15 Biodiversity, Conservation and Environmental Issues

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).
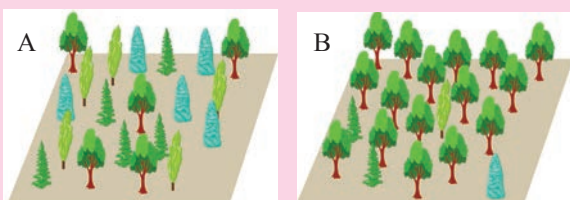
a. Genetic diversity:

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?
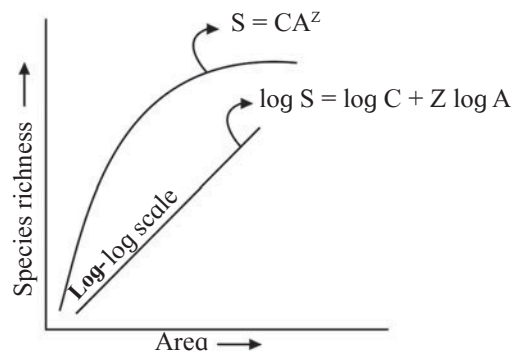
German naturalist Alexander Von

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.

A. Known species of Organism
Total = roughly 1,800,000 species

B. Known species of Animals
Total = roughly 1,315,378 species

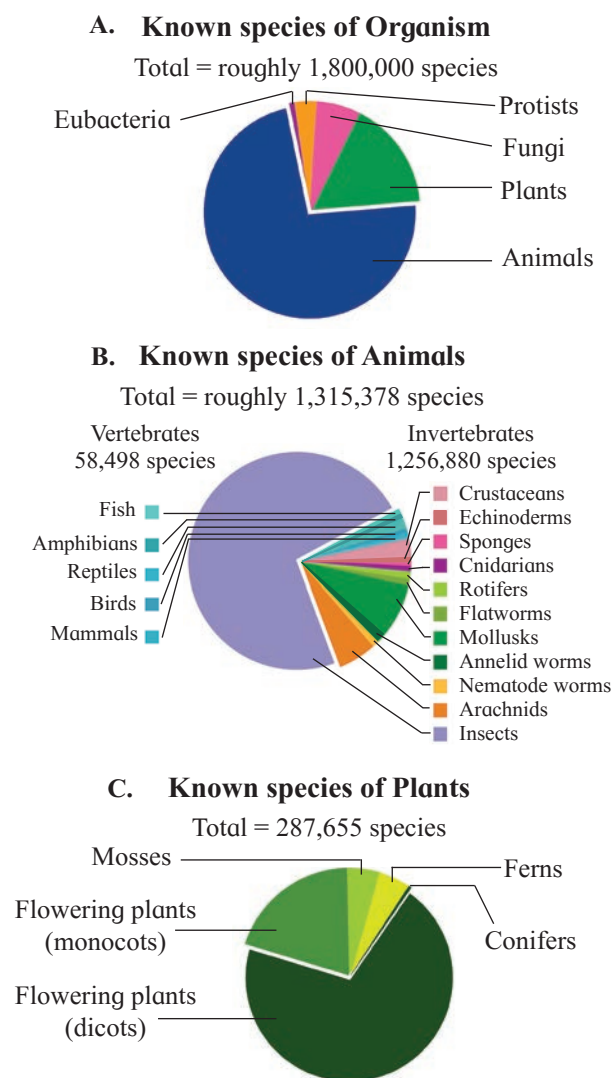**C. Known species of Plants**
Total = 287,655 species

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.

www 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

a. Dodo bird

b. Stellar sea cow

c. Passenger pigeon

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

resources which in turn causes threats to various organisms. Can you corelate 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.

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.

? 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.

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. Eg 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.

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'.

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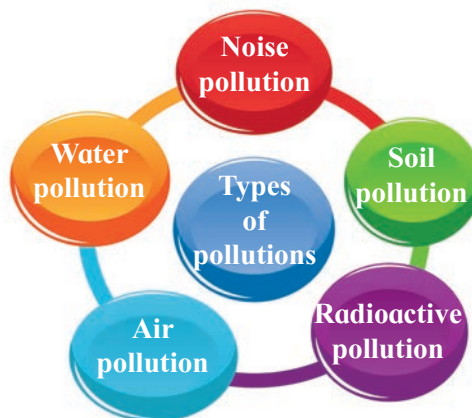
Any substance that causes pollution, is called **Pollutant**. In order to protect and improve the quality of our environment, the Government of India has passed the Environment Protection Act 1986.

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.
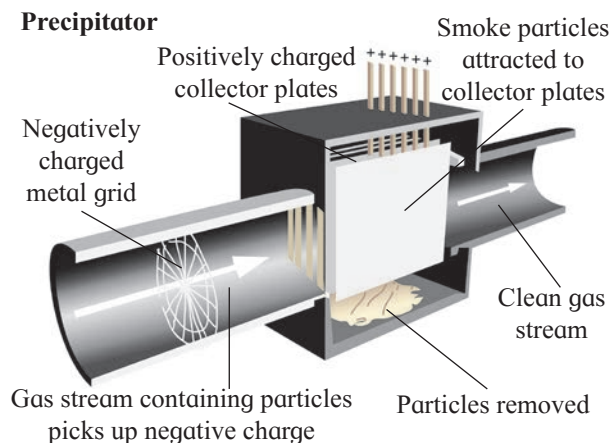
Precipitator

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.

www 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.
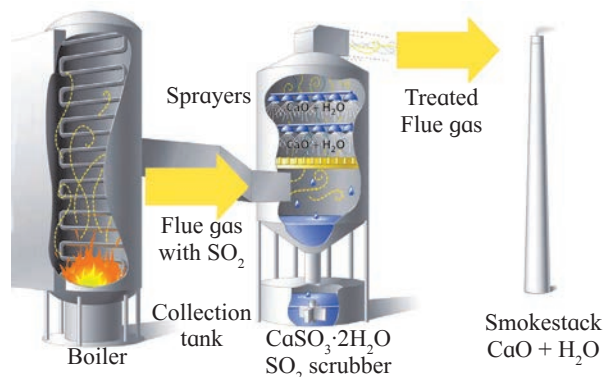

Fig. 15.5 : Exhaust gas Scrubber

Catalytic converters:

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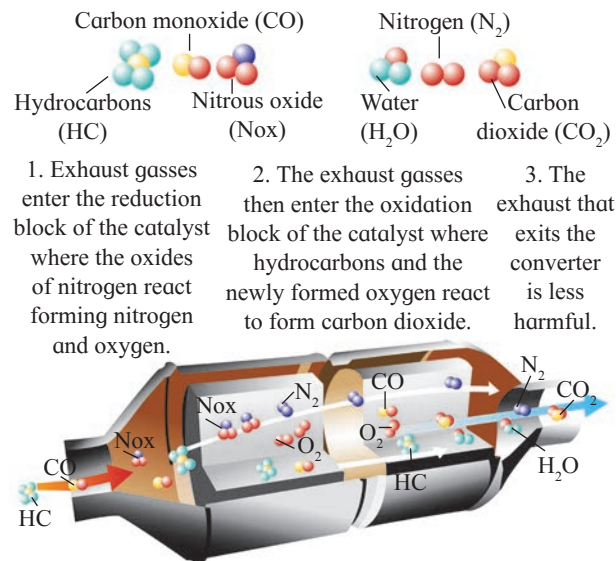

1. Exhaust gasses enter the reduction block of the catalyst where the oxides of nitrogen react forming nitrogen and oxygen.

2. The exhaust gasses then enter the oxidation block of the catalyst where hydrocarbons and the newly formed oxygen react to form carbon dioxide.

3. The exhaust that exits the converter is less harmful.

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
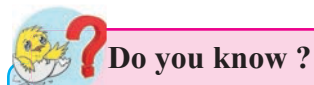
Do you know ?

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.