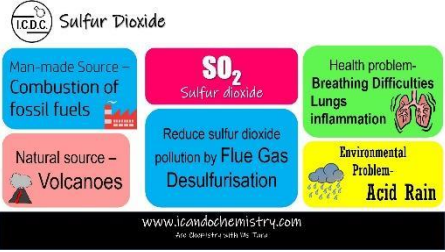
MAJOR AIR POLLUTANTS AND THEIR SOURCES

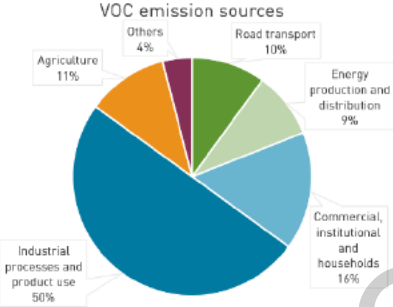
There are 2 types of pollutants

- PRIMARY POLLUTANTS
- SECONDARY POLLUTANTS

<i>POLLUTANTS</i>	<i>SOURCES</i>	<i>EFFECTS/IMPACTS</i>
Carbon Dioxide	<p>Natural Sources: Exhalation through organisms.</p> <ul style="list-style-type: none"> ● Forest fires and volcanoes, hot springs and geysers ● It is freed from carbonate rocks by dissolution in water and acids. ● Carbon dioxide is soluble in water, it occurs naturally in groundwater, rivers and lakes, in ice caps and glaciers and also in seawater. <p>Anthropogenic sources: Burning of fossil fuels (coal, oil and natural gas) for industrial, domestic and transport purposes releases significant, though relatively smaller, amounts.</p>	<p>On Environment It is one of the main "greenhouse gases" contributing to global warming</p> <p>It dissolves in water to form carbonic acid and creates CO₂ which is a major cause of ocean acidification.</p> <p>On Health</p> <ul style="list-style-type: none"> ● At normal environmental concentrations, carbon dioxide has no impacts on human health. ● At extremely high (artificial) concentrations in an enclosed space the reduction in oxygen levels could lead to suffocation. ● CO₂ is an asphyxiant gas. Asphyxia which a condition arising when the body is deprived of oxygen, causing unconsciousness or death.
Carbon Monoxide	<p>Natural Sources:</p> <ul style="list-style-type: none"> ● Worldwide, the largest source of carbon monoxide is natural in origin, due to photochemical reactions in the troposphere. ● It is released into the atmosphere by volcanoes as they erupt, from the smoke of forest fires, from the 	<p>Health effects of CO</p> <ol style="list-style-type: none"> 1. Inhalation of carbon monoxide at high concentrations can be fatal, because it prevents the transport of oxygen (in blood) around the body. 2. It combines with hemoglobin to produce carboxyhemoglobin, which usurps the space in hemoglobin that normally carries oxygen.

	<p>natural gases in coal mines, and even from lightning.</p> <ul style="list-style-type: none"> • Other natural sources of carbon monoxide are marsh gases, which are also called methane and produced by plants decomposing under water, marine algae, kelp and seed germination growth. • Man-made sources include vehicular pollution, crackers, burning of waste etc. 	<p>3. Long-term exposure to lower concentrations (such as through smoking) could harm unborn babies or cause neurological damage</p> <p>Environmental Effects: When carbon monoxide is emitted into the atmosphere it affects the amount of greenhouse gases, which are linked to climate change and global warming. Also land and sea temperature increases changing to ecosystems, increasing storm activity and causing other extreme weather events.</p>
Ozone	<ul style="list-style-type: none"> • Vehicles and industries which are major source of ground-level ozone emissions. • Carbon monoxide, Nitrogen dioxide play a major role in converting O_2 to O_3. • Vegetation can also emit organic chemicals that help form ozone. 	<p>Impact On human health:</p> <ul style="list-style-type: none"> • Ozone can irritate the lining of the nose, airways and lungs. • Makes our eyes itchy, and watery. It lowers our resistance to cold and pneumonia. • People with asthma might have more attacks and athletes might find it harder to perform as well as usual. <p>On Environment: Ozone as a gas is a major pollutant when it is present at surface level otherwise it protects humanity from harmful UV rays.</p>
Sulphur Oxides (SO_x)	<ul style="list-style-type: none"> • Released naturally by volcanic activity and also from forest fires. • Also, from various industrial processes: production of paper and smelting of metals, oil refineries, roasting of sulfide ores such as pyrite, sphalerite, and cinnabar (mercury sulfide) • Burning coal in thermal power plants and diesel fuels. • Reactions involving Hydrogen Sulphide (H_2S) and oxygen. 	<p>Environmental Impacts:</p> <ul style="list-style-type: none"> • It contributes to acid rain : Oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain • It can damage sensitive buildings or monuments, damages vegetation and wildlife and pollutes water bodies • Sulphur dioxide can damage plants and reduce crop yields. • Conversely, its antifungal properties can be beneficial for some plants.

	 <p>The infographic is titled 'Sulfur Dioxide' and features several colored boxes: a blue box for 'Man-made Source - Combustion of fossil fuels', a pink box for 'SO₂ Sulfur dioxide', a green box for 'Health problem - Breathing Difficulties Lungs inflammation' with a lung diagram, a red box for 'Natural source - Volcanoes', a light blue box for 'Reduce sulfur dioxide pollution by Flue Gas Desulfurisation', and a yellow box for 'Environmental Problem - Acid Rain' with a cloud and rain diagram. The website 'www.izandaochemistry.com' is at the bottom.</p>	<p>Health impacts:</p> <ul style="list-style-type: none"> • Sulphur dioxide can irritate the eyes and respiratory system (air passages and lungs). • It also weakens the functioning of certain nerves. <p>Note: Sulphur dioxide pollution contributed to the "great London smog in 1952 which is thought to have contributed to around four thousand premature deaths of people with lung disease or bronchitis.</p>
<p>Nitrogen Oxides (NO_x)</p>	<p>Natural Sources:</p> <ul style="list-style-type: none"> • Produced during thunderstorms by electric discharge. • Natural fires • Also, from microbial processes in soils and water bodies. <p>Anthropogenic Sources:</p> <ul style="list-style-type: none"> • From biomass burning (burning of forest and agricultural lands following harvest) • From the burning of fossil fuels (including vehicle emissions), • Agricultural fertilization and the use of nitrogen fixing plants also contribute to atmospheric NO_x by promoting nitrogen fixation by microorganisms 	<p>Impact on Environment:</p> <ul style="list-style-type: none"> • High levels of nitrogen dioxide and nitrogen monoxide damages plant life. • Nitrogen dioxide contributes to the formation of acid rain which damages vegetation, buildings and water bodies. • Nitrogen dioxide is also involved in the formation of ground level ozone which damages vegetation and other materials. • When NO_x and volatile organic compounds (VOCs) react in the presence of sunlight, they form photochemical smog. • Nitrogen dioxide can react with other air pollutants to form peroxyacetyl nitrates (PANs) which then carry reactive and potentially damaging nitrogen-containing species for long distances. • NO_x emissions cause global cooling through the formation of -OH radicals that destroy methane molecules, countering the effect of greenhouse gases. <p>Impact on human health:</p> <p>Inhalation of higher than average environmental levels of nitrogen dioxide / nitrogen monoxide (found around congested</p>

		<p>urban roads for example) can cause respiratory problems, particularly in sensitive individuals such as asthmatics.</p>														
<p>Volatile Organic Compounds (VOC)</p>	<p>What are they? They are categorized as either methane (CH₄) or non-methane (NMVOCs). Other hydrocarbon VOCs are significant greenhouse gases because of their role in creating ozone and prolonging the life of methane in the atmosphere.</p> <p>Sources-</p>  <table border="1"> <caption>VOC emission sources</caption> <thead> <tr> <th>Source</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Industrial processes and product use</td> <td>50%</td> </tr> <tr> <td>Commercial, institutional and households</td> <td>16%</td> </tr> <tr> <td>Road transport</td> <td>10%</td> </tr> <tr> <td>Agriculture</td> <td>11%</td> </tr> <tr> <td>Energy production and distribution</td> <td>9%</td> </tr> <tr> <td>Others</td> <td>4%</td> </tr> </tbody> </table>	Source	Percentage	Industrial processes and product use	50%	Commercial, institutional and households	16%	Road transport	10%	Agriculture	11%	Energy production and distribution	9%	Others	4%	<p>Impact on human health: Irritation of the eye, nose and throat, headaches, nausea and loss of coordination.</p> <p>Long term impact - suspected to damage the liver and other parts of the body.</p> <p>The aromatic NMVOCs benzene, toluene and xylene which are suspected carcinogens and may lead to leukemia with prolonged exposure.</p>
Source	Percentage															
Industrial processes and product use	50%															
Commercial, institutional and households	16%															
Road transport	10%															
Agriculture	11%															
Energy production and distribution	9%															
Others	4%															
<p>Particulate Matters</p>	<p>What is PM1?</p> <ul style="list-style-type: none"> • Ultrafine particulate matter that are 1 or less microns in diameter. A micron is one/25,000th of an inch <p>Why is it important?</p> <ul style="list-style-type: none"> • The particles are so small that they get deep into the lungs and can enter the blood stream, leading to a range of pollution-related diseases <p>Natural Sources: Some particles occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray.</p> <p>Anthropogenic sources:</p> <ul style="list-style-type: none"> • Burning of fossil fuels in vehicles, power plants • Different Industrial processes 	<p>Impact on Human health:</p> <ul style="list-style-type: none"> • Anthropogenic aerosols—are made by human activities—currently account for approximately 10% of our atmosphere. • Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer. • Particulates are related to respiratory infections and can be particularly harmful to those already suffering from conditions like asthma. • Persistent free radicals connected to airborne fine particles are linked to cardiopulmonary disease. 														
<p>Chlorofluorocarbons (CFCs)</p>	<p>Sources: They are released from</p> <ul style="list-style-type: none"> • Air conditioner • Refrigerators, • Aerosol sprays, etc. 	<ul style="list-style-type: none"> • Environmental & Health impact: On release into the air, CFCs rise to the stratosphere. • When CFC come in contact with other gases and damages the ozone layer. This allows harmful ultraviolet rays to reach the earth's surface. 														

		<ul style="list-style-type: none"> This can lead to skin cancer, eye disease and can even cause damage to plants.
--	--	--

Secondary pollutants:

- Smog is a kind of air pollution. Its types are:

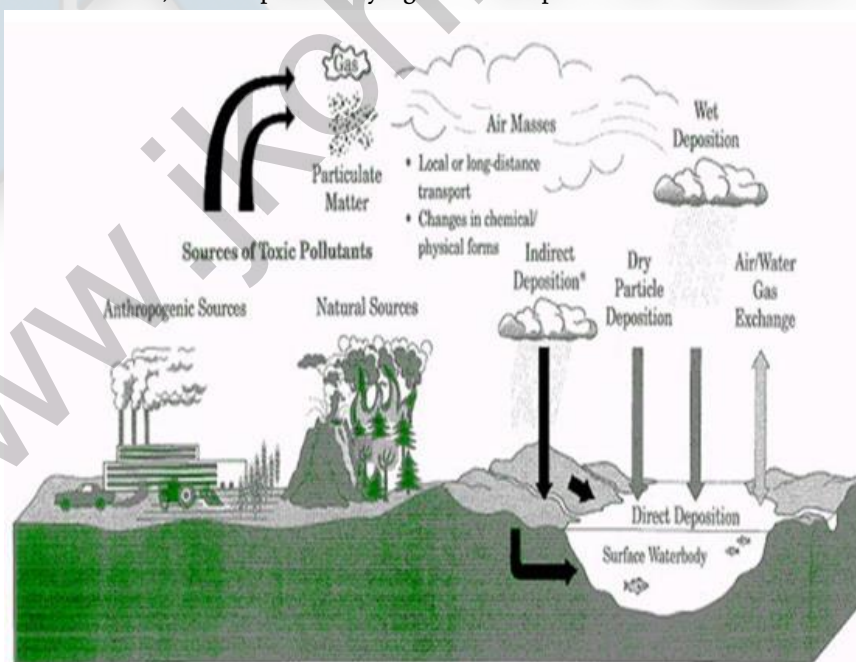
<p>Classic smog results from large amounts of coal burning in an area caused by a mixture of smoke and Sulphur dioxide.</p>	<p>Modern smog does not usually come from coal but from vehicular and industrial emissions that are acted on in the atmosphere by ultraviolet light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.</p>
--	---

- Ground level ozone (O_3) formed from NO_x and VOCs.
- Peroxyacetyl nitrate ($C_2H_3NO_5$) – similarly formed from NO_x and VOCs.

Persistent organic pollutants (POPs)

They are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes.

- Because of this, they have been observed
 - To persist in the environment,
 - To be capable of long-range transport, bioaccumulate in human and animal tissue, biomagnifies in food chains, to have potentially significant impacts on human health and the environment.



Source: Deposition of Air Pollutants to the Great Lakes, First Report to Congress (May 1994)

Dynamics of Persistent Organic Pollutants (POP's) in the Environment

INDOOR AIR POLLUTION

Indoor Air Pollution-Meaning:	<p>If indoor air is contaminated by smoke, chemicals, smells or particles.</p> <p>Unlike outdoor air pollution, the effect of indoor air pollution is health related and less of an environmental issue.</p>
Causes:	<ul style="list-style-type: none"> ● In colder regions, building and heating methods make use of airtight spaces, less ventilation and energy efficient heating. ● Sometimes synthetic building materials, smells from household care and furnishing chemicals can all be trapped indoors. ● As less fresh air gets indoors, the concentration of pollutants such as pollen, tobacco smoke, mold, pesticides, radon, asbestos and carbon monoxide trapped inside the building increases and people breathe in.
Common indoor air pollutants:	<ul style="list-style-type: none"> ● Tobacco smoke: smoke burning cigarettes or exhaled smoke by people smoking. ● Biological Pollutants: These include allergens such as pollen from plants, hair from pets, fungi and some bacteria. ● Radon: This is a gas that is naturally emitted from the ground. Radon can be trapped in basements of buildings and homes. The gas is known to cause cancer after exposure over a period. ● Carbon Monoxide: This is a poisonous gas with no color or smell. Carbon monoxide is produced when fuels such as gas, oil, coal or wood do not burn fully. ● Formaldehyde is a gas that comes mainly from carpets, particle boards, and insulation foam. It causes irritation to the eyes and nose and may cause allergies in some people. ● Asbestos is mainly a concern because it is suspected to cause cancer.
Effects of Indoor Air Pollution on Health	<ul style="list-style-type: none"> ● On the Vulnerable sections About 2 million premature deaths per year, wherein 44% are due to pneumonia, 54% from chronic obstructive pulmonary disease (COPD), and 2% from lung cancer. ● The most affected groups are women and younger children, as they spend maximum time at home. ● The illnesses associated with indoor air pollution are respiratory illnesses, viz., acute respiratory tract infection and COPD, poor perinatal outcomes such as low birth weight and stillbirth, cancer of nasopharynx, larynx, lung, and leukemia. ● The harmful health effects of formaldehyde range from being an acute irritant, reducing vital capacity, causing bronchitis, to being a carcinogen causing leukemia and lung cancer.

ADVERSE EFFECTS OF AIR POLLUTION

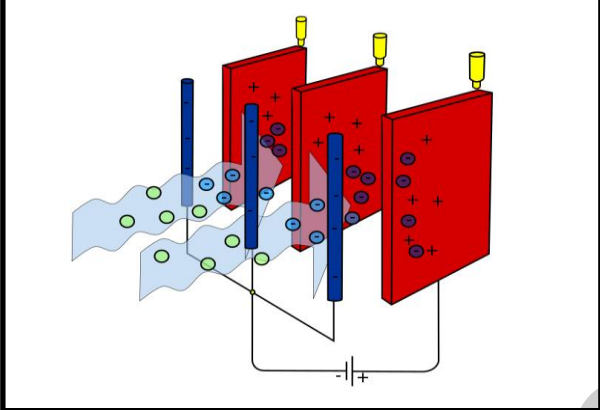

<p>Effects on Weather and Climate</p>	<p>Air pollution changes our planet's climate</p> <ul style="list-style-type: none"> ● Some types cause global warming to speed up. ● Others cause global warming to slow down by creating a temporary cooling effect for a few days or weeks.
<p>Depletion of Ozone</p>	<ul style="list-style-type: none"> ● Chlorofluorocarbons attacked and destroyed the ozone layer, producing holes that would allow dangerous ultraviolet light to stream through. ● In the 1980s, huge "ozone holes" started to appear over Antarctica => prompting countries to unite and sign an international agreement called the Montreal Protocol, which rapidly phased out the use of CFCs. As a result, the ozone layer—though still damaged—is expected to recover by the end of the 21st century.
<p>Greenhouse Gas Effect</p>	<ul style="list-style-type: none"> ● Air pollution includes greenhouse gases. ● Greenhouse gases cause global warming by trapping heat from the Sun in the Earth's atmosphere. ● Some air pollutants slow down global warming <ul style="list-style-type: none"> ○ Cars, trucks, and smokestacks also release tiny particles into the atmosphere which are called aerosols. ○ They can be made of different things such as mineral dust, sulfates, sea salt, or carbon. ○ While different types of aerosols act differently in the atmosphere, the overall effect of aerosols is cooling.
<p>Smog</p>	<ul style="list-style-type: none"> ● Smog is often categorized as being either summer smog or winter smog. <p>Summer smog is primarily associated with the photochemical formation of ozone. - During the summer season when the temperatures are warmer and there is more sunlight present, photochemical smog is the dominant type of smog formation.</p> <p>Winter smog is during the winter months when the temperatures are colder, and atmospheric inversions are common, there is an increase in coal and other fossil fuel usage to heat homes and buildings. These combustion emissions, together with the lack of pollutant dispersion under inversions, characterize winter smog formation.</p> <ul style="list-style-type: none"> ● Smog formation in general relies on both primary and secondary pollutants.
<p>Photochemical Smog</p>	<ul style="list-style-type: none"> ● It is a type of air pollution derived from vehicular emission from internal combustion engines and industrial fumes.

	<ul style="list-style-type: none"> • These pollutants react in the atmosphere with sunlight to form secondary pollutants that also combine with the primary emissions to form photochemical smog. • In certain other cities, such as Delhi, smog severity is often aggravated by stubble burning in neighboring agricultural areas. • The atmospheric pollution levels of Los Angeles, Beijing, Delhi, Lahore, Mexico City, Tehran and other cities are often increased by an inversion that traps pollution close to the ground.
Impact on agriculture	<p>According to a recent study by scientists from IIT Kanpur,</p> <ul style="list-style-type: none"> • Erratic behavior of monsoon rainfall, including phenomenon of concentrated heavy rainfall on small number of days in localized area can be attributed to the rising air pollution, especially the increase in suspended particles in the atmosphere. • An increase in the aerosol content in the atmosphere, a direct consequence of rising air pollution, is interfering with the stable cloud formation system and influencing rainfall patterns. • These changes in cloud structure and cloud dynamics lead to sharp variability in rainfall, the kind of which is being witnessed very often in India in the last few years. • The high pollution levels are not just changing cloud shape and size and depth, but also its microstructure. • Also causes Plant diseases, pollutants get settled on crops/Fruits causing leaching of such pollutants inside fruits.
Acid Rain	<ul style="list-style-type: none"> • When rain falls through polluted air, it can pick up some of the pollution and turn more acidic—producing acid rain. • Air pollution converts the rain into a weak acid. Pollutants like NO_x, SO_x when mixed with rainfall creates acidic rainfall whose PH is less than 4.0. <p>Environmental Impact of Acid Rain:</p> <ul style="list-style-type: none"> • When acid rain accumulates in lakes or rivers, it gradually turns the entire water more acidic. • Fish thrive only in water that is neutral or slightly acidic (typically with a pH of 6.5–7.0). • Once the acidity drops below about pH 6.0, fish soon start to die—and if the pH drops to about 4.0 or less, all the fish will be killed. • It also causes the death of forests, reduces the fertility of soil, and damages buildings by eating away stonework.
	<ul style="list-style-type: none"> • The health effects caused by air pollution may include difficulty in breathing, wheezing, coughing, asthma and worsening of existing respiratory and cardiac conditions. • Mortality: The World Health Organization estimated in 2014 that every year air pollution causes the premature death of some 7 million people worldwide.


<p>Effect on Health of humans, especially vulnerable populations like children, aged people.</p>	<ul style="list-style-type: none"> ● Cardiovascular disease: Air pollution is also emerging as a risk factor for stroke, particularly in developing countries where pollutant levels are highest. ● High numbers of premature deaths: Findings of ‘Know what you breathe’ report released by IIT-Delhi in collaboration with environmental NGO Centre for Environment and Energy Development (CEED) <ul style="list-style-type: none"> ○ Worsening air quality in the last two decades has emerged as one of the major reasons for high numbers of premature (earlier than the expected lifetime of the Indian population) deaths due to chronic exposure from pollution. ○ Annual mortality linked to air pollution to be in the range of 150-300 persons per 1 lakh population. ○ Premature mortality burden would reduce by 14%-28% annually with the achievement of Indian air quality standards. ● Findings of the World Health Organization (WHO) report titled “Inheriting a sustainable world: Atlas on children’s health and the environment” <ul style="list-style-type: none"> ○ Polluted environment kills around 1.7 million children every year. ○ Every year, environmental risks such as outdoor and indoor air pollution, unsafe water, second-hand smoke, lack of sanitation and inadequate hygiene results in a quarter of all global deaths of children under five.
--	---

TECHNOLOGIES AS CONTROL MEASURE

<p>Dust collector</p>	<ul style="list-style-type: none"> ● A dust collector is a system used to enhance the quality of air released from industrial and commercial processes by collecting dust and other impurities from air or gas. ● Five main types of industrial dust collectors are: Inertial separators, Fabric filters, Wet scrubbers, Unit collectors and Electrostatic precipitators
<p>Electrostatic precipitators (ESP)</p>	<ul style="list-style-type: none"> ● It is a filtration device that removes fine particles, like dust and smoke, from a flowing gas using the force of an induced electrostatic charge minimally impeding the flow of gases through the unit. ● In contrast to wet scrubbers which apply energy directly to the flowing fluid medium, an ESP applies energy only to the particulate matter being collected and therefore is very efficient in its consumption of energy (in the form of electricity).

	 <p style="text-align: center;">Fig: Conceptual diagram of an electrostatic precipitator</p>
<p>Catalytic converter</p>	<ul style="list-style-type: none"> ● An exhaust emission control device ● It converts toxic gases and pollutants in exhaust gas from an internal combustion engine into less-toxic pollutants by catalyzing a redox reaction (an oxidation and a reduction reaction).  <p style="text-align: center;">Figure: Picture of catalytic converter</p>
<p>Scrubber systems</p>	<ul style="list-style-type: none"> ● These are a diverse group of air pollution control devices that can be used to remove some particulates and/or gases from industrial exhaust streams. ● Scrubbers are one of the primary devices that control gaseous emissions, especially acid gases. ● Scrubbers can also be used for heat recovery from hot gases by flue-gas condensation. <p>Examples: chemical scrubbers, gas scrubbers</p>
<p>Biofiltration</p>	<ul style="list-style-type: none"> ● A pollution control technique using a bioreactor containing living material to capture and biologically degrade pollutants. ● Common uses include processing wastewater, capturing harmful chemicals or silt from surface runoff, and microbiotic oxidation of contaminants in air.

GOVERNMENT INITIATIVES TO DEAL WITH AIR POLLUTION

<p>National Clean Air Programme (NCAP) 2019</p>	<ul style="list-style-type: none"> The government has formulated NCAP as a medium-term national level strategy to tackle the increasing air pollution problem across the country in a comprehensive manner. <p>Overall objective is:</p> <ul style="list-style-type: none"> To augment and evolve effective ambient air quality monitoring network across the country Ensuring comprehensive management plan for prevention, control and abatement of air pollution. <p>Figure below shows the various details about NCAP</p> 
<p>Technology Assessment Cell</p>	<p>In order to ensure the use of new technologies to combat the rising challenge of air pollution in India, a separate component on ‘Technology Assessment Cell’ has been envisaged under NCAP to evaluate the technologies for prevention, control and abatement of air pollution.</p>
<p>Harit Diwali-Swasth Diwali campaign</p>	<p>Launched by the Union Ministry of Environment, Forests and Climate Change (MoEFCC) aimed to reduce adverse environmental conditions especially pollution in the country after post Diwali celebrations due to excessive bursting of crackers which contributes significantly to air and noise pollution.</p>
<p>Graded Action Plan to reduce Urban Air Pollution 2017</p>	<p>The Government has notified a Graded Response Action Plan for Delhi and NCR. It comprises measures such as</p> <ul style="list-style-type: none"> prohibition on entry of trucks into Delhi; ban on construction activities, introduction of odd and even scheme for private vehicles, shutting of schools, closure of brick kilns, hot mix plants and stone crushers; shutting down of Badarpur power plant, ban on diesel generator sets, garbage burning in landfills and plying of visibly polluting vehicles etc.

SAFAR (System of Air Quality and Weather Forecasting)	<p>It is an integral part of India's first Air Quality Early Warning System operational in Delhi. It will-</p> <ul style="list-style-type: none"> ● It monitors all weather parameters like temperature, rainfall, humidity, wind speed and wind direction. ● It measures sun's UV-Index (UVI), PM1, Mercury and Black carbon in real time ● Measures regular air quality and weather parameters like PM2.5, PM10, Sulfur Dioxide, Ozone, Nitrogen Oxides and CO. ● It provides measurement of online automatic ultrafine particles PM1 and Mercury, both of which have direct relevance to human health. ● Monitors existence harmful pollutants of Benzene, Toluene and Xylene.
National Air Quality Index: an initiative under Swachh Bharat Mission. (2014)	<ul style="list-style-type: none"> ● It is 'One Number- One Color-One Description' for the common man to judge the air quality within his vicinity. ● It will put out real time data about the level of pollutants in the air. ● It takes multiple data on pollution already available with the country's Central Pollution Control Board and presents it as a color-coded scale with six levels. ● Earlier measuring index was limited to 3 indicators, but NAQI has five additional (total 8) parameters. ● AQI will consider 8 pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed.

Major strategies/steps to tackle increasing air pollution in Indian cities and urban areas include

Ambient air quality standards	<ul style="list-style-type: none"> ● Control and mitigation measures related to emissions from automobiles, industrial activities, notification of National Ambient Air Quality Standards; ● Formulation of environmental regulations / statutes; ● Setting up of monitoring network for assessment of ambient air quality;
Alternate source of fuels	<p>Introduction of cleaner / alternate fuels like gaseous fuel (CNG, LPG etc.), ethanol blending; Leapfrogging from BS-IV to BS-VI fuel standards by 1st April, 2020;</p>
Industrial production	<p>Promotion of cleaner production processes; Installation of on-line continuous (24x7) monitoring devices by major industries;</p>
Waste management Rules	<p>Comprehensive amendments to various Waste Management Rules and notification of Construction and Demolition Waste Management Rules.</p>
Eco- friendly habits	<ul style="list-style-type: none"> ● Ban on burning of leaves, biomass, municipal solid waste etc. ● Promotion of public transport and network of metro, e-rickshaws, promotion of carpooling, Pollution Under Control Certificate, lane discipline, vehicle maintenance;
Environment Pollution (Prevention)	<ul style="list-style-type: none"> ● Supreme Court mandated body tasked with taking measures to tackle air pollution in the National Capital Region.

and Control Authority (EPCA)	<ul style="list-style-type: none"> ● It was notified in 1998 by Environment Ministry under Environment Protection Act, 1986. ● Mandate: <ul style="list-style-type: none"> ▪ to protect and improve the quality of environment and prevent and control environmental pollution in the National Capital Region. ▪ to enforce Graded Response Action Plan (GRAP) in NCR as per the pollution levels. ● In November 2017, EPCA had enforced <ul style="list-style-type: none"> ▪ ban on brick kilns, ▪ closure of Badarpur thermal power plant, hot mix plants and stone crushers, and construction activities in NCR.
-------------------------------------	--

CASE STUDY: The Great Smog of Delhi, 2016

- The situation could very well have been like **London's Great Smog of 1952**, which had caused at least 4,000 deaths.
- Levels of **PM2.5 and PM10** particulate matter hit 999 micrograms per cubic meter, while the safe limits for those pollutants are 60 and 100 respectively.
- Although smog can happen in any busy city, it's a particular problem in places **where the local climate (influenced by the ocean and neighboring mountains) regularly causes a 'temperature inversion'**.
 - Normally, air gets colder the higher up you go but in a temperature inversion the opposite happens: a layer of warm air traps a layer of cold air nearer the ground.
 - This acts like a lid over a cloud of smog and stops it from rising and drifting away.
 - Largely because of their traffic levels, smog afflicts many of the world's busiest cities, including Los Angeles, Beijing, Delhi, Madrid, Mexico City, Milan, Paris, and Tokyo.

2. WATER POLLUTION

Water Pollution refers to deterioration of **physical** (such as color, odor, turbidity, taste, temperature), **chemical** (such as acidity, alkalinity, salinity, etc.) and **biological** (presence of bacteria, coliform MPN, algae, etc.) characteristics of water through **natural and anthropogenic processes** to such an extent that it becomes **harmful to human beings, plants and animal communities.**

SOURCES OF WATER POLLUTANTS

<p>Natural Sources: It includes soil erosion, eroded and weathered sediments, landslides, coastal and cliff erosion, volcanic eruptions and decay and decomposition of plants and animals.</p>	<p>Anthropogenic Sources: It includes:</p> <p>Industrial Sources: It includes industrial wastewater that contains chlorides, sulphates, nitrates, mercury, cadmium, arsenic, radioactive substances, etc.</p> <p>Agricultural Sources: It includes chemical fertilizers, pesticides, insecticides and herbicides, etc.</p> <p>Urban Sources: It includes sewage, municipal and domestic garbage, industrial effluents from the industrial units located in the urban centers, fall out of particulate matter of automobile exhausts, etc.</p>
---	---

NATURE OF WATER POLLUTION

- The **nature and intensity of water pollution** is linked with many factors like wastewater disposal and treatment system, hydrological conditions and self-purification capacity of the streams, characteristics of effluents getting discharged and socio-economic conditions of the communities generating the waste.
- The water pollution is assessed on the basis of certain parameters: Physical, chemical and biological parameters.
- **Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO) and pH** values are important indicators of water quality.

Biological oxygen demand (BOD) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period.

Chemical oxygen demand (COD) is an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution. It is commonly expressed in mass of oxygen consumed over volume of solution which in SI units is milligrams per liter (mg/L). A COD test can be used to easily quantify the amount of organics available in water.

BOD vs COD		
	BOD	COD
DEFINITION	A measurement of consumed oxygen by aquatic microorganisms to decompose or oxidize organic matter.	The requirement of dissolved oxygen for the oxidation of organic and inorganic constituents both.
BREAKDOWN OF ORGANIC MATTER	Done by aerobic microorganisms	Done by chemical reagents
COMPLETE BREAKDOWN OF POLLUTANTS	Does not happen	Happens
BREAK DOWNING MATERIALS	Organic matter	Both organic and inorganic constituents
STRONG OXIDIZING REAGENTS	No	Yes
TIME	Takes few days approximately five days.	Takes only a few hours to complete.
VALUE	Lower than COD	Higher than BOD

Figure shows: Biological Oxygen Demand (BOD) vs. Chemical Oxygen Demand (COD)

TYPES OF WATER POLLUTION AND ADVERSE EFFECTS

Surface (River) Water Pollution

Surface water includes river, lake and pond water but here only river water pollution is discussed as lake water pollution is discussed separately.

Major River Water Pollutants:

1. Sewage Wastes
2. Infectious agents include germs and viruses which causes several types of diseases like typhoid, dysentery, cholera, etc.
3. Plants nutrients and dissolved substances e.g. chemical fertilizers, detergents, etc.
4. Particulate Matter e.g. soil and mineral particles
5. Radioactive Substances released from nuclear reactors
6. Mineral and Chemical Substances coming from industries and mining operations
7. Thermal e.g. hot water released by power plants, nuclear reactors, industries, etc.
8. Organic chemical exotics such as synthetic materials like pesticides, insecticides, etc.

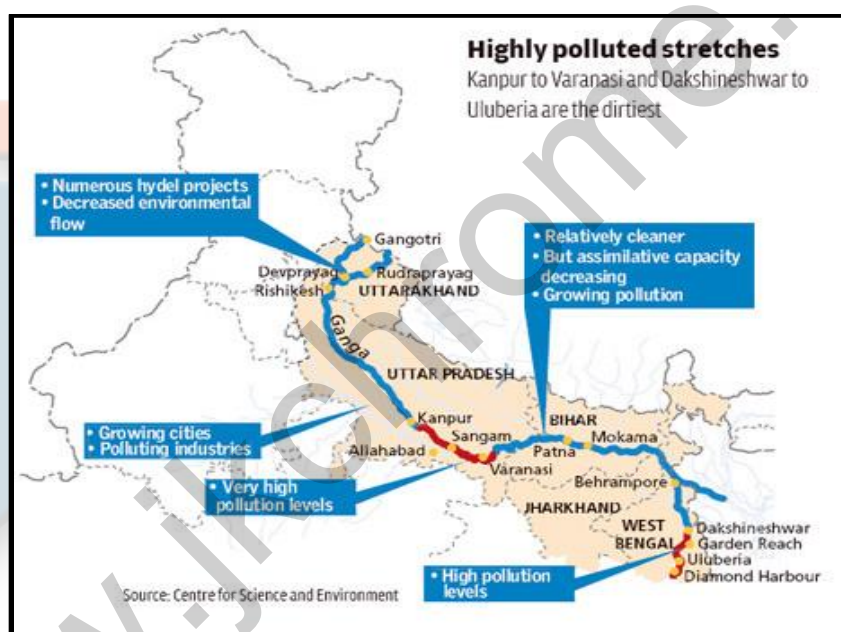
Sources of River Pollution

<p>Point Pollution: The main sources of point pollution of river waters are industrial and urban centers.</p> <p>Sewage Water</p> <ul style="list-style-type: none"> • Sewage water when discharges from houses, commercial and industrial establishments connected to public sewerage system. • The sewage contains human and animal excreta, food residues, cleaning agents, detergents and other wastes. • Domestic and hospital sewage contain many undesirable pathogenic microorganisms. • However, about 70% of the effluents are not treated and disposed off into the environmental media untreated. <p>Industrial Wastes</p> <ul style="list-style-type: none"> • The industries discharge several inorganic and organic pollutants, which may prove highly toxic to living beings. • Discharge of wastewater from industries like petroleum, paper manufacturing, metal extraction and processing, chemical manufacturing, etc.that often contain toxic substances, notably, heavy metals (defined as 	<p>Non-Point Pollution: discharge of pollutants from diffuse sources or from a larger area such as runoff from agricultural fields (agricultural runoff), grazing lands, construction sites, abandoned mines and pits, roads and streets.</p> <ul style="list-style-type: none"> ○ Agricultural runoff contains dissolved salts such as nitrates, phosphates, ammonia and other nutrients, and toxic metal ions and organic compounds. ○ Excess fertilizers and pesticides may reach the ground water by leaching or may be mixed with surface water of rivers, lakes and ponds by runoff and drainage. ○ Animal excreta such as dung, waste from poultry farms, piggeries and slaughter houses etc. reach the water bodies through runoff and surface leaching during the rainy season. ○ Huge amount of sediments caused by accelerated rate of soil erosion (such as deforestation) reaching the rivers is a major cause of nonpoint pollution.
---	--

<p>elements with density > 5 g/cm³ such as mercury, cadmium, copper, lead, arsenic) and a variety of organic compounds.</p> <ul style="list-style-type: none"> • Geogenic contaminants: salinity, iron, fluoride, and arsenic <p>Plastic bags are not biodegradable, clog waterways, spoil the landscape; break down into ever smaller particles that continue to pollute the soil and water.</p>	
--	--

Examples of River Water Pollution in India

1. Pollution of Ganga



Clean up Efforts for Ganga

Main Pillars of Namami Ganges

- Sewage Treatment Infrastructure
- River front Development
- River Surface Cleaning
- Ganga Gram
- Biodiversity Preservation
- Afforestation
- Public Awareness
- Industrial Effluent Monitoring

- **National River Ganga Basin Authority (NRGBA):** established by the Central Government of India, on 20 February 2009 under Section 3 of the Environment Protection Act, 1986.

National Ganga River Basin Authority (NRGBA) has started the Mission Clean Ganga with a changed and comprehensive approach to champion the challenges posed to Ganga through four different sectors, namely, of wastewater management, solid waste management, industrial pollution and river front development. NRGBA has been established with the objectives of

- (a) ensuring effective abatement of pollution and conservation of the river Ganga by adopting a river basin approach to promote inter-sectoral coordination for comprehensive planning and management; and
- (b) maintaining environmental flows in the river Ganga with the aim of ensuring water quality and environmentally sustainable development.

- **Namami Gange Program:** It focus on pollution abatement interventions namely Interception, diversion and treatment of waste water flowing through the open drains through bio-remediation / appropriate in-situ treatment / use of innovative technologies / sewage treatment plants (STPs) / effluent treatment plants (ETPs); rehabilitation and augmentation of existing STPs and immediate short term measures for arresting pollution at exit points on the riverfront to prevent inflow of sewage etc.
- **Clean Ganga Fund:** Aim of using the collection for various activities under the Namami Gange programme for cleaning the Ganga.
- **National Mission for clean Ganga:** It is the implementation wing of National Ganga Council which was set up in October 2016 under the River Ganga (Rejuvenation, Protection and Management) Authorities order 2016. The National Ganga Council will be overall responsible for the superintendence, direction, development and control of River Ganga and the entire River Basin (including financial and administrative matters) for the protection, prevention, control and abatement of environmental pollution in River Ganga and its rejuvenation to its natural and pristine condition and to ensure continuous adequate flow of water in the River Ganga and for matters connected therewith.

The National Ganga Council may consult experts and expert organizations or institutions in the field of river rejuvenation, river ecology and river management, hydrology, environmental engineering, social mobilization and other relevant fields.

2. Pollution of Pamba River (Kerala)

The water of the River, Pamba is influenced by:

- Wastewater from the pilgrim centre Sabarimala in the upper reaches of the river including the place, Pamba, where the pilgrims arrive.
- The Sabarimala temple area is placed in the upper Pamba River catchment area in the centre of a large forest
- The discharge of waste water from Municipalities in the middle and lower reaches of the Pamba.
- Forestry and farming especially, the application of fertilizers and pesticides used in plantations other sources like rubber factories and further industrial and commercial activities.
 - The heavy rainfalls during the monsoon period lead to a steady wash out from the soil directly into the river.
 - The water of the Pamba River is influenced by bacteria, a huge amount of nutrients and oxygen consuming matter discharged during the three months pilgrim season.

- River Sand Mining - The extensive sandy plains at Maramon and Cherukole in Pamba are traditionally being used for holding annual religious congregations.

Case Study: Ulsoor Lake Pollution	Polluted by a vast floating layer of non-recycled debris comprising plastic bags and water bottles and even sacks. It witnesses frequent foaming on the surface.
Lake Water Pollution- Causes behind it	<p>The causes of lake water pollution are similar to the river water pollution. However, the consequences in the lake water pollution is more severe as the water is stagnant unlike river water.</p> <ol style="list-style-type: none"> 1. Siltation of lakes due to dumping of enormous quantities of sediments due to accelerated rate of soil erosion. 2. Toxic effluents from the urban areas. 3. Washing and dumping of tailings or waste sludges from factories into stagnant water. 4. Inorganic nutrients from agricultural fields. 5. Acid rain: they are often called as ‘Lake Killers’.
Case Study: Bellandur Lake Pollution in Bengaluru	<ul style="list-style-type: none"> ● It has become more or less a sewage tank because of untreated sewage water entering into the lake through various inlets. In theory, clean rainwater from Koramangala and Challaghatta (K&C) Valley should flow to Bellandur lake through stormwater drains. However, Bellandur lake gets sewage inflow due to two reasons. ● Improper sewage system due to which untreated sewage water overflows and joins storm water drains, mixes with rain water, which in turn flows to Bellandur lake via Koramangala and Challaghatta Valley. ● Lack of effluent treatment plants to treat industrial wastes from small factories which also get into the storm water drains. ● Fire at the lake: The cooking oil thrown from households that enters the lake from untreated domestic sewage is said to be the cause behind the fire.
Measures Needed for urgent restoration and remedial actions for Lake Pollution in the form of:	<ul style="list-style-type: none"> ● Desiltation of the lake is to eliminate contaminants. ● Stop all encroachments of the lake with suitable fencing ● Only storm water should be allowed into the lake ● Army units should discontinue effluents from cattle house wash, cow dung wash and army mess wash and consider installation of a biogas plant. ● Plastic bags to be prevented from draining into the lake ● Sewage/manholes at identified locations to be closed. ● Drain water from slum around the lake to be treated before draining into the lake. Preferably, connect the slum storm water and wastewater drain to the nearby Cox Town sewage drain as it is close to the slums ● Prohibit submergence of idols during the festival season ● Remove all slum dwellers from region ● Cultivate and harvest fish and aquatic plants to deplete the nitrogen and phosphate content

Seawater Pollution:

It is polluted mostly near the coast through the disposal of urban and industrial waste matters into the coastal waters.

<p>Causes</p>	<ul style="list-style-type: none"> • Discharge of sewage, industrial effluents and toxic chemicals from urban areas and industrial establishment. • Discharge of solid waste materials mainly plastics, microbeads, etc. According to UNEP, plastic accounts for 90% of all debris floating in the oceans. • Leakages of enormous quantity of mineral oil from oil wells and tankers. Ex. Ennore oil spill, Tar balls off Mumbai coast, Deep Horizon disaster, etc. • Ballast water discharge • Deep Sea Mining • Increase in the concentration of heavy minerals like lead, cadmium, chromium, nickel, etc.
<p>Consequences:</p>	<ul style="list-style-type: none"> • Oxygen depletion/hypoxia: Increase in BOD due to eutrophication results in death of marine organisms. Ex. Planktons, mollusks, etc. According to Wilkinson Report: 1998 Red Sea coral bleaching was due to disproportionate growth of algal bloom. • The Great Pacific Garbage Patch: <div> </div> <ul style="list-style-type: none"> • Damage to marine biodiversity: Bottles, plastics choke fish, turtles, etc. <p>For example, Case study of Chennai oil Spill off (Ennore Port):</p> <ul style="list-style-type: none"> ○ 40 tonnes of oil spillage (INCOIS) ○ 74 km stretch affected including Marina beach, Pulicat Lake (Bird sanctuary), Pichavaram mangroves <ul style="list-style-type: none"> • Damage to coral reefs (Rainforest of the oceans)

	<ul style="list-style-type: none"> ● According to Global Coral Reef Monitoring Network, 20% of corals ex. Chitales are threatened due to toxic chemicals, oil spillage, pesticides, heavy metals, etc. as they introduce pathogens and causes bleaching. ● Acidification of oceans: It reduces calcium carbonate mineral affecting coral polyps, oysters, crabs, salmons, etc. in shell and fin formation. ● Deep sea mining: Damage to the habitats of benthic organisms like octopus, mollusks, eelgrass, etc. ● Effect on the food chain: Heavy minerals like nickel, chromium (6), cadmium and bio accumulate in fish and ultimately enters into human food chain (bio amplification). Ex. Minamata disease, DDT, etc.
<p>Steps taken by Indian Government to reduce coastal pollution:</p>	<ol style="list-style-type: none"> 1. The present government has provided subsidies to the farmers of Tamil Nadu for transition towards deep sea fishing instead of bottom trawling fishing. 2. The Society for Integrated Coastal Management (SICOM) under the Ministry of Environment, Forest and Climate Change is developing 13 beaches for blue flag certification under the Unified Coastal Areas Management Program. 3. Indian government has come up with Coastal Regulation Zone (CRZ) Rules. 4. India has become a member of Ballast Water Management Convention under International Maritime Organization.
<p>Issues related to controlling of seawater pollution:</p>	<ol style="list-style-type: none"> 1. The two formidable problems in conservation is: <ul style="list-style-type: none"> ○ International character of marine resources and right of all countries for their use ○ High mobility of marine organisms. 2. Lack of awareness among fishermen communities. 3. Lack of finance, infrastructure and capacity with Coastal Guards. 4. Absence of waste management facilities at the beaches.
<p>Strategies to handle Oil Spillage:</p>	<ol style="list-style-type: none"> 1. Oil spill modelling: It provides a clear idea about oil movement and enhances the decision-making strategy for quick response. 2. Mathematical models: The generic model to predict the movement of oil and the habitat specific model for detailed trajectory and impact analysis on marine resources. (Ministry of Earth Sciences) 3. Use of GIS in estimation: Information on bathymetry, oil concentration and thickness, quantity of dispersed oil may be incorporated in the maps. 4. Ecologically sensitive areas such as coral reefs, seagrass beds, mangroves, mudflats, and wildlife protected areas may be layered. 5. Bioremediation Techniques: Use of oil Zapper and Oilivorous-S (TERI- The energy research institute) to degrade oil contaminants in-situ. 6. Biostimulation and Bioaugmentation.

Steps for the conservation of marine resources:	<p>Food Resource:</p> <ol style="list-style-type: none"> 1. The accurate estimation of the growth and mortality rate of marine organisms is a prerequisite condition to ensure their sustainable yield. 2. Proper survey of fishing areas by applying Echo-sounder techniques, maintaining catch statistics, etc. 3. Accurate prediction of future demand of fish for human food and animal feed. 4. Proper knowledge of potential reserve 5. Developing and enriching Mari culture, ornamental fishing, marine pasture, etc. 6. Investments in Deep Sea Fishing instead of Bottom Trawling fishing. <p>International initiatives:</p> <ol style="list-style-type: none"> 1. Full implementation of the Paris Agreement (UNFCCC) 2. Blue Carbon Initiative (UNEP+IUCN+UNESCO) for the conservation and protection of marine and coastal biodiversity is in the right direction. 3. Coral Triangle Programme (WWF) around Indian coastal States. 4. India should become a member of the LONDON Convention.
--	---

Groundwater Pollution

Groundwater pollution's reason	When hazardous substances come into contact and dissolve in the groundwater
Causes of pollution	<ul style="list-style-type: none"> • When rain/surface water comes into contact with contaminated soil while seeping into the ground and carry the pollution from the soil to the groundwater. • When liquid hazardous substances themselves soak down into the groundwater.
Few groundwater pollutants	<ul style="list-style-type: none"> • Arsenic: Districts of Bihar, West Bengal, etc. <ul style="list-style-type: none"> ○ Major sources of arsenic in drinking water are <ul style="list-style-type: none"> ▪ erosion of natural deposits; ▪ runoff from orchards; and ▪ runoff from glass & electronics production wastes. ○ Arsenic health effects: Some people who drink water containing arsenic well in excess of the MCL over many years could experience skin damage or problems with their circulatory system, and may have an increased risk of getting cancer. • Fluoride: Major hit states: Rajasthan, Gujarat, Andhra Pradesh, etc.
Impact in environment and human health:	<p>Affects the health of animals and humans</p> <p>When they drink or bathe in water contaminated by the groundwater it causes occurrence of many serious diseases or skin infections.</p>

	<p>When they eat organisms that have themselves been affected by groundwater contamination, such harmful contaminants get concentrated in human body ultimately affecting their physical health.</p>
<p>Control of Water Pollution</p>	<ul style="list-style-type: none"> ● The control of water pollution is to reduce the pollution loads from anthropogenic activities to the natural regenerative capacity of the resource. ● Control of water pollution requires appropriate infrastructure and management plans. ● The infrastructure may include wastewater treatment plants. ● Sewage treatment plants and industrial wastewater treatment plants = required to protect water bodies from untreated wastewater. ● Agricultural wastewater treatment for farms ● erosion control from construction sites ● Nature-based solutions ● Effective control of urban runoff includes reducing speed and quantity of flow.
<p>Measures taken by the Government to address the issues of groundwater pollution include the following: -</p>	<ul style="list-style-type: none"> ● Government of India has passed the Water (Prevention and Control of Pollution) Act, 1974 to safeguard our water resources. ● Preparation of action plan for sewage management and restoration of water quality in aquatic resources by State Governments; ● Installation of Online Effluent Monitoring System to check the discharge of effluent directly into the rivers and water bodies; ● Continuous water quality monitoring systems are being established on industrial units in the country, through the directives issued by CPCB, for getting real time information on the effluent quality. ● Financial assistance for installation of Common Effluent Treatment Plants for cluster of Small-Scale Industrial units; ● CPCB has made a comprehensive programme on water pollution for controlling point sources by developing industry specific standards and general standards for sewage which have been notified under Environment (Protection) Act, 1986 which are to be enforced by the SPCBs/PCCs. ● Various steps including Environmental Auditing, promotion of Common Effluent Treatment Plants, promotion of Low Waste and No Waste technology, augmenting flow in rivers, Rain Water Harvesting practices, implementation of guidelines prepared for idol immersion in rivers and lakes, promotion of Zero Liquid Discharge and sewage treatment infrastructure in the housing projects etc. are being taken for the abatement of pollution. ● Implementation of National River Conservation Plan (NRCP) for abatement of pollution in identified stretches of various rivers. ● MoEFCC) has been supplementing the efforts of the State Governments in abatement of pollution in various rivers and lakes/wetlands under the

	National River Conservation Plan (NRCP) and National Plan for Conservation of Aquatic Ecosystem (NPCA) respectively.
Area of concern with regard to implementation of measures to control river, lake and groundwater pollution:	<ul style="list-style-type: none"> ● Right now, there are multiple agencies involved in river and lake conservation, right from planning to implementation and monitoring. There is a need to consolidate all these functions for better coordination and accountability. ● Lack of coordination and ownership between the different agencies that are involved in programme/scheme implementation; ● Need for the government to review the low levels of budgetary priority given to environment programs in the country; ● Need to strengthen truly representative public participation in governmental programs; ● The imperatives of a comprehensive river basin approach for curbing river pollution as opposed to the extant town-based approach; ● The requirement of legislations for <ul style="list-style-type: none"> ○ maintaining minimum amount of water/flow in lakes and ○ setting standards for nitrogen and phosphorus as measures of water quality;
Issues and What more needs to be done:	<ul style="list-style-type: none"> ● The treatment capacity of operational STP (solid waste treatment plants) is not adequate due to an existing gap of more than 38600 KLD in sewage generation and treatment. ● CPCB has issued directions to all SPCBs / PCCs to make it mandatory for local / urban bodies to set up STPs of adequate capacity and provide underground sewerage system to cover areas and bridge the treatment gap. ● CPCB has issued directions to Municipal authorities of 46 metropolitan cities and 20 State capitals and 118 Ganga basin towns/ cities for treatment and utilization of sewage for restoration of water quality of rivers. ● National Mission for Clean Ganga (NMCG) proposes to tap the drains and treat the waste water to improve the quality of water in river Ganga. ● Despite progress, providing safe drinking water to millions of India's rural people remains a challenge.
CAG's recommendations to MoEF:	<ul style="list-style-type: none"> ● MoEF/States need to set out a clear policy on water pollution which takes into account the prevention and control of water pollution as well as ecological restoration of degraded water bodies. ● MoEF/CPCB should initiate steps, along with Ministry of Water Resources and all the States to draw up a comprehensive inventory of all rivers, lakes and ground water sources in India. <ul style="list-style-type: none"> ○ It should also undertake a survey to list the entire keystone species associated with each river and lake in India. ○ This should also be placed in the public domain.

	<ul style="list-style-type: none"> ● MoEF/CPCB should intensify its efforts in developing biological indicators which would shed light on whether the functional integrity of aquatic ecosystems is safeguarded. ● MoEF should take into account the basin approach while planning for reduction of pollution of all rivers and lakes in the country. ● With respect to lakes, all three attributes i.e. the basin, the water body and the command area need to be conserved instead of the present focus of NLCP on the water body only. ● MoEF needs to establish enforceable water quality standards for lakes, rivers and groundwater that would help protect human and ecosystem health. <ul style="list-style-type: none"> ○ Penalties need to be levied for violations of water quality standards. ○ MoEF, in conjunction with Ministry of Agriculture, needs to develop standards for pollutants like nitrogen, phosphorus etc. which arise from agricultural practices, use of pesticides and fertilizers as pollution from agricultural sources is one of the biggest non-point sources of pollution. ● States should involve citizens in proposing and monitoring programs to control pollution of rivers and lakes. <ul style="list-style-type: none"> ○ This will help in mobilizing support in civil society for the proposed projects and thus the projects will face less resistance from local people. ○ Citizens Monitoring Committee and Local Level Lake Monitoring Committees need to be constituted to provide feedback for more effective implementation. <p>MoEF/CPCB, in conjunction with the States, should conduct a city-wise assessment of the levels of pollution in our rivers and lakes.</p>
--	--

Thermal Pollution:

What it is?

It is another sort of water pollution. Power plants (thermal and nuclear), chemical and other industries use a lot of water for cooling purposes, and later used hot water is discharged into rivers, streams or oceans.

Discharge of hot water may increase the temperature of the receiving water by 10 to 15°C above the ambient water temperature. This is thermal pollution.

Impacts:

- Increase in water temperature decreases dissolved oxygen in water which adversely affects aquatic life.
- Unlike terrestrial organisms, aquatic organisms are adapted to a uniform steady temperature of environment. Sudden rise in temperature kills fish and other aquatic animals.
- Discharge of hot water in water body affects feeding in fishes, increases their metabolism and affects their growth.
- Their swimming efficiency declines.
- Their resistance to diseases and parasites decreases.

How to reduce thermal pollution?

Store the hot water in cooling ponds, allow the water to cool before releasing into any receiving water body.

3. SOIL POLLUTION

Decrease in the quality of soils either due to anthropogenic sources or natural sources or by both is called soil pollution.

FACTORS OF SOIL POLLUTION	<p>The main factors of soil pollution are:</p> <ul style="list-style-type: none"> • Accelerated rate of soil erosion • Excessive use of chemical fertilizers, pesticides, insecticides and herbicides • Polluted wastewater from industrial and urban centers • Dumping of industrial and urban solid wastes • Water logging and related capillary process • Leaching processes
SOURCES OF SOIL POLLUTION	<ol style="list-style-type: none"> 1. Physical Sources: it is related to soil erosion and consequent soil degradation caused by natural and anthropogenic sources. The natural factor includes intensity of rainfall, temperature and wind, lithology, etc. These factors are further accelerated by human activities like overgrazing, mining, faulty agricultural practices, etc. 2. Biological Sources: It includes pathogenic micro-organisms excreted by human beings and animals, bacteria, protozoa, etc. 3. Airborne Sources: It includes pollutants released in the air by human volcanoes i.e. chimneys of factories, etc. Huge quantities of particulate matters emitted from cement factories, lime kilns, coal mining, loading and unloading of coal, thermal power plants, etc., reach the soil and thus pollute them. 4. Chemical Fertilizers and Biocides: Excessive use of chemical fertilizers, especially in the Green Revolution areas of India causes alteration in the physical and chemical properties of soil. 5. Urban and Industrial Sources: Industrial Effluents, sewages, plastics, solid wastes, etc. changes the physical and chemical composition of the soil.
ADVERSE EFFECTS OF SOIL POLLUTION	<p>Effects on Human Beings:</p> <ul style="list-style-type: none"> • It leads to substantial decrease in the productivity of the soil. It renders land unusable for farming, thus endangering food security of a nation. • Arsenic containing pesticides and sodium fluoroacetate reaches the food chains and causes gastric and digestive problems. • Soil erosion through rill and gully erosion converts the land into wastelands. <p>Effects on Animals:</p> <ul style="list-style-type: none"> • Plastics in the soil causes death to animals. • Fertilizers and pesticides also reach them through food chains.

	<p>Effects on Plants: Plant growth process reduces due to over saturation of minerals and nutrients.</p>
MEASURES TO CONTROL SOIL POLLUTION	<p>To implement various control measures of soil erosion.</p> <ul style="list-style-type: none"> • Controlled and judicious use of fertilizers, pesticides and insecticides. • Development of organic pesticides and insecticides. • Immediate restriction on the use of DDT. • Proper disposal of urban and industrial wastes. • Proper land use and crop management. • Education to farmers about the proper uses of fertilizers.

4. SOLID WASTE POLLUTION

WHAT IS SOLID WASTE?

Solid waste is the **unwanted or useless solid materials generated from human activities** in residential, industrial or commercial areas. According to MoEFCC, **62 million tonnes of waste** is generated annually in the country at present, out of which 5.6 million tonnes is plastic waste, 0.17 million tonnes is biomedical waste, hazardous waste generation is 7.90 million tonnes per annum and 15 lakh tonnes is e-waste. Only about 75-80 per cent of the municipal waste gets collected and only 22-28 percent of this waste is processed and treated.

CATEGORIES	<ul style="list-style-type: none"> • It may be categorized in three ways. According to its: <ol style="list-style-type: none"> 1. Origin (domestic, industrial, commercial, construction or institutional) 2. Contents (organic material, glass, metal, plastic paper etc.) 3. Hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc.).
MAGNITUDE OF THE PROBLEM:	<ul style="list-style-type: none"> • In metro cities in India, an individual produces an average of 0.8 kg/waste/person daily. • The total municipal solid waste (MSW) generated in urban India has been estimated at 68.8 million tons per year (0.573 million metric tons per day in the year 2008). • The average collection efficiency of MSW ranges from 22% to 60%. • MSW typically contains 51% organic waste, 17% recyclables, 11% hazardous and 21% inert waste. • However, about 40% of all MSW is not collected at all and hence <ul style="list-style-type: none"> ○ lies littered in the city/town ○ finds its way to nearby drains and water bodies ○ causing choking as well as pollution of surface water. • Unsegregated waste collection and transportation leads to <ul style="list-style-type: none"> ○ dumping in the open, which generates leachate and gaseous emissions ○ causing nuisance in the surrounding environment.

<p>TYPES OF SOLID WASTES</p>	<p>Municipal Solid Waste (MSW): It consists of household waste, construction and demolition debris, sanitation residue, and waste from streets, generated mainly from residential and commercial complexes. As per the MoEF it includes commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes. It includes Plastics waste, E-waste, construction and demolition waste.</p> <p>Industrial Solid Waste (ISW): In a majority of cases it is termed as hazardous waste as they may contain toxic substances, are corrosive, highly inflammable, or react when exposed to certain things e.g. gases.</p> <p>Biomedical waste or hospital waste: It is usually infectious waste that may include waste like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc., usually in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc.</p> <p>These can be a serious threat to human health if not managed in a scientific and discriminate manner.</p>
<p>SOLID WASTE MANAGEMENT</p>	<p>Centralized management method:</p> <ul style="list-style-type: none"> • This method involves collection of municipal waste from all over the local area and by means of landfilling, dump outside the city/nagar panchayat limits. • This process looks at door-to-door collection of solid waste by waste pickers who hand over to the collection team who then discard the collected waste in the landfill. • The waste pickers are employees of the Municipal Corporation or Nagar Panchayat. • The collection team is generally contracted out by a tendering process. <p>Decentralized management method:</p> <ul style="list-style-type: none"> • This is a model seen in a few places like Suryapet in Andhra Pradesh and Bangalore in Karnataka. • The waste is collected ward-wise and is segregated at source into biodegradable and non-biodegradable. • The biodegradable waste is composted at a nearby facility by different methods of aerobic and anaerobic composting. • The non-biodegradable waste is further categorized into paper, plastic, metal and other waste and then further collected by recyclers for up-cycling or downcycling of products.

TREATMENT METHODS FOR SOLID WASTES

<p>Thermal Treatment</p>	<p>Incineration is the combustion of waste in the presence of oxygen, so that the waste is converted into carbon dioxide, water vapour and ash.</p> <ul style="list-style-type: none"> • Also labeled as Waste to Energy (WtE) method, it is a means of recovering energy from the waste. • Advantages: Waste volume reduction, cutback on transportation costs and reduction of greenhouse gas emissions. • Disadvantages: When garbage is burned, pollutants, such as mercury, lead, dioxins may be released into the atmosphere, and cause health issues etc.
<p>Pyrolysis and Gasification:</p>	<p>Pyrolysis In this method, thermal degradation/processing of organic material in the complete absence of oxygen or with less amount of air. Thermal decomposition of organic components in the waste stream starts at 350°C–550°C and goes up to 700°C–800°C in the absence of air/oxygen.</p> <p>Gasification It involves heating the waste plastic with air or steam, to produce a valuable industrial gas mixture called “synthesis gas”, or syngas. This can then be used to produce diesel and petrol, or <u>burned directly in boilers to generate electricity.</u></p>
<p>Biological Treatment Methods:</p>	<p>This involves using microorganisms to decompose the biodegradable components of waste.</p> <p>These are two types of processes:</p> <ul style="list-style-type: none"> • Aerobic: This needs the presence of oxygen and includes windrows composting, aerated static pile composting & in-vessel composting, vermiculture etc. • Anaerobic digestion: Takes place in the absence of oxygen.
<p>Landfills and Open Dumping:</p>	<p>Sanitary landfills: It is the controlled disposal of waste on land in such a way that contact between waste and the environment is significantly reduced and the waste is concentrated in a well-defined area.</p> <p>Dumps are open areas where waste is dumped exposing it to natural elements, stray animals and birds. With the absence of any kind of monitoring and no leachate collection system, this leads to the contamination of both land and water resources.</p>

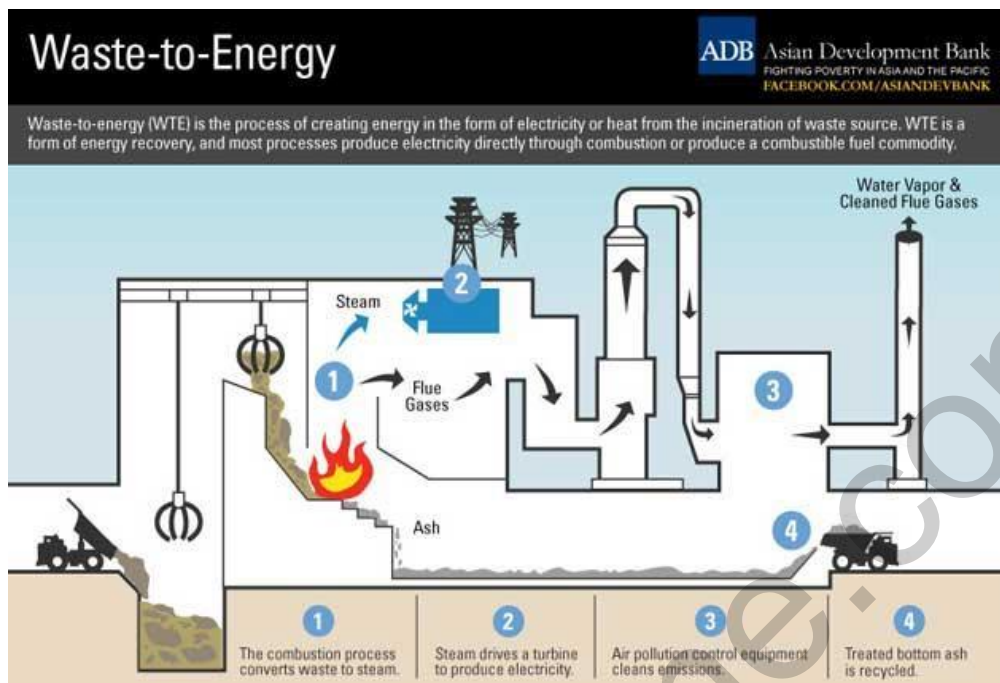


Figure shows mechanism of Waste to Energy

RULES AND REGULATIONS ASSOCIATED WITH SOLID WASTE MANAGEMENT

<p>Constitutional provisions</p>	<p>Under the 74th Constitutional Amendment, Disposal and management of Municipal Solid Waste is one of the 18 functional domains of the Municipal Corporations and Nagar Panchayats.</p>
<p>Various rules and regulations for solid waste management are:</p>	<ol style="list-style-type: none"> 1. The Bio-Medical Waste (Management and Handling) Rules 2. Municipal Solid Waste (Management and Handling) Rules 3. The Plastic Waste (Management and Handling) Rules 4. E-Waste (Management and Handling) Rules 5. Construction and Demolition waste (Management and Handling) Rules
<p>Municipal Solid Waste Management Rules 2016</p>	<p>It will replace the Municipal Solid Wastes (Management and Handling) Rules, 2000, which have been in place for the past 16 years.</p> <p>Applicability- Applicable beyond municipal areas and have included urban agglomerations, census towns, notified industrial townships, areas under the control of Indian Railways, airports, special economic zones, places of pilgrimage, religious and historical importance, and State and Central Government organizations in their ambit.</p>

Major Highlights of Solid Waste Management Rules 2016:

<p>Segregation at source</p>	<p>The new rules have mandated the source segregation of waste in order to channelize the waste to wealth by recovery, reuse and recycle.</p> <ul style="list-style-type: none"> • Waste generators would now have to now segregate waste into three streams- Biodegradables, Dry (Plastic, Paper, Metal, Wood, etc.) and Domestic Hazardous waste (diapers, napkins, mosquito repellants, cleaning agents etc.) before handing it over to the collector. • Institutional generators, market associations, event organizers and hotels and restaurants have been directly made responsible for segregation and sorting the waste and manage in partnership with local bodies. • All hotels and restaurants will also be required to segregate biodegradable waste and set up a system of collection to ensure that such food waste is utilized for composting / bio methanation.
<p>Collection and disposal of sanitary waste</p>	<p>The manufacturers or brand owners of sanitary napkins are responsible for awareness for proper disposal of such waste by the generator and shall provide a pouch or wrapper for disposal of each napkin or diapers along with the packet of their sanitary products.</p>
<p>Collect Back scheme for packaging waste</p>	<p>Brand owners who sales or market their products in packaging material which are non-biodegradable, should put in place a system to collect back the packaging waste generated due to their production.</p>
<p>User fees for collection</p>	<p>Municipal authorities will levy user fees for collection, disposal and processing from bulk generators.</p> <p>The generator will have to pay “User Fee” to the waste collector and a “Spot Fine” for littering and non-segregation, the quantum of which will be decided by the local bodies.</p> <p>The integration of rag pickers, waste pickers and kabadiwalas from the informal sector to the formal sector by the state government.</p> <p>Stipulate zero tolerance for throwing; burning, or burying the solid waste generated on streets, open public spaces outside the generator’s premises, or in the drain, or water bodies.</p>
<p>Waste processing and treatment</p>	<p>It has been advised that the biodegradable waste should be processed, treated and disposed of through composting or bio-methanation.</p> <p>The rules have mandated bio-remediation or capping of old and abandoned dump sites within five years.</p>
<p>Promotion of waste to energy</p>	<p>In a not-so welcoming move, the SWM Rules, 2016 emphasize promotion of waste to energy plants.</p> <p>Ministry of New and Renewable Energy Sources should facilitate infrastructure creation for Waste to Energy plants</p>

Revision of parameters and existing standards	The landfill site shall be 100 metres away from a river, 200 metres from a pond, 500, 200 metres away from highways, habitations, public parks and water supply wells and 20 km away from airports/airbase.
Constitution of a Central Monitoring Committee	The government has also constituted a Central Monitoring Committee under the chairmanship of Secretary, MoEF&CC to monitor the overall implementation of the rules.

5. PLASTIC POLLUTION

About plastic pollution	<ul style="list-style-type: none"> • It happens due to the accumulation of plastic objects (plastic bottles and much more) that severely affects wildlife, wildlife habitat and human beings, waterbodies, land and soil etc. • Plastics that act as pollutants are categorized into micro-, meso-, or macro debris, based on size. • We celebrated 'World Environment Day' (June 5) with a critical theme: Beat the plastic Pollution
Critical impact of Plastics	<ul style="list-style-type: none"> • About 50% of our plastic use is single use (disposable) and it constitutes 10% of the total waste generated. • Each year, 13 million tonnes of plastic ends up in the oceans. • Researchers exploring the Arctic have found very high levels of microplastics trapped in the ice. • Plastic disposed of on land degrades slowly and its chemicals leach into the surroundings thus affecting environment around it. • Drinking water samples analyzed from 14 countries, including India, revealed that 83% of samples have micro-plastics concentrations. • According to a United Nations Environment Programme report, the overall annual natural capital cost of plastic use in the consumer goods sector is \$75 billion.
What should we do to fight with plastic pollution?	<ul style="list-style-type: none"> • In reality, we cannot eliminate plastic use from our day-to-day activities. • However, we should not allow plastic to reach the soil or water. The government should restrict plastic production and encourage recycling through appropriate policies. • The 'Plastic Waste Management Rules' need to be strictly followed. • As most plastic items pass through our hands, public care, with behavioral change, is necessary. <ul style="list-style-type: none"> ○ Household-wise waste segregation is the key. ○ Every shopkeeper should go in for and encourage the use of biodegradable packing materials while shoppers should use cloth bags. Mass public awareness on the dangers of plastic hazards is a prerequisite. ○ Eco-friendly substitutes (cloth/paper/jute bags, leaves/areca leaf plates, paper straws) should be developed.

	<ul style="list-style-type: none"> ○ For this, scientific and financial support (soft loans and subsidies) is required. ● Charges for plastic bag use and deposit-refund for plastic bottles may be effective options. ● The recent decision by the Cabinet Committee on Economic Affairs on extending the mandate on packing food grains and sugar products in jute bags is welcome. ● Even if the intention is to promote the jute industry, it is a step that reduces plastic pollution. The Swachh Bharat Mission should emerge as a platform for plastic waste management.
<p>SINGLE USE PLASTIC THREAT</p>	<ul style="list-style-type: none"> ● Single-use plastics, or disposable plastics, are used only once before they are thrown away or recycled. These items are things like plastic bags, straws, coffee stirrers, soda and water bottles and most food packaging. ● We produce roughly 300 million tons of plastic each year and half of it is disposable! World-wide only 10-13% of plastic items are recycled. The nature of petroleum based disposable plastic makes it difficult to recycle and they have to add new virgin materials and chemicals to it to do so. Additionally, there are a limited number of items that recycled plastic can be used. ● Petroleum based plastic is not biodegradable and usually goes into a landfill where it is buried or it gets into the water and finds its way into the ocean. Although plastic will not biodegrade (decompose into natural substance like soil,) it will degrade (break down) into tiny particles after many years. In the process of breaking down, it releases toxic chemicals (additives that were used to shape and harden the plastic) which make their way into our food and water supply. ● These toxic chemicals are now being found in our bloodstream and the latest research has found them to disrupt the Endocrine system which can cause cancer, infertility, birth defects, impaired immunity and many other ailments. ● We produce hundreds of millions of tons of plastic every year, most of which cannot be recycled. It's obvious that we need to use less plastic, move towards environmentally sustainable products and services and come up with technology that recycles plastic more efficiently.
<p>Features of Plastic Waste Management (Amendment) Rules 2018</p>	<ul style="list-style-type: none"> ● The phasing out of Multilayered Plastic (MLP) is now applicable to MLP, which are “non-recyclable, or non-energy recoverable, or with no alternate use.” ● Rules prescribe a central registration system for the registration of the producer/importer/brand owner. ● It also lays down that any mechanism for the registration should be automated and should take into account the ease of doing business for producers, recyclers and manufacturers.

	<ul style="list-style-type: none"> • The centralized registration system will be evolved by Central Pollution Control Board (CPCB) for the registration of the producer/importer/brand owner. • A national registry has been prescribed for producers with a presence in more than two states, • A state-level registration has been prescribed for smaller producers/brand owners operating within one or two states.
<p>MICROPLASTICS/ MICROBEADS- A NEW THREAT</p>	<p>Microbeads are pieces of plastic, usually spherical in shape, that range in width from a fraction of a millimeter to about a millimeter and a quarter. They're used in soaps because exfoliating products need small, hard particles to rub debris from the skin. These particles can be natural materials, such as ground nut shells or crushed apricot seeds--or they can be manufactured products like microbeads.</p> <p>Microbeads have become so ubiquitous that an estimated 808 trillion pieces swirl down American drains every day. One percent that escaped the sludge—roughly 8 trillion microbeads—are released directly into our waterways. That's enough plastic to cover 300 tennis courts.</p>

Risks associated with exfoliating agents used in personal care products has alarmed green panel

<p>What are microbeads?</p> <p>◦ Microbeads are plastic pieces or fibre measuring less than 1 mm</p>		<p>Why is it used?</p> <p>◦ Microbeads have been used to replace natural exfoliating materials. Microspheres in different colors add visual appeal to cosmetic products because of which their usage is becoming more rampant</p>
<p>What are microbeads made of?</p> <p>◦ Microbeads used in personal care products are mainly made of polyethylene (PE), but can be also be made of polypropylene (PP), polyethylene terephthalate (PET), polymethyl methacrylate (PMMA) and nylon</p>		<p>What is the danger from them?</p> <p>Microbeads — largely non-biodegradable — flow through sewer systems and end up in seas and oceans, where they contribute to the huge chunk of plastic soup in the environment</p> <p>Microbeads are also likely to be transported to wastewater treatment plants. Due to their small size, a substantial proportion passes through the filtration system and enters aquatic environments</p>
<p>What are they mainly used in?</p> <p>◦ They are widely used in cosmetics as exfoliating agents and in personal care products such as toothpaste, as well as in biomedical and health science research. In layman's language, these microbeads are so small that a person can barely feel them. Their roundness and particle size create a ball-bearing effect in creams and lotions, resulting in a silky texture and spread ability</p>		

Figure given above is describing various aspects of Microplastics

6. HAZARDOUS WASTES

<p>What is it?</p>	<ul style="list-style-type: none"> • It is any waste, which because of its characteristics, such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger to health, or environment. • As per the information furnished by CPCB in the year 2015, the total hazardous waste generation in the country is 7.46 million metric tonnes per annum from about 44,000 industries.
<p>Problems associated with hazardous waste</p>	<ul style="list-style-type: none"> • Unscientific disposal of hazardous and other waste through burning or incineration leads to the emission of toxic fumes comprising of Dioxins & Furans, Mercury, heavy metals which causes air pollution and associated health-related problems. • Disposal of such wastes in water bodies, or in municipal dumps leads to toxic releases due to leaching in land and water entailing into degradation of soil and water quality. • The workers employed in such unscientific disposal related practices suffer from neurological disorders, skin diseases, genetic defects, cancer, etc. • Hence, it is quintessential to systematically manage hazardous and other waste in an environmentally sound manner by way of prevention, minimization, re-use, recycling, recovery, utilization including co-processing and safe disposal of waste.
<p>Salient features of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016</p>	<ul style="list-style-type: none"> • It will ensure resource recovery and disposal of hazardous waste in optimum and environmentally sound manner. • For the first time, Rules have been made to distinguish between Hazardous Waste and other wastes. • Waste Management hierarchy in the sequence of priority of prevention, minimization, reuse, recycling, recovery, co-processing; and safe disposal has been incorporated. • Co-processing as preferential mechanism over disposal for use of waste as a supplementary resource, or for recovery of energy has been provided. • Responsibilities of State Government for environmentally sound management of hazardous and other wastes have been introduced. <p>The following items have been prohibited for import:</p> <ul style="list-style-type: none"> • Waste edible fats and oils of animals, or vegetable origin; • Household waste; • Critical Care Medical equipment; • Tires for direct reuse purpose; • Solid Plastic wastes including Pet bottles; • Waste electrical and electronic assemblies scrap; • Other chemical wastes especially in solvent form.

	<ul style="list-style-type: none"> ➤ State Government is authorized to prepare integrated plan for effective implementation of these provisions, and have to submit an annual report to the Ministry of Environment, Forest and Climate Change. ➤ State Pollution Control Board is mandated to prepare an annual inventory of the waste generated; waste recycled, recovered, utilized including co-processed; waste re-exported and waste disposed and submit to the Central Pollution Control Board by the 30th day of September every year.
--	---

7. BIOMEDICAL WASTES

<p>WHAT BIOMEDICAL WASTE IS? AND ITS EXAMPLES.</p>	<ul style="list-style-type: none"> ● Any kind of waste containing infectious (or potentially infectious) materials. ● It includes waste associated with the generation of biomedical waste that visually appears to be of medical or laboratory origin (e.g., packaging, unused bandages, infusion kits, etc.), as well as research laboratory waste containing biomolecules or organisms that are restricted from environmental release. ● Examples of infectious waste include discarded blood, sharps, unwanted microbiological cultures and stocks, identifiable body parts (including those as a result of amputation), other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body fluids, and laboratory waste that exhibits the characteristics described above. ● Biomedical waste is generated from biological and medical sources and activities, such as the diagnosis, prevention, or treatment of diseases.
<p>Salient features of Bio-Medical Waste Management (Amendment) Rules, 2018:</p>	<ul style="list-style-type: none"> ● Bio-medical waste generators including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, health care facilities, and clinical establishments who will have to phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019. ● The State Pollution Control Boards/ Pollution Control Committees have to compile, review and analyze the information received and send this information to the Central Pollution Control Board, which seeks detailed information regarding district-wise bio-medical waste generation, information on Health Care Facilities having captive treatment facilities, information on common bio-medical waste treatment and disposal facilities. ● Every occupier, i.e. a person having administrative control over the institution and the premises generating biomedical waste shall pre-treat the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by the

	World Health Organization (WHO) or guidelines on safe management of wastes from health care activities, then sent to the Common bio-medical waste treatment facility for final disposal.
--	--

8. E-WASTES

- It is a term used to cover **all items of electrical and electronic equipment** and its parts **that have been discarded** by its owner as waste **without the intent of re-use**.
- **Composition**
 - Loosely discarded, surplus, obsolete, broken, electrical or electronic devices.
 - Computer and its accessories monitors, printers, keyboards, central processing units; typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air conditioners, refrigerators and other household appliances.
- **Why dangerous:**
 - It contains toxic substances such as
 - lead and cadmium in circuit boards;
 - lead oxide and cadmium in monitor Cathode Ray Tubes (CRTs);
 - Mercury in switches and flat biphenyls (PCBs) in capacitors and transformers and
 - brominated flame retardant on printed circuit boards, plastic casing, cable and polyvinyl chloride (PVC) cable insulation that release highly toxic dioxins and furans when burned to retrieve copper from the wires.
 - **Also, the presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold quantities make e-waste hazardous in nature.**

Norway model:

- Norway has **e-waste take back system** in place.
- The producers/importers of e-waste in Norway are **obliged to be members of a take-back company and have to pay a fee for their membership to the take-back companies**. This is how it provides the funding for collection and treatment of the waste.
- The take back companies in Norway need to get an approval from the Norwegian Environment Agency. The approval process includes
 - **providing a plan detailing how they will collect e-waste** and treat it in an environmentally sound way.
 - ensuring that they will collect all e-waste from their market share which is determined by how much of electronics is put into the market by their members.
- Creates serious pollution upon disposal.

Why e-waste pollution so critical?

- India generates around 2 million tonnes per annum (TPA) of E-waste of which 12% constituted of telecom equipment alone.
- India is the world's 5th largest e-waste producer acc to ASSOCHAM and soon inching towards the 3rd spot.
- In India, e waste accounts for 5% of global e-waste.
- A recent ASSOCHAM-NEC study on "Electricals & Electronics Manufacturing in India" has revealed that India recycles only 5% of its e-waste and the country is one of the biggest contributors of e-waste in the world.

Salient features of the E-waste (Management) Amendment Rules, 2018:

1. The e-waste collection targets under EPR (Extended polluter responsibilities) have been revised
2. The phase-wise collection targets for e-waste in weight shall be 10% of the quantity of waste generation, with a 10% increase every year until 2023.
 - After 2023 onwards, the target has been made 70% of the quantity of waste generation.
3. Separate e-waste collection targets have been drafted for new producers, i.e. those producers whose number of years of sales operation is less than the average lives of their products.
 - The average lives of the products will be as per the guidelines issued by CPCB from time to time.
4. Producer Responsibility Organizations (PROs) shall apply to the Central Pollution Control Board (CPCB) for registration to undertake activities prescribed in the Rules.
5. Under the Reduction of Hazardous Substances (RoHS) provisions, **cost for sampling and testing shall be borne by the government** for conducting the RoHS test.
 - If the product does not comply with RoHS provisions, then the cost of the test will be borne by the Producers.

9. CONSTRUCTION AND DEMOLITION WASTES

- The construction and demolition waste generated is about 530 million tonnes annually.

Government Intervention:

- The Ministry of Environment, Forest and Climate Change notified the Construction & Demolition Waste Management Rules, 2016.
- The rules are an initiative to effectively tackle the issues of pollution and waste management.

Construction and Demolition Waste Management Rules, 2016

- **Application:** The rules shall apply to everyone who generates construction and demolition waste such as building materials, debris, rubble waste resulting from construction, re-modelling, repair and demolition of any civil structure of individual or organization or authority.

- **Responsibility of service providers:**
 - The service providers shall **prepare a comprehensive waste management plan** covering segregation, storage, collection, reuse, recycling, transportation and disposal of construction and demolition waste generated within their jurisdiction.
 - The service providers shall **remove all construction and demolition waste** in consultation with the concerned local authority on their own or through any agency.
 - **Responsibility of Local Authority:** Local Authority shall be **responsible for proper management of construction and demolition waste** within its jurisdiction including **placing appropriate containers for collection of waste, removal at regular intervals, transportation to appropriate sites for processing and disposal.**
 - **Processing and recycling facility for C & D waste**
 - The processing / recycling site shall be **away from habitation clusters, forest areas, water bodies, monuments, National Parks, Wetlands and places of important cultural, historical or religious interest**
 - **A buffer zone of no development shall be maintained around solid waste processing and disposal facility, exceeding five Tones per day of installed capacity.**
- **Duties of the Central Pollution Control Board (CPCB)-** CPCB shall **prepare operational guidelines** related to environmental management of construction and demolition waste.
- **Duties of the Central Government**
 - The Ministry of Urban Development, and the Ministry of Rural Development Ministry & Panchayat Raj, shall be responsible for **facilitating local bodies in compliance of these rules;**
 - The Ministry of Environment, Forest and Climate Change shall be responsible for **reviewing implementation of these rules** as and when required.
 - Envisage to provide the technical and financial support to the State Agencies from the Central Government for implementation of these Rules and modification of rules according to the requirement in future.

Likely implications of such waste management rule:

- This will address the **indiscriminate disposal of C & D Waste** and **enable channelization** of the waste for **reuse and recycling** in gainful manner
- Duties of waste generators, service providers would **envisage people's participation (Jan Bhagidari) in scientific management** of C & D waste
- Segregation and channelizing the C & D waste **will improve the other waste utilization and management** namely organic waste for composting, high calorific waste to energy recovery etc.
- This will ensure **Sustainability of Waste Management System** of C&D Waste.
- The provision has been introduced on line of concept of Extended Producers Responsibility. Here, the waste generator (Service provider) has been **made responsible for waste generated by them in public places** to authorized C&D waste recycling facilities.
- This has been introduced to seek special attention of local bodies/ agencies responsible for waste management in the States.
- These provisions **will put in place the Institutional framework** for C&D waste management and also **strengthen system** for waste management wherever they exist in the country.

- This will **prevent indiscriminate disposal** and **ensure scientific conversion** C&D waste into useful raw material for buildings/ construction.
- This is to **provide technical support** to local bodies, waste recyclers and other stakeholders.



ENVIRONMENTAL IMPACT ASSESSMENT



www.jkchrome.com

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Meaning and concept of Environmental Impact Assessment (EIA)

- EIA refers to the studies and statements which attempt to produce estimates of future environmental changes related to a proposed action/plan,
- EIA attempts to suggest the probable impact of environmental changes happening due to human's actions and its impact on the environment.
- Environmental Impact Statement (EIA) is an integral part of Environmental Management. Environment conservation, protection and sustainable development have become a necessity in the age of rapid industrialization and urbanization throughout the world.

Origin of EIA	<ul style="list-style-type: none"> ● The genesis of the concept and methods of environmental impact assessment has its root in the enactment of the National Environmental Policy Act (NEPA) in the year 1969 in the USA. ● The Environmental Impact Statement (EIS) in India was started in 1976-77 when the Planning Commission asked the Department of Science and Technology to examine the river valley projects from environmental angle. ● EIA was made mandatory in India under the Environmental (Protection) Act, 1986.
Where can EIA be performed?	<ul style="list-style-type: none"> ● Environmental impact assessment is a method of evaluating environmental consequences i.e. environmental changes that are likely to be caused by the proposed human activities related to land use changes, construction of dams, reservoirs, roads, rails, bridges, etc. and the possible adverse effects of these environmental changes (environmental degradation and pollution resulting in ecological imbalance and ecosystem disequilibrium). ● It is one of the tools available with the planners to achieve the goal of harmonizing development activities with environmental concerns. ● It is one of the most successful interventions in environmental management till date.
Need for Environmental Impact Assessment	<ul style="list-style-type: none"> ● Human impact - In present times anthropogenic activities like rapid industrialization, mass production and clearing of forests have created immense pressure on the natural environment. ● Extinction- Environmental degradation at this pace, if continues, will bring humanity on the brink of extinction. ● Advance assessment – Assessment of environment vulnerability due to initiation of a new project so as to ensure that the economic development and environmental conservation goes hand in hand, appropriate methods and tools have to be formulated. Thus, EIA as a tool aims to minimize the environmental impacts emanating out of any economic activity that have the potential to cause environmental degradation as shown below.

Aims and Objectives of EIA	<ol style="list-style-type: none"> 1. To bring out a national policy to encourage productive and enjoyable harmony between man and environment. 2. To promote efforts to prevent or eliminate damage to the environment. 3. To increase understanding of ecological systems and natural resources important to the nation.
Environmental Impact Assessment (EIA) statements includes the following considerations:	<ul style="list-style-type: none"> • Evaluation of condition- Presentation of the existing environmental conditions in terms of physical, biological, social and economic conditions of the site of the proposed project. • Impact and effects- Statements on the possible effects of proposed project, if implemented, on the proposed site. • Adverse effects- Statements about those unavoidable adverse effects which may come after the implementation. • Alternatives- Presentation of viable alternative projects to the proposed projects. • Financial impacts- Evaluation of the cost of the project and its probable benefits to the society. • Remedial measures- Statements on suitable remedial measures of adverse effects arising out of the project after its implementation.

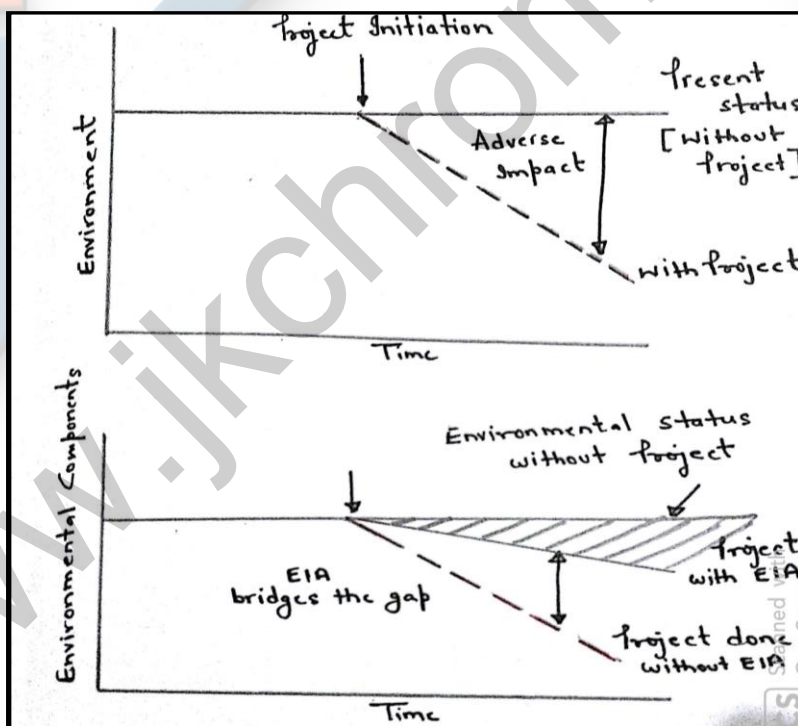


Figure: Environment impact rectification after EIA

Steps and Procedures of EIA process in India

EIA process is a very meticulous one where holistic impact on the site both positive and negative with more emphasis on negative is evaluated so as to give future course of action which shall be taken with respect to the

particular site. If a site's ecological and environmental condition is such that it will impact it negatively such site is left and an alternative site is explored for the project, EIA process account/s for the negative impacts of the said project and if the negative aspects are very severe such project is not picked up. Following are the steps and procedures of EIA process-

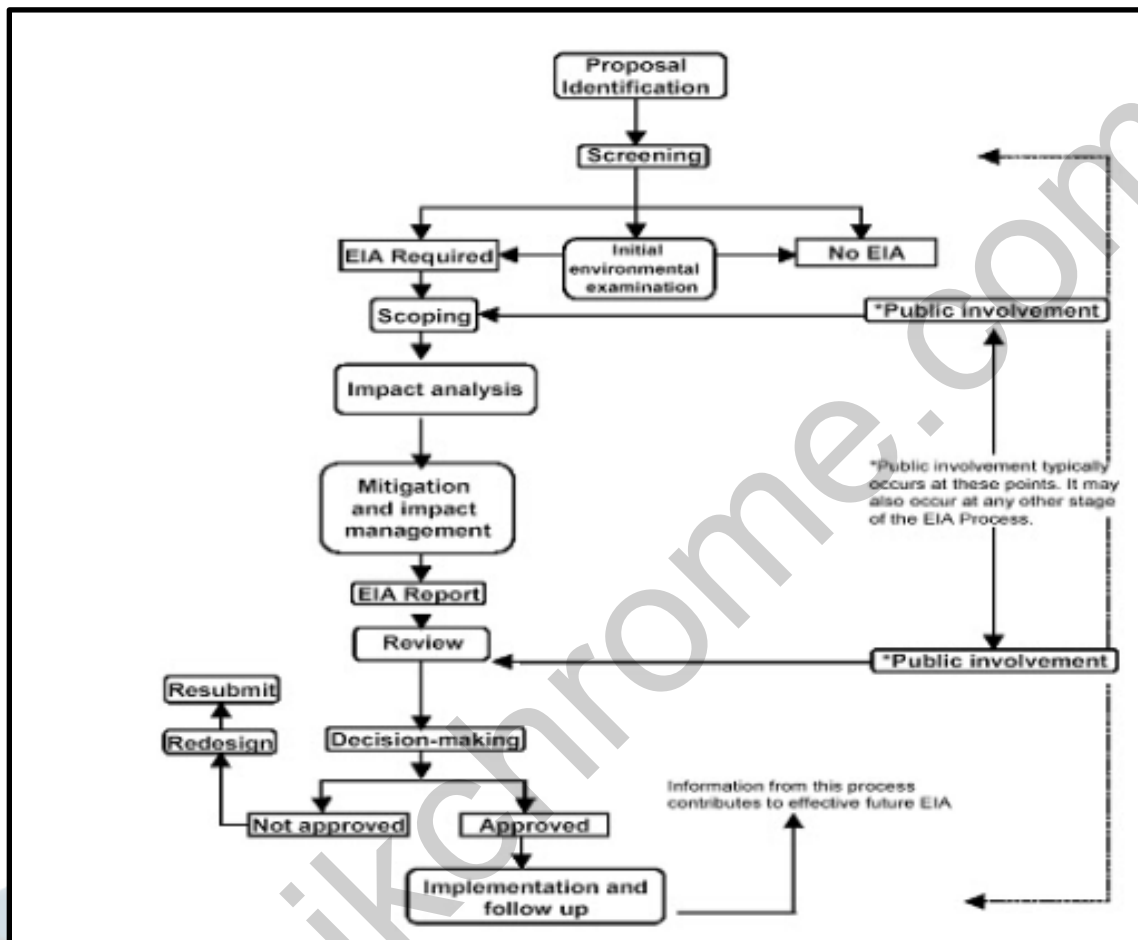


Figure: Areas of Decision Making in the complete EIA process.

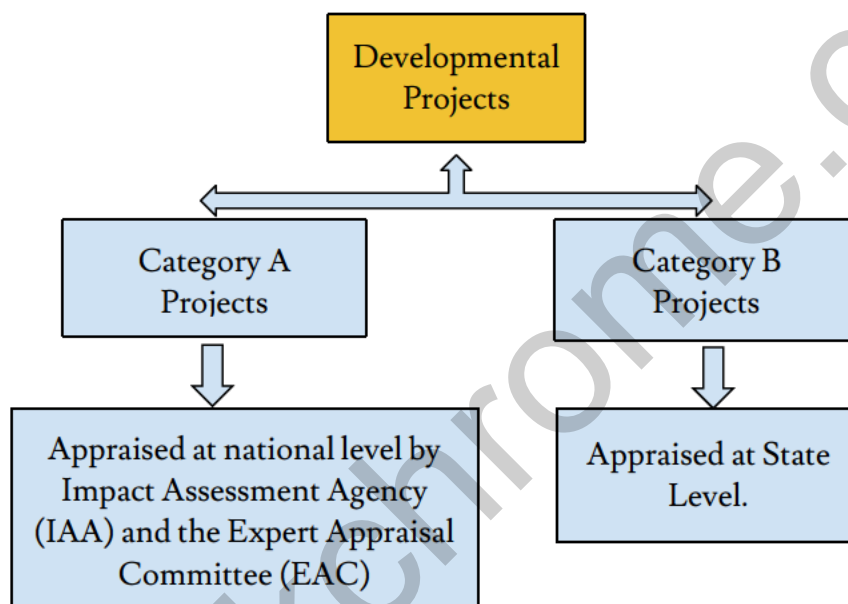
<p>1. Screening</p>	<p>It is done to see whether a project requires environmental clearance as per the statutory notifications. Screening criteria are based upon:</p> <ul style="list-style-type: none"> • Scales of investment • Type of development • Location of development
<p>2. Scoping</p>	<ul style="list-style-type: none"> • Meaning- It looks at the impact on the area that needs to be studied, whether a scope for development on the site exists. • It is a process of providing in detail the terms of reference of EIA. It has to be done by the consultants in consultation with the project proponent and guidance.

	<ul style="list-style-type: none"> • The Ministry of Environment and Forests has published sector wise guidelines which outline the significant issues which have to be addressed while conducting the EIA studies. • For ex. Setting up of Hydro-electric project: impact on river, water, forests, impact on tribes, soil erosion, sediment deposition, seismicity, etc.
3. Baseline Data	<ul style="list-style-type: none"> • It describes the existing environmental status of the identified study area. The site-specific primary data is monitored and supplemented with secondary data.
4. Impact Prediction	<ul style="list-style-type: none"> • Analyzing the possible effects on the physical, biological, social and economic conditions and suggesting alternatives. For example: <ul style="list-style-type: none"> ○ Impact of biological diversity in an area ex. EIA done by Gadgil panel on the western ghats regions. ○ Impact on habitat because of deforestation and pollution- Impact on Himalyan ecosystem when hydropower projects are opened. ○ Impact on endangered animals and migratory paths. For ex Great India hornbill's trail in India is evaluated so as to see that such developmental project is not affecting its pathway. • The predictions of impact can never be absolute and certain and thus there is a need to comprehensively consider all factors and take all possible precautions for reducing the degree of uncertainty. • Predictions should be done and experts and experienced people.
5. Assessment of alternatives, mitigation measures & Environmental, Impact Assessment Report	<ul style="list-style-type: none"> • Identification of alternatives and their comparison- For every project, possible alternatives should be identified and environmental impacts and benefits to be compared. • Alternatives should then be ranked for selection of the best environmental option for optimum economic benefits to the community at large. • Once alternatives have been reviewed, an impact mitigation plan is drawn up. • An EIA Report should provide clear information to the decision maker on the different environmental scenarios without the project, with the project and with project alternatives. • Uncertainties should be clearly reflected in the EIA report.
6. Public Hearing	<ul style="list-style-type: none"> • The public must be informed and consulted on a proposed development after the completion of EIA report. • The Gram Sabha must be consulted before the project starts. Gram sabha means the electorate (people eligible to vote) of the region.
7. Environment Management Plan (EMP)	<ul style="list-style-type: none"> • Delineation of mitigation measures including prevention and control for each environmental component and rehabilitation and resettlement plan. • It also includes delineating in detail the various aspects of financial plan.
8. Decision Making	<ul style="list-style-type: none"> • It involves consultation between the project proponent and the impact assessment authority.

9. Monitoring the clearance conditions	<ul style="list-style-type: none"> • To monitor compliance with the report throughout the project to ensure corrective actions, wherever the impacts exceed the predicted levels. • Monitoring will enable the regulatory agency to review the validity of the predictions and the conditions of implementation of the environmental management plan.
---	---

Salient Features of EIA rules Amendment done in 2006

- Environmental Impact Assessment Notification 2006 has decentralized the environmental clearance projects by categorizing the developmental projects in two categories i.e. Category A and Category B.



- After 2006 Amendment, EIA comprises of four cycles:
 - ❖ Screening
 - ❖ Scoping
 - ❖ Public Hearing
 - ❖ Appraisal
- State Level Environment Impact Assessment Authority (SEIAA) and State Level Expert Appraisal Committee (SEAC) are constituted to provide clearance to category B projects.
- Category A Projects requires mandatory environmental clearance and screening process is not required.
- Category B projects undergo screening process and they are classified in two types:
 - 1) Category B1 Projects: Mandatorily requires EIA
 - 2) Category B2 Projects: Does not require EIA

Thus, category A projects and category B1 projects undergo the complete EIA process whereas Category B2 projects are excluded from complete EIA process.

Procedure for Public Hearing

1. Process of public Hearing

The environmental clearance projects shall be submitted to the State Pollution Control Board.

2. Notice of Public Hearing

- The State Pollution Control Board shall issue a notice for environmental public hearing which shall be published in at least two newspapers widely circulated in the region around the project.
- One of them must be in local vernacular language.
- Suggestions, views, comments and objections of the public shall be invited within thirty days from the date of publication of the notification.

3. Composition of public Hearing Panel

The composition of the public hearing panel may consist of:

- Representatives of State Pollution Control Board
- District Collector or his nominee
- Representatives of state governments dealing with the subject
- Representatives of Department of the State Government dealing with Environment
- Not more than three representatives of the local bodies such as Municipalities or Panchayats.
- Not more than three senior citizens of the area nominated by the District Collector.

Difference between Rapid EIA and Comprehensive EIA

The difference is in the time scale of the data supplied. But both types require complete coverage of all EIA procedures.

<p>Rapid EIA: Under Rapid EIA data supplied is of only one season (other than monsoon) to reduce the time required.</p> <p>Rapid EIA is for speedier appraisal process.</p>	<p>Comprehensive EIA: It collects data from all four seasons.</p> <p>Rapid EIA is acceptable if it does not compromise upon the quality of decision making. The review of Rapid EIA submissions will show whether a comprehensive EIA is warranted or not. Therefore, submission of comprehensive EIA in the first stance would generally be more efficient approach.</p> <p>Comprehensive EIA includes appraisal of those projects whose analysis is not to be done soon, here time is not the essential factor but the quality of the appraisal is.</p>
--	--

Critical evaluation of EIA in India

Applicability	There are several projects with environmental impacts that are exempted from the notification. Ex. Low scale sand mining.
Inadequate capacity of EIA approval authorities:	Lack of technical and environmental experts, anthropologists and social scientists among the members and involvement of crony capitalism and nexus between

	corporates and politicians leads to faulty decision making, where projects which severe harm the environment may also get approved.
Deficiencies in screening, scoping and impact analysis:	<ul style="list-style-type: none"> • There are no independent bodies and no standardized formats for project evaluation. • Absence of standardized baseline data brings arbitrariness in impact prediction. • It is allegedly done by those people which are on the payroll of company which creates a conflict of interest. They intentionally exclude negative impact on forests/ environment and impact on tribes during the scoping process.
Poor quality EIA reports:	<p>EIA is used presently as a project justification tool rather than as a project planning tool to contribute to achieving sustainable development.</p> <p>Involvement of planning for future activities should also be focused upon along with the justification of the project itself.</p> <p>It is not just a tool to describe YES or NO regarding a project but also about how the harm if any to the environment can be minimized, so as to be pollution neutral and environmentally sustainable.</p>
Initiated at a later stage	One of the faults in India is that it is undertaken at a much later stage, especially after the project has been designed, approved and almost ready for construction. Thus, by the time EIA starts huge costs are incurred and the project becomes too big to fall.
Inadequate public participation:	<ul style="list-style-type: none"> • In many countries like Nepal, Argentina and Australia, public involvement is mandatory at various stages of the EIA process (i.e. screening, scoping, report preparation and decision making), but in India consultation occurs only once, just before decision making, and the points raised by the public are rarely taken into account. • Even the notifications issued for public hearing are not published in local vernacular languages thus keeping it out of the scope of understanding of locals.
Weak monitoring:	<ul style="list-style-type: none"> • Monitoring is not done through an independent agency. • Environment management plans of strategic industries like nuclear energy are not put into the public domain.

While shortcomings are challenging, Government of India is showing a high degree of commitment. The EIA system in the country is undergoing progressive refinements by steadily removing the constraints.

Measures for strengthening the EIA process:

Independent Agency:	<ul style="list-style-type: none"> • The entire EIA process right from screening to monitoring should be done by independent agencies and establishing a National Accreditation Body for agencies carrying out EIA. • Creation of centralized baseline data bank.
Applying Precautionary Principle:	<ul style="list-style-type: none"> • The list of concerns raised by the public should be studied in detail to arrive at any conclusion. Ex. GM crops.

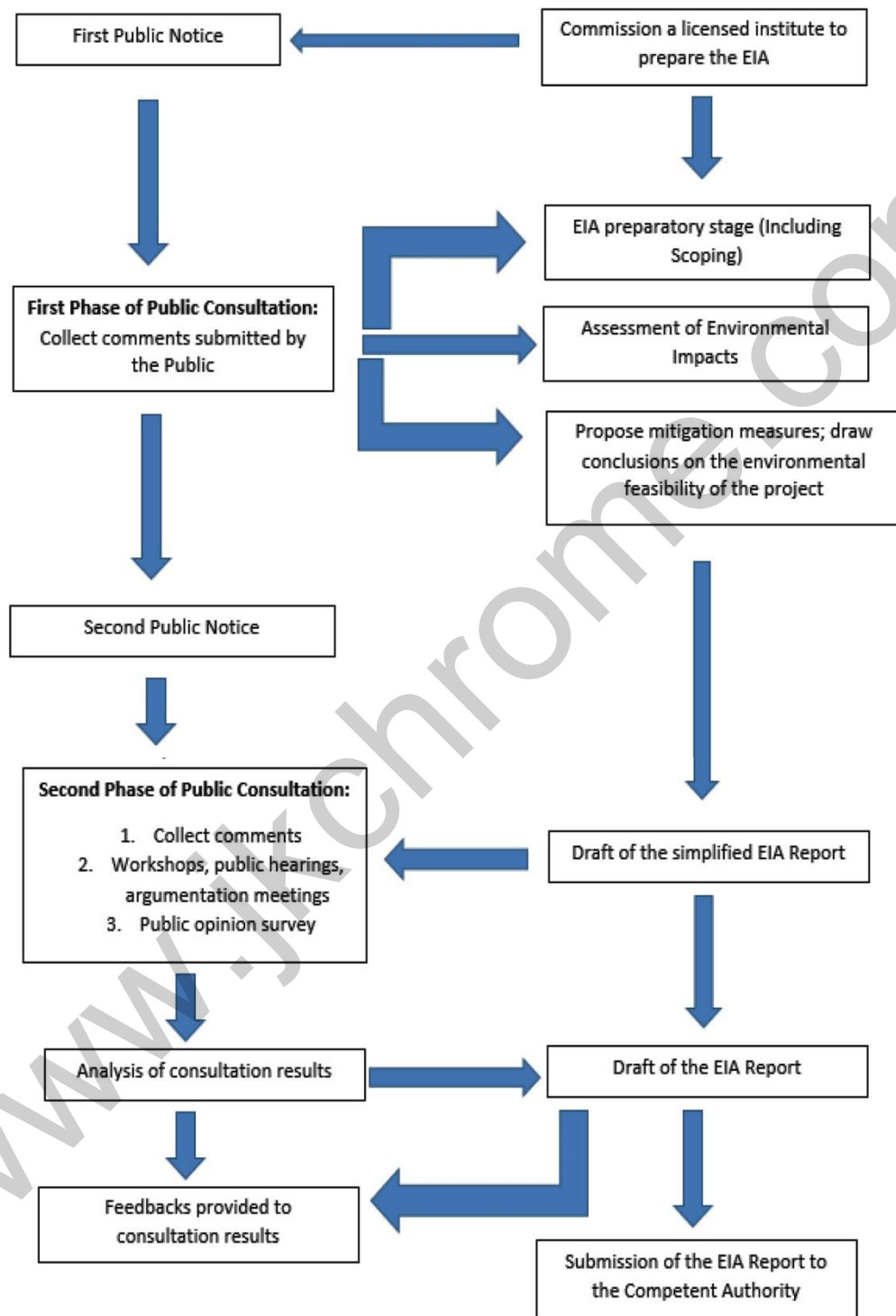
	<ul style="list-style-type: none"> Clearances given to project that is not clearly justified becomes questionable as happened in Sethusamudram Project.
Strategic Environment Assessment (SEA)	It helps in choosing a project and not just evaluate it. It offers alternatives and guides project financing. The directives of SEA are reflected in the National Environment Policy 2006. Similarly, Nepal also carries out SEA's.
Robust and Inclusive public hearing:	A key role for local people through Panchayats and ULB's at every stage. Special focus on forests and tribal. The traditional knowledge of locals needs to be incorporated.
Transparency	Greater transparency in the clearance process and dissemination of all documents for public scrutiny.
Capacity Building	NGO's, civil society groups and local communities need to build their capacities to use the EIA notification towards better decision making on projects that can impact their local environments and livelihoods. Capacities can be built to proactively and effectively use the notification rather than respond in a manner that is seen as negative or unproductive.

Case study: Neutrino Observatory, Bodhi Hills, Theni

- The project has been approved under category B item 8(a) — building and construction projects — of the Schedule to the Environmental Impact Assessment (EIA) Notification, 2006.
- It should have been treated as category A as the project lies just 4.9 km from the national park in Idukki district of Kerala.
- Once, EIA was done by the Salim Ali Centre for Ornithology and Natural History, which is an “unaccredited agency”.

And though a public consultation with local people who have a “plausible stake” in the project was conducted in July 2010, the details of the meeting were submitted only by the end of February 2018.

Case Study: EIA Public Participation process in China



WAY FORWARD

In a world that is challenged by environmental degradation and social conflicts, scholars have upheld **public and local participation** to be a “threshold condition” for development. EIA provides this necessary element in the economic development process. Therefore, EIA-based approvals for most projects should mandatorily and necessarily involve the process of conducting public hearings so that the views and opinions of people who are likely to be affected can be taken on board before a decision to approve the project is made so as to reduce future scope of resentment.



ENVIRONMENTAL ISSUES



ENVIRONMENTAL ISSUES

The **relationship** between **Environment and human**, that is **essential and necessary** has been established since time immemorial. However, **unprecedented population growth** in the developing nations and **unsustainable consumption patterns** in the developed nations have burdened both ‘**assimilative**’ and ‘**absorptive**’ capacity of **Mother Nature**.

The **anthropogenic activities** have caused immense damage to the nature and functioning of its ecosystem. These activities like **unsustainable mining and quarrying, reckless deforestation, indiscriminate use of fertilizers and pesticides** that has altered the mutual relationship existing between human and nature have resulted into **environmental issues like desertification, soil erosion, bleaching of coral reefs, ozone depletion, etc.**

But in the race of endless economic development, humanity forgot that it’s not nature whose existence is threatened rather it’s humanity itself would come to the brink of collapse in the future. Therefore, to ensure **equity and equality** in the distribution of natural resources both for **present as well as future** lies at the heart of a dilemma between **environmental consciousness and economic development**.

I. DEFORESTATION

Concept-	<p>Deforestation is a mass elimination of trees which continues to threaten tropical forests, their biodiversity and the ecosystem services they provide.</p> <p>The conversion of forests through felling trees, clearance and burning through anthropogenic activities into non-forest use like agriculture, urbanization and industrialization is called deforestation.</p> <p>However, the term deforestation is more associated with felling of trees in the equatorial rainforests’ region like Amazon rainforest, Congo rainforest, etc.</p> <p>The extent of deforestation can be understood through realizing the fact that the world has been losing forest land equivalent to the size of 1,000 football fields every one hour in the last 25 years.</p>
Importance of Forests:	<ul style="list-style-type: none"> ● Forest and Climate: Forest acts as lungs of earth. They are rain magnets and does carbon sequestration. They stabilize the climate and helps in mitigation and adaptation of climate change. ● Forest and Land: Forests promote soil formation, prevents soil erosion and soil degradation and are home to major gene pool centers. ● Forest and Water: Forests reduces runoff and promotes percolation thus recharging groundwater. They also contribute heavily in the hydrological cycle. ● Forest and Humans: Forest provides food, timber, wool, hides, gums, etc. They are sources of livelihoods for many people. ● Forest and Tribal: Forests are integral for the survivability of the indigenous people as they provide basic resources for their food and livelihoods.
Forest Data of India:	<ul style="list-style-type: none"> ● With a forest cover of 24.4 percent, India stands well behind its target of 33 percent, and much behind the neighboring country of Bhutan which boasts a cover of 72 percent.

	<ul style="list-style-type: none"> ● Meanwhile, the country is roughly on an equal footing with China that has a green cover of 21.7 percent. ● In February this year, the Forest Survey of India (FSI) published its State of Forest 2017, which recorded a modest increase of 1 percent in the forest cover, from 7,01,673 sq km in 2015 to 7,08,273 sq km in 2017. ● According to recent data acquired through RTI from the Ministry of Environment and Forest revealed that on an average forest land diverted across the country stands at 135 hectares per day. ● Karnataka, Madhya Pradesh, Chhattisgarh, Maharashtra, Arunachal Pradesh and Jharkhand are the states where maximum diversion of forests has taken place.
<p>Causes of Deforestation</p>	<p>Anthropogenic Activities:</p> <ul style="list-style-type: none"> ● Expansion of Agriculture- For setting up of agriculture vast patches of trees are cleared, recent examples include, Brazil's rainforests being cleared to grow soybean and various other agricultural crops. ● Commercial Logging- Logging and lumbering activity is also behind the clearing of forests. Logging is done for furniture making etc. ● Urbanization and Industrialization- Forests are cut down to create human settlements or setting up of industries. Urbanization which is happening haphazardly has made it incumbent upon humans to clear trees so as to create their shelters. ● Mining and Quarrying- Many resources like coal, oil, natural gas and other such resources are seen to be buried in the areas of high forest density. To extract such resources from the land clearing of forest is done. ● Wood as Domestic Fuel Supply- At grassroot level due to unavailability of cleaner sources of fuel, wood is felled and used as a fuel, the tree logs are cut down so as to meet domestic fuel needs. ● Shifting Cultivation- Jhum or similar form of shifting cultivation is done so as to reap the benefits of a nutrient rich soil and when once the nutrients deplete the growers move towards other areas. The mechanism involves felling of forests, once the patch of land is cleared crops are grown and nutrient gets depleted over a period of time in such a manner. ● Negligence- Forest fires start due to negligence which causes the whole forest to burn. Recently, chir pine needles in the lower Himalayan (Uttarakhand) region became reason of forest fires as small fire, even a single match being lit and thrown on them or friction between vehicle tires and road can create conflagration of the whole forest. <p>Natural Factors:</p> <ul style="list-style-type: none"> ● Lightning- lightning and thunderstorms causes trees to burn and such fire spreads and burns more trees.

	<ul style="list-style-type: none"> Global Warming- Climate change and global warming is a major factor which is creating changes in environment due to which the warming increases and changes in weather affects the growth and resilience of the forests.
Consequences of Deforestation:	<ul style="list-style-type: none"> Reduction in Carbon Sequestration- Trees are a major capturer of carbon, if trees are cut down it reduces the carbon sequestration ability of nature. Depleting underground Water Table- Trees and their roots help in seepage of water down the soil in the water table, if trees are not available, water seepage will reduce and it will become difficult for the local population to survive. Decrease in Soil Productivity- Soil productivity reduces massively due to deforestation, soil erosion happens as tree roots in the soil hold it tightly and does not let the soil to get eroded away, unavailability of trees will ultimately reduce productivity. Reduction in livelihood Opportunities – More deforestation means those who are dependent on forests, they won't be able to survive, indigenous tribal population which are vastly dependent on forests and its resources. Increase in intensity and Magnitude of Natural Disasters- Natural disaster's occurrence becomes frequent and its intensity also rises, some examples of this is Forest Fires, worsening floods, landslides and droughts. Biodiversity Extinction- The biodiversity which is totally dependent on the forest for their habitat, food etc. will go extinct eventually if ecological services are affected due to deforestation.
Forests and Climate Change	<ul style="list-style-type: none"> Deforestation = one of the main contributors to climate change. It comes in many forms, natural fires, agricultural clear cutting, livestock ranching, and untenable logging for timber, and degradation due to climate change, and etc. Deforestation = 2nd largest anthropogenic source of carbon dioxide to the atmosphere, after fossil fuel combustion. Deforestation and forest degradation contribute to atmospheric greenhouse gas emissions through combustion of forest biomass and decomposition of remaining plant material and soil carbon. It used to account for more than 20% of carbon dioxide emissions, but it's currently somewhere around the 10% mark. Averaged over all land and ocean surfaces, temperatures warmed roughly 1.53 °F (0.85 °C) between 1880 and 2012, according to the Intergovernmental Panel on Climate Change.
Striving towards achieving INDC goal through increase in forest cover	<ul style="list-style-type: none"> India is striving towards achieving its NDC goal of creating additional carbon sink of 2.5 to 3.0 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030. <p>As per present assessment total carbon stock in forest is estimated to be 7,082 million tonnes. There is an increase of 38 million tonnes in the carbon stock of country as compared to the last assessment.</p>

State of Forest Report 2017 and its Analysis:

- Published by **Forest Survey of India** (under MoEFCC), Dehradun
- India has **21.73% of geographic area under forest**. India posted a **marginal 0.21% rise in the area under forest** between 2015 and 2017, according to the **biennial India State of Forest Report (SFR) 2017**.
- State with largest forest area = **Madhya Pradesh** (77,414 km²)
 - Haryana = Minimum forest cover (by area & by %age)
- Andhra Pradesh, Karnataka and Kerala topped the States that posted an increase in forest cover.
- In India's **north-east** however, forest cover **showed a decrease**.
- The category of '**very dense forest**'— defined as a canopy cover over 70% — and an indicator of the quality of a forest, **saw a dramatic rise** but the category of '**moderately dense forest**' (40%-70%) **saw a decline** from 2015.
- India's total forest cover increased by 0.94 per cent in the last two years, shows the State of Forest Report 2017
- India is ranked 10th in the world, with 24.4% of land area under forest and tree cover.
- The forest survey for the **first time mapped 633 districts** and relied on satellite-mapping.
- **BAMBOO**: Earlier this year, the government ceased to define bamboo as a tree to promote economic activity among tribal. The survey found that India's **bamboo bearing area rose** by 1.73 million hectares (2011) to 15.69 million hectares (2017).
- The report also points towards an **expansion of agro-forestry and private forestry**. There is a jump from 42.77m³ in the 2011 assessment to 74.51m³ in timber production in 'Trees outside Forests' (TOF) category.
- That most of the increase in the forest cover was observed in Very Dense Forest (VDF). The increase in forest cover in VDF is followed by increase in open forest.

<i>Class</i>	<i>Area sq. kms</i>	<i>% of geographical area</i>	<i>% of geographical area (SFR 2015)</i>
Very Dense Forest	98,158	2.99	2.26
Moderately Dense Forest (all lands with tree cover including mangrove cover with canopy density between 40-70%)	3,08,318	9.38	9.59
Open Forest (all lands with tree cover including mangrove cover with canopy density between 10-40%)	3,01,797	9.18	9.14
Total Forest Cover	7,08,273	21.54	21.34

Difference between Forest Cover and Recorded Forest Area?

- "Forest Cover" refers to **all lands more than one hectare in area with a tree canopy of more than 10% irrespective of land use, ownership and legal status.**
 - It may include even orchards, bamboo, and palm.
- "Forest Area" refers to **all the geographic areas recorded as 'Forest' in government records** under Indian Forests Act, 1927 and under other respective local acts.
 - Such areas with less than 10% tree cover such as cold deserts, alpine pastures will be excluded from the assessment.

Assessment of the Forest Report:

Forest and Tree Cover of the country **has increased by 8,021 sq km (1 %)** as compared to assessment of Forest survey 2015. The **very dense forest has increased by 1.36 %** as compared to last assessment.

Assessment:

- The increasing trend of forest and tree cover is largely due to the **various national policies** aimed at conservation and sustainable management of our forests like **Green India Mission, National Agroforestry policy (NAP), REDD plus policy, Joint Forest Management (JFM), National Afforestation Programme and funds under Compensatory Afforestation to States.**
- **Successful agroforestry practices, better conservation of forests, improvement of scrub areas to forest areas, increase in mangrove cover, conservation and protection activities** have also led to an increase in the forest and tree cover.
- **Green Highways (Plantations & Maintenance) Policy** to develop 1,40,000 km long tree line with plantation along with both sides of national highways will go a long way in enhancing the forest & tree cover.

Top 5 states where forest cover has decreased are

Mizoram (531 sq km), Nagaland (450 sq km), Arunachal Pradesh (190 sq km), Tripura (164 sq km) and Meghalaya (116 sq km).

Assessment:

- It is important to mention here that these states are in the North Eastern region of the country where the total forest cover is very high i.e. **more than 70% in each state.**
- The main reasons for the decrease are - **shifting cultivation, other biotic pressures, rotational felling, diversion of forest lands for developmental activities, submergence of forest cover, agriculture expansion and natural disasters.**

Water bodies inside forests have increased by 2,647 sq. km over a decade

- Forests play a vital role in water conservation and improve the water regime in the area.
- State Forest Departments besides plantation and protection also undertake steps to improve water conservation through different interventions such as **building Check dams, vegetation barriers, percolation ponds, contour trenches** etc. under various Central & State Government schemes
- **Maharashtra (432 sq kms), Gujarat (428 sq kms), Madhya Pradesh (389 sq km) are the top three states** showing an increase in water bodies within forest areas.

Mangrove cover of the country has shown a positive change

- As per ISFR 2017, mangrove forests have increased by 181 sq. kms.
- Maharashtra (82 sq. kms), Andhra Pradesh (37 sq. kms) and Gujarat (33 sq. km) are the top three gainers in terms of mangrove cover.
- 7 out of the 12 mangrove states have shown an increase in mangrove cover and none of them show any negative change.
- Mangrove ecosystems are rich in biodiversity and provide a number of ecological services. They also play a major role in protecting coastal areas from erosion, tidal storms and tsunamis.

Criticisms of Forest Report:

1. According to the report, forest and tree cover together registered a 1% rise over the previous estimate two years ago. However, such an estimate listing very dense, moderately dense, open and scrub forests mapped through remote sensing does not really provide deep insights into the integrity of the green areas.
2. There has been an increase over the baseline cover of 20% at the turn of the century. Yet, tree cover is not the same as having biodiverse, old-growth forests.
3. The ecosystem services performed by plantations that have a lot of trees grown for commercial purposes cannot be equated with those of an undisturbed assemblage of plants, trees and animals.
4. The Ministry's report has calculated a cumulative loss of forests in Mizoram, Nagaland and Arunachal of nearly 1,200 sq. km. Any gains achieved through remediation programmes in Odisha, Assam, Telangana, Rajasthan, Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir and Manipur cannot compensate the loss in North East adequately.

1.7 Government Initiatives Towards Conservation of Forests:

National Mission for a Green India: The objectives of the Mission: increased forest/tree cover and improved quality of forest cover in two to eight million hectares, along with improved ecosystem services including biodiversity, hydrological services, increased forest-based livelihood income of households, living in and around the forests, and enhanced annual CO₂ sequestration.

Implementation:

- Mission implementation will be on a decentralized participatory approach with involvement of grass root level organizations in planning, decision making, implementation and monitoring.
- The gram sabha and the committees mandated by the gram sabha, including revamped JFMCs will oversee implementation at the village level.

Partnership for Land Use Science (FOREST PLUS)

- A joint programme by the United States Agency for International Development (USAID) and the Ministry of Environment, Forest and Climate Change (MoEF&CC)
- To strengthen capacity for REDD (Reducing Emissions from Deforestation and Forest Degradation) implementation in India.
- The programme brings together experts from India and the United States to develop technologies, tools and methods of forest management to meet the technical challenges of managing forests for the health of the ecosystem, carbon stocks, biodiversity and livelihood.

National Redd+ Strategy

Complying with the UNFCCC decisions on REDD+, India has prepared its **National REDD+ Strategy**.

REDD +: Reducing Emissions by Deforestation and Degradation

An initiative finalized under the UN's Paris Agreement in 2015

A mechanism developed by Parties to the United Nations Framework Convention on Climate Change (UNFCCC)

It creates a financial value for the carbon stored in forests by offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development.

Developing countries would receive results-based payments for results-based actions.

REDD+ goes beyond simply deforestation and forest degradation and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

- The Strategy builds upon existing national circumstances which have been updated in line with India's National Action Plan on Climate Change, Green India Mission and India's Nationally Determined Contribution (NDC) to the UNFCCC.
- India has begun implementing REDD+ pilot projects, developing protocols for improving measurement, reporting, and verification (MRV) and safeguard information systems (SIS).

Compensatory Afforestation Act, 2016

This act provides for setting up **Compensatory Afforestation Fund Management and Planning Authority (CAMPA)** at both **central and state level** to ensure **expeditious and transparent utilization of amounts realized in lieu of forest land diverted for non-forest purpose**. The utilization of funds is expected to mitigate the impact of diversion of such forest land.

Why CAMPA:

- Continuous diversion of forests (20,000-25,000 hectares per year acc to MoEFCC) => a large sum of money is being accumulated by the government.
- At present, more than Rs 40,000 crore has been realized and it is increasing at the rate of about Rs 6,000 crore every year.
- So, **to manage this money + to utilize it for the designated purposes** = the CAMPA is proposed to be set up.
- The **compensatory afforestation money** and **NPV** are supposed to be **collected from the user agency by the state government** where the project is located, and **deposited with the central government**. The money will eventually flow back to the state to be used for afforestation or related works.

Draft National Forest Policy 2018

Background:

- The first National Forest Policy in independent India took effect in 1952, with a second edition in 1988.
- Once finalized, the 2018 policy will guide the forest management of the country for the next 25-30 years.

Salient features of the draft policy:

- **Objective:** To safeguard the ecological and livelihood security of people, of present and future generations, based on sustainable management of the forests for the flow of ecosystem services.
- **Aim:** Bringing a minimum of **one-third of India's total geographical area under forest or tree cover.**
 - In the hills and mountainous regions, the aim will be to maintain two-thirds of the area under forest and tree cover.
- **Conservation:** It proposes to restrict “schemes and projects which interfere with forests that cover steep slopes, catchments of rivers, lakes, and reservoirs, geologically unstable terrain and such other ecologically sensitive areas”.
- **New Bodies:** It suggests setting up of two national-level bodies—National Community Forest Management (CFM) Mission and National Board of Forestry (NBF)—for better management of the country's forests.
- **Afforestation:** “Public-private participation models will be developed for undertaking afforestation and reforestation activities in degraded forest areas and forest areas available with forest development corporations and outside forests”.
 - It calls for “promotion of trees outside forests and urban greens”, while stating that it will be taken up in “mission mode”.
- Efforts will be made to achieve harmonization between policies and laws like Forest Rights Act (FRA) 2006”.
- **Community participation:** “India has a rich and varied experience in participatory forest management and thus there is a need to further strengthen this participatory approach, for which a National Community Forest Management (CFM) Mission will be launched.”
 - All efforts to ensure synergy between gram sabha & JFMC (Joint Forest Management Committee) will be taken for ensuring successful community participation in forest management”.
- **Finances required for management of forests:** The compensatory afforestation fund which is being transferred to the states would be a major source of funds for taking up afforestation and rehabilitation works in degraded forest areas as well as for bringing new areas under forest and tree cover.
- **Forest fire:** It addressed the issue of forest fires, stating that “adequate measures would be taken to safeguard ecosystems from forest fires, map the vulnerable areas and develop and strengthen early warning systems and methods to control fire, based on remote sensing technology and community participation.”
- **Climate change:** It emphasized on integrating climate change concerns into forest management while noting that forests acts as a natural sink of carbon dioxide thereby assisting in climate change mitigation.
- **Wildlife conservation:** “wildlife rich areas and corridors outside protected areas would be identified and maintained for ensuring ecological and genetic continuity.”
- **Human-wildlife conflict:** To tackle rising human-wildlife conflict, the draft outlined short-term and long-term actions.

Critical Analysis of Government Initiatives

Compensatory Afforestation Act, 2016

Difficulties in implementation:

- Lack of availability of non-forest land for afforestation.
 - Law says: **the land selected should preferably be contiguous to the forest being diverted**, so that it is easier for forest officials to manage it.
 - But in case that is not possible, land in any other part of the state can be used for the purpose.
 - **If no suitable non-forest land is found, degraded forests can be chosen for afforestation, but in that case, twice the area of diverted forest has to be afforested. Still, there is difficulty in finding land**, especially in smaller states, and in heavily forested ones like Chhattisgarh.
- The purposes for which the money can be used.
 - **The fund was envisaged to be used only for “compensatory” afforestation**, but the Act has expanded the list of works that this money can be utilized for
 - the general afforestation programme run through the Green India Mission.
 - Forest protection,
 - forest management,
 - forest and wildlife related infrastructure development,
 - wildlife conservation,
 - facilitating the relocation of people from protected wildlife areas etc.
 - Critics say **this will take the focus away from the prime objective of compensating for the forest cover lost to industrial or infrastructure development.**

Criticism: As per civil society groups

- Provisions of the Act fundamentally are opposed to Forest Rights Act (FRA) and **did not address the legal rights of scheduled tribes and other traditional forest dwellers (OTFDs)**. Reason: consent of gram sabhas for implementation of compensatory afforestation on their customary lands **not required**.
- Community forest rights (CFRs) recognized under the FRA now constituted a new forest category to be governed and managed by the gram sabhas and forest rights holders. Therefore, any government programme on forest lands, including with CAMPA funds, had to be compatible with that law.
- **The structure of funding and implementation proposed under CAMPA Bill was entirely opposed to the structure of forest governance established by FRA**
- Major reason for poor implementation of FRA = the **opposition of the forest bureaucracy to empowerment of gram sabhas and democratization of forest governance**
- CAMPA Bill would serve only to empower notoriously unaccountable bureaucracy to further deprive forest dwellers and tribal of their livelihood by forcibly undertaking plantations on their customary lands
- **In many cases, under the name of infrastructure development, the funds have been misused for administrative and non-budgeted tasks.**

Way forward:

- CAMPA funds can be used for securing the existing natural tracks, make forests contiguous, safeguarding habitat and providing fair compensation to the local stakeholders.

- The National Highway Authority of India (NHAI) has suggested that the **CAMPA funds could be used for mitigation of wildlife deaths on roads by creating underpasses and by-passes for animals.**
- Wildlife impact assessment has to be conducted over the kind of infrastructure the CAMPA money has created.

Draft National Forest Policy 2018


Criticism of the policy:


- The draft policy **persists with the outdated approach on plantations** to tackle the challenge of climate change.
- The draft policy **fails to mention or address the degradation of growing stock in the natural forests.**
- The policy remains **vague on the issue of forests rights for forest dwelling communities.**
 - FRA is a major movement in forest areas at present and its progress has been very lackadaisical over a decade of its implementation in India.
- The draft policy
 - **Does not discuss in detail the issue of diversion of forest land for mining** and other purposes.
 - Orients itself more on the conservation and preservation of forest wealth rather than regenerating them through people's participation.
 - **Mentions major forestry issues ailing the forest sector, but it doesn't provide answers to them** as to how these objectives will be achieved considering the competitive demands for forestlands.

2. SOIL EROSION

Meaning and Concept	Soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage. Erosion, whether it is by water, wind or tillage, involves three distinct actions – soil detachment, movement and deposition. <ul style="list-style-type: none"> • Soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinization and soil acidity problems = can accelerate the soil erosion process.
Extent of Soil Erosion in India:	<ul style="list-style-type: none"> • <i>The National Assessment of Shoreline Changes along Indian coast</i> says that almost 1/3rd of India's 6,632 km coastline was lost to soil erosion between 1990 and 2016. • It has been estimated that an area of 80 mha of our total area is exposed to wind and water erosion out of which 40 million hectares of land has undergone serious erosion. • About 45 million hectares of land is subject to severe wind erosion in Rajasthan, Punjab, Haryana, Gujarat and Western Uttar Pradesh. • According to ICAR, there are 40 lakh hectares of ravines. Out of which 28 lakh hectares are in the states of Uttar Pradesh, Madhya Pradesh, Rajasthan and Gujarat.

	<ul style="list-style-type: none"> • In Madhya Pradesh about 4 to 8 lakh hectares are affected by deep gullies and ravines along the banks of rivers Chambal and Kali Sindh. • The flood plains of Ganga and its tributaries in Uttar Pradesh and Bihar also suffer from soil erosion due to water. The Siwalik Range has also been badly affected by gully erosion. Erosion by Chos in Punjab is most marked in Hoshiarpur district. • It has been estimated that 15 lakh hectares of forest land is cleared for shifting agriculture every year. Ex. Nilgiris, Lushai Hill, Naga Hills, etc. • Coastal erosion is evidenced along the coast of Kerala by uprooting of coconut trees.
Causes of soil erosion	<p>Natural Factors:</p> <ul style="list-style-type: none"> • Water erosion: Runoff water is responsible for much soil erosion, moving the soil particles by surface creep, saltation and suspension. Water erosion can be through splash erosion, sheet erosion, rill erosion and gully formations. The slope of land is potent factor in determining the velocity of water and the consequent soil erosion. • Erosion due to waves and glaciers: Soil erosion by tidal waves along coasts and erosion among the higher reaches of Himalayas by glaciers. • Wind erosion: Winds blowing at considerable speed in arid and semi-arid lands with little rainfall remove the fertile, arable, loose soils leaving behind a depression devoid of topsoil. <p>Anthropogenic factors:</p> <ul style="list-style-type: none"> • Deforestation: Roots of trees and plants bind the soil particles and regulate the flow of water, thus saving soil from erosion. Ex. Chos of Punjab and Ravines of Madhya Pradesh are the result of deforestation. • Overgrazing: It leads to lose structure of the soil especially during dry period. The soil gets easily washed away during rains. • Faulty methods of agriculture: The most outstanding are wrong ploughing, lack of crop rotation, indiscriminate use of chemical fertilizers, over-irrigation and practice of shifting cultivation. • Soil Compaction: It occurs when soil particles are pressed together, reducing pore space between them. It reduces percolation and promotes run-off. <p>Soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinization and soil acidity problems are other serious soil degradation conditions that can accelerate the soil erosion process.</p>
Consequences of Soil Erosion:	<ul style="list-style-type: none"> • Productivity loss: It leads to loss of soil fertility and fall in agricultural productivity. • Ecological problems: The agricultural runoff releases nutrients into water bodies and causes eutrophication. Ground water level is lowered and there is a decrease in soil moisture.

	<ul style="list-style-type: none"> ● Environmental hazards: The incidence and damaging power of landslides increases. Frequency and intensity of floods and droughts increases. ● Social problems: It leads to rural out-migration and slums development, social conflicts and low sex ratio in urban areas. ● Economic problems: There is loss of livelihood in rural areas and contribution of agriculture in GDP reduces.
<p>Government Initiatives Towards Prevention and Remediation of soil:</p>	<p>ICAR, through National Bureau of Soil Survey and Land Use Planning, Nagpur conducted scientific soil survey from time to time for assessing the extent and nature of soil erosion and land degradation across the country.</p> <ul style="list-style-type: none"> ● In order to prevent soil erosion and land degradation, Ministry of Agriculture is implementing various watershed programmes, namely; <ul style="list-style-type: none"> ○ National Watershed Development Project for Rainfed Areas (NWDPA), ○ Soil Conservation in the Catchments of River Valley Project and Flood Prone River (RVP&FPR) and ○ Reclamation and Development of Alkali & Acid Soils (RADAS) across the country. ● Ministry of Rural Development is also implementing Integrated Watershed Management Programme (IWMP) for the purpose. ● About 57.61 million ha area has been developed under various watershed development programmes of Ministry of Agriculture and Ministry of Rural Development since inception upto 2011-12. ● Besides, 1.5 million ha sodic land has been reclaimed using gypsum technology and 0.5 million ha saline land have been reclaimed using sub-surface drainage technology across the country.
<p>What more needs to be done to prevent Soil Erosion:</p>	<ul style="list-style-type: none"> ● Careful tilling: Because tilling activity breaks up the structure of soil, doing less tilling with fewer passes will preserve more of the crucial topsoil. ● Crop rotation: allows organic matter to build up, making future plantings more fertile. ● Contour bunding and Farming ● Strip Cropping <p style="text-align: center;">Figure below shows how crops are grown in strips</p> 

	<ul style="list-style-type: none"> • Terracing  • Shelter Belt • Mulching: Applying a layer of mulch to the soil top allows the soil to slowly soak up water, as it protects against rain impact, and restores pH levels = erosion prevention • Increased structure for plants: Introducing terraces or other means of stabilizing plant life or even the soil around them can help reduce the chance that the soil loosens and erodes. • Water control: specialized chutes and runoff pipes can help to direct these water sources away from the susceptible areas <ul style="list-style-type: none"> ○ Retaining Walls can be built around the area of erosion to prevent water run-off. ○ Gully Reclamation
--	--

3. DESERTIFICATION

Meaning and concept	<p>Desertification is defined as “a type of land degradation in which a relatively dry land region becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife.”</p> <ul style="list-style-type: none"> • Desertification does not refer to the expansion of existing deserts according to UNCCD. • It occurs because dryland ecosystems (which cover over 1/3rd of the world’s land area) are extremely vulnerable to overexploitation and inappropriate land use. • It is caused primarily by human activities and climatic variations. • Poverty, political instability, deforestation, overgrazing and bad irrigation practices can all undermine the productivity of the land.
Causes of Desertification:	<p>Anthropogenic Activities:</p> <ul style="list-style-type: none"> • The extension of cultivation in marginal lands, • Inadequate soil and water conservation measures, • Tillage for agriculture,

	<ul style="list-style-type: none"> ● Overgrazing and deforestation for fuel or construction materials. ● Intensive cropping systems and ● Poor irrigation management and overexploitation of groundwater. ● According to State of India’s Environment 2017: In Figures book published by the Centre for Science and Environment and Down to Earth magazine <ul style="list-style-type: none"> ○ Increasing desertification of India’s soil, is a fundamental threat to agriculture ○ Nearly 30 per cent of India is degraded or facing desertification. ○ Of India’s total geographical area of 328.72 million hectares (MHA), 96.4 MHA is under desertification. ○ In 8 states—Rajasthan, Delhi, Goa, Maharashtra, Jharkhand, Nagaland, Tripura and Himachal Pradesh—around 40 to 70% of land has undergone desertification. ○ More to it, 26 of 29 Indian states have reported an increase in the area undergoing desertification in the past 10 years. ○ Biggest reasons for desertification: <ul style="list-style-type: none"> ■ Loss of soil cover, mainly due to rainfall and surface runoff <ul style="list-style-type: none"> ➤ It is responsible for 10.98% of desertification in the country. ➤ Water erosion in both hot and cold desert areas, across various land covers and with varying levels of severity. ■ Wind erosion- Movement of <p>Natural Factors:</p> <ul style="list-style-type: none"> ● Natural Disasters: There are some cases where the land gets damaged because of natural disasters, including drought. ● Climate Change: As the days get warmer and periods of drought become more frequent, desertification becomes more and more eminent. Unless climate change is slowed down, huge areas of land will become desert; some of those areas may even become uninhabitable as time goes on.
<p>Case Study: Sahara Desert</p>	<ul style="list-style-type: none"> ● Scientists agree that there is a natural cause for the existence of desert in the place where is now the Sahara Desert: a natural climate cycle cause a lack of water in this area from time to time. ● There is a suggestion that the last time that the Sahara was converted from savannah to desert it was partially due to overgrazing by the cattle of the local population. ● Extent of Desertification in Sahara.

<p>Consequences of Desertification</p>	<ul style="list-style-type: none"> ● Impact on farming: If an area becomes a desert, then it's almost impossible to grow substantial crops there without special technologies. ● Hunger: Inadequate farm production => farms produce will become much scarcer, and the people who live in those local areas will be a lot more likely to try and deal with hunger problems. Animals will also go hungry, which will cause even more of a food shortage. ● Flooding: Without the plant life in an area, flooding is a lot more eminent. <ul style="list-style-type: none"> ○ Not all deserts are dry; those that are wet could experience a lot of flooding because there is nothing to stop the water from gathering and going all over the place. ● Poor Water Quality: Water quality declines because the plant life plays a significant role in keeping the water clean and clear; without its presence, it becomes a lot more difficult for you to be able to do that. ● Overpopulation: When areas start to become desert, animals and people will go to other areas where they can actually thrive. This causes crowding and overpopulation, which will, in the long run, end up continuing the cycle of desertification that started this whole thing anyway.
<p>International Initiatives to Prevent Deforestation:</p>	<p>Desertification and the Sustainable Development Goals:</p> <p>The 2030 Agenda for Sustainable Development declares that “we are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations”. Specifically, Goal 15 states our resolve to halt and reverse land degradation.</p> <p>United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (UNCCD)</p> <ul style="list-style-type: none"> ● A Convention to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements.

	<ul style="list-style-type: none"> • It is the only internationally Legally binding framework set up to address the problem of desertification. • The Convention is based on the principles of participation, partnership and decentralization • India is a signatory to the United Nations Convention to Combat Desertification (UNCCD). • The National Action Programme for combating desertification was prepared in 2001 to take appropriate action in addressing the problems of desertification.
<p>Indian Government Initiatives to Prevent Deforestation:</p>	<ul style="list-style-type: none"> • Programmes that address issues related to land degradation and desertification: <ul style="list-style-type: none"> ○ Integrated Watershed Management Programme (IWMP), ○ National Afforestation Programme (NAP), ○ National Mission for Green India (GIM), ○ The Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) ○ National Watershed Development Project for Rainfed Areas (NWDPA), ○ Command Area Development and • With a view to mitigate adverse impact of land degradation/desertification, increasing the productivity of agricultural land and sustaining foodgrain production, Government of India, Ministry of Agriculture is implementing various Schemes/Programmes, namely; <ul style="list-style-type: none"> ○ National Project on Organic Farming (NPOF), ○ National Food Security Mission (NFSM), ○ Rashtriya Krishi Vikas Yojana (RKVY), ○ Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM)
<p>What more need to be done to control deforestation:</p>	<p>To reduce the severity of the desertification process, adoption of proper and regular management practices such as following are suggested:</p> <ul style="list-style-type: none"> • Identifying suitable areas for afforestation with the selection of suitable climate-resilient multipurpose tree species, perennial forage and fodder species. • Managing soil erosion by adopting location-specific soil and water conservation practices. • Dealing with soil salinity in agricultural lands through proper irrigation water management, development and maintenance of surface and subsurface drainage systems. • Adopting proper agriculture and land management practices. • Converging these activities with the ongoing national and state government programmes like Joint Forest Management, Integrated Watershed Management Programme and Mahatma Gandhi National Rural Employment Guarantee Act, etc.

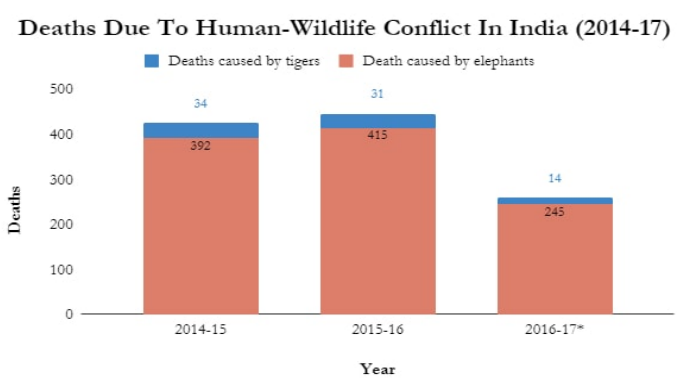
4. SAND MINING

<p>Meaning and concept</p>	<p>Sand Mining is the process of the actual removal of sand from the foreshore including rivers, streams and lakes. Sand is mined from beaches and inland dunes and dredged from ocean beds and river beds. A related process is the mining of mineral sands, such as mineral deposits like diamond, gold and silver.</p>
<p>Uses of Sand</p>	<p>Use of Sand in manufacturing industry: It is used for manufacture of both common and optical glasses.</p> <p>Use of Sand in infrastructure sector:</p> <ul style="list-style-type: none"> ● Sand is an ingredient in plaster and concrete ● It is added to clays to reduce shrinkage and cracking in the manufacture of bricks. ● River sand is used along with cement, gravel, water and steel for making reinforced concrete. ● Along with cement and water, it is used as mortar for joint filling and plastering.
<p>Environmental significance of sand:</p>	<ul style="list-style-type: none"> ● It provides a suitable substrate for many benthic organisms. ● It is an unavoidable component for psammophile (sand loving or shallow sandy water creature) fish as it provides breeding, spawning, feeding and hiding grounds. ● Inter-beds of sand within floodplain deposits act as aquifer systems storing large quantities of ground water. ● sand acts as an efficient filter for various pollutants => maintains the quality of water in rivers and other aquatic ecosystems.
<p>Issues with Sand Mining:</p>	<p>In earlier days, mining of sand did not create any problem to the river ecosystem as the quantity of mining was well within the replenishment limits. However, increase in population and the rise in economic and industrial developments during the past few decades have aggravated mining of river sand many folds higher than natural replenishments</p> <p>Impact of sand mining on environment:</p> <ul style="list-style-type: none"> ● Excessive in-stream sand-and-gravel mining <ul style="list-style-type: none"> ○ lowers the stream bottom, which may lead to bank erosion. ○ is a threat to bridges, river banks and nearby structures ○ results in the destruction of aquatic and riparian habitat through large changes in channel morphology. ○ Impacts include bed degradation, bed coarsening, lowered water tables near the streambed, and channel instability. ● Depletion of sand in the streambed and along coastal areas causes the deepening of rivers and estuaries + enlargement of river mouths and coastal inlets.

	<ul style="list-style-type: none"> • Bed degradation from in-stream mining lowers the elevation of stream flow and the floodplain water table => can eliminate water table-dependent woody vegetation in riparian areas, and decrease wetted periods in riparian wetlands. • Saline-water intrusion from the nearby sea <p>Impact on humans:</p> <ul style="list-style-type: none"> • Sand mining also affects the adjoining groundwater system and the uses that local people make of the river. • Degraded stream habitats result in loss of fisheries productivity, biodiversity, and recreational potential. Severely degraded channels may lower land and aesthetic values. • Sand mining transforms the riverbeds into large and deep pits; as a result, the groundwater table drops leaving the drinking water wells on the embankments of these rivers dry. <p>Impact upon the river's water quality:</p> <ul style="list-style-type: none"> • Increased short-term turbidity at the mining site due to resuspension of sediment, • Sedimentation due to stockpiling and dumping of excess mining materials and organic particulate matter • Oil spills or leakage from excavation machinery and transportation vehicles.
<p>Case study: National Chambal Sanctuary</p>	<ul style="list-style-type: none"> • Last of the wild and breeding gharials left = Found in maximum strength in National Chambal Sanctuary running across three states (UP, MP and Rajasthan) • Mining of sand banks is destructive for gharial population as sand banks are essential for nesting and basking. Gharials lay their eggs under sand beds, but illegal sand mining destroys their nests. • Local inhabitants are cultivating river banks immediately adjacent to the river and this is causing considerable disturbance to the natural habitat of gharials. • Villagers residing along the river are flattening ravines present in the sanctuary for farming. • The 425 km stretch of the Chambal River was declared a protected area in 1979.
<p>Government intervention to control sand mining:</p>	<ul style="list-style-type: none"> • Legal provision: Sand is a minor mineral, as defined under section 3(e) of the Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act). • Section 15 of the MMDR Act empower state governments to make rules for regulating the grant of mineral concessions in respect of minor minerals and for purposes connected therewith. • The regulation of grant of mineral concessions for minor minerals is, therefore, within the legislative and administrative domain of the state governments. • Under the power granted to them by section 15 of the MMDR Act, State Governments have framed their own minor mineral concession rules.

	<ul style="list-style-type: none"> • Further, section 23C of the MMDR Act, 1957 empowers state governments to frame rules to prevent illegal mining, transportation and storage of mineral sand for purposes connected therewith. • Control of illegal mining is, therefore, under the legislative and administrative jurisdiction of state governments. • Ministry of Environment, Forest and Climate Change has issued Sustainable Sand Mining Management Guidelines, 2016, which, inter-alia, addresses the issues relating to regulation of sand mining. • Salient features of the Guidelines: <ul style="list-style-type: none"> ○ It provides for a detailed programme for ensuring that mining of river sand is done in a sustainable manner; <p>Grant of Environment Clearance for minor minerals, including sand and gravel, for mining lease of area up to 5 hectares will be done by the District Environment Impact Assessment Authority headed by the District Collector / District Magistrate.</p>
<p>Sand Mining Framework</p>	<p>Objectives:</p> <ul style="list-style-type: none"> • To help states deal with the sand mining issues, including demand supply deficit and illegal extraction <p>Significance:</p> <ul style="list-style-type: none"> • This will help states to frame their policies, taking into consideration their objectives, endowments and state deployment of resources • The framework addresses the issues of state objectives, demand-supply assessment, measures to sand availability, allocation model, transportation and monitoring mechanism. • it also includes suggestions for faster clearances /approvals and using its interventions in complete process chain of sand mining. • The framework also lays emphasis on alternatives of sand i e manufactured sand, import of sand etc.

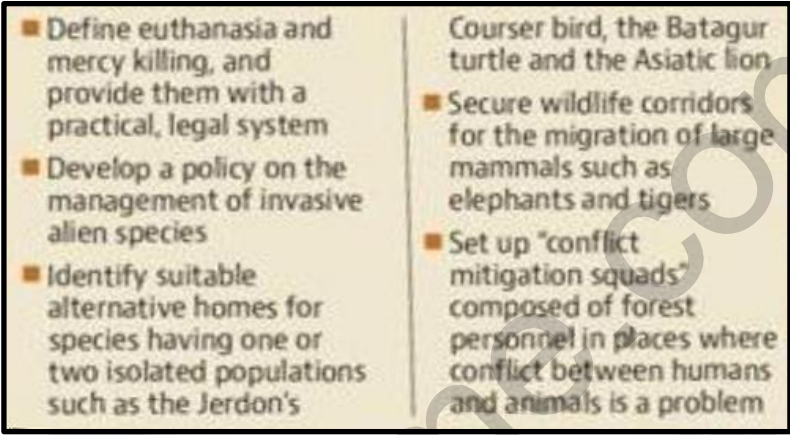
5. HUMAN-ANIMAL CONFLICT

<p>Concept</p>	<p>Human-animal conflict simply refers to the interaction between man and animal and resultant negative impact on man and his resources or animal and its habitat. The conflicts between man and animal become more frequent in recent times.</p> <div style="border: 1px solid black; padding: 10px;"> <p style="text-align: center;">HUMAN-WILDLIFE CONFLICT</p> <p>4 states have plans in place to cull the following animals</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>HIMACHAL PRADESH MONKEYS Monkeys are a menace for farmers and residents. Allowed to kill them for a year in 10 districts</p> <p>UTTARAKHAND WILD BOAR Wild boars destroy crops outside forest areas and hilly regions. Allowed to kill them for a year in the state</p> </td> <td style="width: 50%; vertical-align: top;"> <p>BIHAR NILGAI & WILD BOAR Nilgai declared vermin in 20 districts and wild boar in eight. State has killed 200 wild bulls in the last 2 years</p> <p>MAHARASHTRA WILD BOAR & NILGAI State told ministry that it pays ₹5 crore compensation every year for crops destroyed by the two animals</p> </td> </tr> </table> <p style="text-align: center;">PROPOSED PLAN</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>GUJARAT WILD BOAR State govt wants animal to be declared vermin for a year in 19 districts</p> </td> <td style="width: 50%; vertical-align: top;"> <p>GOA PEACOCK State govt wants the peacock to be killed for damaging crops but is yet to send a proposal</p> </td> </tr> </table> </div> <p>The incidents of Man-Animal Conflicts can be categorized into the following major types:</p> <ul style="list-style-type: none"> ● Human beings get killed or injured by wild animals ● Livestock/Cattle reared by man get killed or injured ● Crop cultivated by man damaged ● Wild animals get killed or injured 	<p>HIMACHAL PRADESH MONKEYS Monkeys are a menace for farmers and residents. Allowed to kill them for a year in 10 districts</p> <p>UTTARAKHAND WILD BOAR Wild boars destroy crops outside forest areas and hilly regions. Allowed to kill them for a year in the state</p>	<p>BIHAR NILGAI & WILD BOAR Nilgai declared vermin in 20 districts and wild boar in eight. State has killed 200 wild bulls in the last 2 years</p> <p>MAHARASHTRA WILD BOAR & NILGAI State told ministry that it pays ₹5 crore compensation every year for crops destroyed by the two animals</p>	<p>GUJARAT WILD BOAR State govt wants animal to be declared vermin for a year in 19 districts</p>	<p>GOA PEACOCK State govt wants the peacock to be killed for damaging crops but is yet to send a proposal</p>								
<p>HIMACHAL PRADESH MONKEYS Monkeys are a menace for farmers and residents. Allowed to kill them for a year in 10 districts</p> <p>UTTARAKHAND WILD BOAR Wild boars destroy crops outside forest areas and hilly regions. Allowed to kill them for a year in the state</p>	<p>BIHAR NILGAI & WILD BOAR Nilgai declared vermin in 20 districts and wild boar in eight. State has killed 200 wild bulls in the last 2 years</p> <p>MAHARASHTRA WILD BOAR & NILGAI State told ministry that it pays ₹5 crore compensation every year for crops destroyed by the two animals</p>												
<p>GUJARAT WILD BOAR State govt wants animal to be declared vermin for a year in 19 districts</p>	<p>GOA PEACOCK State govt wants the peacock to be killed for damaging crops but is yet to send a proposal</p>												
<p>Recent statistics and cases</p>	<p>A total of 1,557 people was killed due to human-elephant conflict between 2014-15 and 2017-18 (till November 2017).</p> <p>Recent cases of the conflict:</p> <ul style="list-style-type: none"> ● A tigress named Avni, who was believed to have turned man-eater and killed 13 people in the last two years in Yavatmal district Pandharkawada area, was shot dead in Borati forest. ● An incident of a train colliding with an elephant. <div style="border: 1px solid black; padding: 10px;"> <p style="text-align: center;">Deaths Due To Human-Wildlife Conflict In India (2014-17)</p>  <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th>Year</th> <th>Deaths caused by tigers</th> <th>Death caused by elephants</th> </tr> </thead> <tbody> <tr> <td>2014-15</td> <td>34</td> <td>392</td> </tr> <tr> <td>2015-16</td> <td>31</td> <td>415</td> </tr> <tr> <td>2016-17*</td> <td>14</td> <td>245</td> </tr> </tbody> </table> </div>	Year	Deaths caused by tigers	Death caused by elephants	2014-15	34	392	2015-16	31	415	2016-17*	14	245
Year	Deaths caused by tigers	Death caused by elephants											
2014-15	34	392											
2015-16	31	415											
2016-17*	14	245											

<p>Reasons behind growing cases of Man-Animal Conflict:</p>	<ul style="list-style-type: none"> ● Changing times + Ever-increasing population = the lines between human settlements and forests have started to blur => a greater number of conflicts. ● rapid urbanization and industrialization have led to diversion of forest land to non-forest purposes => wildlife habitat is shrinking. This habitat fragmentation may be the result of construction of roads, especially big Highways and canals passing through dense jungles and the big mines. ● Encroachment in the forest lands by local people => shrinkage of wildlife habitats, especially on the fringes which has increased the pressure on the limited natural resources in the forest areas. ● Increased disturbance due to collection of fuel wood, fodder, NTFPs, water etc. from the forests. There are numerous incidences where the cattle grazers were killed/ mauled by tiger/ panther/ bear. ● Livestock grazing in the forest areas ● Increase in area under cultivation around wildlife habitats and changed cropping pattern. People have started growing commercial crops like sugarcane and banana, which provide good hiding place for wild animals like wild boar, sloth bear and panther. ● Infestation of wildlife habitat by the invasive exotic weeds (like Lantana, Eupatorium and Parthenium etc.) have resulted in decreased availability of edible grasses for wild herbivores. As a result, herbivores come out of forest area and cause depredation of agricultural crops on the fringes. ● Monoculture of teak in the large-scale forest plantations has also adversely affected the wildlife habitat value of the forest areas. ● During summer, water becomes scarce. The livestock and wild animals have to share the limited water sources on the fringes or inside forest. Human interference with the natural drainage system in forest areas and diversion of water towards habitation has further complicated the issue. ● Poaching of herbivores => Decreased prey base => Carnivores moving out of forest in search of prey and indulge in cattle lifting.
<p>Measures that can be taken to mitigate Man-Animal Conflict:</p>	<ul style="list-style-type: none"> ● Stop fragmentation of wildlife habitat and wildlife corridors. While going for construction of dams, long canals for irrigation and Highways through the forest areas, ensure that the connectivity through wildlife corridors is not disturbed. ● One method is to make a mixture of oil, used car grease, fresh elephant dung and crushed chili (piri piri), which is slathered on ropes which are strung around fields of crops. When elephants run into these ropes the substance burns their skin and the pungent odor repels them. ● Ensure that both humans and animals have the space they need. Protecting key areas for wildlife, creating buffer zones and investing in alternative land uses are some of the solutions. ● Control poaching: Poaching of wild animals should be stopped so that the number of wild animals can stabilize at its carrying capacity which would reach

	<p>equilibrium in the ecosystem and this equilibrium between the numbers of prey animals and predators in the forest ecosystem would be maintained.</p> <ul style="list-style-type: none"> ● Stop plant monoculture of species like teak; instead go for mixed plantations of miscellaneous, bamboo and fruit species which will provide ● To increase water availability in the forests, soil and moisture conservation measures (SMC) like vegetative checks dams, loose boulder check-dams, cement plugs, nala bunding, water tanks, should be taken in the forest. ● Providing LPG to villagers who frequently go to the forest areas specially wildlife habitats to fetch fuel wood. <ul style="list-style-type: none"> ○ Maharashtra Forest Department has started in a big way to distribute LPG to villagers residing on the fringes under Joint Forest Management Program and Village Eco-Development Program. ● Eco-development activities in villages to elicit the cooperation of the local community in the management of the Protected Areas. ● Eco-Tourism = create an alternate source of income for local people = it can help in minimizing man-animal conflict on account of crop depredation or livestock killing. ● Awareness Raising through meetings and pamphlets etc. that they should avoid going deep into the forest areas. If they have to go in any case, they should go in groups and they should keep talking to each other to detract the wild animals. School children in vulnerable villages should be educated about the importance of wildlife and human coexistence with it. ● Stone fencing or Solar Fencing around agriculture fields situated near wildlife habitat/forest areas. ● Controlling crop pattern. Crops like sugarcane, Banana, Bajra, tuhar should not be allowed to be grown near forest areas. These crops attract wildlife for food as well as good hiding place. ● Paying ex-gratia/Compensation to victims of wildlife attack so that the people will not become enemy of the wild animals. <ul style="list-style-type: none"> ○ Otherwise people tend to take revenge from the wild animals by killing them by poison, trap, hacking or shooting as has been noticed in many cases. ● Relocation/Rehabilitation of problematic and disadvantaged wild animal should be considered.
<p>Guidelines for the management of human-animal conflict</p>	<p>The management of human-animal conflict is handled by State Government as per Rules, Guidelines in vogue. Some of the mechanisms in mitigation of human animal conflict include:</p> <ul style="list-style-type: none"> ● Provisions under Section 11 of Wild Life (Protection) Act, 1972 empower the Chief Wildlife Warden and authorized officer to take necessary steps to handle problematic wild animals. ● Standard Operating Procedures/guidelines for management of major problematic animals like tigers, elephant, leopard, rhino etc. are being used by the respective state governments.

	<ul style="list-style-type: none"> ● Construction/erecting physical barriers, such as barbed wire fence, solar powered electric fence, bio-fencing using cactus, boundary wall etc. to prevent the entry of wild animals into crop field. ● Improvement of wildlife habitats by augmenting the availability of food and water in forest areas to reduce the entry of animals from forest to human habitations. ● The Ministry has issued guidelines in the context of human-wildlife conflict to the Chief Wildlife Wardens of all the State
<p>Steps taken by the Central/State Governments for improvement of natural habitat of wild animals includes:</p>	<p>A network of Protected Areas namely viz., national parks, Sanctuaries, Conservation Reserves and Community Reserving covering important wildlife habitat have been created all over the country under the provisions of the Wild Life (Protection) Act, 1972.</p> <ul style="list-style-type: none"> ● Financial assistance is provided to the State/Union Territory governments under the Centrally Sponsored Schemes of ‘Integrated Development of Wildlife Habitats’, ‘Project Tiger’ and ‘Project Elephant’ for providing better protection to wildlife, and improvement of its habitats. ● The MoEF&CC, with financial assistance from Ad-hoc Compensatory Afforestation Fund Management and Planning Authority (CAMPA), has formulated a scheme to provide assistance to the States for ‘Augmentation of Fodder and Water in Protected Areas/Forest Areas’, aimed at improving habitat in the areas by making provision for augmenting grass, fodder and water to the wild herbivores. ● The Wild Life (Protection) Act, 1972 provides regulatory functions for taking up activities in National Parks and Sanctuaries to protect the wildlife habitats. ● Payment of ex-gratia amount to victims of wild animal attack is provided with a view to reduce retaliatory killings. ● Periodic awareness campaigns to sensitize guide and advise the general public on man-animal conflict, including dissemination of information through various forms of media. ● Financial assistance is provided under Centrally Sponsored Scheme (CSS) of Integrated Development of Wildlife Habitats (IDWH) and Project Tiger for voluntary relocation of villages from within Protected Areas. This helps in moving people away from wildlife rich habitats and thus reducing conflict situations. <p>Recently (Oct 2018), in possibly the first-of-its-kind move, the Uttar Pradesh government has made the man-animal conflict a ‘State Declared Disaster’ bringing such incidents under the ambit of State Disaster Response Fund (SDRF) to ensure better coordination and relief during such mishaps in the state.</p>
<p>Issues with the government intervention to</p>	<p>Majority of the States awarded compensation for loss of livestock, human injury and death. Only 18 states provided compensation for property damage.</p> <ul style="list-style-type: none"> ● 22 states provide for compensation for crop loss (states like Gujarat and Rajasthan do not provide compensation for crop loss)

<p>mitigate man-animal conflict:</p>	<ul style="list-style-type: none"> • Inconsistencies in eligibility, application, assessment, implementation and payment procedures across States in giving compensation. • Discrepancies in eligibility procedure for filling compensation for loss. <p>Source: 2010 to 2015 data by Bengaluru Centre for wildlife studies on man-human conflict</p>
<p>Way forward for the government</p>	 <p>The box contains the following text:</p> <ul style="list-style-type: none"> Define euthanasia and mercy killing, and provide them with a practical, legal system Develop a policy on the management of invasive alien species Identify suitable alternative homes for species having one or two isolated populations such as the Jerdon's Courser bird, the Batagur turtle and the Asiatic lion Secure wildlife corridors for the migration of large mammals such as elephants and tigers Set up "conflict mitigation squads" composed of forest personnel in places where conflict between humans and animals is a problem

6. EUTROPHICATION

<p>Concept and Meaning</p>	<p>Inorganic plant nutrients are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication.</p> <p>Eutrophication is characterized by excessive plant and algal growth due to the increased availability of one or more limiting growth factors needed for photosynthesis such as sunlight, carbon dioxide, and nutrient fertilizers.</p> <ul style="list-style-type: none"> • Eutrophication occurs naturally over centuries as lakes age and are filled in with sediments. • However, human activities have accelerated the rate and extent of eutrophication through both point-source discharges and non-point loadings of limiting nutrients, such as nitrogen and phosphorus, into aquatic ecosystems (i.e., cultural eutrophication), with dramatic consequences for drinking water sources, fisheries, and recreational water bodies.
<p>Factors responsible behind eutrophication:</p>	<ul style="list-style-type: none"> • Use of fertilizers: Agricultural practices and the use of fertilizers in the soil contribute to the accumulation of nutrients. When these nutrients reach high concentration levels and the ground is no longer able to assimilate them, they are carried by rain into rivers and groundwater that flow into lakes or seas.

- **Adding fertilizers to enhance primary productivity** and increase the density and biomass of recreationally and economically important fish via bottom-up effects on higher trophic levels.
- **Discharge of waste water into water bodies:**
 - wastewater is discharged directly into water bodies such as rivers, lakes and seas.
 - The result of this is the **release of a high quantity of nutrients which stimulates the disproportionate growth of algae.**
 - When water is treated by means of water treatment plants before discharge into the environment, the treatments applied are not always such as to reduce the organic load, with the consequent accumulation of nutrients in the ecosystem.
- **Reduction of self-purification capacity:**
 - Over the years, lakes accumulate large quantities of solid material transported by the water (sediments).
 - These sediments are such as to be able to absorb large amounts of nutrients and pollutants.
 - Consequently, the **accumulation of sediments starts to fill the basin** and, increasing the interactions between water and sediment, the resuspension of nutrients present at the bottom of the basin is facilitated. This phenomenon could in fact lead to a further deterioration of water quality, accentuating the processes connected with eutrophication.

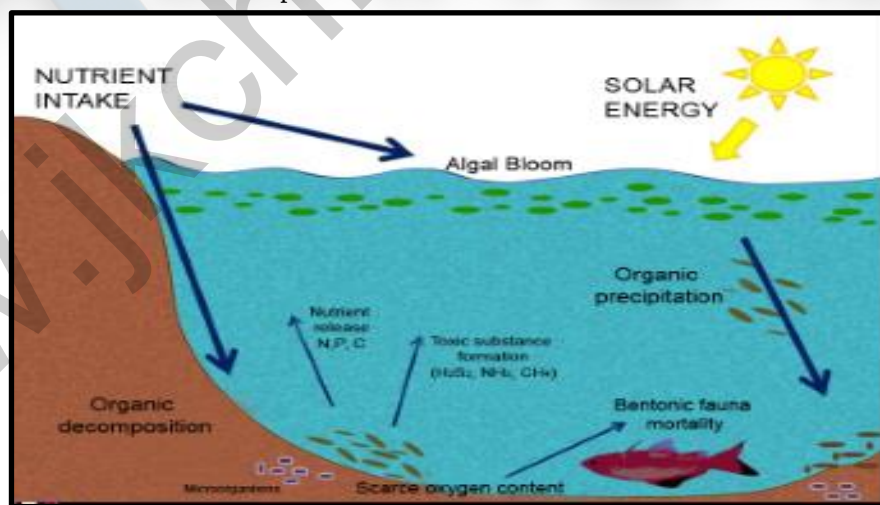


Fig: Eutrophication process

<p>Consequences of Eutrophication</p>	<p>Impact on human life:</p> <ul style="list-style-type: none"> ● They may interfere with the use of the water by clogging water intake pipes, changing the taste and odour of water and cause a buildup of organic matter. ● Poisonings of domestic animals, wildlife, and even humans by blooms of toxic cyanobacteria ● Disappearance or significant reduction of quality fish with very negative effects on fishing ● Prohibition of touristic use of the lake and bathing, due to both the foul odour on the shores caused by the presence of certain algae, as well as the turbidity; bathing is dangerous because certain algae cause skin irritation. <p>Impact on environment:</p> <ul style="list-style-type: none"> ● Creation of dense blooms of noxious, foul-smelling phytoplankton that reduce water clarity and harm water quality ● Algal blooms limit light penetration, reducing growth and causing die-offs of plants in littoral zones while also lowering the success of predators that need light to pursue and catch prey ● Furthermore, high rates of photosynthesis associated with eutrophication can deplete dissolved inorganic carbon and raise the pH to extreme levels during the day. <ul style="list-style-type: none"> ○ Elevated pH can in turn 'blind' organisms that rely on perception of dissolved chemical cues for their survival by impairing their chemosensory abilities ● When these dense algal blooms eventually die, microbial decomposition severely depletes dissolved oxygen, creating a hypoxic or anoxic 'dead zone' lacking sufficient oxygen to support most organisms. ● Some algal blooms produce noxious toxins (e.g., microcystin and anatoxin-a).
<p>Measures to control Eutrophication</p>	<ul style="list-style-type: none"> ● Pass legislations to regulate point-source loading of nutrients ● Need to employ a variety of strategies for (1) diversion of excess nutrients, (2) altering nutrient ratios, (3) physical mixing, (4) shading water bodies with opaque liners or water-based stains, and (5) application of potent algaecides and herbicides. ● Water quality can often be improved by reducing nitrogen and/or phosphorus inputs into aquatic systems ● Use of algaecides such as copper sulfate = effective at reducing HABs temporally <ul style="list-style-type: none"> ○ Criticism: algaecides are expensive to apply and do not control the primary cause of the problem ● The alteration of a food web to restore ecosystem health secondary consumers (planktivorous fishes) are removed either through the addition of tertiary consumers (piscivorous fishes) or harvesting, which allows for the

	dominance of large-bodied, generalist grazers (e.g., <i>Daphnia</i>) to control phytoplankton
Way Forward:	Improvement of the purifying performance of wastewater treatment plants, installing tertiary treatment systems to reduce nutrient concentrations; <ul style="list-style-type: none"> • Implementation of effective filter ecosystems to remove nitrogen and phosphorus present in the run-off water (such as Phyto-purification plants); • Reduction of phosphorus in detergents; • Rationalization of agricultural techniques through proper planning of fertilization and use of slow release fertilizers; Use of alternative practices in animal husbandry to limit the production of waste water.

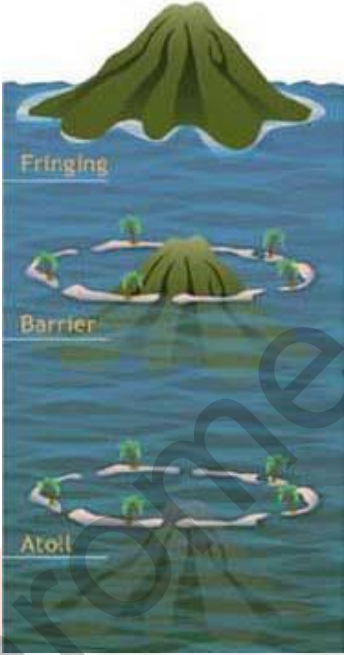
7. BIOACCUMULATION AND BIOMAGNIFICATION

<p>Concept and Meaning</p>	<ul style="list-style-type: none"> • Bioconcentration and bioaccumulation occur within an organism, but biomagnification occurs across levels of the food chain. • Bio amplification (or biomagnification) refers to an increase in the concentration of a substance as you move up the food chain. <ol style="list-style-type: none"> 1. This often occurs because the pollutant is persistent, meaning that it cannot be, or very slowly, broken down by natural processes. 2. These persistent pollutants are transferred up the food chain faster than they are broken down or excreted. • In contrast, bioaccumulation occurs within an organism, where a concentration of a substance builds up in the tissues and is absorbed faster than it is removed. • Bioaccumulation often occurs in two ways: <ol style="list-style-type: none"> 1. by eating contaminated food, and 2. by absorption directly from water. This second case is specifically referred to as bioconcentration. Bioconcentration is the accumulation of a chemical in or on an organism when the source of chemical is solely water. <div> </div>
----------------------------	--

Mechanism	<ul style="list-style-type: none"> • While excess fertilizers cause eutrophication, pesticides cause bioaccumulation and biomagnification. • Pesticides which enter water bodies enter into the aquatic food chain. • Later they are then absorbed by the phytoplankton and aquatic plants. • These plants are eaten by herbivorous fish which are in turn eaten by the carnivorous fish which are in turn eaten by the water birds. • At each link in the food chain these chemicals which do not pass out of the body are accumulated and increasingly concentrated resulting in biomagnification of these harmful substances.
Consequences	<p>Impact on environment:</p> <ul style="list-style-type: none"> • One of the effects of accumulation of high levels of pesticides such as DDT is that birds lay eggs with shells that are much thinner than normal. <ul style="list-style-type: none"> ○ This results in the premature breaking of these eggs, killing the chicks inside. ○ Birds of prey such as hawks, eagles and other fish-eating birds are affected by such pollution. • Although DDT has been banned in India for agricultural use and is to be used only for malaria eradication, it is still used in the fields as it is cheap. <p>Impact on Humans</p> <ul style="list-style-type: none"> • The toxic elements like mercury, cadmium, arsenic, etc. through these processes can enter the food chain. They have harmful effects on human health. It slows down human cognition, causes diseases like cancer and tumors. • Mercury through the process of magnification can cause Minamata disease.
Measures to control	<ul style="list-style-type: none"> • Effectively banning DDT. • Controlling industrial effluents outflows into oceans and rivers. • Passing legislation to ban those toxic substances that have the potential to biomagnify and cause detrimental health effects.

8. CORAL BLEACHING

CONCEPT	<p>Corals live in tropical waters throughout the world, generally close to the surface where the sun's rays can reach the algae.</p> <ul style="list-style-type: none"> • While corals get most of their nutrients from the byproducts of the algae's photosynthesis, they also have barbed, venomous tentacles they can stick out, usually at night, to grab zooplankton and even small fish.
How coral reefs are formed?	<ul style="list-style-type: none"> • Coral polyps are tiny, soft-bodied organisms related to sea anemones and jellyfish. • At their base is a hard, protective limestone skeleton called a calicle, which forms the structure of coral reefs.

	<ul style="list-style-type: none"> • Reefs begin when a polyp attaches itself to a rock on the seafloor, then divides, or buds, into thousands of clones. • The polyp calicles connect to one another, creating a colony that acts as a single organism. • As colonies grow over hundreds and thousands of years, they join with other colonies and become reefs.  <p style="text-align: center;">Figure shows types of coral reefs</p>
<p>What is coral bleaching?</p>	<ul style="list-style-type: none"> • Coral bleaching is the loss of intracellular endosymbionts (<i>Symbiodinium</i>, also known as zooxanthellae) through either expulsion or loss of algal pigmentation. • When a coral bleaches, it is not dead. • Why coral bleaching: When corals are stressed by changes in conditions such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn completely white.
<p>Factors responsible for coral bleaching</p>	<ul style="list-style-type: none"> • Increased (most commonly) or reduced water temperatures: Warm water prompts algae inside the coral to leave, which starves coral and turns it white. • Oxygen starvation caused by an increase in zooplankton levels as a result of overfishing. • Increased solar irradiance (Photosynthetically Active Radiation and ultraviolet band light). • Changes in water chemistry (acidification). <ul style="list-style-type: none"> ○ Major part of pollution comes from land-based runoff, oil spills, nutrients and pesticides from agriculture, wastewater, industrial effluent, untreated sewage and others. ○ Toxic chemicals like POPs and PAHs can destroy or damage reef communities by affecting coral's reproduction and growth.

	<ul style="list-style-type: none"> • Marine debris like plastic, glass, metal, rubber abandoned fishing nets and other gear often get entangle and kill reef organisms and break or damage them. • Increased sedimentation due to silt runoff • Bacterial infections • Changes in salinity
<p>Case study: Bleaching in Australia's Great Barrier Reef:</p>	<p><i>The Great barrier reef:</i></p> <ul style="list-style-type: none"> • It is the world's largest coral reef system composed of over 2,900 individual reefs and 900 islands stretching for over 2,300 kilometres over an area of approximately 344,400 square kilometres. • The reef is located in the Coral Sea, off the coast of Queensland, Australia. • This reef structure is composed of and built by billions of tiny organisms, known as coral polyps. It was selected as a World Heritage Site in 1981. • What has happened: <ul style="list-style-type: none"> ○ Incidents of mass bleaching has killed more than a third of the coral in the northern and central parts of Australia's Great Barrier Reef. ○ Coral along large swathes of the 2,300-kilometre reef have been killed by rising sea temperatures linked to climate change, leaving behind skeletal remains. ○ The northern reaches of the reef suffered an unprecedented two successive years of severe bleaching in 2016 and 2017. • Factors responsible: Experts say the bleaching has been triggered by <ul style="list-style-type: none"> ○ global warming and El Nino, a warming of parts of the Pacific Ocean that changes weather worldwide. ○ Farming runoff ○ Development ○ Predatory crown-of-thorns starfish • Suggested solutions <ul style="list-style-type: none"> ○ Reducing the exposure of corals to physical stressors ○ Boosting coral regeneration rates by cultivating reef-building coral larvae that attract other important marine species
<p>Measures to Control Coral Bleaching</p>	<ul style="list-style-type: none"> • Effective implementation of the Paris Agreement so as to limit the average temperature rise within 1.5 C compared to pre-industrial levels through proper adherence to INDC targets. • Controlling ocean water pollution by restricting flows of untreated industrial effluents, oil leakages, etc. • Phasing out ocean bottom trawling by deep ocean fishing. • Controlling and eliminating introduction of invasive alien species. • Ensuring that the developmental projects like Carmichael coal mine in Australia, Bharat Sethum Project in Gulf of Mannar, etc. does not leads to destruction or bleaching of coral reefs. • Practice safe and responsible diving and snorkeling

9. GENETICALLY MODIFIED ORGANISM(GMO)

Concept	<p>A GMO or genetically engineered organism is an organism whose genetic material has been altered using genetic engineering techniques. An organism in which one or more genes (called transgenes) have been introduced into its genetic material from another organism using recombinant DNA technology.</p>
Examples of GMOs	<p>Bt Cotton (Genetically modified cotton)</p> <ul style="list-style-type: none"> ● It was developed to reduce the heavy reliance on pesticides. ● The Bacterium Bacillus Thuringiensis (Bt) naturally produces a chemical harmful only to a small fraction of insects (larvae of moths and butterflies, beetles, and flies etc) and harmless to other forms of life. ● The Gene coding for (Bt) toxin has been inserted into cotton, causing cotton to produce this natural insecticide in its tissues. <p>Bt Brinjal</p> <ul style="list-style-type: none"> ● A transgenic brinjal created by inserting a crystal protein gene (Cry1Ac) from the soil bacterium <i>Bacillus thuringiensis</i> into the genome of various brinjal cultivators. ● It is developed to give resistance against lepidopteran insects, in particular the Brinjal Fruit and Shoot Borer (FSB). ● The insertion of the Gene, along with other genetic elements like promoters, terminators and an antibiotic resistance marker gene into the brinjal plant is accomplished using <i>Agrobacterium</i>-mediated genetic transformation. <p>Dhara Mustard Hybrid-II (DMH-II)</p> <ul style="list-style-type: none"> ● A genetically modified variety of mustard. ● Developed by the Delhi University's Centre for Genetic Manipulation of Crop Plants under a government-funded project.
Difference between a Living Modified Organism (LMO) and a GMO	<ul style="list-style-type: none"> ● a Living Modified Organism is capable of growing, and typically refers to agricultural crops. ● Genetically Modified Organisms include both LMOs and organisms which are not capable of growing, i.e. are dead.
Arguments in support of Genetically Modified (GM) crops	<p>Impact on farmers:</p> <ul style="list-style-type: none"> ● GM Crops offer improved yields, enhanced nutritional value, longer shelf life and resistance to drought, frost or insect pests. ● Herbicide/Pest/Viral/Fungal/bacteria resistance = reduce any loss in yields => increasing profitability for farmers. ● slow-ripening + Quality improvement (protein and oil) ● Herbicide resistance + Disease resistance + Cod tolerance + Salinity tolerance ● Desired change can be achieved in very few generations. ● Allows greater precision in selecting characteristics.

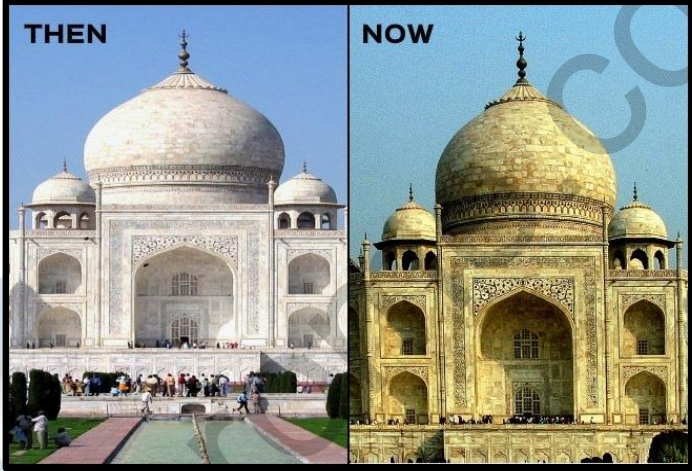
	<p>Impact on human health:</p> <ul style="list-style-type: none"> • Value addition (Vitamins, micro-and macro-elements). • Additional access to minerals can be provided and thus deficiencies can be curbed (Especially in women and children) <p>Impact on food security:</p> <ul style="list-style-type: none"> • GM food => eradicate hunger. “It is better to die eating GM food instead of dying of hunger”. • Better flavour and colour + Early maturing + All year availability • Regulatory mechanism in India is adequate. Government can reject a GM crop for commercial cultivation if field trials find the product is not suitable for the environment or human consumption.
<p>Potential benefits for the environment:</p>	<ul style="list-style-type: none"> • Genetically engineered resistance to pests and diseases could greatly reduce the use of pesticides and insecticides needed for crop protection. => reduce environmental impact • unsustainable irrigation practices => Large areas of crop-land have become saline = Genetic modification could produce salt-tolerant varieties.
<p>Arguments in support of introduction to GM mustard</p>	<ul style="list-style-type: none"> • Introduction of GM Mustard may reduce dependence on edible oil. <ul style="list-style-type: none"> ○ India is the world’s 2nd largest consumer of edible oil after China ○ 14.5-15.5 million tonnes of the total 20-21 million tonnes annual consumption is imported.
<p>Arguments against Genetically Modified (GM) crops</p>	<ul style="list-style-type: none"> • Unintended environmental impacts: <ul style="list-style-type: none"> ○ harming non--target and/or beneficial species in the case of crops with engineered insecticidal properties ○ The potential for pests to evolve resistance to the toxins produced by GM crops. ○ The likelihood of transgenes escaping from cultivated crops into wild relatives. ○ The risk of these toxins affecting non-target organisms. • At present, there is no evidence to suggest that GM foods are unsafe. However, there are no absolute guarantees, either. • Impact on farmers: <ul style="list-style-type: none"> ○ Autonomy of farmers affected because the seeds of these tech crops are monopolized and are marketed by big private firms. If he is unable/does not provide us the requisite seeds, we have a problem. ○ Genetic erosion of our local varieties. • Higher costs for farmers, as well as lost premiums and markets. • The danger of unintentionally introducing allergens and other anti-nutrition factors in foods. • According to data provided by FAO, the highest yields in mustard are from the five countries which do not grow GM mustard — U.K., France, Poland, Germany and Czech Republic — and not from the GM-growing US or Canada.

	<ul style="list-style-type: none"> • Reduced effectiveness of pesticides • Playing with nature and its mechanisms.
Counter-arguments to GM mustard's high yield	<ul style="list-style-type: none"> • Yields claims are not reliable: The yield claims on which GM mustard has been cleared are not reliable. They are based on comparisons with 30-year-old cultivars, and not on more recent high-yielding hybrids. • If India wants to increase mustard production yield rapidly and safely, then the government can adopt the practice of “System of Mustard Intensification”, for which successful trials have been done in Bihar through a World Bank project. Results showed higher yields and better income. And all of this was done without the spraying of any toxic herbicides.
Is the objection to GM justified?	<ul style="list-style-type: none"> • No. GM technology has already been commercialized in India through Bt cotton. <ul style="list-style-type: none"> ○ country's cotton production has gone up more than 2½ times since Bt hybrids were first planted in 2002. ○ No evidence of Bt cotton causing any adverse human or animal health effects has emerged. • Argument against GM Mustard: cotton is not a food crop, while mustard is India's largest edible oil-yielding crop. [Counter Argument]: cotton-seed yields not only fibre (lint), but also oil and oilcake (meal) fed to animals. <ul style="list-style-type: none"> • Cotton-seed oil = 2nd largest produced edible oil in the country (1.4 million tonnes) after mustard (2 million tonnes). That makes cotton also a food crop. • 95% of India's cotton production is Bt = its harmful toxins would already have been consumed directly or indirectly during the last decade and more. • India imports soybean oil and rapeseed oil = they are predominantly GM. • Developer of GM Mustard = is a government-funded institution. <p>Bt cotton = proprietary technology of an MNC Monsanto</p>
Worldwide Practice:	<ul style="list-style-type: none"> • GM crops have been gaining acceptance. • However, their use still remains highly skewed. <ul style="list-style-type: none"> ○ Only 29 countries allow commercial cultivation of GM crops while a similar number also allow their import. ○ And most of the 170 million hectares under GM crops are in the USA, Brazil, Argentina, India and China. ○ Moreover 98% of GM cultivation falls under four main crops: soybean, maize, cotton and canola.
What needs to be done?	<ul style="list-style-type: none"> • Crops should be released only after full satisfaction on the assessment of their impact on plants, animals and human beings. • Field trials in India must ensure that there are sufficient safeguards against such violations.

	<ul style="list-style-type: none"> • If GM food is allowed to be sold to consumers, they must have the right to know what they are buying, and labelling should be made mandatory. • A strong regulatory authority should also be established for overseeing matters related to GM crops. • Dependence on GM crops is a risky proposition. Hence, India can use other technologies = increase productivity by molecular breeding and integrated pest management.
--	--

10. ACID RAIN

Concept and meaning	<p>When rain falls through polluted air, it can pick up some of the pollutants (oxides of nitrogen and sulphur) and turn more acidic thus producing acid rain.</p> <p>Air pollution converts the rain into a weak acid.</p> <p>The reaction behind formation of Acid Rain</p> <p>Sulphur dioxide and nitrogen dioxide undergo oxidation and then they react with water resulting in the formation of sulphuric acid and nitric acid respectively.</p> $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2\text{SO}_4(\text{aq})$ $4\text{NO}_2(\text{g}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{HNO}_3(\text{aq})$
Causes of Acid Rain	<p>Mixing of Sulfur and Nitrogen particles with the wet components of rain. Thus, sources of Sulfur and Nitrogen particles are</p> <ul style="list-style-type: none"> • Emissions given out from industries • Burning of fossil fuels • Lightning strike in the atmosphere releases nitrogen ions • Sulphur is released from volcanic eruptions also.
Impacts of Acid Rain	<p>Impact on Environment</p> <ul style="list-style-type: none"> • When acid rain accumulates in lakes or rivers, it gradually turns the entire water more acidic. • Fish thrive only in water that is neutral or slightly acidic (typically with a pH of 6.5–7.0). • Once the acidity drops below about pH 6.0, fish soon start to die—and if the pH drops to about 4.0 or less, all the fish will be killed. • It also causes the death of forests, reduces the fertility of soil, and damages buildings by eating away stonework <p>Impact on humans Affects human health</p>
Difficulties in Tackling Acid Rain	<ul style="list-style-type: none"> • It can happen over very long distances. • In one notable case, sulphur dioxide air pollution produced by power plants in the UK was blamed for causing acid rain that fell on Scandinavian countries

	such as Norway, producing widespread damage to forests and the deaths of thousands of fish in acidified lakes.
<p>Case study: Impact of acid rain on the Taj Mahal</p>	<p>Agra has many power plants and industries which emit oxides of sulphur and nitrogen in the atmosphere.</p> <ul style="list-style-type: none"> ● People continue to use low-quality coal and firewood as domestic fuel ● All these led to acid rain. ● Acid rain reacts with the marble (calcium carbonate) of Taj Mahal. This caused damage to this wonderful structure $\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2$ <div style="text-align: center;">  </div> <p>Steps taken by Government to protect Taj Mahal</p> <ul style="list-style-type: none"> ● Agra will be converted into a city that relies only on “biofuel”. ● The government has set a deadline for addressing the water pollution that affects the iconic monument. ● Establishment of Taj Trapezium Zone <ul style="list-style-type: none"> ○ It is an area of 10,400 sq. km around the Taj Mahal to protect the monument from pollution. ○ The Supreme Court has banned the use of coke/coal in industries located in the TTZ with a mandate for switching over from coke/coal to natural gas, relocating them outside the TTZ or shutting down.



JK Chrome

JK Chrome | Employment Portal



Rated No.1 Job Application of India

Sarkari Naukri
Private Jobs
Employment News
Study Material
Notifications



JOBS



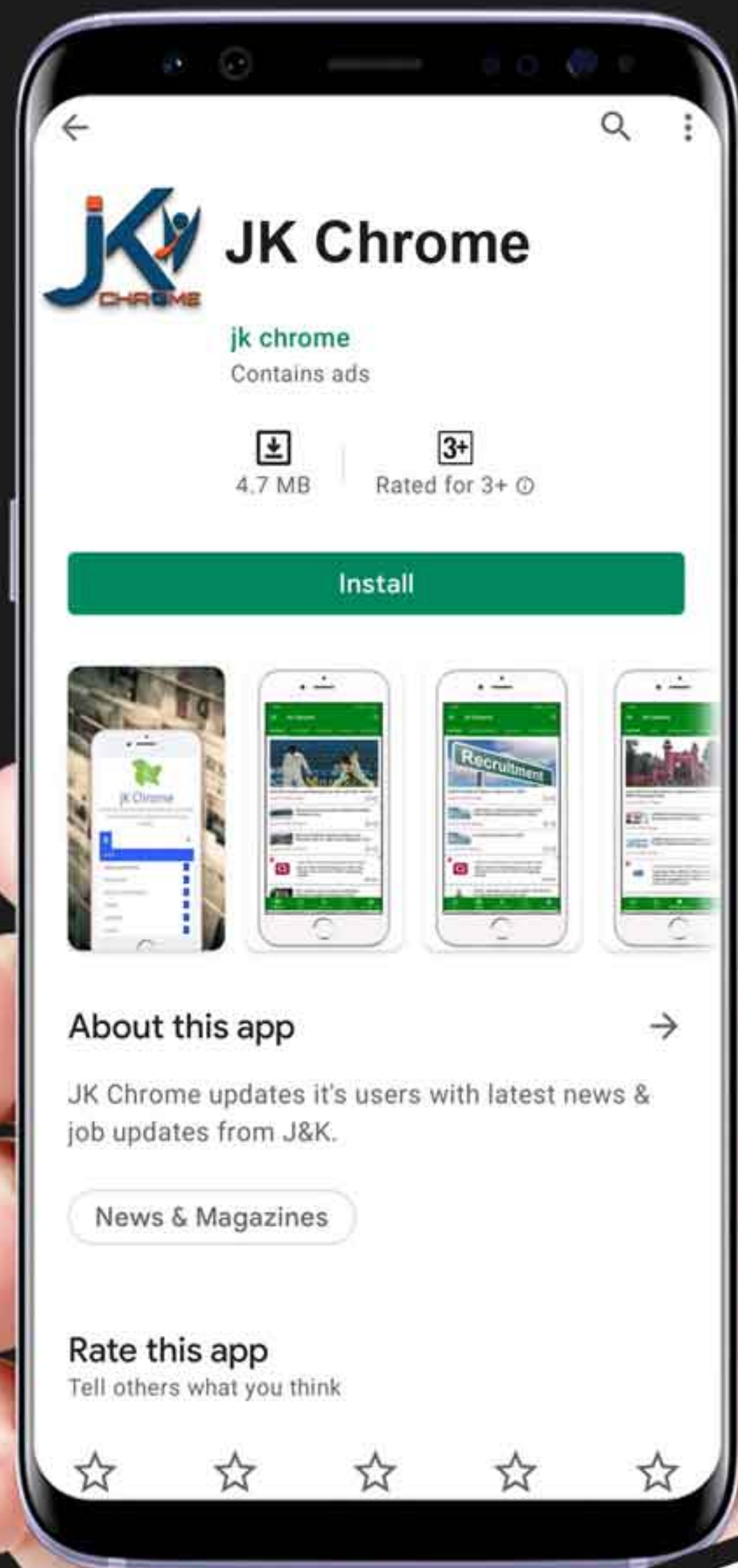
NOTIFICATIONS



G.K



STUDY MATERIAL



JK Chrome

jk chrome
Contains ads



www.jkchrome.com | Email : contact@jkchrome.com