15 Biodiversity, Conservation and Environmental Issues

Can you recall?

1. You have learnt about Chipko movement and efforts of Shri. Jadav Payeng in school. What is the importance of such activities?
2. Why should we have national parks and sanctuaries?
3. We have read about how Indian scientists won the battle for patent of Turmeric and Basmati rice. Why was gaining these patents essential?
4. What is *in situ* and *ex situ* conservation?

Diversity is variety. This variety of life is called biodiversity. **Biodiversity** includes a vast array of species of microorganisms- viruses, algae, fungi, plants and animals occurring on Earth, either in terrestrial or aquatic habitat and the ecological complexes of which they are part.

The diversity is with respect to size (microscopic to macroscopic), shape, colour, form, mode of nutrition, type of habitat, reproduction, motility, duration of life cycle span, etc. This is actually due to the attempt of living beings to accomodate with different environmental conditions (like climatic, edaphic, topographic, geographic, etc.) or situations, solely for their survival and perpetuation. In doing so, living organisms adapt themselves to overcome different situations and thus develop distinct but different features and that has actually lead to the diversity in them. The diversity in features become infused in the life cycle. In short, these adaptations in different environments serve as basis for diversity.

Definition of Biodiversity : It is the part of nature which includes the differences in the genes among the individuals of a species; the variety and richness of all plants and animal species at different scales in a space - local regions, country and the world; and the types of ecosystem, both terrestrial and aquatic, within a defined area.

The term biodiversity was actually coined by Walter Rosen (1982) but the term was popularised by sociologist Edward Wilson to describe combined diversity at all the levels of biological organisation.

Biodiversity that we see today, is the outcome of over 3.5 billion of years of evolutionary history mainly influenced by natural processes and of late by influence of humans.

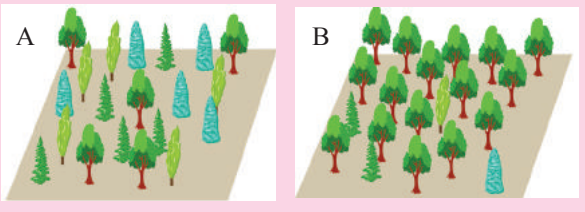
In this chapter, we shall study the basic concepts of biodiversity such as levels and patterns of biodiversity, expanse, importance, loss and conservation methods and efforts undertaken.

15.1 Levels of Biodiversity:

Diversity of living world can be observed at various levels, ranging from molecular to ecosystem level. Major hierarchial and interrelated levels are genetic diversity, species diversity (community), and ecosystem diversity (ecological).

Can you tell?

What can you say about species diversity A and B?



a. Genetic diversity:

It is the **intraspecific diversity**. It is the diversity in the number and types of genes as well as chromosomes present in different species and also the variation in the genes and their alleles in the same species. It includes variation within a population and diversity between populations that are associated with adaptation to local conditions. Genetic variations (e.g. allelic genes) lead to individual differences within species. Such variations pave way to evolution. They also improve chances of continuation of species in the changing environmental conditions or allow the best adapted to survive. Existence of subspecies, races are examples of genetic diversity. Greater the diversity, better would be sustenance of a species. You know about 1000 varieties of mangoes and 50,000 varieties of rice or wheat in India.

Another case of genetic diversity is a medicinal plant *Rauwolfia vomitoria* which secretes active component reserpine, is found in different Himalayan ranges. This plant shows variations in terms of potency and concentration of active chemical, from location to location.

Genetic diversity or variability is essential for a healthy breeding population of a species.

b. Species diversity:

It is the **interspecific diversity**. The number of species of plants and animals that are present in a region, constitutes its species diversity. Some areas or regions are richer in species than in the other regions. **Species diversity** deals with variety of species (**species richness**) as well as number of individuals of different species (**species evenness**) observed in area under study. E.g. amphibian species diversity is more in western ghats than in eastern ghats. Natural undisturbed tropical forests have much greater species richness than monoculture plantation of timber plant, developed by forest plantation. India is one among 15 nations that are rich in species diversity.

c. Ecological (Ecosystem) diversity:

It is related to the different types of ecosystems/ habitats within a given geographical area. There are a large variety of ecosystems on Earth having their own complement of distinctive interlinked species, based on the differences in the habitat. It can be described for a specific geographical region. Generally, there may be one or many different types of ecosystems in a region. Thus, ecosystem diversity is very high in India while it is quite low in Norway. In India, we can find a great variety of ecosystems - deserts, rain forests, deciduous forests, estuaries, wetlands, grasslands, etc. The Western ghats show great ecosystem diversity while regions like Ladakh and Rann of Kutch do not show variance like we observe in Western ghats.

The diversity of life at all the three levels is now rapidly being modified by modern man.

15.2 Patterns of Biodiversity:

There are two patterns viz, Latitudinal and Altitudinal gradient, and species-area relationship.

Think about it

What are latitudes and longitudes? Which of these imaginary lines are more significant with reference to diversification of living beings? Why?

a. Latitudinal and altitudinal gradients :

Biodiversity, barring Arid/ Semiarid and aquatic habitat, show latitudinal and altitudinal gradient.

Latitudinal : Ecological studies have revealed that the distribution of diversity is not uniform around the Globe. Species richness exhibits latitudinal gradient for many plants and animals (if not all). It has been observed that species richness is high at lower latitudes and there is a steady decline towards the poles.

Factors like overall stability of tropical regions for millions of years, lesser climatic changes throughout the year and availability of plenty of sunlight that favoured speciation. Tropical areas have less often experienced drastic disturbances like periodic glaciations observed at poles. Such a stability over millions of years might have favoured speciation. Lesser migrations in tropics might have reduced gene flow between geographically isolated regions and favoured speciation. Scientists also have considered availability of more intense sunlight, warmer temperatures and higher annual rainfall in tropics, as factors responsible for bountifulness of these regions. In more or less constant climatic conditions and abundance of resources, some animals enjoy food preferences. For e.g. fruits being available throughout the year in rain forests, variety of frugivorous organisms is obviously more as compared to the temperate regions.

In short, species richness or diversity for plants and animals decreases as we move away from equator to the poles. It is maximum in tropical rain forests e.g. Amazon rain forest (40,000 plants, 1300 birds, 427 mammals, 3000 species).

Altitudinal : It speaks for the height from mean sea level (MSL) upwards. Species diversity is more at lower altitudes than at the heigher altitudes. It is because at heigher altitudes, change in the climatic conditions and drastic seasonal varitations, lead to the decrease in the species diversity.

b. Species-Area relationships :

Scientists have tried to establish relationship between species diversity and the size of the habitat. It is considered that number of species present is directly proportional to the area. It is understood that larger areas may have more resources that can be distributed amongst the inhabitant species. Does this always hold true?

German naturalist Alexander Von

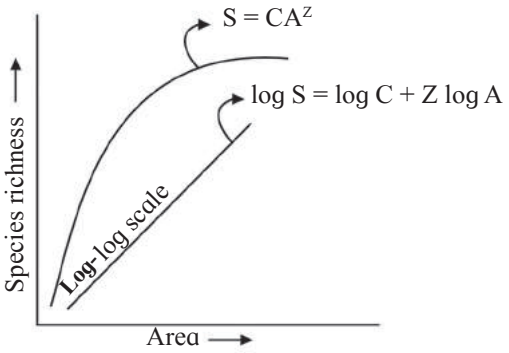


Fig. 15.1 : Graph showing species area relationship

Humboldt observed that species richness does increase with the increase in area but upto a limit. Observe the graph for species-area relationship. For many species this curve is a rectangular hyperbola. If we consider S to be species richness, A as area under study, C as the Y intercept and Z as the slope of the line, this relationship can be described by the equation,

$$\log S = \log C + Z \log A.$$

On logarithmic scale this relationship is a straight line, as observed in the figure above.

For smaller areas, value of Z ranges between 0.1 to 0.2 regardless of species or region under study.

But for the larger areas like the entire continents, slopes are closer to vertical axis i.e. steeper. This observation indicates that in very large areas, number of species found, increase faster than the area explored.

Can you tell?

1. What is biodiversity? Explain genetic diversity with suitable example.
2. Species richness goes on decreasing as we move from equator to pole. Explain.

Importance of species diversity to the ecosystem:

Let us now understand whether we really need all the diversity around us. What if few species are lost permanently?

A community is said to be stable, if average biomass production remains fairly constant over a period of time. It should be strong enough to withstand disturbances and recover quickly. It also must be resistant to invasive species. David Tillman carried out various field experiments and proved that species richness does help the stability of an ecological community. Rich diversity leads to lesser variation in biomass production over a period of time. This is called **Productivity-Stability Hypothesis**.

Paul Ehrlich, an ecologist from Stanford gave an analogy to explain significance of diversity. It is called **Rivet Popper Hypothesis**. He compared Aeroplane to ecosystem and the species as rivets that keep all parts of the aeroplane together. Ofcourse, there are thousands of rivets needed to hold all the parts of the aeroplane together. If each passenger decides to pop even one rivet or in other words, if one species gets extinct, initially not much of the turbulence will be experienced but slowly, as number of popped rivets will increase, there will be a serious threat to the safety of the aeroplane. Also, which rivets are removed will also matter.

Suppose, rivets at key positions such as the ones that bind the wings to the body of the aeroplane, are removed, situation will become serious. Thus, we can say that relationship between diversity and well being of ecosystem is not linear. But it is certain that loss of species may not pose threat to the ecosystem only initially. Loss of key species will certainly cause threat in very short span of time. It will affect food chains, food web, energy flow, natural cycles, etc. In short it will affect the balace of ecosystem.

15.3 Biodiversity Current Scenario

How many species do really exist on earth and how many of them are found in India? It is difficult to come to consensus about the exact number of species that are present on earth today. Though over 1.5 million species have been documented as per IUCN data (2004) so far, we are yet to study lot more than these. We are also unaware about speciation process that might have continued. Most of the studies that have been carried out are in temperate regions.

Tropical rain forests, the major diversity hubs, are yet to be explored completely. Some exorbitant numbers like existence of 20 to 50 million varieties have been made. But Robert May has given convincing estimate of about 7 million species round the globe. Observe the given pie charts and find out the relative share of various plant and animal groups in the existing knowledge of biodiversity.

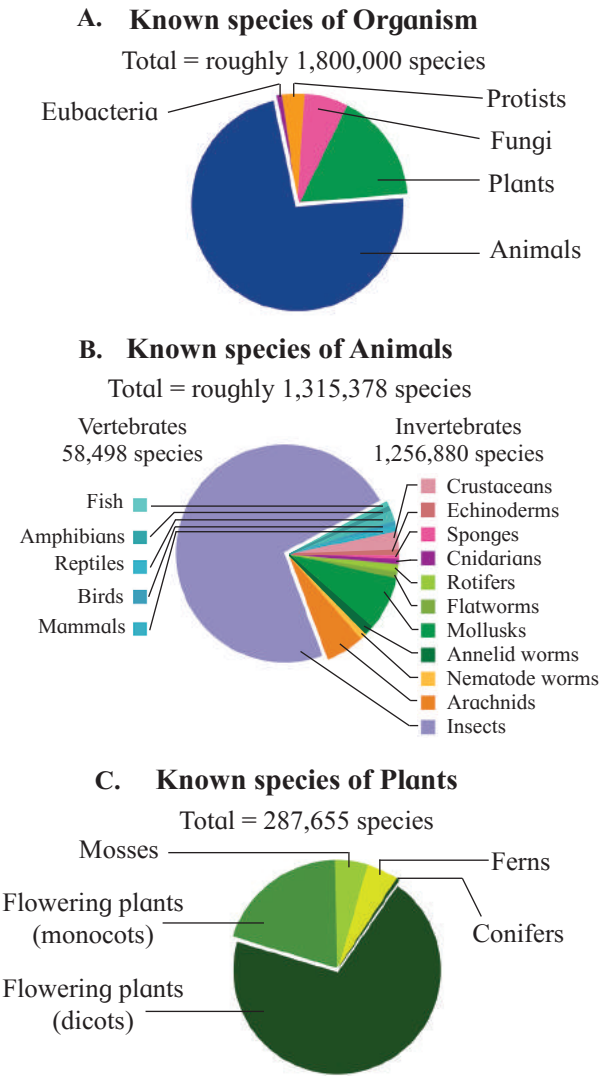


Fig. 15.2 : Graphic representation of known animal and plant groups

In the diagrams, we do not find any data of prokaryotes. Several moneran species are not cultivable under laboratory conditions. Also, conventional taxonomic methods are not suitable for identification of prokaryotic species.

India boasts a handsome share of 8.1% of total biodiversity wealth of the earth. One of the 12 megadiversity countries of the globe, India has 2.4% of total land area of the world. We have identified around 45000 plant species and nearly double the number of animal varieties from our natural wealth. If we consider May's estimate of global biodiversity, we have recorded only 22% of our natural wealth. This situation underlines the need of taxonomists to study the biodiversity. But major concern is the possibility of loss of these varieties before we identify them because of activities like reclamation and deforestation.

Do you know ?

Recently a group of naturalists proved that a lizard from Amboli ghat of Maharashtra was misidentified. They proved it on the basis of DNA profiling as well as number of glands and scales present on the legs of the lizard. Earlier thought to be *Hemidactylus brookii*, the lizard is now renamed as *Hemidactylus varadgirii* in the honour of renowned herpetologist and conservationist, Dr. Varad Giri. They also proved that *brookii* variety is not found in India.

Internet my friend

1. Find out information about Zoological Survey of India and Botanical Survey of India.
2. You may visit Zoological Survey of India, Pune office and find out how information about natural wealth is conserved.

15.4 Loss of Biodiversity:

Loss of biodiversity leads to the overall imbalance in the ecosystem. The chief serious aspect of loss of biodiversity is extinction of species. There are three types of extinction viz, **natural** extinction, **mass** extinction and **man-made** (anthropogenic) extinction.

Damage to biodiversity takes place due to both, natural and manmade reasons. Natural reasons include forest fires, earthquakes, volcanic eruptions etc. Manmade reasons are habitat destruction, hunting, settlement, overexploitation and reclamation.

Major mass extinction events occured between Cretaeous and Coenozoic period; between Triassic and Jurassic period; between Permian and Triassic period; between Devonian and Carbaniferous period; between Ordovician and Silurian period in the geological time scale where plants as well as animal groups underwent mass extinction.

We are aware of five mass extinctions during various stages of history of earth (e.g. ice age). The current loss of biodiversity is considered to be the Sixth extinction which is progressing at an alarming rate which is estimated to be 100 to 1000 times faster than prehuman times. Ecologists blame this to the human intervention in natural habitats. They do not forget to warn that if the current trend continues, we might lose about 50% of diversity. Loss of biodiversity in any area can lead to the decline in plant production, lower resilience to environmental disturbance like flood. It may also lead to alteration in environmental processes like disease cycles, plant productivity etc.

Causes of Biodiversity losses:

There are four major causes popularly known as, 'The Evil Quartet'.

i. Habitat loss and fragmentation:

It is the prime cause of destruction. Reduction in vast natural habitats and local degradation by pollution, create crisis situation for the living beings. Loss of local habitat due

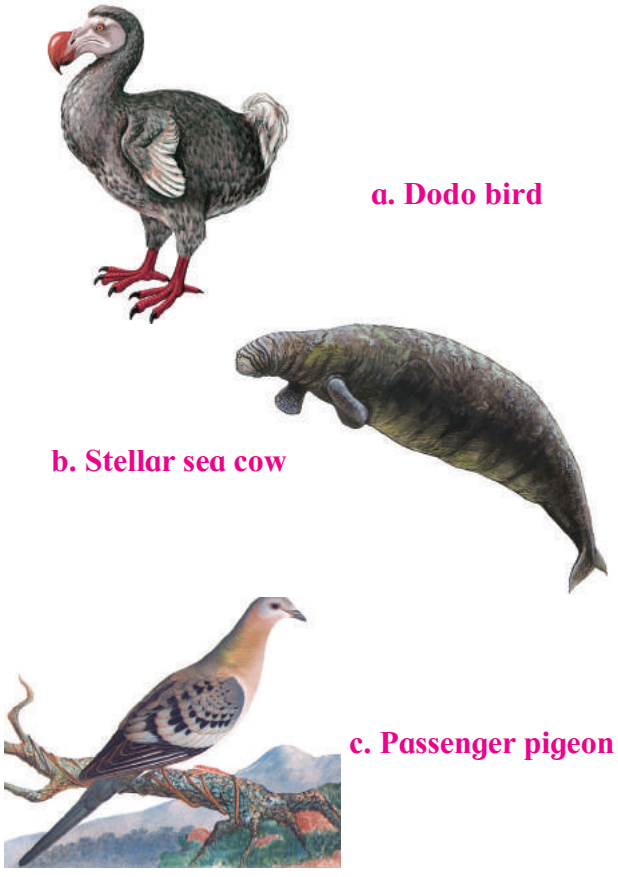
to human activities, creates threat to migratory birds as well as those animals that need larger territories. Tropical rain forests are being lost at an alarming rate. Tropical rain forest cover has reduced from 14% to 6% over the years.

Do you know ?

Great Indian Bustard alias *Maldhok* is a critically endangered bird. It is considered as flagship species of grasslands. We lost last *Maldhok* from Maharashtra in 2018. Now this bird is found in Rajasthan and Gujrat. It is an example of local extinction due to habitat loss and hunting.

ii. Over-exploitation:

Basic difference between human beings and other animals is that, humans have the tendency to accumulate beyond their needs. This has resulted in the overexploitation of resources which in turn causes threats to various organisms. Can you correlate this with dirth of fish, we observe now a days? Dodo bird, stellar sea cow and passenger pigeon are few examples of extinction due to overexploitation.



a. Dodo bird

b. Stellar sea cow

c. Passenger pigeon

Fig. 15.3 : Examples of extinction due to over-exploitation

iii. Alien species invasion:

When a new species gets introduced into any ecosystem accidentally or intentionally, there are chances that it proves harmful for existing species. Sometimes, it can lead to extinction of local species. In such a case, it is called as **invasive species**. E.g. the carrot grass (*Parthenium*), *Lantana* and water hyacinth (*Eichhornia*). Introduction of **predator fish** - Nile perch in Lake Victoria, proved deleterious for 200 **local species** of Cichlid fish.

In India, introduction of African catfish *Clarias gariepinus* for aquaculture purpose has proved harmful to endemic catfish varieties. One of the major reasons of such a harmful effect of alien species is, lack of local predator.

iv. Co-extinctions:

Many a times, organisms are associated with each other in obligatory way. In such cases, extinction of one variety leads to loss of associate variety from the ecosystem. e.g., Extinction of host fish causes extinction of unique parasites. Coevolved plant-pollinator, also will have such a threat.

We are aware of threat to diversity and loss of species from earth. When any species is totally eliminated from earth, it is called **extinct**. e.g. Dinosaurs. When the number of members of a species starts dwindling, it is said to be **endangered**. The International Union for Conservation of Nature and Natural Resources (IUCN) maintains a Red Data Book also known as Red List, where conservation status of plant and animal species is recorded.

Internet my friend

What is ballast water and how can it bring about introduction of alien species into any ecosystem?

Do you know ?

Many a times, we read about leopard attacks on humans or about elephants from Karnataka destroying agricultural lands and orchards in Sindhudurg region of Maharashtra. With increase in human population, man started encroaching forest land. Animals either out of sheer curiosity (in case of young leopards) or for lack of sufficient resources, venture out from their original place. This results in Man-Animal conflict.

Various measures are adapted by forest department to minimise this tussle. e.g., Government not only gives monetary compensation to farmers affected by elephant attacks, but even the forest department conducts community meetings to train locals to face the attack. Also, measures like appointing experts to tame the wild elephants with the help of domesticated elephants, and sensitising people towards wild life are most important part of such activities.

Do you know ?

The IUCN system uses a set of five quantitative criteria to assess the extinction risk of a given species. These criteria are : The rate of population decline; The geographic range; Whether the species already possesses a small population size; Whether the species is very small or lives in a restricted area; and Whether the results of a quantitative analysis indicate a high probability of extinction in the wild.

After a given species has been thoroughly evaluated, it is placed into one of following several categories.

1. **Extinct (EX)**, a designation applied to species in which the last individual has died or is not recorded.
2. **Extinct in the Wild (EW)**, a category containing those species whose members survive only in captivity
3. **Critically Endangered (CR)**, a category containing those species that possess an extremely high risk of extinction with very few surviving members (50).
4. **Endangered (EN)**, a designation applied to species that possess a very high risk of extinction as a result of rapid population decline of 50 to more than 70 percent over the previous 10 years (or three generations).
5. **Vulnerable (VU)**, a category containing those species that possess a very high risk of extinction as a result of rapid population decline of 30 to more than 50 percent over the previous 10 years (or three generations).
6. **Near Threatened (NT)**, a designation applied to species that are close to becoming threatened or may meet the criteria for threatened status in the near future.
7. **Least Concern (LC)**, a category containing species that are pervasive and abundant after careful assessment
8. **Data Deficient (DD)**, a condition applied to species in which the amount of available data related to its risk of extinction, is lacking in some way.
9. **Not Evaluated (NE)**, a category used to include any of the nearly 1.9 million species described by scientists, but not assessed by the IUCN

Can you tell?

1. Explain how loss of species diversity can harm ecosystem?
2. Give various categories of endangered species explained by IUCN.
3. What do you understand by invasive species? How does it affect local population?

15.5 Conservation of Biodiversity :

Conservation of biodiversity means protection, upliftment and scientific management of biodiversity to maintain its optimum level and to derive sustainable benefits for the present and future strategies.

Why to conserve Diversity?

The reasons for conservation of biodiversity can be classified into three categories:

a. Narrowly utilitarian reasons:

Since time immemorial, humans are reaping material benefits from biodiversity. It may be deriving resources for basic needs such as food, clothes, shelter or industrial products like resins, tannins, perfume base etc. For aesthetic use as in ornaments or artefacts. Medicinal use of plants and animals, is another major factor. It shares 25% of global medicine market. Around 25000 species are put to use by tribals worldwide as traditional medicines. Several are yet to be explored for their potential as medicinal plants.

Nowadays bioprospecting of economically important species is carried out. Bioprospecting is systematic search for development of new sources of chemical compounds, genes, micro-organisms, macro-organisms, and other valuable products from nature.

b. Broadly utilitarian reasons:

If we find out the cost of oxygen cylinder and try to calculate the value of oxygen we breathe with such ease; we will understand what nature is giving us for free! Animals play a crucial role in pollination and seed dispersal.

Amazon forest is estimated to produce 20% of total oxygen of earths atmosphere. We need to consider recreational use of diversity too.

You must have come across the news about devastating fires in amazon rainforest in August 2019.

These are mainly caused in Brazil and are more manmade than natural. The slash and burn policy of locals to reclaim forestland has caused a towering 906000 hectares of forest devastation, only in the year 2019. We the humans, need to rethink about our attitude towards nature!

c. Ethical reasons:

We have no right to destroy the diversity simply because we share the earth with them! All living beings have equal right to survive irrespective of their known or prospective economic use.

Internet my friend

Visit www.gotul.org.in to find out information about various efforts for biodiversity conservation in Maharashtra.

How do we conserve biodiversity?

Conservation means sustainable use of natural resources. There are two main types of conservation strategies :

a. *In situ* conservation:

Protection of an organism will automatically takes place, if its natural habitat is protected. e.g. Announcing Kanha forest as tiger reserve. This is called ***in situ* conservation**. This is the most appropriate method of conservation. It is nothing but conservation 'at home'. Around **34 Biodiversity hotspots** have been identified by the conservationists. These are the regions with high species richness as well as density. These areas need to be protected strategically by setting legislative measures apart from awareness and conservation.

In situ conservation also includes introduction of varieties traditionally used into farming and horticulture. E.g. In Maharashtra, Pawra tribals in Satpuda have protected varieties of corn with different coloured kernels.

India has three of world's biodiversity hotspots (the areas with high density of biodiversity), **Western ghats**, **Indo-Burma** and **Eastern-Himalayas**. It has been estimated that protection of these diversity rich hotspots could reduce extinction rate by almost 30%.

India, at present has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries. In Maharashtra, there are 5 national parks and 11 sanctuaries.

Internet my friend

Collect the information about protected areas, biosphere reserves, national parks and wild life sanctuaries.

Can you recall?

What are sacred groves?

Indian culture and traditions are always connected with nature and rituals are laid down to protect biodiversity. In many cultures, stretches of forests were set aside and protected in the name of Almighty, which are called **sacred groves**.

Such sacred groves are found in Khasi and Jaintia hills in Meghalaya, Western ghat regions of Maharashtra and Karnataka, Aravali hills of Rajasthan and Bastar, and Chanda and Sarguja areas of Madhya Pradesh.

Sacred groves serve the only chance of survival for some endangered varieties of animal and plant species. Tribals do not allow to cut even a single branch of tree from sacred grove. But with the increasing lust and greed, are sacred groves safe? We must think about it.

b. *Ex situ* conservation:

Sometimes when a species is critically endangered, special measures have to be under taken to protect it. It might be protected in captivity, as one of the measures of protection. This is called *Ex situ* conservation. In this type of conservation, living beings are protected away from their natural habitats in special settings. Wild life safari parks, zoological parks and botanical gardens serve this purpose. Animals which have decreased in number, are allowed to breed in captivity in order to protect them. e.g. crocodile bank of Chennai.

Seed banks are established to conserve wild varieties of food grains and vegetables. Now a days, modern techniques like tissue culture, *in vitro* fertilization of eggs and cryopreservation (preservation at low temperature -196^{0}C) of gametes, are used to protect endangered species.

By now we have, thus, understood the immense importance of biodiversity and dire need to protect it.

Do you know ?

Dr. Akira Miyawaki studied native forests of Japan especially the old shrine groves and developed a technique of growing dense plantations in short time. It is a technique for restoration of natural vegetation on degraded land. In this technique, after soil testing, the landmass is dugout and soil is mixed with local biomass and humus. Plantation is done in layers and saplings are planted close to each other. Due to this, sunlight doesn't reach soil retaining the moisture. Close proximity of plants leads to faster vertical growth than lateral. Also, it promotes natural selection. Native varieties are planted and the forest develops at almost ten times faster than the natural way. It requires a caring period of 3 years after which it grows and develops its own diversity naturally. In India, this technique is adapted at several places including remote districts like Chandrapur as well as metro cities like Mumbai and Bengaluru. Though there is debate about feasibility of the technique, it is certainly helping in retaining and recharging groundwater table, supporting local biodiversity and curbing air pollution by adding to green cover.

Internet my friend

Find out information about LACONES, Hyderabad.

15.6 Biological diversity Act 2002:

India participated in Earth Summit, Rio de Janeiro and is a party to Convention on Biological Diversity (CBD-1992).

In order to provide framework for the sustainable management and conservation of our country's natural resources, government passed Biological Diversity Act (BD Act) in the year 2002 in compliance with CBD. The law broadly defines biodiversity, as plants, animals and microorganisms and their parts, their genetic materials and by-products. It excludes value added products and human genetic material.

Regulation of access to Indian biological resources as well as scientific cataloguing of traditional knowledge about ethnobiological materials, were the main objectives for proposing this act.

A three-tier system has been established with **National Biodiversity Authority** (NBA) at the national level, the **State Biodiversity Boards** (SBBs) at the state level, and **Biodiversity Management Committees** (BMCs) at the local level for approval of utilization of any biological resource for commercial or research purpose. It is mandatory for foreigners, NRIs as well as Indian citizens and institutions to seek permission from NBA before exploiting local resource. NBA has powers of civil court. Not seeking approval of NBA, can incur jail and fine up to 10 lakh rupees.

Can you tell?

1. Differentiate between *in situ and ex situ* conservation.
2. Name any two modern methods of *ex situ* conservation of species.
3. Write a note on BD Act 2002.

Know the Conservationist

Rahibai Popere, seed mother of Maharashtra. Hailing from remote village in Ahmednagar district, Rahibai runs seed bank for 54 crops and 116 varieties. Crops include wild varieties of brinjal, guava, mango, spinach, methi, millets, pulses, hyacinth beans and peas. She also trains farmers and students for seed selection, enhancement of soil fertility, pest management and control. She is among 3 Indians on BBC list of '100 women, 2018'. She was awarded Padma Shri in 2020.

Can you recall?

1. What is pollution? Enlist its types.
2. Define pollutant. How are our daily activities responsible for pollution?

15.7 Environmental issues:

Exponential growth of human population coupled with industrial development, has resulted in the rampant loss of natural resources over last ten decades.

This uncontrolled exploitation of nature disturbed the delicate balance between living and non-living components of biosphere. Utilization and production of synthetic materials and construction activities have pumped several undesired substances in ecosphere. This has resulted in severe pollution.

Any substance that causes pollution, is called **Pollutant**. In order to protect and improve the quality of our environment, the Government of India has passed the Environment Protection Act 1986.

a. Air Pollution :

Effect of air pollution :

Respiratory surfaces of living beings are constantly interacting with air. Any unfavourable alteration in air quality, affects the respiratory system. Severity of damage depends on concentration of pollutant, duration of exposure and the organism. Even in case of plants, air pollution results in poor yield of crops and premature death of plants. Nowadays automobiles are omnipresent. They are major cause for atmospheric (air) pollution. Regular maintenance of vehicles and use of lead-free petrol or diesel can reduce pollutant from exhausts.

Types of air pollutants :

Air pollutants are of two types – **particulate** pollutants and **gaseous** pollutants.

Particulate air pollutants may be solid or liquids. Particles with diameter 10 µm may settle in the soil but particles with 1 µm or less remain suspended in the air. According to Central Pollution Control Board (CPCB), particulate matter of size 2.5µm or less in diameter (PM2.5) are responsible for causing the greatest harm to humans.

These fine particulates can be inhaled deep into the lungs and are responsible for irritation, inflammation and damage to lungs. In addition to this, it causes breathing and respiratory disorders and premature deaths.

Smoke, smog, pesticides, heavy metals, dust and radioactive elements are the examples of particulate pollutants.

Use your brain power

Does particulate matter help to reduce atmospheric temperature?

Gaseous pollutants include CO_2, CO, SO_2, NO, NO_2 etc.

Carbon di-oxide is a greenhouse gas. In the past, levels of CO_2 in the atmosphere remained low. Due to burning of fossil fuels, as well as increasing deforestation the levels of CO_2 are rising at alarming rate. Photosynthesis process balances CO_2 : O_2 ratio of the air to a great extent. CO_2 is also removed from the air by weathering of silicate rocks forming limestone. A jet plane in a single trip across the Atlantic uses 35 tonnes of oxygen and releases 70 tonnes of CO_2. We are going to discuss the role of CO_2 in global warming later in this chapter.

Carbon monoxide (CO) :

It is a poisonous gas produced by incomplete combustion of fuel such as coal or wood. Vehicular exhausts are the largest source of CO.

Use your brain power

State the effects of CO on human body.

Nitrogen di oxide (NO_2) and nitrogen monoxide (NO):

These are released by automobiles and chemical industries as waste gases. NO_2 when combines with water vapours forms nitric acid. It causes irritation to eyes and lungs. At high concentration, it causes injury to lungs, liver and kidneys.

Control measures:

Various ingenious mechanisms have been developed to control emission of gaseous and particulate pollutants through vehicles and industries. Few examples are explained below:

Electrostatic precipitator :

It is most widely used for removing particulate matter like soot and dust present in industrial exhaust. It can remove almost 99% particulate matter present in exhaust from a thermal power plant.

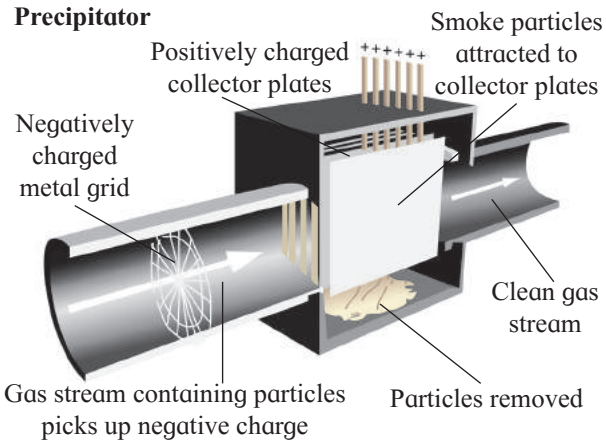


Fig. 15.4 : Electrostatic precipitator

In this method, high voltage is applied and electric discharge takes place which causes ionisation of air in the smokestack. Free electrons in the ionised air get attached to the gaseous/dust particles moving up the stack. These negatively charged particles move towards the positive electrode and settle down there. These particles are removed by vibrations of the electrodes and collected in the reservoir.

Internet my friend

Find out information about carbon foot print. Think about measures to reduce your own carbon foot print.

Exhaust gas Scrubbers are used to clean air for both dust and gases by passing it through dry or wet packing material. It can remove gases like SO_2. In the scrubber, the exhaust is passed through a spray of water or lime.

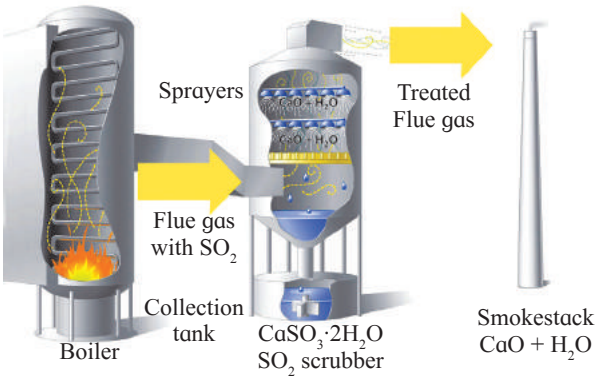


Fig. 15.5 : Exhaust gas Scrubber

Catalytic converters:

Motor vehicles equipped with catalytic converter should use unleaded petrol because lead in the petrol, inactivates the catalyst.

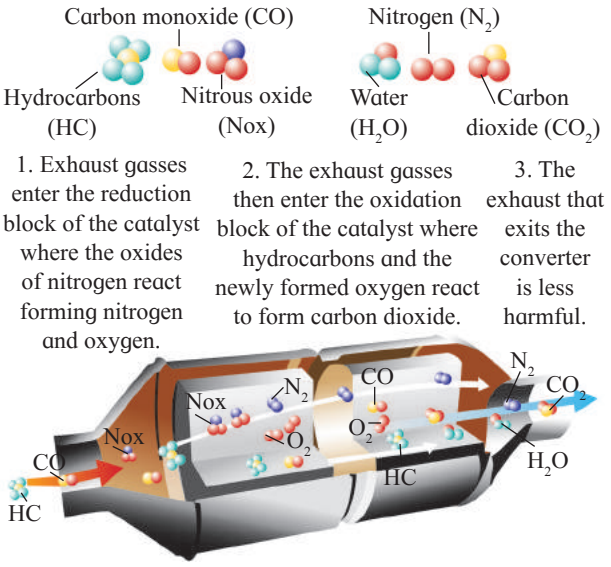


Fig. 15.6 : Catalytic converter

Controlling Vehicular Air Pollution : A case study of Delhi

In the year 1990, Delhi ranked fourth among 41 most polluted cities of the world. In response to PIL (Public Interest Litigation), Supreme court of India sent orders to Delhi government to take appropriate actions.

In response, several measures were taken by Delhi Government. By 2002, all the city buses were converted to run on CNG **(compressed natural gas).** CNG is advantageous over other fuels because it is economic, burns efficiently and is adulteration proof fuel.

According to new fuel policy, the norms are set to reduce sulphur and aromatic content of petrol and diesel. Another provision is upgradation of engines. For this, **Bharat stage emission standards (BS)** are set. These standards are equivalent to Euro norms and have evolved on similar lines as Bharat Stage II (BS II) to BS VI from 2001 to 2017. Let us observe how the norms have changed in the following table 15.7

Table 15.7 :Bharat stage emission standards in cities of India.

Vehicle	Norms	Cities of Implementation
4 wheelers	Bharat Stage II	All metro cities
4 wheelers	Bharat Stage III	Throughout the country since October 2010
4 wheelers	Bharat Stage IV	13 mega cities (Delhi and NCR, Mumbai, Kolkata, Chennai, Bengaluru, Surat, Kanpur, Agra, Lucknow, Solapur) since April 2010.
2 wheelers	Bharat Stage III	Throughout the country since October 2010
3 wheelers	Bharat Stage III	Throughout the country since October 2010

Do you know ?

Pradhan Mantri Ujjwala yojana (Pradhan Mantri clean fuel programme)

It was launched by Prime Minister of India, on 1st May 2016 to distribute 50 million LPG connections to women of BPL families. In many BPL families, chullhas are used where incomplete combustion of wood and coal leads to CO poisoning. Use of LPG helps in reducing such household air pollution.

Have you noticed that BS V is missing in above table? Note that, in 2001, Bharat stage II emission norms were set for CNG and LPG vehicles. It stipulates that emission of sulphur be controlled at 50 ppm in diesel and 150ppm in petrol. Aromatic hydrocarbons should be just 42% in concerned fuel. The aim is to reduce sulphur emission to 50ppm in petrol and diesel along with aromatic hydrocarbons to 35%. Government of India directly adapted BS VI in the year 2018, skipping BS V. These efforts decreased the levels of CO_2 and SO_2 in Delhi.

Do you know ?

Inspite of all the measures, New Delhi and adjoining areas witnessed great smog between 1st to 9th November 2016. Air pollution at this time peaked on both 2.5PM and 10PM levels. This is reported as one of the worst levels of air quality since 1999.

Colder weather and stagnant winds, trap smoke from various sources like firecrackers, burning crop stubbles, lit garbage and road dust. Citizens suffered breathlessness, chest muscle contraction, irritation in eyes, asthma and allergy. Administration took certain measures like closing educational institutions, suspending of construction or demolition work, undertaking vacuum cleaning of roads etc. Even Badarpur thermal power plant was temporarily closed down. Do you think mere setting standards is not enough? We must encourage means like car pooling and use of public transport.

Can you tell?

1. Describe any 2 particulate and gaseous pollutants.
2. Explain various technologies used for removing particulate matter from different sources of air pollution.
3. What are the ill effects of noise pollution on human health?
4. Give any norms for reducing sulphur and aromatic contents of petrol and diesel.

b. Noise pollution :

In India, the Air (Prevention and control of pollution) Act 1981, amendment 1987, includes **noise** as an air pollutant. Noise is an undesired high level of sound. Noise causes psychological and physiological changes in human beings. There is dire need of creating awareness about noise pollution caused during festivals and processions in our society.

Exposure to extremely high sound level (150 decibels or more) generated during a take-off of a jet plane or rocket, may damage ear drums and cause permanent hearing loss.

Noise also can cause sleeplessness, increased heartbeat, altered breathing pattern and psychological stress. Noise may negatively interfere with child's learning and behaviour pattern. The common sources of noise pollution are machines, transportation, construction sites, industries etc.

Activity :

Find out different sources of noise pollution in your surrounding.

Reduction of noise in our industries can be brought about by use of sound absorbent materials or by muffling the noise. Laws which prohibit blowing horn in the areas of schools and hospitals, need to be implemented strictly to curb decibel levels.

Govt. of India has rules and regulations against firecrackers and loudspeakers. Supreme court of India has banned loudspeakers at public gatherings after 10pm.

Internet my friend

We have studied about health effects of noise pollution on humans. How does this pollution affect birds? Does it affect marine life? Find out.

Can you recall?

1. Define water pollution.
2. When will you call a water body polluted?

c. Water Pollution and its Control:

Water has been a controlling factor in distribution and density of living beings in an area. Human water consumption increased many folds with increased industrialisation. Increased utilisation and discharge of harmful waste water in water bodies has caused severe pollution.

Most of the water pollution is manmade. Polluted water may be turbid, foul smelling, and may contain number of pathogens, heavy metals, oils etc.

Realising the importance of maintaining the cleanliness of the water bodies, Government of India has passed the **Water (prevention and control of pollution) Act 1974** to safe guard our water resources.

Can you recall?

1. Where does domestic waste water go in urban and rural areas?
2. What is importance of sewage treatment plant?

Domestic sewage and Industrial Effluents:

Even a small quantity of about 0.1% impurities in water, can make it unfit for human consumption. Solids are relatively easy to separate but dissolved salts such as nitrates, phosphates, other nutrients and toxic metal ions as well as organic compounds, are difficult to remove.

Domestic sewage is one of the most common source of water pollution. It contains biodegradable organic matter. It readily gets decomposed by bacteria and other microorganisms. They use organic matter as substrate and utilise some amount of sewage.

It is possible to estimate biodegradable organic matter in sewage water by measuring **Biochemical Oxygen Demand (BOD)**. It is the amount of dissolved oxygen required by microorganisms for decomposing the organic matter present in water. It is expressed in milligram of oxygen per litre (mg/L) of water. High BOD indicates intense level of microbial pollution.

Microorganisms involved in biodegradation of organic matter in water body consume lot of dissolved oxygen. This results in sharp decline in oxygen level of water which leads to mortality of fish and other aquatic creatures.

Presence of large amount of nutrients in water causes excessive growth of **planktonic** free-floating algae specially, blue green algae. This is called **algal bloom** which gives colour to the water bodies. Algal bloom often releases toxins in water. So, fish die due to toxicity. Quality of water deteriorates and becomes toxic for human beings and other animals.

Another threat to aquatic ecosystem, is water hyacinth (*Eichhornia crassipes*). It is an aquatic plant, native of amazon basin, highly problematic invasive species. It was first introduced in India for its lovely purple coloured flowers. But, now it is a nuisance as it grows excessively and covers entire water body. This plant grows faster than our ability to remove it. It is commonly called 'Terror of Bengal'.

Natural Eutrophication is aging of a lake due to nutrient enrichment of water. Depending on the size of the lake, climatic conditions and other factors, natural aging of lakes require thousands of years. However, due to pollutants from human activities like effluents from agricultural lands, industries and homes (house hold) have accelerated this aging process. This phenomenon is called **Cultural or Accelerated Eutrophication.** Observe the flow chart and understand the process of eutrophication.

This results in non-availability of dissolved oxygen for aquatic organisms. This leads to death of fish and other aquatic organisms. Its decomposition further depletes the dissolved oxygen. So, a lake can literally get choked to death.

A few substances usually present in industrial waste waters can undergo biological magnification. The phenomenon through which

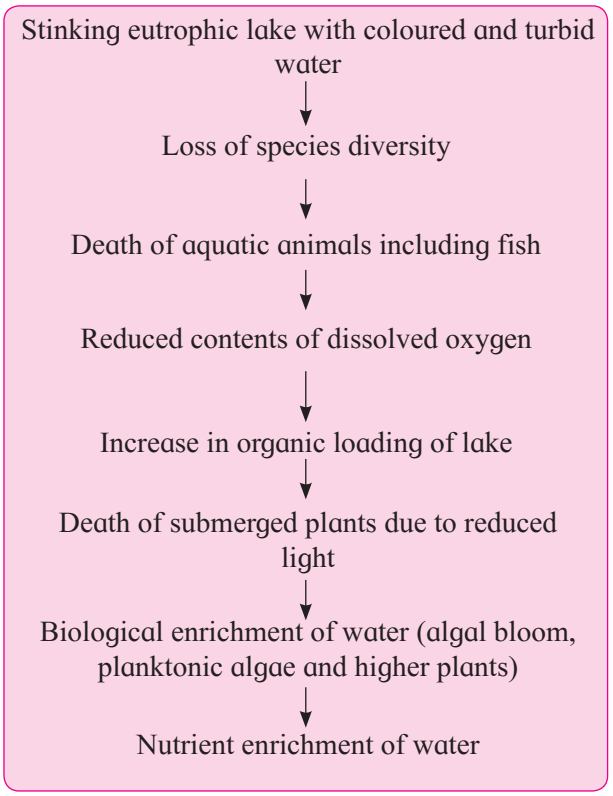


Fig. 15.8 : Eutrophication

certain pollutants get accumulated in tissues in increasing concentration along the food chains (successive trophic levels) is called **Biological Magnification (Biomagnification)**

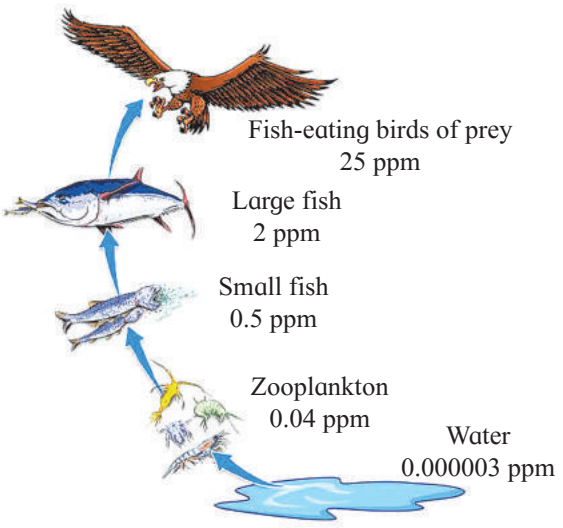


Fig. 15.9 : Biomagnification of DDT

Many of the pesticides are non-degradable. So, they get accumulated in the tissues of organisms. They neither get metabolised nor are excreted.

They are passed on to the next trophic level. This is commonly seen in case of DDT and Mercury. Observe the food chain in the given figure. It shows how biomagnification of DDT takes place.

Use your brain power

Why do you think the amount of DDT is maximum in birds?

Thermal pollution of water is caused due to rise in temperature of water. The main source of thermal pollution are the thermal and nuclear power plants. The power plants use water as coolant and release hot water. As many organisms are sensitive to temperature, sudden rise in temperature leads to loss of flora and fauna.

Internet my friend

1. Find out biomagnification of diclofenac and DDT in birds.
2. Find out various types of agrochemicals which have ill effects on ecosystem.

Measures to reduce sewage water:

In order to conserve water and prevent creation of sewage, ecosan is a sustainable system for handling human excreta using dry composting toilets. This is a practical, efficient and cost-effective solution for human waste disposal.

Ecological sanitation (Ecosan) is an approach to sanitation provision which safely reuses excreta in agriculture. It reduces the need for chemical fertilizers.

Ecosan toilet is a closed system that does not need water. It is an alternative to leach pit toilets in place where water is scarce or where there is risk of ground water contamination.

It is based on the principle of recovery and recycling of nutrients from excreta to create a valuable resource for agriculture.

When the pit of an ecosan toilet fills up, it is closed and sealed. After about 8-9 months, the faeces are completely composted to organic manure.There are working EcoSan toilets in many areas of Gujrat, Kerala, Tamilnadu and Sri Lanka.

Recycling of sewage water by reverse osmosis will help to solve the problem of not only scarcity of water but also the disposal of sewage water. At Tirumala hills, millions of pilgrims visit. Every building here has R.O. system which solves the problem of huge water demand. Recycling of sewage water is seen in many townships in Mumbai. Rain water harvesting is encouraged and made mandatory for new constructions by Municipal Corporation.

Can you tell?

1. Explain BOD and its effects on aquatic ecosystem.
2. Ecological sanitation is the need of the day. Justify.
3. Explain the phenomenon of biological magnification.

Solid Waste Management :

You have already studied about solid waste management in ninth standard.

Can you recall?

1. Why is it necessary to separate wet and dry garbage?
2. What are the six R's to combat solid waste?

Solid waste is everything that goes to trash. It includes wastes from home, offices, stores, schools, hospitals etc. Wastes are collected and disposed by municipality. Municipal solid waste generally consists of paper, food, plastic, glass, metals, rubber, leather, textile etc;

Burning reduces volume of the waste. Generally, it is not burnt to completion. So open dumps become breeding ground for rats and flies.

Sanitary landfills are substitute for open burning dumps. Here wastes are dumped in depression or trench. Everyday wastes are added to this pit. Landfills get filled very soon especially in metro cities. The amount of garbage generated is too high. In addition to this, there is a danger of chemicals percolating and reaching down to ground water and contaminate this water source.

All wastes can be categorised in three types-

1. Bio degradable
2. Recyclable
3. Non bio degradable

Our rag pickers and *kabadiwallahs* do a great job of separation of materials for recycling. Primary goal of all citizens should be to reduce generation of waste.

The biodegradable materials can be put into deep pits in the ground and left for natural degradation. Non biodegradable wastes have to be disposed off.

Maharashtra government in a notification on 23rd June 2018 banned use of plastic to fight pollution caused due to extensive use of plastic. Ban on the use, sale, distribution and storage of plastic material.

Mission-Plastic Free Maharashtra :

The union environment ministry has amended rules in 2016 in order to strengthen the implementation of environmentally sound management of hazardous waste in the country.

It also includes ban on use of Thermocol.

Large amount of use of plastic can be avoided, if we inculcate the habit of carrying cloth bags when we go for shopping and strictly refusing plastic bags from the venders. Goverment should charge high penalty/fine for the individuals not abiding by this rule.

Hospitals generate harmful waste that contains disinfectants, harmful chemicals and also pathogenic microorganisms.

Such wastes require careful treatment and disposal. You are aware of colour code for disposal of biomedical waste.

Irreparable computers and other electronic goods as well as electrical waste are known as **e-wastes.** They are buried in landfills or are completely burnt. Major part of e-waste generated by developed countries are exported to developing countries like China, India and Pakistan. During recycling process of this waste, metals like copper, iron, silicon, nickel and gold are recovered. Developed countries have facilities for recycling of e-waste. In developing countries, manual participation is involved. So, workers are exposed to toxic substances from e-waste. Treatment of e-waste should be carried out in environment friendly manner.

You have already studied about radioactive pollution.

Can you recall?

1. What is greenhouse effect?
2. Enlist greenhouse gases.
3. How do you correlate green house effect and global warming?

15.8 Greenhouse effect and Global warming:

Greenhouse effect : It is responsible for heating of earth's surface and atmosphere. Without greenhouse effect, the average temperature of Earth would have been -18^{0}C rather than average of 15^{0}C.

Of the solar radiation that reaches earth, Clouds and gases reflect about 1/4th and absorb some of it. But half of total incoming radiations reach the earth's surface and heat it. Small portion of it, is reflected back. Earth's surface re emits the heat in the form of infrared radiations. Part of these radiations do not escape into the space because atmospheric gases (CO_2, CH_4) absorb a major portion.

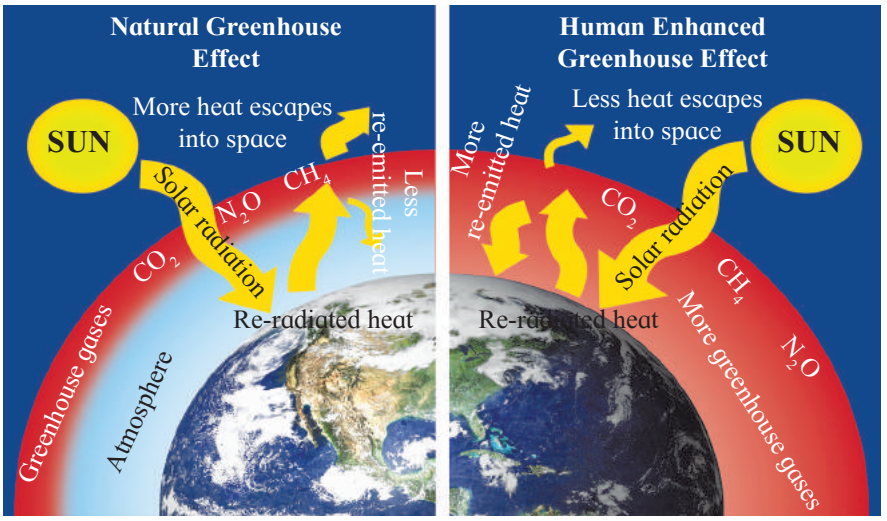


Fig. 15.10 : Greenhouse effect

The molecules of these gases radiate heat energy and a major part of it comes back to earth's surface. Thus reheating the earth. This cycle is repeated many times. Hence CO_2 and CH_4 are commonly called **greenhouse gases**.

The atmosphere around the earth acts as glass wall of a greenhouse. It absorbs solar radiations from the sun and radiates it to earth. Atmosphere prevents infrared radiations emitted by the earth to escape into the space.

Gases responsible for this effect are carbon di-oxide (CO_2), Methane (CH_4), chloroflorocarbons (CFC), Nitrous oxide (N_2O) and water vapours.

Because of burning of fossil fuels in industries, by automobiles, burning of agricultural wastes, levels of CO_2 are increasing. Biogas plants, paddy fields, cattle sheds add methane to atmosphere. Chloroflorocarbons are emitted by fire extinguishers and air conditioners.

Global warming :

Increase in atmospheric concentration of green house gases, has resulted in the heating of Earth or rise in the temperature. During past century, the temperature of the Earth has increased by 0.6^0C, most of it during last three decades.

This rise in temperature leads to unfavourable changes in environment and resulting in odd climatic changes.(eg; EI Nino effect). EI Nino effect results in melting of polar ice caps and Himalayan snow caps which may be the cause for submerging of the coastal areas.

Do you know ?

In order to overcome the problem of global warming, **Chewang Norphel, Ice Man of India** has built 13 artificial glaciers. He is an Indian civil engineer from Ladakh.

Norphel noticed a small stream had frozen solid, under the shade of a group of poplar trees, though it flowed freely elsewhere in his yard.

The reason for this phenomenon :

The flowing water was moving quickly to freeze while the sluggish trickle of water beneath the trees, was slow enough to freeze. Based on this, he created artificial glaciers by diverting a river into a valley, slowing the stream by constructing checks.

The artificial glaciers increase the ground water recharge, rejuvenating the spring and providing water for irrigation. He constructed them at lower elevations, so that they melt earlier expanding the growing season.

Global warming can be controlled by reducing use of fossil fuel, improving efficiency of energy usage, reducing deforestation, planting trees and checking of human population growth.

Do you know ?

El Nino effect is a climate cycle in pacific ocean with global impact on weather pattern. The cycle begins when warm water in the western tropical pacific ocean shifts eastwards along the equator towards the coast of America. Normally, this warm water pools near Indonesia and Philippines.

La Nina is a climatic pattern that describes the cooling of surface ocean waters along the tropical west coast of south America.

15.9 Ozone depletion :

Ozone is a form of oxygen.In the stratosphere, ozone is photo-dissociated and is generated by absorption of short wave length UV radiations.

$$O_3 \rightarrow O_2 + [O]$$

$$O_2 + [O] \rightarrow \text{UV RAYS} \rightarrow O_3$$

Generation and dissociation of ozone are in equilibrium leading to steady concentration of ozone in the stratosphere (12 to 15 kilometers from Earth's surface in the atmosphere).

This ozone layer acts as shield that absorbs UV radiations from the sun and protects all types of life on earth. Absorption of UV radiations by ozone blanket is proportional to its thickness. Thickness is more above the poles than at the equator. UV rays are highly injurious to living organisms since DNA and proteins of living organisms absorb UV rays and its high energy breaks the chemical bonds within these molecules.

Thickness of the ozone in a column of air from the ground to the top of the atmosphere is measured as **Dobson units** (DU).

The ozone shield has been disturbed due to increased rate of ozone degradation by **Chlorofluorocarbon** (CFC). CFCs move upwards and reach stratosphere. UV rays act on them and release Cl atoms. Cl degrades ozone releasing molecular oxygen. Cl atoms act as catalyst. So they remain in the stratosphere and continue the effect of ozone degradation. This results in ozone depletion. Although it occurs widely in the stratosphere, the depletion is particularly marked over the Antarctic region. This has resulted in formation of large area of thinned ozone layer, commonly called **ozone hole.**

UV radiations of wave length shorter than UV-B i.e. 100-280nm are almost completely absorbed by earth's atmosphere, given that the ozone layer is intact. UV-B (wavelength 280-322nm) damages DNA and mutation may occur. It causes aging of skin, damage to skin cells and various types of skin cancers. In human eye, cornea absorbs UV-B radiations and a high dose of UV-B causes inflammation of cornea called **snow blindness,** cataract etc; Such exposure may permanently damage cornea.

Recognising the harmful effects of ozone depletion, an international treaty, known as the **Montreal Protocol** was signed at Montreal (Canada) in 1987 to control emission of ozone depleting substances.

Later many more efforts have been made and protocols have laid down definite roadmaps separately for developing and developed countries for reducing emission of CFCs and other ozone depleting chemicals.

Can you tell?

1. How pollution by domestic garbage can be controlled?
2. Give effect of CFC on ozone shield.
3. Give an account of possible effects of global warming.
4. Plastic ban in Maharashtra is an essential step. Give reason.

Internet my friend

1. Find out more about artificial glaciers.
2. Collect information about colour code used for biomedical waste.

15.10 Deforestation :

Deforestation is conversion of forest area into non-forest area. According to an estimate, almost 40% forests are lost in the tropics and only 1% in temperate region. The scenario of deforestation is grim in India. At the beginning of 20th century, forest cover was about 30% in India. By the end of the century, it got reduced to 19.4 %. The National Forest Policy 1988 of India has recommended 33% forest cover for the plains and 67% for the hills.

Deforestation takes place by conversion of forest to agricultural land so as to feed the growing human population.Trees are cut for timber, firewood, for keeping cattle in farm and for other purposes.

Slash and burn agriculture commonly called **Jhum Cultivation** in north eastern parts of India, where farmers cut down trees of the forest and burn the plant remains. The ash is used as fertilizer and the land is used for farming and cattle grazing. After cultivation, the area is left for several years so as to allow its recovery.

Major Effect of Deforestation is the increased concentration of CO_2 in the atmosphere because trees hold lot of carbon in their biomass, are lost with deforestation.

It leads to the loss of biodiversity due to habitat destruction, disturbs hydrologic (= hydrological) cycle, causes soil erosion and desertification in extreme cases.

Can you tell?

1. How Jhum cultication has led to deforestation in recent years?
2. Comment on deforestation status of the world and its major effects.

Reforestation is the process of restoring a forest that once existed but was distroyed or removed at some time in past. Reforestation occurs naturally in a deforested area. We can speed up this by plantation of tree with due consideration to biodiversity that existed before.

Best example of peoples participation in reforestation is **Saalumara Thimmakka,** an Indian environmentalist from state of Karnataka noted for her work in planting and tending to 385 banyan trees along a 4km stretch of highway between Hulikal and Kudur. She has also planted nearly 8000 other trees. Her work has been honoured with the National Citizens Award of India. She was also conferred with Padma Shri in 2019.

Moirangthem Loiya from Manipur dedicated 17 years of his life to restore Punshilok forest. He left his job and took over the task of bringing back the lost glory of 300 acres forest land. He planted a variety of trees like, bamboo, oak, ficus, teak, jackfruit and magnolia. Today the forest has over 250 varieties of plants including 25 varieties of bamboo. It is now selected as home by great diversity of animals too.

Can you recall?

What is Chipko movement?

Case study of people's participation in conservation of forests.

History of people's participation in India can be traced back to 1731. The ministers of the king of Jodhpur in Rajasthan tried to cut forest to procure wood for a new palace. Local Bishnoi community known for peaceful co-existence with nature, opposed king's men.

A Bishnoi woman **Amrita Devi** hugged the trees and lost her life in an attempt for protecting the forest. Her three daughters and hundreds of other Bishnois too lost their lives.

The Government of India has recently instituted **Amrita Devi Bishnoi Wildlife protection Award for** individuals or community from rural areas that have shown extraordinary courage and dedication in protecting wildlife.

In 1980s, realising the significance of participation of local communities, Government of India introduced the concept of **Joint Forest Management** (JFM) so as to work closely with local communities for protecting and managing forests. In return, for their services to the forest, the communities get benefit of various forest products (Fruits, gum, rubber, medicine etc.) and thus the forest can be conserved in a sustainable manner.

15.11 Mission Harit Maharashtra :

An ambitious project of planting 50 crore trees in four years was taken up by Government of Maharashtra in the year 2016. Under this project yearly targets were given to each district. The plantation drive is in line with National Forest Policy (NFP) which aims at maintaining 33% forest cover in the country. A 24-hour toll free helpline number 1926 called 'Hello Forest' has been set up to provide information regarding plantation, protection and for mass awareness.

The Forest Department has created a mobile application called 'My Plants' to record details of the plantation such as numbers, species and location. Authorities are expected to take care of saplings in the first year i.e., year 2016, 2.87 crore saplings were planted. In 2017, 5.17 crore and in 2018, 15.17crore plantation count was achieved! In the year 2019, the government aimed at a phenomenal 33 crore sapling plantation which was launched at Anandwan, Warora.

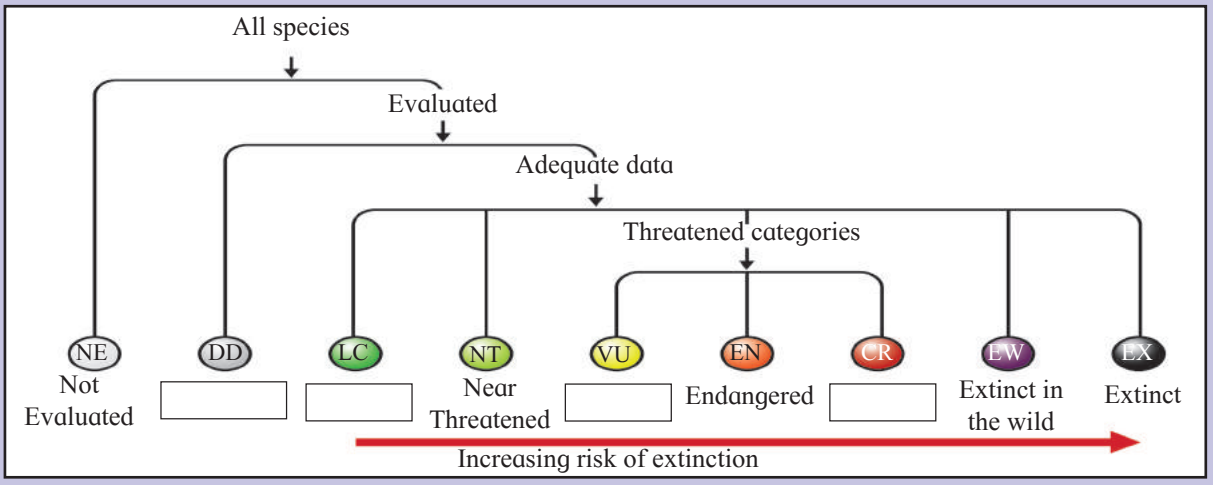
The government has decided to adapt Japanese Miyawaki method of plantation for this project. State Forest Department and Social Forestry Department have run successful pilot plantation programmes using Miyawaki pattern in various districts like, Beed, Hingoli, Pune, Jalgaon, Aurangabad etc.

Use your brain power

Floods in Sangli and Kolhapur in August 2019, were responsible for many problems during and after the floods. Think and enlist different types of problems faced by flood affected areas.

Activity :

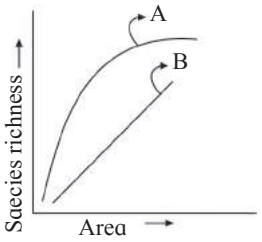
Complete the following chart :



Exercise

Q. 1 Choose the correct option

1. Observe the graph and select correct option.



   a. Line A represents, $S=CA^2$
   b. Line B represents, log C= log A + Z log S
   c. Line A represents, $S=CA^Z$
   d. Line B represents, log S= log Z + C log A

2. Select odd one out on the basis of *Ex situ* conservation.
   a. Zoological park
   b. Tissue culture
   c. Sacred groves
   d. Cryopreservation

3. Which of the following factors will favour species diversity?
   a. Invasive species b. Glaciation
   c. Forest canopy d. Coextinction

4. The term "terror of Bengal' is used for _____.
   a. algal bloom b. water hyacinth
   c. increased BOD d. eutrophication

5. CFC are air polluting agents which are produced by _____.
   a. Diesel trucks
   b. Jet planes
   c. Rice fields
   d. Industries

Q. 2 Very short answer type questions.

1. Give two examples of biodegradable materials released from sugar industry.
2. Name any 2 modern techniques of protection of endangered species.
3. Where was ozone hole discovered?
4. Give one example of natural pollutant.
5. What do you understand by EW category of living being?

Q. 3 Short answer type questions.

1. *Dandiya raas* is not allowed after 10.00 pm. Why?
2. Tropical regions exhibit species richness as compared to polar regions. Justify.
3. How does genetic diversity affect sustenance of a species?
4. Green house effect is boon or bane? Give your opinion.
5. How does CO cause giddiness and exhaustion?
6. Name two types of particulate pollutants found in air. Add a note on ill effects of the same on human health.

Q. 4 Long answer type questions.

1. Montreal protocol is an essential step. Why is it so?
2. Name any 2 personalities who have contributed to control deforestation in our country. Elaborate on importance of their work.
3. How BS emission standards changed over time? Why is it essential?
4. During large public gatherings like *Pandharpur vari* mobile toilets are deployed by the government. Explain how this organic waste is disposed.
5. How Indian culture and traditions helped in bio-diversity conservation? Give importance of conservation in terms of utilitarian reasons.

Project : Find out at least 2 plant and animal varieties native to Maharashtra which are endangered. Find out their IUCN status and reasons for the same. Suggest conservation measures.

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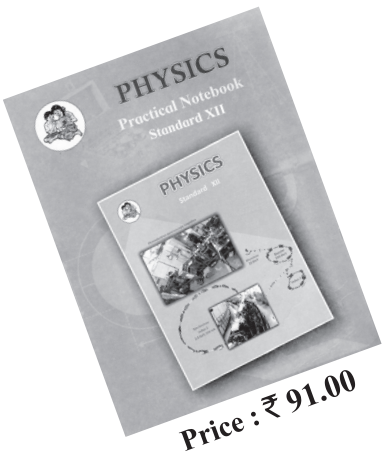

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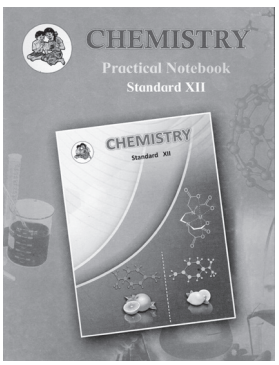

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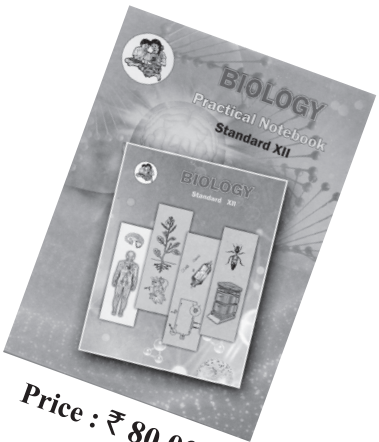

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