# CHAPTER 1

# MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

### 1.1. Definition

The word environment is derived from the French word “environ” meaning surroundings. Hence, everything surrounding us is called environment. Every organism is surrounded by materials and forces that constitute its environment. It is the environment from where every organism must derive its requirement. The environment creates favourable conditions for the existence and development of living organisms. The survival of any organism requires a steady supply of materials and removal of waste products.

The natural environment encompasses all living and non-living things. This environment encompasses the interaction of all living species, climate, weather, and natural resources that affect human survival and economic activity. Environmental studies is multi-disciplinary because it comprises various branches of studies like chemistry, physics, medical science, life science, agriculture and public health. It is the science of physical phenomena in the environment. Environmental studies deals with every issue that affects an organism. It is an applied science as its seeks practical answers to making human civilization sustainable on the earth’s finite resources.

The environment is constituted by the interacting systems of physical, biological and cultural elements inter-related in various ways, individually as well as collectively. These elements are

**(1) Physical Elements**

Space, landforms, water bodies, climate, soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations

**(2) Biological Elements**

Plants, animals, microorganisms and human beings constitute the biosphere.

**(3) Cultural Elements**

Economic, social and political elements are essentially manmade features, which constitute the cultural milieu.

### 1.2. Scope and importance

Environment Studies enlighten us about the importance of protection and conservation of our environment. At present, a great number of environment issues have grown in size and complexity day by day, threatening the survival of mankind on earth.

We live in landscapes that have been heavily modified by human beings, in villages, towns or cities. But even those of us who live in cities get our food supply from surrounding villages and these in turn are dependent on natural landscapes such as forests, grasslands, rivers, seashores, for resources such as water for agriculture, fuel wood, fodder, and fish. Thus, our daily lives are linked with our surroundings and inevitably affects them. We use water to drink and for other day-to-day activities. We breathe air, we use resources from which food is made and we depend on the community of living plants and animals which form a web of life, of which we are also a part. Everything around us forms our environment and our lives depend on sustaining its vital systems.

The industrial development and intensive agriculture that provides the goods for our increasingly consumer oriented society uses up large amounts of **natural resources** such as water, minerals, petroleum products, wood, etc. **Non renewable resources**, such as minerals and oil are those which will be exhausted in the future if we continue to extract these without a thought for subsequent generations. **Renewable resources**, such as timber and water, are those which can be used but can be regenerated by natural processes such as re growth or rainfall. However, these too will be depleted if we continue to use them faster than nature can replace them. Deforestation leads to floods in the monsoon and dry rivers once the rains are over

What we should implement is Sustainable Development. It is the organizing principle for meeting human needs while at the same time sustaining the ability of natural systems to provide the resources and ecosystem services upon which the economy and society depends. The desirable end result is a society where living conditions and resource use continue to meet human needs without undermining the stability of the natural systems.

**The scope of environmental studies include:**

1. Developing an awareness and sensitivity to the environment and its related problems.
2. Motivating people for active participation in environmental protection.
3. Developing skills to find solutions to environmental problems.
4. Imbibe and inculcate in others the necessity for conservation of natural resources.

### 1.3 Needs for awareness

Increasing population, urbanization and poverty have exerted pressure on the natural resources and led to degradation of the environment. To prevent the environment from further degradation, the Supreme Court has ordered and initiated environmental protection awareness through government and non-government agencies.

Environmental pollution cannot be prevented by laws alone. Public participation is equally important with regards to environmental protection. Environmental Education (EE) is a process of learning by giving an

overall perspective of knowledge and awareness of the environment. It sensitizes the society about environmental issues and challenges interested individuals to develop skills and expertise, thereby providing appropriate solutions.

Climate change, loss of biodiversity, declining fisheries, ozone layer depletion, illegal trade of endangered species, destruction of habitats, land degradation, depleting ground water supplies, introduction of alien species, environmental pollution, solid waste disposal, storm water and sewage disposal pose a serious threat to ecosystems in forest, rural, urban and marine ecosystems.

Both formal and informal education on the environment will give the interested individual the knowledge, values, skills and tools needed to face the environmental challenges on a local and global level.

## QUESTIONS

## SECTION A

1. Environmental Studies is multidisciplinary in nature. Account.
2. What are renewable resources? Give examples.
3. Discuss the need for the awareness of environmental studies programme.
4. What is the importance of studying environmental studies as a core paper ?
5. Environmental pollution cannot be prevented by laws alone. Discuss.
6. Explain sustainable development.
7. What are natural resources. Give examples.
8. What are the physical, biological and cultural elements that constitute environment?
9. List out the scope of environmental studies.
10. What are non-renewable resources? Give examples

## CHAPTER 2

# NATURAL RESOURCES

### 2.1. Introduction to Natural Resources

Any material which can be transformed in a way that it becomes more valuable and useful can be termed as resource. In other words, it is possible to obtain valuable items from any resources. Resource, therefore, are the means to attain given ends. The aspect of satisfaction is so important that we consider a thing or substance a resource, as so long it meets our needs. Life on this planet depends upon a large number of things and services provided by the nature, which are known as Natural Resources. Thus water, air, soil, minerals, coal, forests, crops and wild life are all examples of natural resources.

### 2.1.1. Classification of natural resources

Depending upon availability of natural resources can be divided into two categories such as (1) renewable and (2) Non renewable resources.

***1. Renewable resources***

Renewable resources are in a way inexhaustible resources. They have the ability to replenish themselves by means such as recycling, reproduction and replacement.Examples of renewable resources are sunlight, animals and plants,soil,water,etc.

***2. Non-Renewable Resources***

Non renewable resources are the resources that cannot be replenished once used or perished. Examples of non renewable resources are minerals, fossil fuels, etc.

Resources can also be classified as biotic or abiotic.

***a) Biotic resources***

These are living resources (e.g. forest, agriculture, fish and wild life) that are able to reproduce or replace them and to increase.

***b) Abiotic resources***

These are non-living resources (e.g. petrol, land, minerals etc.) that are not able to replace themselves or do so at such a slow rate that they are not useful to consider them in terms of the human life times.

### 2.1. 3 Problems associated with natural resources

***1. The unequal consumption of natural resources***

A major part of natural resources today are consumed in the technologically advanced or ‘developed’ world, usually termed ‘the west’. The ‘developing nations’ of ‘the east’, including India and China, also over use many resources because of their greater human population. However, the consumption of

resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases.

***2. Planning land use***

Land is a major resource, needed for not only for food production and animal husbandry, but also for industry and growing human settlements. These forms of intensive land use are frequently extended at the cost of 'wild lands', our remaining forests, grasslands, wetlands and deserts. This demands for a pragmatic policy that analyses the land allocation for different uses.

***3. The need for sustainable lifestyles***

Human standard of living and the health of the ecosystem are indicators of sustainable use of resources in any country or region. Ironically, both are not in concurrence with each other. Increasing the level of one, usually leads to degradation of other. Development policies should be formulated to strike a balance between the two.

## 2.2. FOREST RESOURCES

Forest is important renewable resources. Forest vary in composition and diversity and can contribute substantially to the economic development of any country .Plants along with trees cover large areas, produce variety of products and provide food for living organisms, and also important to save the environment.

It is estimated that about 30% of world area is covered by forest whereas 26% by pastures. Among all continents, Africa has largest forested area (33%) followed by Latin America (25%), whereas in North America forest cover is only 11%. Asia and former USSR has 14% area under forest. European countries have only 3% area under forest cover. India's Forest Cover accounts for 20.6% of the total geographical area of the country as of 2005.

**Uses of forests**

Forest can provide prosperity of human being and to the nations. Important uses of forest can be classified as under

- Commercial values
- Ecological significance
- Aesthetic values
- Life and economy of tribal

***Commercial values***

- Forests are main source of many commercial products such as wood, timber, pulpwood etc. About 1.5 billion people depend upon fuel wood as an energy source. Timber obtained from the forest can used to make plywood, board, doors and windows, furniture, and agriculture implements and sports goods. Timber is also a raw material for preparation of paper, rayon and film.
- Forest can provide food , fibre, edible oils and drugs.
- Forest lands are also used for agriculture and grazing.
- Forest is important source of development of dams, recreation and mining.

***Life and economy of tribal***

Forest provide food, medicine and other products needed for tribal people and play a vital role in the life and economy of tribes living in the forest.

***Ecological uses***

Forests are habitat to all wild animals, plants and support millions of species. They help in reducing global warming caused by green house gases and produces oxygen upon photosynthesis.

Forest can act as pollution purifier by absorbing toxic gases. Forest not only helps in soil conservation but also helps to regulate the hydrological cycle.

***Aesthetic values***

All over the world people appreciate the beauty and tranquillity of the forest because forests have a greatest aesthetic value. Forest provides opportunity for recreation and ecosystem research.

**2.2.1.Over exploitation of forests**

Forests contribute substantially to the national economy. With increasing population increased demand of fuel wood, expansion of area under urban development and industries has lead to over exploitation of forest .At present international level we are losing forest at the rate of 1.7 crore hectares annually. Overexploitation also occurs due to overgrazing and conversion of forest to pastures for domestic use.

**2.2.2. Deforestation**

1. Forest are burned or cut for clearing of land for agriculture ,harvesting for wood and timber , development and expansion of cities .These economic gains are short term where as long term effects of deforestation are irreversible

2. Deforestation rate is relatively low in temperate countries than in tropics If present rate of deforestation continues we may losses 90% tropical forest in coming six decades
3. For ecological balance 33% area should be under forest cover but our nation has only 20.6% forest cover.

***Causes of deforestation***

Forest area in some developed area has expanded. However in developing countries area under forest is showing declining trend particularly in tropical region. Main causes of deforestation are

*a) Shifting cultivation or jhum cultivation*

This practice is prevalent in tribal areas where forest lands are cleared to grow subsistence crops. It is estimated that principle cause of deforestation in tropics in Africa, Asia and tropical America is estimated to be 70, 50, and 35% respectively. Shifting cultivation which is a practice of slash and burn agriculture are posses to clear more than 5 lakh hectares of land annually. In India, shifting cultivation is prevalent in northeast and to limited extent in M.P, Bihar and Andhra Pradesh and is contributing significantly to deforestation.

*b) Commercial logging*

It is a important deforestation agent. It may not be the primary cause but definitely it acts as secondary cause, because new logging lots permits shifting cultivation and fuel wood gatherers access to new logged areas.

*c) Need for fuel wood*

Increased population has lead to increasing demand for fuel wood which is also acting as an important deforestation agent, particularly in dry forest.

*d) Expansion for agribusiness*

With the addition of cash crops such as oil palm, rubber, fruits and ornamental plants, there is stress to expand the area for agribusiness products which results in deforestation.

*e) Development projects and growing need for food*

The growing demand for electricity, irrigation, construction, mining, etc. has lead to destruction of forest. Increased population needs more food which has compelled for increasing area under agriculture crops compelling for deforestation.

*f) Raw materials for industrial use*

Forest provides raw material for industry and it has exerted tremendous pressure on forest. Increasing demand for plywood for backing has exerted pressure on cutting of other species such as fir to be used as backing material for apple in J&K and tea in northeast states.

***Major effects of deforestation***

Deforestation adversely and directly affects and damages the environment and living beings .Major causes of deforestation are

- Soil erosion and loss of soil fertility
- Decrease of rain fall due to affect of hydrological cycle
- Expansion of deserts
- Climate change and depletion of water table
- Loss of biodiversity ,flora and fauna
- Environmental changes and disturbance in forest ecosystems

### 2.2.3. Case studies

***1. Jhum cultivation***

Jhum Agriculture or shifting agriculture has destroyed large number of hectare of forest tracts in North-Eastern states and Orissa. Jhum agriculture is subsidence agriculture in which tract of forest land is cleared by cutting trees and it is used for cultivation. After few years, when productivity of the land decreases, cultivators abandon the land and clear next tract. As a result of this practice, combined with increasing population there is rapid deforestation as more and more cultivators clear forest to cultivate land. Also, with increase in population there is cultivators are forced to return to previous tracts of land in relatively shorter durations, not allowing the land to regain its productivity.

***2. Chipko movement***

The Chipko movement or Chipko Andolan is a social-ecological movement that practiced the Gandhian methods of satyagraha and non-violent resistance, through the act of hugging trees to protect them from being felled. The modern Chipko movement started in the early 1970s in the Garhwal Himalayas of Uttarakhand,with growing awareness towards rapid deforestation. The landmark event in this struggle took place on March 26, 1974, when a group of peasant women in Reni village, Hemwalghati, in Chamoli district, Uttarakhand, India, acted to prevent the cutting of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department. Their actions inspired hundreds of such actions at the grassroots level throughout the region. By the 1980s the movement had spread throughout India and led to formulation of people-sensitive forest policies, which put a stop to the open felling of trees in regions as far reaching as Vindhyas and the Western Ghats.

***3. Western himalayan region.***

Over the last decade, there has been widespread destruction and degradation of forest resources in Himalayas, especially western Himalayas. This has resulted in various problems such as erosion of top soil, irregular rainfall, changing weather patterns and floods. Construction of roads on hilly slopes, have not only undermined their stability, but also damaged protective vegetation and forest cover. Tribes in these areas are increasingly facing shortage of firewood and timber, due large scale tree cutting. Increased traffic volumes on these roads leads to increased pollution in the area.

**2.2.4. Timber extraction**

There has been unlimited exploitation of timber for commercial use. Due to increased industrial demand; timber extraction has significant effect on forest and tribal people.

***Logging***

- Poor logging results in degraded forest and may lead to soil erosion especially on slopes.
- New logging roads permit shifting cultivators and fuel wood gatherers to gain access to the logging area.
- Loss of long term forest productivity
- Species of plants and animals may be eliminated
- Exploitation of tribal people by contractor.

**2.2.5. Mining**

Major effects of mining operations on forest and tribal people are:

- Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. It leads to degradation of lands and loss of top soil. It is estimated that about eighty thousands hectare land is under stress of mining activities in India
- Mining leads to drying up perennial sources of water sources like spring and streams in mountainous area.
- Mining and other associated activities remove vegetation along with underlying soil mantle, which results in destruction of topography and landscape in the area. Large scale deforestation has been reported in Mussorie and Dehradun valley due to indiscriminating mining.
- The forested area has declined at an average rate of 33% and the increase in non-forest area due to mining activities has resulted in relatively unstable zones leading to landslides.

- Indiscriminate mining in forests of Goa since 1961 has destroyed more than 50000 ha of forest land. Coal mining in Jharia, Raniganj and Singrauli areas has caused extensive deforestation in Jharkhand.
- Mining of magnetite and soapstone have destroyed 14 ha of forest in hilly slopes of Khirakot, Kosi valley and Almora.
- Mining of radioactive minerals in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation.
- The rich forests of Western Ghats are also facing the same threat due to mining projects for excavation of copper, chromites, bauxite and magnetite.

**2.2.6. Effects of dams on forests and tribal people**

India is one of the largest dam-building nations in the world and the fact is that dams are the single largest cause of human displacement in India and account for 75 per cent to 80 per cent of displacement of about four to five crore people.

The impact of large dams on forests and on the lifestyle and identity of tribal people is extremely high. Almost 40 per cent of those displaced by dams belong to scheduled tribes and 20 per cent to schedule castes. Only 25 per cent of the displaced people have been rehabilitated so far.

A government report based on a study of 110 dam projects stated that more than50 per cent of the total 1.69 million people displaced by these projects were tribals. This means that the tribal communities which account for just 8 per cent of India's total population constitute about 40 per cent of the displaced persons. About 92 per cent of the tribal people in India live in rural areas which are dry, forested or hilly. Most of them depend on agriculture and minor forest produce for sustenance. These largely self-sufficient tribal communities live in close proximity to forests, rivers and mountains. Since these areas are rich in natural resources they are most likely to be developed for dams, mines, industries and so on.

Immediately after Independence, only a few dams were built in tribal areas. However, by the 1970s, when the resources in more accessible areas were exhausted, more dams were planned in tribal areas thereby displacing a large number of tribal people.

Tribals are socially, economically and politically the weakest and the most deprived community in India. They have been evicted from their ancestral homes and are either forced to migrate to urban slums in search of employment or become landless labourers in rural areas to pay the price of development'. Unfortunately, tribal people hardly get to share the benefits of development projects that cause their displacement. They are always forced to live without the basic amenities like roads, electricity, transport, communication,

healthcare, drinking water or sanitation. On the contrary, a majority of them end up with less income than before, less work opportunities, inferior houses, less access to the resources of the common people such as fuel wood and fodder, poor nutrition and poor physical and mental health. Developmental projects have invariably led to the dispersal of communities, the breakdown of traditional support systems and the devaluation of their cultural identity. Therefore, the government should devise a strategy to minimize tribal displacement. It must ensure 100 per cent rehabilitation and make sure that the fruits of development are shared with the dispersed people as well. It must augment the rehabilitation of the displaced persons of previous projects, protect the customary rights of the tribal people over natural resources and take their opinions into consideration for future projects.

Pandit Jawaharlal Nehru referred dam and valley projects as "Temples of modern India". These big dams and rivers valley projects have multi-purpose uses. However, these dams are also responsible for the destruction of forests. They are responsible for degradation of catchment areas, loss of flora and fauna, increase of water borne diseases, disturbance in forest ecosystems, rehabilitation and resettlement of tribal peoples.

- India has more than 1550 large dams, the maximum being in the state of Maharashtra (more than 600), followed by Gujarat (more than 250) and Madhya Pradesh (130).
- The highest one is Tehri dam, on river Bhagirathi in Uttaranchal and the largest in terms of capacity is Bhakra dam on river Satluj in Himachal Pradesh. Big dams have been in sharp focus of various environmental groups all over the world, which is mainly because of several ecological problems including deforestation and socio-economic problems related to tribal or native people associated with them.
- The Silent valley hydroelectric project was one of the first such projects situated in the tropical rain forest area of Western Ghats which attracted much concern of the people.
- The crusade against the ecological damage and deforestation caused due to Tehri dam was led by Shri. Sunder Lal Bahaguna, the leader of Chipko Movement.
- The cause of Sardar Sarovar Dam related issues have been taken up by the environmental activitist Medha Patkar, joined by Arundhati Ray and Baba Amte. For building big dams, large scale devastation of forests takes place which breaks the natural ecological balance of the region.

Floods, droughts and landslides become more prevalent in such areas. Forests are the repositories of invaluable gifts of nature in the form of biodiversity and by destroying them (particularly, the tropical rain forests), we are going to lose these species even before knowing them. These species could be having

marvelous economic or medicinal value and deforestation results in loss of this storehouse of species which have evolved over millions of years in a single stroke.

## 2.3. WATER RESOURCES

Water resources are sources of water that are potentially useful. Uses of water include agricultural, industrial, household, recreational and environmental activities. The majority of human uses require fresh water. 97% of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps. The remaining unfrozen fresh water is found mainly as ground water, with only a small fraction present above ground or in the air.

Fresh water is a renewable resource, yet the world's supply of ground water is steadily decreasing. The depletion is occurring most prominently in Asia, South America and North America. The framework for allocating water resources to water users (where such a frame-work exists) is known as water rights.

### 2.3.1. Surface water and Ground water use and over exploitation

Surface water is water in a river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapo transpiration and groundwater recharge. Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial reservoirs, the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All of these factors also affect the proportions of water loss.

Human activities can have large and sometimes devastating impact on these factors. Humans often increase storage capacity by constructing reservoirs and decrease it by draining wetlands. Humans increase runoff quantities and velocities by paving areas and channelizing the stream flow. The total quantity of water available at any given time is an important consideration. Some human water users have an intermittent need for water. For example, many farms require large quantities of water in the spring, and no water at all in the winter. To supply such a farm with water, a surface water system may require a large storage capacity to collect water throughout the year and release it in a short period of time. Other users have a continuous need for water, such as a power plant that requires water for cooling. To supply such a power plant with water, a surface water system only needs enough storage capacity to fill in when the average stream flow is below the power plant's need.

Nevertheless, over long term, the average rate of precipitation within a watershed is the upper bound for average consumption of natural surface water from that watershed.

Natural surface water can be augmented by importing surface water from another water-shed through a canal or pipeline. It can also be artificially augmented from any of the other sources; however, in practice the quantities are negligible.

Brazil is the country estimated to have the largest supply of fresh water in the world, followed by Russia and Canada.

**Groundwater** is fresh water located in the subsurface pore space of soil and rocks. It is also water that is flowing within acquifers below the water table. Sometimes it is useful to make a distinction between ground water that is closely associated with surface water and deep groundwater in an aquifer (sometimes called "fossil water").

Ground water can be thought of in the same terms as surface water: inputs, outputs and storage. The critical difference is that due to its slow rate of turnover, groundwater storage is generally much larger (in volume) compared to inputs than it is for surface water. This difference makes it easy for humans to use groundwater unsustainably for a long time with-out severe consequences. Nevertheless, over the long term, the average rate of seepage above a ground water source is the upper bound for average consumption of water from that source.

The natural input to groundwater is seepage from surface water. The natural outputs from ground water are springs and seepage to the oceans.

If the surface water source is also subject to substantial evaporation, a ground water source may become saline. This situation can occur naturally under endorheic bodies of water, or artificially under irrigated farmland. In coastal areas, human use of a ground water source may cause the direction of seepage to ocean to reverse which can also cause soil salinization. Humans can also cause ground water to be "lost" (i.e become unusable) through pollution. Human can increase the input to a ground water source by building reservoirs or detention ponds.

Ground water depletion is primarily caused by sustained ground water pumping. Some of the negative effects of ground water depletion are:

- **Lowering of the Water Table**

Excessive pumping can lower the ground water table, and cause wells to no longer be able to reach ground water.

- **Increased Costs**

As the water table lowers, the water must be pumped farther to reach the surface, using more energy. In extreme cases, using such a well can be cost prohibitive.

•\ **Reduced Surface Water Supplies**

Ground water and surface water are connected. When groundwater is overused, the lakes, streams, and rivers connected to ground water can also have their supply diminished.

•\ **Land Subsidence**

Land subsidence occurs when there is a loss of support below ground. This is most often caused by human activities, mainly from the overuse of ground water, when the soil collapses, compacts and drops.

•\ **Water Quality Concerns**

Excessive pumping in coastal areas can cause salt water to move inland and upward, resulting in salt water contamination of the water supply.

**Case Study 4**

**Coca-Cola ground water exploitation in Kerala**

In 1999, the Hindustan Coca-Cola Beverages Private Limited, a subsidiary of the Atlanta based Coca-Cola Company, established a plant in Plachimada, in the Palakkad district of Kerala, southern India. The Perumatty Village Council gave a license to the company to commence production in 2000. Coca-Cola drew around 510,000 litres of water each day from boreholes and open wells. For every 3.75 litres of water used by the plant, it produced one litre of product and a large amount of waste water.

Local residents started to protest after two years. Local communities complained that water pollution and extreme water shortages were endangering their lives. In 2003, women from the Vijayanagaram Colony in the village of Plachimada, protested that their wells had dried up because of the over exploitation of groundwater resources by the Coca-cola plant. In April 2003, the Perumatty Grama Panchayat (Village Council) refused renewal of Coca-Cola's license to operate on the grounds that it was not in the public interest to renew the license stating:

"…the excessive exploitation of ground water by the Coca-Cola Company in Plachimada is causing acute drinking water scarcity in Perumatty Panchayat and nearby places…" The Village Council considered revocation of the license to be necessary in order to protect the interests of local people.

Since December 2003, various cases were filed by the accused and Perumatty Grama Panchayat. Finally in 2017, the Supreme Court of India ordered Coca-cola company authorities not to resume operations at Plachimada, thus ending a 12-year-long legal battle with local people.

### 2.3.2. Conflicts over water

**Water conflict** is a term describing the conflict between countries, states, or groups over access to water resources. The United Nations recognizes that water disputes result from opposing interests of water users-public or private.

A wide range of water conflicts appear throughout history, though rarely are traditional wars waged over water alone. Instead, water has historically been a source of tension and a factor in conflicts that start for other reasons. However, water conflicts arise for several reasons, including territorial disputes, a fight for resources, and strategic advantage. A comprehensive online database of water-related conflicts-the Water Conflict Chronology-has been developed by the Pacific Institute. This database lists violence over water going back nearly 5,000 years.

These conflicts occur over both fresh water and salt water, and both between and within nations. However conflicts occur mostly over fresh water; because fresh water resources are necessary, yet limited. They are the center of water disputes arising out of need for potable water and irrigation. As freshwater is a vital, yet unevenly distributed natural resource, its availability often impacts the living and economic conditions of a country or region. The lack of cost-effective water supply options in areas like the Middle East, among other elements of water crises can put severe pressure on all water users, whether corporate, government, or individual, leading to tension and possibly, aggression. Recent humanitarian catastrophes, such as the Rwandan Genocide or the war in Sudanese Darfur, have been linked to water conflicts.

**Case study 5**

**Kaveri river water issue**

The sharing of waters of the Kaveri River has been the source of a serious conflict between the two states of Tamil Nadu and Karnataka. The genesis of this conflict rests in two agreements in 1892 and 1924 between the erst while Madras Presidency and Kingdom of Mysore. The 802 kilometers Kaveri river has 44,000 Km2 area in Tamil Nadu and 32,000 Km2 basin area in Karnataka. The inflow from Karnataka is 425 TMC ft whereas that from Tamil Nadu is 252 TMC ft.

Based on inflow, Karnataka is demanding its due share of water from the river. It states that the pre-independence agreements are invalid and are skewed heavily in the favour of the Madras Presidency and has demanded a renegotiated settlement based on “equitable sharing of the waters”. Tamil Nadu, on the other hand, pleads that it has already developed almost 3,00,000 acres (12,000 Km2 ) of land and as a result, has come to depend very heavily on the existing pattern of usage. Any change in this pattern, it says, will adversely affect the livelihood of millions of farmers in the state.

Decades of negotiations between the parties bore no fruit. The Government of India then constituted a tribunal in 1990 to look into the matter. After hearing arguments of all the parties involved for the next 16 years, the tribunal delivered its final verdict on 5th February 2007. In its verdict, the tribunal allocated 419 TMC of water annually to Tamil Nadu and 270 TMC to Karnataka; 30 TMC of Kaveri river water to Kerala and 7 TMC to Puducherry. Karnataka and Tamil Nadu being the major shareholders, Karnataka was ordered to release 192 TMC of water to Tamil Nadu in a normal year from June to May. The dispute however, did not end there, as all four states decided to file review petitions seeking clarifications and possible renegotiation of the order.

### 2.3.3. Dams – benefits and problems

A dam is a barrier that impounds water or underground streams. Dams generally serve the primary purpose of retaining water apart from managing or preventing water flow into spe-cific land regions eg: Bakranamgal, Hirakud, Mullapaeriyar Dam, Damodar Valley Dam etc.

Dams are built across rivers to store water for irrigation, hydroelectric power generation and flood control. The dams built to serve more than one purpose are called “multi-purpose dams”. These dams were called the “temples of modern India” by the country’s first Prime Minister, Jawaharlal Nehru.

**Benefits of dams:**

1.\ Dams are built to control flood and store flood water

2.\ Sometimes dams are used for diverting part or all of the water from river into a channel.

3.\ Water in dams are used mainly for drinking and agricultural purposes.

4.\ Dams are built for generating electricity

5.\ Dams are used for recreational purpose

6.\ Navigation and fishery can be developed in the dam areas.

**Problems of dams** – Dams may face problems upstream or downstream as listed below:

Upstream problems:-

1.\ Displacement of tribal people

2.\ Loss of non-forest land

3.\ Loss of forests, flora and fauna

4.\ Landslides, sedimentation and siltation occurs

5.\ Stagnation and water logging around reservoirs retards plant growth

6.\ Breeding of vectors and vector-borne diseases

7.\ Reservoir Induced Seismicity (RIS) causes earthquakes

8.\ Navigation and aquaculture activities can be developed in the dam area

Down steam problems:

1.\ Water logging and salinity due to over irrigation

2.\ Reduced water flow and silt deposition in rivers

3.\ Salt intrusion at river mouth

4.\ Since the sediments carrying nutrients gets deposited in the reservoir, the fertility of the land along the river gets reduced

5.\ Structural defects or faulty design of the dam may cause sudden dam failure leading to collapse and destruction to life and property.

## 2.4. MINERAL RESOURCES-USE AND EXPLOITATION

### 2.4.1. Use and Exploitation

A mineral is pure, inorganic substance that occurs naturally in the Earth's crust. All of the Earth's crust, except the rather small proportion of the crust that contains organic material, is made up of minerals. Some minerals consist of a single element such as gold, silver, diamond (carbon), and sulphur. Minerals provide the material used to make most of the things of industrial – based society: roads, cars, computers, fertilizers, etc. Demand for minerals is increasing world wide as the population increases and the consumption demands of individual people increase. The mining of earth's natural resources is, therefore accelerating, and it has accompanying environmental consequences.

More than two-thousand minerals have been identified and most of these contain inorganic compounds formed by various combinations of the eight elements (O, Si, Al, Fe, Ca, Na, K, and Mg) that make up 98.5% of the Earth's crust. Industry depends on about 80 of the known minerals.

A mineral deposit is a concentration of naturally occurring solid, liquid, or gaseous material, in or on the Earth's crust in such form and amount that its extraction and its conversion into useful materials or items are profitable now or may be so in the future. Mineral resources are non renewable and include metals (e.g. iron, copper, and aluminum) and non-metals (e.g. salt, gypsum, clay, sand, phosphates).

Minerals are valuable natural resources that are finite and non-renewable. They constitute the vital raw materials for many basic industries and are a major resource for development. therefore, Management of

mineral resources has, to be closely integrated with the overall strategy of development; and exploitation of minerals is to be guided by long-term national goals and perspectives.

The use of minerals varies greatly between countries. The greatest use of minerals occurs in developed countries. Like other natural resources, mineral deposits are unevenly distributed around on the earth. Some countries are rich in mineral deposits and other countries have no deposits. The use of the mineral depends on its properties. For example, aluminum is light but strong and durable, so it is used for aircraft, shipping and car industries.

Recovery of mineral resources has been with us for a long time. Early Paleolithic man found flint arrowheads and clay for pottery before developing codes for warfare. This was done without geologists for exploration, mining engineers for recovery or chemists for extraction techniques. Tin and copper mines were necessary for a Bronze Age; gold, silver, and gemstones adorned the wealth of early civilizations; and iron mining introduced a new age of man.

Human wealth basically comes from agriculture, manufacturing, and mineral resources. Our complex modern society is built around the exploitation and use of minerals resources. Since the future of humanity depends on minerals resources, we must understand that these resources have limits; our known supply of minerals will be used up early in the third millennium of our calendar.

Furthermore, modern agriculture and the ability to feed an overpopulated world is depen-dent on mineral resources; to construct the machines that till the soil, enrich it with mineral fertilizers and to transport the products.

We are now reaching limits of reserves for many minerals. Human population growth and increased industrialization are depleting our available resource at increasing rates. The pressure of human growth upon the planet’s resources is a very real problem.

The consumption of natural resources proceeded at a phenomenal rate during the past hundred years and population and production increases cannot continue without increasing pollution and depletion of mineral resources.

### 2.4.2. Environmental effects of mineral extraction

The scale and level of requirement of minerals have increased manifold in our country and it is heading towards the stage where much larger consumption of minerals will be inevitable to sustain even the minimum growth rate of our economy.

It is pertinent to note that out of the total land area of the country (3.29 million sq.kms),the area leased out of mining, as on 1-9-94, was 7126.13 sq.kms. Comprising about 9,213 mining leases, excluding atomic

minerals, minor minerals, petroleum and natural gas, this constitutes only about 0.25 per cent of the geographic area of the country and that including atomic minerals and minor minerals it may be around 0.28 per cent of the total area.

Although the area occupied for mining activity is small, the damage to the environment on account of mining is causing grave concern. Environmental degradation resulting from mining activity in general can be briefly enumerated as flows:

1.\ Air pollution with dust and gases due to drilling, blasting, mine haulage and transpor-tation by road, and also from waste heaps.

2.\ Water pollution when atomic elements and other harmful elements are present in the ore/mineral mine effluents.

3.\ Modifying water regimes such as surface flow, ground water availability and lowering down of water table.

4.\ Soil erosion, soil modification with dust and salt.

5.\ Noise and vibration problem in the mine and adjoining habitat including wild life.

6.\ Alteration of the landform.

7.\ Deforestation affecting flora and fauna; and

8.\ Spoiling aesthetics with untreated waste dumps

**Case Study 6**

**Mining and Quarrying in Udaipur**

About 200 open cast mining and quarrying centers in Udaipur, about half of which are illegal, are involved in stone mining including soapstone, building stone, rock phosphate and dolomite. The mines spread over 1500 hectares in Udaipur have caused many adverse impact on environment. About 150 tons of explosives are used per month in blasting. The overburden, wash off, discharge of mine water etc. pollute the water. The Maton mines have badly polluted the Aharriver. The hills around the mines are devoid of any vegetation except a few scattered patches and the hills are suffering from acute soil erosion. The waste flows towards a big tank of “Bag Dara”. Due to scarcity of water, people are compelled to use this effluent for irrigation purpose. The blasting activity has adversely affected the fauna and the animals like tiger, lion, deer and even hare, fox, wild cats and birds have disappeared from the mining area.

## CHAPTER 2

# NATURAL RESOURCES

### 2.5. FOOD RESOURCES

Food is usually of plant or animal origin, and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals. The substance is ingested by an organism and assimilated by the organism's cells to provide energy, maintain life, or stimulate growth. Historically, humans secured food through two methods: hunting and gathering and agriculture. Today, the majority of the food energy required by the ever increasing population of the world is supplied by the food industry.

Food safety and food security are monitored by agencies like the International Association for Food Protection, World Resources Institute, World Food Programme, Food and Agriculture Organization, and International Food Information Council. They address issues such as sustainability, biological diversity, climate change, nutritional economics, population growth, water supply, and access to food.

The food resources are a composite of the goods (the foodstuffs) and the services in commerce and distribution through which these are made available for consumption.

The 3 major sources of food for humans are: - the croplands, the rangelands and fisheries.

- The croplands provide the bulk amount of food for human. Though there are thousands of edible plants in the Earth, solely 4 are essential crops ; potatoes, rice, wheat and corn account for many of the caloric consumption of human beings. Few animals are raised for milk, meat and eggs (for example. poultry, cattle and pigs)

- The rangelands provide a different source of milk and meat from animals.

- The fisheries provide fish which are a major source of animal protein in the Earth, particularly in coastal areas and Asia.

Most food has its origin in plants. Some food is obtained directly from plants; but even animals that are used as food sources are raised by feeding them food derived from plants. Cereal grain is a staple food that provides more food energy worldwide than any other type of crop. Corn (maize), wheat, and rice in all of their varieties account for 87% of all grain production worldwide. Most of the grain that is produced worldwide is fed to livestock.

Food products produced by animals include milk produced by mammary glands, which in many cultures is consumed raw or processed into dairy products (cheese, butter, etc.). In addition, birds and other animals lay eggs, which are often eaten, and bees produce honey, reduced nectar from flowers, which is a popular sweetener in many cultures.

Some cultures and people do not consume meat or animal food products for cultural, dietary, health, ethical, or ideological reasons. Vegetarians choose to forgo food from animal sources to varying degrees. Vegans do not consume any foods that are or contain ingredients from an animal source.

### 2.5.1. World Food Problems

Food is essential to survive. There are three degrees of hunger: acute, chronic, and hidden. Famine is caused by food shortage and the inability of people to obtain food. It is usually caused by low food production resulting from drought, other factors, or it could be a result of the inability of a country or its population to afford to buy food.

Every year, 15 million children die of hunger. It is estimated that 925 million people in the world do not have enough to eat. The WHO estimates that one-third of the world population is well-fed, one third is under-fed and one-third is starving. There are many factors that have contributed in making food security one of the most important global issues. An increasing population wants a more varied diet, but trying to grow more food on less land with limited access to water, all the time facing increased costs for fertilizer, and fuel for storage and transport poses great problems for which there are no easy solutions.

The available water is decreasing at an alarming rate. This warns us that there is not going to be enough water on the agricultural land that is needed for producing enough food in order to feed the projected population of 9 billion people by 2050. Also, the food prices have skyrocketed in the past few years making it difficult for average earners to afford a three course meal. These effects are witnessed in developing countries that rely heavily on imported food, such as North Africa, Latin America, and Middle East.

Currently, the world food situation is being defined by some new driving forces. These include climate change, globalization, urbanization, energy prices, and income growth as they are responsible in transforming food production, consumption and markets. The security of food in the world depends from the available food supply, the income of the targeted population, accessibility of food, food consumption rate, as well as the amount that can be stocked for future use.

• **The Problem of Distribution of Food**

In the world today, there are many people dying because of the shortage of food, however, there are also many people who are obese. So evidently there is a problem in the way food is distributed .There are wide gaps of economy between countries. In short, the problem of "distribution" is to devise ways to feed people in the world with no shortage. If the world population grows in current pace, the amount of production of food crops is said to be unable to catch up with the population in the future.

**Case Study 7**

In May 2008 Cyclone Nargis devastated much of the southern part of Myanmar, causing 4000 deaths, displacing nearly 1,00,000 people and disrupting food supplies so badly as to create a real risk of famine. The government could not provide the required emergency aid or accept help from other countries. Four months later, parts of Myanmar were struck by another natural disaster — a plague of rats.

Once every 50 years or so, bamboo plants in the western part of Myanmar produce a fruit. The fruit attracts hordes of rats, which feed on its seeds. These seeds are rich in nutrients and allow the rats to multiply rapidly. Once the seeds have been devoured, the hungry rats turn on villagers' crops, destroying rice and maize, bringing the inhabitants to the brink of starvation. The Chin region was the part of Myanmar worst hit by the plague of rats. An estimated 20% of the population were thought to be in immediate need of food aid.. Despite appeals, little or no emergency food aid was sent to the area. In desperation, many people migrated and sought food and help in India.

**2.5.2. Changes Caused by Agriculture and overgrazing**

Agriculture is the world's oldest and largest industry. Agriculture has both primary and secondary environmental effects. A primary effect is an effect on the area where the agriculture takes place i.e. on-site effect. A secondary effect, also called an off-site effect, is an effect on an environment away from the agricultural site.

The effects of agriculture on the environment can be broadly classified into three groups, viz. global, regional and local.

**(1) Global Effects:** These include climate changes as well as potentially extensive changes in chemical cycles.

**(2) Regional Effects:** This is caused by the combined effects of farming practices in the same large region. Regional effects include deforestation, desertification, large scale pollution, increase in sedimentation in

major rivers and in the estuaries at the mouths of the rivers and changes in the chemical fertility of soils over large areas. In tropical waters, sediments entering the ocean can destroy coral reefs.

**(3) Local Effects:** Soil erosion and increase in sedimentation downstream in local rivers in the vicinity of the agricultural land can be called local effects. Fertilizers carried by sediments can also transport toxins and destroy the local fish population.

The environmental impact of agriculture is the effect that different farming practices have on the ecosystems around them. The environmental impact depends on the production practices of the system used by farmers. There are two types of indicators of environ-mental impact: "means-based", which is based on the farmer's production methods, and "effect-based", which is the impact that farming methods have on the farming system or on emissions to the environment.

The environmental impact of agriculture involves a variety of factors from the soil, to water, the air, animal and soil variety, people, plants, and the food itself. Some of the environmental issues that are related to agriculture are climate change, deforestation, genetic engineering, irrigation problems, pollutants, soil degradation, and waste.

### 2.5.3. Problems of Modern Agriculture

Agriculture is the management of the growth of plants and animals for human use. Agriculture includes preparation of soil for cultivation of crops, harvesting crops, breeding and raising livestock, dairying and forestry.

The two major types of agriculture are:

• Traditional agriculture

• Modern or Industrialized agriculture

The development of agriculture was achieved in terms of:

1. Expansion and/or conversion of agricultural lands
2. Increased agricultural productivity
3. Multiple-cropping pattern
4. Conversion of single-cropping system to two tier and / or three tier cultivation

In due course of time, agricultural development became possible due to

(a) Development of modern scientific techniques
(b) Advanced technology
(c) Expansion of irrigational facilities
(d) Use of chemical fertilizers
(e) Use of pesticides and insecticides

(f) Development and use of high yielding varieties of seeds
(g) Mechanization of agriculture
(h) Varying crop sequences

It will be difficult for us to maintain our present standard of living and current consumption-pattern if we continue to destroy land. Considering this, it becomes essential to understand the related incidences causing environmental degradation.

Pests and diseases such as gall midge, brown plant hopper, bacterial blight and tungro virus (or paddy) considered as minor diseases earlier to the Green Revolution suddenly appeared as major diseases.

Agricultural losses due to such pests and/or diseases increased tremendously since the high-yielding varieties were more prone to pests and diseases. Naturally, use of pesticides increased and this brought about widespread occurrence of pesticide-residues practically in every agricultural produce, widespread pesticide resistance in vectors and finally even resistance to pesticides in stored grains.

Such pesticide resistance to wards pests of agricultural importance became a major constraint in improving agricultural productivity.

### 2.5.4. Fertilizer and Pesticide Problems

To assure enhanced productivity in areas where intensive cultivation has been initiated, increased application of chemical fertilizers supplying the plant nutrients has become an essential component of modern agriculture.

Fertilizer application in South Asia including India has multiplied with widespread intro-duction of the Green Revolution. The number of fertilizer plants has gone up and the production has multiplied.

**Problems caused by using Fertilizers:**

1. Micronutrient imbalance: Chemical fertilizers used in modern agriculture contain Nitrogen, Phosphorus and Potassium (N,P,K) which are macronutrients. Excess use of fertilizers in fields causes micronutrient imbalance. Ex: Excessive use of fertilizers in Punjab and Haryana caused deficiency of micronutrient Zinc thereby affecting productivity of soil.
2. Nitrate pollution: Excess Nitrogenous fertilizers applied in fields contaminates the groundwater.
3. Eutrophication: The application of excess fertilizers in fields leads to wash off of the nutrient loaded water into nearby lakes causing over-nourishment. This is called “Eutrophication”. Eutrophication causes the lakes to be attacked by “algal blooms”. Algal blooms use up nutrients rapidly and they die and pollute water thereby affecting aquatic life in the lakes.

**Problems in using Pesticides :**

In order to improve crop yield, pesticides are used indiscriminately in agriculture. Pesticides are of two types:

1. First generation pesticides that use Sulphur, Arsenic, Lead or Mercury to kill pests
2. Second generation pesticides such as Dichloro Diphenyl Trichloroethane (DDT) used to kill pests. These pesticides are organic in nature

Although pesticides protect our crops from severe losses due to pests, they have several side-effects as listed below:

• Death of non-target organisms: Several insecticides kill not only the target species but also several beneficial non-target organisms

• Pesticide resistance: Some pests that survive the pesticide generate highly resistant generations that are immune to all kinds of pesticides. These pests are called "superpests"

• Bio-magnification: Most pesticides are non-biodegradable and accumulate in the food chain. This is called bioaccumulation or bio-magnification. These pesticides in a biomagnified form are harmful to human beings.

• Risk of cancer: Pesticide enhances the risk of cancer in two ways (i) It acts as a carcinogen and (ii) It indirectly suppresses the immune system.

**Case Study 8**

Potato farmers in the province of Carchi in northern Ecuador suffer a number of health problems caused by high exposure to chemical insecticides. The dangers to both workers and their families are heightened by the fact that the most commonplace pesticides used in Ecuador are also among the world's most dangerous. Carbofuran (used to control the Andean weevil) and methamidophos (used to combat foliage pests) account for 47 percent and 43 percent, respectively, of all active insecticide ingredients applied in Carchi. Both of those chemicals are classified as highly toxic by the World Health Organization and are restricted in Northern countries because of their acute toxicity and ease of absorption. Exposure to pesticides such as these is associated with genetic and reproductive disorders and cancers, dermatitis and other skin problems, as well as neurological disorders. In the Carchi case, scientists have also speculated that the high rate of suicide may be related to the mood-altering effects of pesticide exposure.

### 2.5.5. Water logging

If water stands on land for most of the year, it is called water logging. Water logging refers to the saturation of soil with water. Soil may be regarded as waterlogged when it is saturated with water much of the time such that its air phase is restricted. In water logged conditions the soil gets filled with water and soil-air gets depleted. In such a condition the roots of plants do not get enough air for respiration. Water logging also leads to low crop yield. In agriculture, various crops need air. In irrigated agricultural land, water logging is often accompanied by soil salinity.

Causes of Water logging:

1. Excessive water supply to the croplands

2. Heavy rain

3. Poor drainage

Measures To Prevent Water Logging:

1. Avoid and prevent excessive irrigation

2. Bio-drainage by trees like Eucalyptus

### 2.5.6. Salinity

The term salinity refers to the amount of dissolved salts that are present in water. Salinity is an important factor in determining many aspects of the chemistry of natural waters and of biological process within it. The salts are compounds like sodium chloride, magnesium chloride, etc

## 2.6. ENERGY RESOURCES

Energy is essential for the existence of mankind. Energy production and energy utilization indicates a country's progress. It is available on earth in different forms and today every country draws its energy needs from a variety of sources. *Major energy sources are fossil fuels, nuclear fuels, hydro energy, geothermal, solar energy, wind energy, tidal energy, bio-mass, hydrogen etc. However, sun is the main source of our energy resources*. The energy policy of India is largely defined by the country's expanding energy deficit and increased focus on developing alternative energy sources, particularly nuclear, solar and wind energy. India has been ranked 78$^{th}$ among 114 countries on the world economic Forum's energy transition index.

### 2.6.1. Growing energy needs

All developmental activities of the world depend directly or indirectly on energy. Most of the industrial processes like mining, transport, lighting, heating and cooling in buildings need energy. With the growing population, the world is facing an energy deficit. Lifestyle changes from simple to complex and luxurious lifestyle adds to this energy deficit. Almost 95% of commercial energy is available from fossil fuels like coal and natural gas. These fossil fuels will not last for more than a few years. Hence, we must explore alternative fuel or energy options.

**Indian Scenario:**

In India, commercial energy like coal, oil, gas and water constitute the main sources of energy. The share of agriculture in commercial energy consumption has risen rapidly over the past four decades. Industries like fertilizer, aluminium, textiles, cement, iron, steel, paper etc consume about 80% of the coal and 70% of the electrical energy in India. The transport sector accounts for 65% of the total oil consumption (petrol and diesel). The energy consumption of household sector has also increased due to air conditioners, refrigerators and other electrical appliances. Apart from commercial energy, a large amount of traditional energy sources in the form of wood, agricultural waste and animal residue are also used.

Due to rapid economic expansion, India has to increase not only the indigenous availability but also aim at efficient utilization of energy. Our ambitious plan is to expand its renewable and nuclear power industries. India has the second highest wind capacity in Asia and is the only Asian country apart from China, with a total capacity of 35 GW. India's solar power installed capacity reached 34.404 GW as of February 2020. India also envisages to increase the contribution of nuclear power to overall electricity generation capacity from 4.2% to 9% within 25 years. Five nuclear reactors are under construction and plans are to construct 18 additional nuclear reactors by 2025.

### 2.6.2. Renewable and Nonrenewable energy sources

Based on continual utility, natural resources can be classified into two types:

**Renewable energy sources:** These resources can be generated continuously and are in-exhaustible. They are available in plenty and are the cleanest sources of energy available on this planet. Examples include Wood, Solar energy, Wind energy, Hydro power, Tidal energy, Geo-thermal energy, forest, etc. They have low carbon emission;therefore, they are considered as green and environmental friendly.

**Non-renewable energy sources:** They are natural resources that cannot be regeneratedonce they are exhausted. They cannot be used again. They are not environmental friendly and can have serious effect on our health. Ex: Coal, Petroleum, Natural gas and Nuclear fuels. Non-renewable sources release toxic gases in the air when burnt, which are the major cause for global warming.

The points of differences between renewable and non-renewable resources include:

| **Renewable energy resources** | **Non-renewable energy resources** |
|---|---|
| They are natural resources around us | They are formed deep down the earth crust millions of years ago |
| It can be generated continuously and are in-exhaustible | It cannot be regenerated once they are exhausted |
| It is environmental friendly as the amount of carbon emission is low | It is not environmental friendly as the amount of carbon emission is high |
| They are pollution free | They are not pollution free |
| These resources are sustainable | These resources are exhaustible |
| They are present in unlimited quantity | They are present in a limited quantity |
| These resources cause no harm to life on earth | These resources adversely affect the health of organisms by emitting radiations, smoke, carcinogenic elements to environment |
| The rate of renewal of these resources are greater than the rate of consumption | The rate of renewal of these resources are lower than the rate of consumption |

### 2.6.3. Alternative energy sources

Energy sources that are not popularly used and are environmental friendly are called alternative energy sources. They cause little or no pollution. They help us to maintain the balance of nature without causing

much harm as compared to conventional energy sources. Alternative or renewable energy sources show significant promise in helping us to reduce the amount of toxins that are byproducts of energy use and help preserve many of the natural resources that we currently use as sources of energy. They are available free of cost and is clean and green.

The damage that we have caused to earth due to industrialization is huge and if we want to keep the planet sustainable for our future generation, use of alternative energy sources is very important. Examples for alternative energy source include *wind energy, solar energy, geothermal energy, hydroelectric energy, biomass, tidal energy etc.*

**(i)Wind energy**

It is an effective source of energy in areas where the velocity of wind flow is high. Wind energy harnesses the power of the wind to propel the blades of wind turbines. The rotation of turbine blades is converted into electrical current by means of an electrical generator. Wind towers are built together in wind farms. They can be also built off-shore.

Advantages:

- •No pollution (a clean form of energy)
- • Source of power generation
- • Free of cost
- • It is a renewable source of energy

Disadvantages:

- • Wind power is intermittent. Consistent wind is needed for continuous power generation. If wind speed decreases, the turbine lingers and less electricity is generated.
- • Large wind farms can have a negative effect on the scenery.
- • They sometimes create noise disturbances and cannot be used near residential areas.

**(ii) Solar energy**

It is one of the promising alternative energy sources which the Earth receives from sun. The solar power generation is done using a series of photovoltaic cells where the solar rays are converted to electricity. Solar energy is also used commonly for heating, cooking and in the desalination of seawater.

Advantages:

- • It is a renewable resource and will not deplete
- • Solar power generation releases no by-products
- • It is free of cost and can be very efficiently used for heating and lighting
- • Solar power generation is quiet, absolutely clean and pollution free

Disadvantages:

- Solar power stations are very expensive to built
- Solar power does not produce energy when sun is not shining
- Night time and cloudy days limit the amount of energy produced

**(iii) Geothermal energy**

Geothermal literally means "earth heat".Geothermal energy harnesses the heat energy present underneath the Earth. Hot rocks under the ground will heat the water to produce steam. When holes are drilled in the region, the steam that shoots up is purified and is used to drive turbines, which power electric generators.

Advantages:

- It does not produce any harmful by-products
- Geothermal plant is self– sufficient (energy wise)
- They are small and has little effect on landscape
- Cost is less

Disadvantages:

- If constructed incorrectly, it produces pollutants
- Improper drilling into the earth can release hazardous minerals and gases
- It is suitable only to particular region and cannot be harnessed everywhere
- The areas where this energy is harnessed are prone to earthquakes and volcanoes.
- Setting up of geothermal power stations requires huge installation cost

**(iv) Hydroelectric energy**

Hydropower is the largest producer of alternative energy in the world. Hydroelectric power stations capture the kinetic energy of moving water to give mechanical energy to turbines.The moving turbines convert mechanical energy to electricity through generators.

Advantages:

- Hydropower is renewable, constant and predictable
- Hydroelectric power produces no waste or pollution since there is no chemical reaction to produce power
- Electricity can be generated constantly, because there are no outside forces
- Water used for hydropower can be reused

Disadvantages:

- Dams are very expensive to build.
- They cause adverse effect on aquatic life

Another form of hydropower is tidal energy, where rise and fall of ocean tides are captured by tidal energy generators which run turbines. The movement of turbines is responsible for producing electricity. The main advantage of tidal energy is that it is completely renewable and more predictable than wave energy.

**(v) Hydrogen Energy**

Hydrogen is a clean fuel and an energy carrier that can be used for a broad range of applications as a possible substitute to liquid and fossil fuels. It has tremendous potential and can be used to power homes, vehicles and space rockets. NASA has used liquid hydrogen in space shuttles since 1970s. A fuel cell combines hydrogen and oxygen to produce electricity, heat and water. Fuel cells are often compared to batteries. Both convert the energy produced by a chemical reaction into usable electric power.

Advantages:

- It is a renewable and clean energy source
- It is non-toxic
- It is more efficient than other forms of energy
- Used for powering space ships

Disadvantages:

- Production of hydrogen is expensive
- Difficulty in handling, storing and transportation of hydrogen.
- Its low availability in pure form
- Requirement of energy for the production of Hydrogen

### 2.6.4. Case study 9

***Kochi International airport becomes world's first airport to completely operate on solar power***

Cochin International airport has scripted another chapter in aviation history by becoming the first airport in the world that completely operates on solar power. The CIAL solar power project is a 40-megawatt power station built at COK airport, India. Now, Cochin airport's solar power plant is producing 50,000 to 60,000 units of electricity per day to be consumed for all its operational functions, which technically make the airport absolutely power neutral. This plant will produce 18 million units of power from 'sun' annually-the power equivalent to feed 10,000 homes for one year. Over the next 25 years, this green power project will avoid carbon dioxide emissions from coal fired power plants by more than 3 lakh metric tons, which is equivalent to planting 3 million trees or not driving 750 miles. Inspired by

the success of the above plant, CIAL decided to set up a larger scale 12MWpsolar PV plant as part of their green initiatives. This was set up in an area of 45 acres near the International cargo complex.

## 2.7. LAND RESOURCES

### 2.7.1. Land as a resource

The term 'Environment' includes all physical and social resources. It includes all the resources such as rivers, oceans, soil, forests, animals etc. Land is a free gift of the nature. The progress and prosperity of any country largely depends upon the geographical nature. Natural resources are derived from the environment. A natural resource is often characterized by amounts of biodiversity existent in various ecosystems.

Land resources mean the resources available from the land. No one can deny the importance of land and natural resource endowments as factors in the growth process. The quality of land can markedly affect the level of agricultural productivity in the economic development.

Land can be broadly divided into Urban land, Rural land, Forest land and Sea bed. Man needs land for building houses, for agriculture purpose , maintaining pastures for domestic animals and developing industries. If land is utilized carefully it can be considered a renewable resource.

Land is also converted into a non-renewable resource when highly toxic industrial and nuclear wastes are dumped on it. Man needs to preserve our grasslands, wetlands, wilderness area in forests, mountains etc to protect our vitally valuable biodiversity. A rational use of land needs careful planning. Land use may be defined as man's activities on land which are directly related to the land.

### 2.7.2. Land degradation

*Land degradation takes place when land use exceeds the carrying capacity of a system*. It is a process in which the value of the biophysical environment is affected by a combination of human induced processes acting upon the land. Houghton and Charman defines land degradation "It encompass soil degradation and the deterioration of natural landscape and vegetation". *Human induced degradation includes the adverse effects of overgrazing, erosion, urbanization, disposal of industrial wastes, road construction, decline of plant communities and pollution of the air with its effects on land*.

During the last few decades, there has been tremendous pressure on land in India due to increase in population. As urban centers grow and industrial expansion occurs, the agricultural land and forests shrink.

According to studies, water and wind erosion are the two primary causes of land degradation. Combined, they are responsible for about 84% of the global extent of degraded land. And the excessive erosion is now one of the most significant environmental problems worldwide.

**Effects**

- •Deteriorated Soil texture
- •Loss of soil fertility
- •Increase in water logging, salinity and acidity problems
- •Affects social, economic and biodiversity level

### 2.7.3. Man induced landslides

The sudden movement of the soil and the down slope of weathered rock material due to the force of gravity is called landslide. *During construction of roads and mining activities huge portions of mountainous regions are cut down and thrown into adjacent areas and streams. When the rivers are in flood they greatly add to landslides. These land masses weaken the already delicate mountain slopes leading to man-induced landslides.* It results in the loss of habitat and biodiversity and loss of infrastructure and hence in economic loss. *Man induced activities such as deforestation in hilly areas, excessive mining in hilly areas, dam construction, road and other infrastructure developments are also responsible for man induced landslides.*

### 2.7.4. Soil erosion and desertification

Soil erosion is a naturally occurring process that affects all landforms. *It is the removal of the top fertile layer of the soil*. In other words, it is the displacement of the upper layer of soil. Soil erosion by *water and wind* is the most common and extensive form of soil erosion. The loss of soil from farmlands may be reflected in *reduced crop production, lower surface water quality and damaged drainage networks*. **Intensive agriculture, deforestation and climate change** are the most significant factors responsible for soil erosion.

Desertification is a type of land degradation in which a relatively *dry area of land becomes increasingly arid, typically losing its water bodies as well as vegetation and wildlife*. It is caused by *climate change and soil erosion.* When deserts appear automatically over the natural course of an Earth's life cycle, then it can be called a natural phenomenon. Desertification is a significant global ecological and environmental problem. The UNO Conference on Desertification has defined it as *" the destruction of the biological potential of land and can lead ultimately to desert like conditions."*

The major causes of desertification are *mismanagement of forests, overgrazing, mining and quarrying*. The increasing rate of desertification will be a threat to food security.

## 2.8. ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

Resource management may be defined as *"the conservation of natural resources by technical and managerial practices for the purpose of man's utilitarian needs under prevailing socio-economic conditions."*

Man has exploited nature excessively at the cost of the environment. Continuing current practices will lead to a massive and unsustainable gap between global supply and demand for natural resources.

**What Can We do?**

Public awareness and participation are highly effective to improve environmental conditions.

- Conducting education programmes relating to environmental management and awareness can go a long way in controlling environmental degradation. Education and public participation may change and improve the quality of environment. According to UNESCO "Environmental education is a way of implementing the goals of environmental protection".
- Building a sustainable society will require participation by governments, businesses and individuals. The goals of sustainable development cannot be met without individuals support and actions. Citizens are an integral part of the economic system as consumers of goods and services, and they are also vital to the adoption of sustainable practices.
- By becoming conscientious consumers/ individuals (buying green products, buying what you needetc) you can help to stimulate the transition to sustainability. Transition to a sustainable society requires participation of human beings.
- Citizens can take actions to promote a sustainable future (Driving fuel efficient vehicles, carpooling, bicycling, walking or using public transport etcall make significant contributions.)
- Do Recycling.

## 2.9. EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFESTYLES

Economic development and growth strategies encourage rapid accumulation of physical and human capital, but it is at the expense of excessive depletion and degradation of natural resources and eco systems. Depleting the world's resources for development and growth have had detrimental impacts on the well-being of present generations and results challenges for the future. *Equity is supposed to be a central ethical principle of sustainable development*. It means that *there should be a minimum level of income and*

*environmental quality below which nobody falls*. It is generally agreed that equity implies a need for fairness (not necessarily equality) in the distribution of gains and losses, and the entitlement of everyone to an acceptable quality and standard of living.

Environmental inequities already exist in all societies. There is a big divide in the world as North and South, the more developed countries (MDC'S) and less developed countries (LDC'S), the haves and the have nots. The MDC's have only 22% of world's population, but they use 88% of its natural resources, 73% of its energy and command 85% of its income. In order to achieve sustainable development, it is desirable to achieve a more balanced and equitable distribution of global resources and income to meet everyone's basic needs. Reduction of the unsustainable and unequal use of resources and control of population growth are essential for the survival of our nation. A fairer sharing of resources will narrow down the gap between the rich and the poor and will lead to sustainable development for all.

**SECTION A (2 marks)**

1. What are renewable resources?
2. Describe non-renewable resources.
3. State biotic resources.
4. What are abiotic resources?
5. What is the commercial values forest?
6. How forest affects life and economy of tribes?
7. Explain the ecological uses of forest.
8. Enumerate aesthetic values of forest.
9. What is Jhum cultivation?
10. Write notes on Chipko movement.
11. What are renewable energy resources? Give examples.
12. What are non-renewable energy resources? Give examples.
13. List the advantages of using solar power over other forms of energy.
14. What is geothermal energy? What are its advantages?
15. List one advantage and one disadvantage of using wind as energy resource.
16. What is soil erosion?
17. What do you mean by equitable use of resources?
18. What you mean by land as a resource?
19. List out the important cause of land degradation. What tits effects?
20. Define desertification.

21. What is man induced landslides. What are its effects?
22. Define resource management.

**SECTION B (5 marks)**

23. Differentiate renewable and non-renewable energy sources
24. Write briefly on alternate energy sources
25. What are the advantages and disadvantages of hydrogen as a fuel?
26. What are the advantages and disadvantages of solar and wind energy?
27. How geothermal energy can be used to generate electricity. What are its advantages and disadvantages?
28. What is land degradation? State its causes.
29. What do you mean by soil erosion and desertification?
30. Write a note on Man induced landslides.
31. Write notes on classification of natural resources.
32. Enumerate the uses of forest.
33. Write critical notes on overexploitation of forests.
34. How timber extraction does affect forest and tribes?
35. What are the major effects of mining operation on forest and tribes?
36. List out the effects of dams on forest and tribes
37. What is the impact of human activities on water resources?
38. What are the effects of mineral exploitation on environment?
39. What are the negative effects of ground water depletion?
40. List the benefits of a dam.
41. What are the upstream problems caused by a dam?
42. Explain the harmful effects of over exploitation of water resources.
43. Write a note on the conflicts over water.
44. Briefly describe the benefits and problems caused by dams.
45. Explain the use and exploitation of mineral resources.
46. Name the agencies that monitor food safety.
47. Why is food security important?
48. How has agriculture altered the environment?

## SECTION C (15 marks)

49. Write notes on a) Renewable and non-renewable energy sources b) alternate energy sources.
50. Discuss the role of an individual in conservation of natural resources.
51. Describe the classification of natural resources and problems associated with natural resources.
52. How forests help to provide prosperity of human beings and to the nation?
53. What is deforestation? Enumerate causes and major effects of deforestation

# UNIT 3

# ECOSYSTEMS

## 3.1 CONCEPT OF AN ECOSYSTEM

An ecosystem is an area whose environment is unique and recognizable. **Natural ecosystems** include forests, grasslands, deserts, wetlands such as ponds, rivers, lakes, and the sea. **Man-modified ecosystems** include agricultural patterns, and patterns of urban or industrial land use. The ecosystem's existence is based on its geographical features, such as hills, mountains, plains, rivers, coastal areas or islands. Climatic conditions such as the amount of sunshine, temperature, and rainfall also influence it.

**The living portion of the ecosystem is called its biotic component and abiotic component is its non-living portion.** All the living organisms in an area live in communities of plants and animals. They interact with their abiotic environment and with each other. Living organisms cannot survive without their non-living environment as this provides food and energy for the former's survival, Thus, the biotic population and its environment work to create a natural self-sufficient unit known as an ecosystem. Ecosystems are the very base of life itself.

**Definition of an ecosystem: A natural functional ecological unit comprising of living organisms (biotic community) and their non-living (abiotic or physio chemical) environment that interact to form a stable self-supporting system.**

All of the earth's habitats are connected to each other. For example, an ecosystem of the river is linked to the ocean ecosystem and a small ecosystem of dead logs is part of a large forest ecosystem. A complete self-sufficient ecosystem is rarely found in nature but situations can occur that approach self-sufficiency.

**Ecosystems are divided into terrestrial or land-based ecosystems and aquatic ecosystems.** These form the two major habitat conditions for the Earth’s living organisms.

### Stability of ecosystems

Many ecosystems are relatively stable and less influenced by some degree of human perturbation. Some are weak and quickly destroyed by human activity. Eg: Mountain ecosystems are extremely fragile, because degradation of forest cover contributes to significant soil erosion and changes in river courses. Island ecosystems are also

easily affected by human activity which can contribute to the rapid extinction of many of their unique plant and animal species. Some species may have a significant impact on the environment if eliminated. These are called '**keystone species'**. Extinction is caused by land-use changes and other geographical changes. Forests are deforested for timber, wetlands are drained to create more agricultural land and semi-arid grasslands are turned into irrigated fields. The pollution from industries and the waste from urban settings can also lead to poisoning and extinction of several species.

## 3.2 STRUCTURE AND FUNCTIONS OF AN ECOSYSTEM

The concept of ecosystem was first put forth by A.G. Tansely in 1935. Ecosystem is an essential unit of ecology. It has both structure and function. The structure is related to species diversity. The more complex the structure, the greater the species diversity within the ecosystem. The functions of an ecosystem are related to energy flow and materials cycling through structural components of the ecosystem.

Every ecosystem has two key components from the structural perspective: Abiotic and Biotic.

### 3.2.1. Abiotic components

The non-living factors or the physical environment prevailing in an ecosystem form the abiotic components. They have a significant impact on the structure, distribution, behavior and inter-relationship of organisms. Abiotic components are primarily of two types:

(a) Climate Factors which include rain, temperature, light, wind, humidity etc.

(b) Edaphic Factors which include soil, pH, topography minerals etc.

The functions of important factors in abiotic components are given below:

Soils are much more complex than simple sediments. They contain a mixture of weathered rock fragments, highly altered soil mineral particles, organic matter, and living organisms. Soils provide nutrients, water, a home, and a structural growing medium for organisms. The vegetation found growing on topsoil is closely linked to this component of an ecosystem through nutrient cycling.

The atmosphere provides carbon dioxide for photosynthesis and oxygen for respiration for the organisms found within ecosystems. The processes of

evaporation, transpiration and precipitation cycle water between the atmosphere and the Earth's surface.

Solar radiation is used in ecosystems to heat the atmosphere and to evaporate and transpire water into the atmosphere. Sunlight is also necessary for photosynthesis. Photosynthesis provides the energy for plant growth and metabolism, and the organic food for other forms of life.

Most living tissues are composed of a very high percentage of water, up to and even ex-ceeding 90%. The protoplasm of a very few cells can survive if their water content drops below 10% of their saturation level and most are killed if it is less than 30-50% below the saturation level. Water is the medium by which mineral nutrients enter and are trans-lo-cated in plants. It is also necessary for the maintenance of leaf turgidity and is required for photosynthetic chemical reactions. Plants and animals receive their water from the Earth's surface and soil. The original source of this water is precipitation from the atmosphere.

3.2.2. Biotic Components

The living organisms including plants, animals and micro-organisms (Bacteria and Fungi) that are present in an ecosystem form the biotic components. From nutrition point of view, the biotic components can be grouped into two basic components:

(i) Autotrophic components and (ii) Heterotrophic components

The autotrophic components include all green plants which fix the radiant energy of sun and manufacture food from inorganic substances. The heterotrophic components include non-green plants and all animals which take food from autotrophs.

On the basis of their role in the ecosystem, the biotic components can be classified into three main groups:

(A) Producers (B) Consumers (C) Decomposers or Reducers

(A) Producers:

Green plants have chlorophyll with the help of which they trap energy and change it into chemical energy of carbohydrates using simple inorganic compounds, namely, water and carbon dioxide. This process is known as photosynthesis. As the green plants manufacture their own food they are known as Autotrophs (i.e. auto=self, trophos= feeder). The chemical energy stored by the producers is utilized partly by the producers for their own growth and survival and the remaining is stored in the plant parts for their future use.

(B) Consumers:

Animals lack chlorophyll and are unable to synthesize their own food. Therefore, they depend on the producers for their food. They are known as heterotrophs (i.e. heteros= other, trophos= feeder).

The consumers are of four types, namely:

(a) Primary Consumers or First Order Consumers or Herbivores:

These are the animals which feed on plants or the producers. They are called herbivores.

Eg: rabbit, deer, goat, cattle etc.

(b) Secondary Consumers or Second Order Consumers or Primary Carnivores:

The animals which feed on the herbivores are called the primary carvivores. Eg: cat, fox, snake etc.

(c) Tertiary Consumers or Third Order Consumers:

These are the large carnivores which feed on the secondary consumers. E.g. wolf.

(d) Quaternary Consumers or Fourth Order Consumers or Omnivores:

These are the largest carnivores which feed on the tertiary consumers and are not eaten up by any other animal: Eg: lion and tiger.

(C) Decomposers or Reducers:

Bacteria and fungi belong to this category. They breakdown the dead organic materials of producers (plants) and consumers (animals) for their food and release to the environment the simple inorganic and organic substances produced as by-products of their metabolisms. These simple substances are reused by the producers resulting in a cyclic exchange of ma-terials between the biotic community and the abiotic environment of the ecosystem. The decomposers are known as Saprotrophs (i.e., sapros=rotten, trophos=feeder).

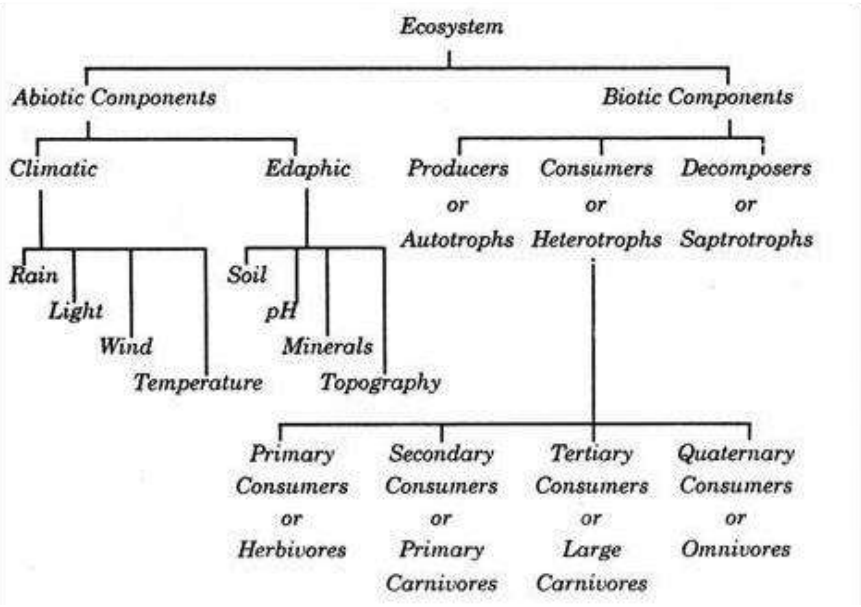



*Fig. 3.1 Schematic representation of the structure of an ecosystem*

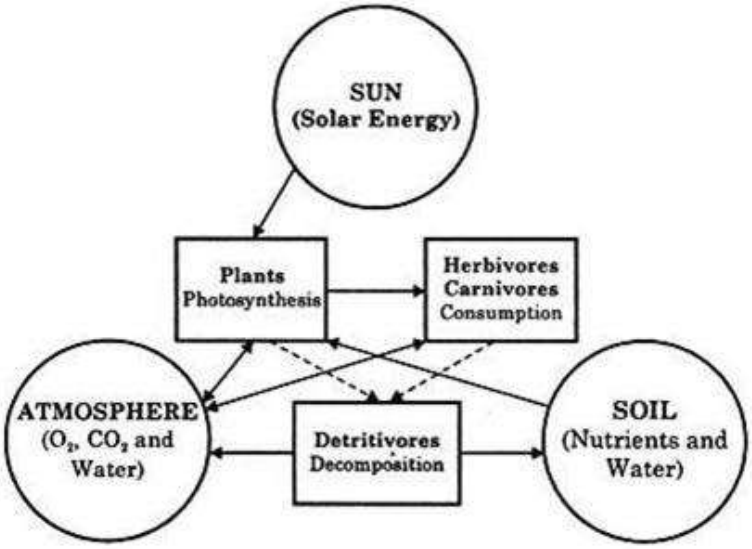



*Fig. 3.2 Relationship within an ecosystem*

3.3. FUNCTION OF AN ECOSYSTEM

In any ecosystem we have the following functional components:

(i) Inorganic constituents (air, water and mineral salts)

(ii) Organisms (plants, animals and microbes) and

(iii) Energy input which enters from outside (the sun).

These three interact and form an environmental system. Inorganic constituents are synthesized into organic structures by the green plants (primary producers) through

photo-synthesis and solar energy is utilized in the process. Green plants become the source of energy for renewals (herbivores) which in turn become the source of energy for the flesh eating animals (carnivores). Animals of all types grow and add organic matter to their body weight and their source of energy is a complex organic compound taken as food. They are known as secondary producers.

All the living organisms, whether plants or animals, in an ecosystem have a definite life span after which they die. The dead remains of plants and animals provide food for saprophytic microbes, such as bacteria, fungi and many other animals. The saprobes ultimately decompose the organic structure and break the complex molecules and liberate the inorganic components into their environment.

These organisms are known as decomposers. During the process of decomposition of organic molecules, the energy which kept the organic components bound together in the form of organic molecules gets liberated and dissipated into the environment as heat energy. Thus, in an ecosystem, energy from the sun is fixed by plants and transferred to animal components.

Nutrients are withdrawn from the substrate, deposited in the tissues of the plants and animals, cycled from one feeding group to another, released by decomposition to the soil, water and air, and then recycled. The ecosystems operating in different habitats, such as deserts, forests, grasslands and seas are interdependent on one another. The energy and nutrients of one ecosystem may find their way into another so that ultimately, all parts of the earth are interrelated, each comprising a part of the total system that keeps the biosphere functioning.

Thus the principal steps in the operation of ecosystem are as follows:

(1) Reception of radiant energy of sun

(2) Manufacture of organic materials from inorganic ones by producers

(3) Consumption of producers by consumers and further elaboration of consumed materials

(4) After the death of producers and consumers, complex organic compounds are degraded and finally converted by decomposers and converters into such forms that are suitable for reutilization by producers.

The principal steps in the operation of ecosystem not only involve the production, growth and death of living components but also influence the abiotic aspects of habitat. It is now clear that there is transfer of both energy and nutrients from producers to consumers and finally to decomposers and transformers levels. In this

transfer, there is a progressive decrease of energy but nutrient component is not diminished and it shows cycling from abiotic to biotic and vice versa.

The flow of energy is unidirectional. The two ecological processes, energy flow and mineral cycling, which involve interaction between biotic and abiotic components lie at the heart.

of ecosystem dynamics. The principal steps and components of ecosystem are illustrated in figure 3.3.

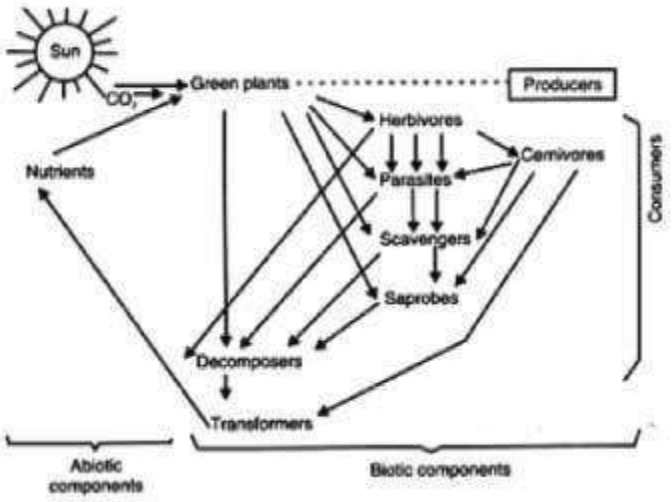



*Fig. 3.3 Different components of ecosystem*

## 3.4 PRODUCERS, CONSUMERS AND DECOMPOSERS

The biotic community of any ecosystem can be divided simply into producers, consumers and decomposers.

Producers or autotrophs are organisms that make their own organic material from simple inorganic substances. For most of the biospheres, the main producers are photosynthet-ic plants and algae that synthesise glucose from carbon dioxide and water. The glucose produced is an energy source and combines with other molecules from the soil to build biomass. It is this biomass that provides the total theoretical energy available to all non photosynthesizing organisms in the ecosystem.

Consumers or heterotrophs are organisms that obtain molecules by eating or digesting other organisms. By eating other organisms, they gain both food as an energy supply and nutrient molecules from within the biomass ingested. For instance, to build new protein, consumers have to eat protein containing amino acids. Consumers are of three types:

Herbivores – animals that eat only plants-primary consumers. Eg: hare, deer, elephant and fish that live on algae

Carnivores – animals that eat only animals-secondary consumers. Eg: tigers, leopards, jackals, foxes, carnivorous fish.

Omnivores – animals that eat both animals and plants. Eg: humans

Decomposers are the waste managers of any ecosystem. They are small, like worms, in-sets, bacteria and fungi. They are the final link in a foodweb and break down dead organic material into smaller particles and finally into simpler substance that are used by plants as nutrition. Thus, decomposition is a vital function in nature. Without this, all the nutrients would be tied up in dead matter and no new life would be produced. Decomposers can be divided into two groups based on their mode of nutrition:

1.Detrivores are organisms that ingest non-living organic matter. These can include earth-worms, beetles and many other invertebrates.

2.Saprotrophs are organisms that live on or in non-living organic matter, secreting diges-tive enzymes into it and absorbing the products of digestion. These include fungi and bacteria.

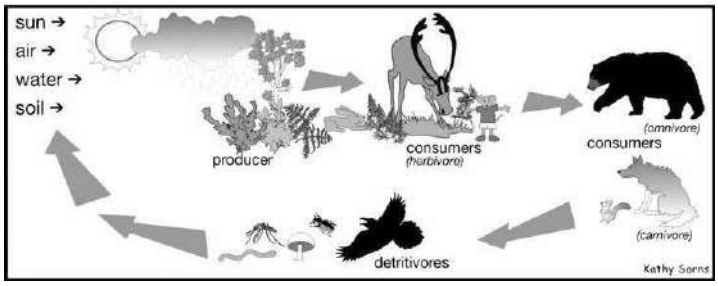



*Fig. 3.4 Relationship between producers, consumers and decomposers*

## 3.5 ENERGY FLOW IN ECOSYSTEM

Every ecosystem has several interrelated mechanisms that affect human life. All the func-tions of the ecosystem are in some way related to the growth and regeneration of its plant and animal species. These interlinked processes can be depicted as various cycles. All these processes depend on energy from sunlight. During photosynthesis, carbon dioxide is absorbed by plants and oxygen is released into the atmosphere. Animals depend on this oxygen for their respiration. The water cycle depends on the rainfall, which is necessary for plants and animals to live. The energy cycle recycles nutrients into the soil on which plant life grows. Our own lives are closely linked to the proper functioning of these cycles of life. If human activities alter them, humanity cannot survive on earth.

### 3.5.1 Energy Cycle

The energy cycle is based on the flow of energy through the ecosystem. The energy from sunlight is converted by plants into growing new plant material like leaves, flowers, fruits, branches, trunks and roots of plants. Since plants can grow by converting the solar energy directly into their tissues, they are known as producers in the ecosystem. The plants are consumed by herbivores as food, which gives them energy. A large part of this energy is used up for the metabolic functions of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood flow and body temperature. Energy is also used for activities like looking for food, finding shelter, breeding and rearing the young ones. The carnivores, in turn, depend on the herbivores on which they feed. Thus, the different plant and animal species are linked to one another through food chains. Each food chain has three or four links. However, as each plant or animal can be linked to several other plants or animals through many different linkages, these interlinked chains can be depicted as a complex food web. This is called the 'web of life' that shows that there are thousands of interrelationships in nature.

The producers and consumers in ecosystem can be arranged into several feeding groups, each known as trophic level (feeding level). In any ecosystem, producers represent the first trophic level, herbivores represent the second trophic level, primary carnivores represent the third trophic level and top carnivores represent the last level.

The energy in the ecosystem can be depicted in the form of a food pyramid or energy pyramid. The food pyramid has a large base of plants called producers. The pyramid has a narrower middle section that depicts the number and biomass of herbivorous animals, which are called first order consumers. The apex depicts the small biomass of carnivorous animals called second order consumers. Man is one of the animals at the apex of the pyra-mid. Thus, to support mankind, there must be a large base of herbivorous animals and an even greater quantity of plant material.

When plants and animals die, this material is returned to the soil after being broken down into simpler substances by decomposers such as insects, worms, bacteria and fungi; so that plants can absorb the nutrients through their roots. Animals excrete waste products after digesting food, which goes back to the soil. This links the energy cycle to the nitrogen cycle.

On average about 10 percent of net energy production at one trophic level is passed on to the next level. Processes that reduce the energy transferred between trophic levels include respiration, growth and reproduction, defecation, and nonpredatory

death (organisms that die but are not eaten by consumers). The nutritional quality of material that is consumed also influences how efficiently energy is transferred, because consumers can convert high-quality food sources into new living tissue more efficiently than low-quality food sources.

The low rate of energy transfer between trophic levels makes decomposers generally more important than producers in terms of energy flow. Decomposers process large amounts of organic material and return nutrients to the ecosystem in inorganic form, which is then taken up again by primary producers. Energy is not recycled during decomposition, but rather is released, mostly as heat. The Figure 3.5 shows the flow of energy (dark arrows) and nutrients (light arrows) through ecosystems.

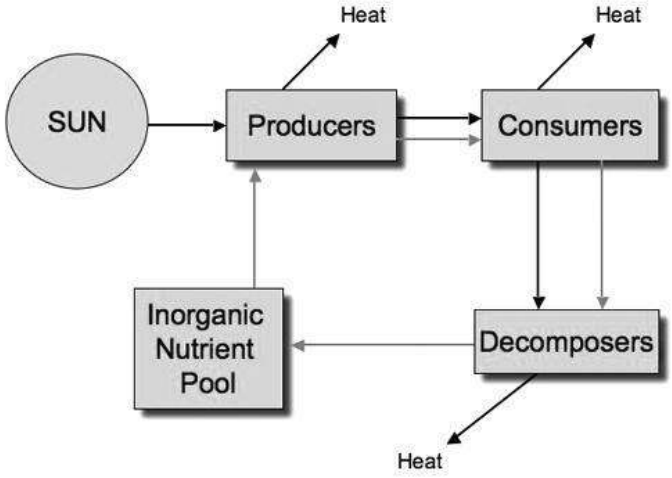



*Fig. 3.5 Energy and nutrient transfer through an ecosystem*

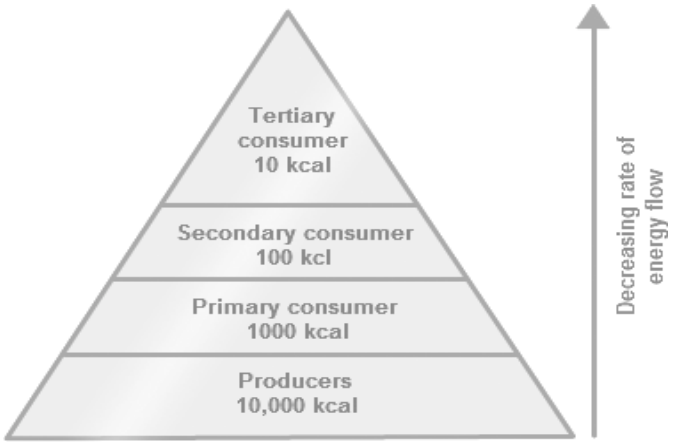



*Fig. 3.6 Energy pyramid*

### 3.6 ECOLOGICAL SUCCESSION

**Ecological Succession is the process by which the ecosystem tend to**

**change over a period of time.** There are several developmental stages in the ecosystem. Developmental stages in the ecosystem consist of a pioneer stage, a series of changes known as serial stages and finally a climax stage. The successive stages are related to the way in which energy flows through the biological system. Succession usually produces a stable state at the end. For example, an open area will gradually be converted into grassland, a shrub land and finally, a woodland and a forest.

There are two different types of succession- primary and secondary.

**Primary succession** occurs in regions in which the soil is incapable of sustaining life. This may occur due to factors like lava flows, newly formed sand dunes, or rocks left from a retreating glacier. **Secondary succession** occurs in areas where a community that previously existed has been removed. It is characterized by smaller-scale disturbances that do not eliminate all life and nutrients from the environment.

The most frequent example of successional changes occur in a pond ecosystem. The different stages may be: dry terrestrial habitat, an early colonization stage by small aquatic species after the monsoon, a mature aquatic ecosystem. It may go back to its dry stage in summer when its aquatic life remains dormant.

Succession can be related to seasonal environmental changes, which create changes in the community of plants and animals living in the ecosystem. Other successional events may take much longer periods of time, extending to several decades. If a forest is cleared, initially only a small number of species from surrounding habitats are capable of thriving in this disturbed habitat. As new plant species take hold, they modify the habitat by altering things like the amount of shade on the ground or the mineral composition of the soil. These changes allow other species that are better suited to this modified habitat to succeed the old species. These newer species are superseded, in turn by still newer species. A similar succession of animal species occurs, and interactions between plants, animals, and environment influence the pattern and rate of successional change.

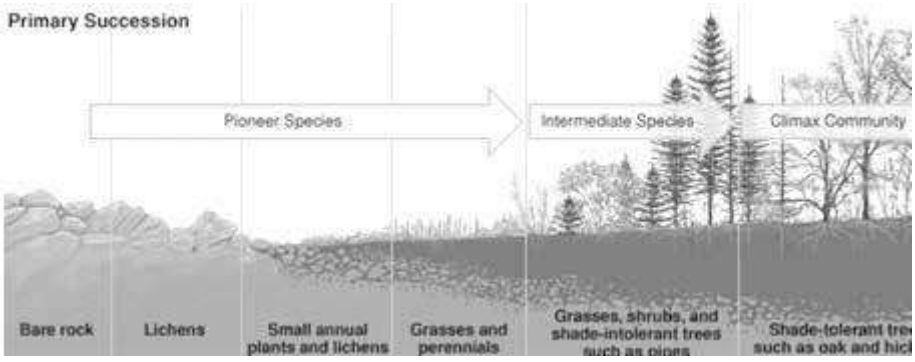



*Fig. 3.7 Ecological Succession*

## 3.7 FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

In the ecosystem, green plants alone are able to trap solar energy and convert it into chemical energy. The chemical energy is locked up in the various organic compounds, such as carbohydrates, fats and proteins, that are present in the green plants. Since virtually all other living organisms depend upon green plants for their energy, the efficiency of plants in any given area in capturing solar energy sets the upper limit to long-term energy flow and biological activity in the community.

The food manufactured by the green plants is utilized by themselves and also by herbivores. Herbivores fall prey to some carnivorous animals. In this way, one form of life supports the other form. Thus, food from one trophic level reaches the other trophic level and in this way a chain is established. This is known as the food chain.

Definition of food chain: A food chain may be defined as the transfer of energy and nu-trients through a succession of organisms through repeated process of eating and being eaten. In a food chain, the initial link is a green plant or producer which produces chemical energy available to consumers. For example, marsh grass is consumed by a grasshopper, the grasshopper is consumed by a bird and that bird is consumed by hawk.

Food chains are of three types:

Grazing food chain, Parasitic food chain, Saprophytic or detritus food chain

1.\ Grazing food chain

The grazing food chain starts from green plants (autotrophs) and from them, it goes to herbivores (primary consumers) to primary carnivores (secondary consumers) and then to secondary carnivores (tertiary consumers) and so on. The gross production of a green plant in an ecosystem may be utilized in three ways – it may be oxidized in respiration, it may be eaten by herbivorous animals and after the death and decay of producers it may be utilized by decomposers and finally released into the environment. In herbivores, the assimilated food can be stored as carbohydrates, proteins and fats, and transformed into much more complex organic molecules.

As in autotrophs, the energy in herbivores also meets three routes-respiration, decay of or-ganic matter by microbes and consumption by the carnivores Likewise, when the secondary carnivores or tertiary consumers eat primary carnivores, the total energy assimilated by primary carnivores or gross tertiary production follows the same course and its disposition into respiration, decay and further consumption by other carnivores is entirely similar to that of herbivores.

2.\ Parasitic food chain

It goes from large organisms to smaller ones without outright killing as in the case of predator.

3.\ Detritus food chains:

The dead organic remains including metabolic wastes and exudates derived from grazing food chain are generally termed detritus. The energy contained in detritus is not lost in ecosystem as a whole; rather it serves as a source of energy for a group of organisms called detritivores that are separate from the grazing food chain. The food chain so formed is called detritus food chain.

## 3.8 FOOD WEB

Many food chains exist in an ecosystem, and they are not independent. In an ecosystem, one organism does not depend wholly on another. The resources are shared specially at the beginning of the chain. The marsh plants are eaten by variety of insects, birds, mammals and fishes and some of the animals are eaten by several predators. Similarly, in the food chain eg: grass→mouse → snakes→owls. Sometimes mice are not eaten by snakes but directly by owls. This type of interrelationship interlinks the individuals of the whole community. In this way, food chains become interlinked. A complex of interrelated food chains makes up a food web. Food web maintains the stability of the ecosystem. The greater the number of alternative pathways, the more stable is the community of living things.

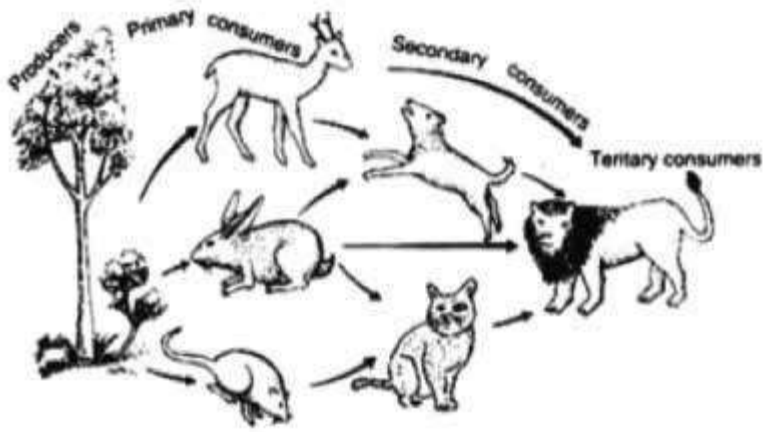



*Fig 3.8 Food web in an ecosystem*

### 3.8.1 Ecological Pyramids

The idea of ecological pyramids was advanced by C.E. Eltron (1927). The trophic structure of an ecosystem can be indicated by means of ecological pyramid. At each step in the food chain, a considerable fraction of the potential energy is lost as heat. As a result, organisms in each trophic level pass on lesser energy to the next trophic level than they actually receive. This limits the number of steps in any food chain to 4 or 5. The longer the food chain, the lesser is the energy available for the final members on the chain. Because of this taper-ing off of available energy in the food chain, a pyramid is formed and this is known as the ecological pyramid. The higher the steps in the ecological pyramid, the lower will be the number of individuals and the larger their size.

There are different types of ecological pyramids. In each ecological pyramid, the producer level forms the base and successive levels make up the apex. Three types of pyramidal re-lations may be found among the organisms at different levels in the ecosystem. They are:

1. Pyramid of numbers, 2. Pyramid of biomass (biomass is the weight of living organisms), and 3. Pyramid of energy.

3.8.1.1 Pyramid of Numbers

It depicts the numbers of individuals in producers and in different orders of consumers in an ecosystem. The base of pyramid is represented by producers which are the most abun-dant. In the successive levels of consumers, the number of organisms goes on decreasing rapidly until there are a few carnivores.

The pyramid of numbers of an ecosystem indicates that the producers are ingested in large numbers by smaller numbers of primary consumers. These primary consumers are eaten by relatively smaller number of secondary consumers and these secondary consumers, in turn, are consumed by only a few tertiary consumers. In a parasitic food chain starting from tree, the pyramid of numbers will be inverted.

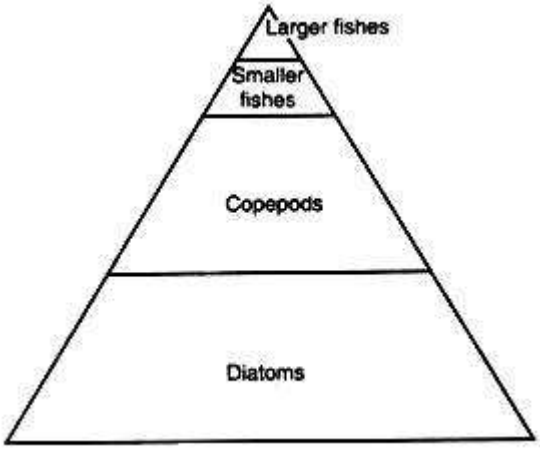



*Fig 3.9 Pyramid of numbers of a lake ecosystem*

3.8.1.2 Pyramid of Biomass

The living weights of the members of the food chain present at any one time form the pyramid of biomass of organisms. This indicates the total bulk of organisms or fixed energy present at one time. Pyramid of biomass indicates the decrease of biomass in each trophic level from base to apex, e.g., total biomass of producers is more than the total biomass of the herbivores.

Likewise, the total biomass of secondary consumers will be lesser than that of herbivores and so on. Since some energy and material are lost in each successive link, the total mass stored at each level is limited by the rate at which the energy is being stored below. This usually gives a sloping pyramid for most of the communities in terrestrial and shallow water ecosystems. The pyramid of biomass in a pond ecosystem will be inverted.

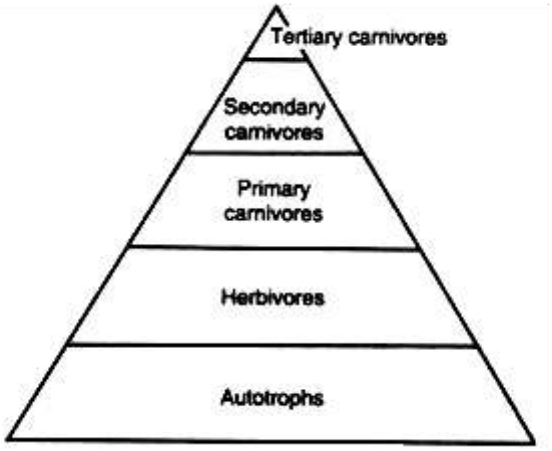



*Fig 3.10 A pyramid of biomass*

3.8.1.3 Pyramid of Energy

This depicts not only the amount of total energy utilized by the organisms at each trophic level of food chain but more importantly, the actual role of various organisms in transfer of energy. At the producer level, the total energy will be much greater than the energy at the successive higher trophic level. Some producer organisms may have small biomass but the total energy they assimilate and pass on to consumers may be greater than that of organisms with much larger biomass. Higher trophic levels are more efficient in energy utilization, but much heat is lost in energy transfer. Energy loss by respiration also progressively increases from lower to higher triophic states.

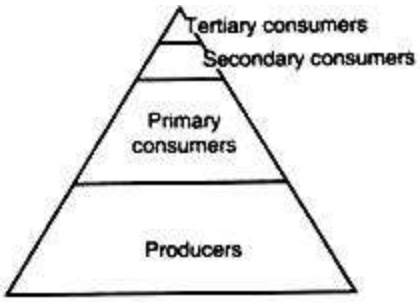



*Fig 3.11 Pyramid of energy*

In the energy flow process, two things become obvious. Firstly there is only one way along which energy moves i.e unidirectional flow of energy. Energy comes in the ecosystem from an outside source i.e. sun.The energy captured by autotrophs does not go back to the sun; the energy that passes from autotrophs to herbivores also does not revert back. As the energy moves progressively through the various trophic levels, it is no longer available to the previous levels. Thus, due to unidirectional flow of energy, the system would collapse if the supply from primary source, the sun, is cut off. Secondly, there occurs a progressive decrease in energy level at each trophic level which is accounted largely by the energy dissipated as heat in metabolic activities.

## 3.9 TYPES OF ECOSYSTEMS

### 3.9.1 Forest Ecosystem

A forest ecosystem is a population of organisms residing within a tree. In general, a forest is defined as a large group of trees. Other important aspects of a forest, however, are the shrubs, the floor-leaf mulch and the plants that live in conjunction with the trees. A forest ecosystem, however, isn't just about the forest environment. It also deals with the animals that live in the forest.

#### 3.9.1.1 Characteristic Features of Forest Ecosystems

Forest ecosystems are rich and diverse, and they have many exciting and fascinating features.

1.\ Seasonality: In countries that have seasonal climate, forest ecosystems will change with the seasons.

2.\ Deciduous or evergreen: A forest may be deciduous (i.e. it sheds its leaves in winter) or evergreen (i.e. its leaves stay green and intact all the time), or it may be a mix of both deciduous and evergreen trees.

3.\ Different levels: Some forest ecosystems such as rain forests, features several levels– such as the forest floor, the lower canopy, the upper canopy and the tree tops.

4.\ Attractive to birds: Many bird species nest in tree tops and this makes forest ecosys-tems attractive to birds.

5.\ Attractive to insects: Many insects live in tree barks, leaf mulch or flowers and as such they find forest ecosystems very attractive places to make their homes.

#### 3.9.1.2 Importance of Forest Ecosystems

Forest ecosystems are important not just for the community close to the forest, but for the whole world. The following are the reasons for this.

1.\ The Amazon rainforest is described as a biotic pump-like a giant green lung that releases oxygen into the atmosphere and locks away carbon.

2.\ Some of our forests are truly ancient, and much older than many human civilizations.

3.\ All our forest ecosystems are important for biodiversity. In fact, biologists very often claim that they are still discovering new species in the Amazon rain forest on a regular basis.

4.\ Forest ecosystems are not just habitats for animals. Many human communities including indigenous communities live in forests all over the world.

5.\ Forests keep the earth rich in minerals, protect it from desertification by providing a shield against winds, and so on.

3.9.1.3 Types of Forest Ecosystems

Taiga: This thin, sparse forest exists at the extreme north of the world, in countries such as Canada and Finland and in the Arctic Circle. It is characterized by chilly conditions and the fact that the animals and birds and other organisms that live there have adapted to the cold. The taiga is a very ancient forest.

Rain forests: Rain forests are huge, humid, highly bio-diverse swathes of forest that are usually found within the global South. Due to the thick canopy created by their leaves, rain forests usually create their own mini ecosystem that seals off heat and humidity.

Boreal forests: Boreal forests exist in the sub Arctic zones of the world (i.e. less far north than the Taiga). Here, you can find a mix of deciduous and evergreen trees and plenty of different animals, insects, birds and so on.

Forests of the temperate zone: Located between the freezing cold of the polar zone and the scorching heat of the equator, the temperate zone is somewhere where forests can truly flourish. Some very ancient forests, such as the New Forest in Britain are examples of how the temperate zone conditions are just right for huge amounts of biodiversity to occur. Again, in this zone, forests can be made of a mix of deciduous and evergreen trees or of mainly one or mainly the other type of tree.

3.9.1.4 Functions of Forest ecosystems

Different organisms exist within the forest layers. These organisms interact with each other and their surrounds. Each organism has a role or niche in sustaining the ecosystem. Some provide food for other organisms, other provide shelter or control populations trough predation.

3.9.2 Grass Land Ecosystem

Grasslands are areas where the vegetation is dominated by grassland Ecosystems and other herbaceous (non-woody) plants. Grasslands occupy about 24% of the earth's surface. They occur in regions too dry for forests and too moist for deserts. The annual rainfall ranges between 25-75cm, usually seasonal. The principal grasslands includes Prairies (Canada, USA), Pampas (South America), Steppes (Europe and Asia), and Veldts (Africa). The highest abundance and greatest diversity of large mammals are found in these ecosystems. The dominant animal species include wild horses, asses and antelope of Eurasia, herds of Bison of America, and the antelope and other large herbivores of Africa. Grasslands are found primarily on plains or rolling topography in the interiors of great land masses, and from sea level to elevations of nearly 16,400 ft in the Andes. Because of their continental location, they experience large differences in seasonal climate and wide ranges in diurnal conditions.

3.9.3 Desert Ecosystem

A desert ecosystem is a community of organisms that live together in an environment that seems to be deserted wasteland. A desert ecosystem generally witnesses little rainfall, resulting in less vegetation

than in more humid areas of the globe. Look closely at any seemingly deserted piece of land and you will usually be able to see numerous insets living in communities, an abundance of plant life, mammals and birds. In addition, micro organ-isms such as bacteria will also be present in this ecosystem, though they are not visible to the naked human eye.

There are many different types of desert ecosystems. They are:

1. Hot deserts: Hot deserts can be found close to the equator. The Sahara is a good exam-ple. Hot deserts tend to feature scorching hot ground which many plants may struggle to grow on, little shade, and a shortage of water. The plants and animals that live here have evolved in order to adapt to these very hot conditions. For example, cacti have grown a tough outer skin and interiors which can store any fluid that they absorb so that they can stay hydrated during droughts.

2. Cold deserts: Desertification can exist at high altitudes too, and when this happens, the desert will be cold. A good example is the deserted rocky peaks of a mountain. A cold desert may be sandy or rocky, but it will be a harsh environment where organisms have adapted in strange and wonderful ways so that they can survive. Eg: Gobi desert.

3. Ice deserts

Ice deserts are another type of cold desert. Here, instead of a sandy or rocky wasteland, we have a seemingly uninhabited region that is composed of ice. Ice deserts can be found towards the north and south poles of the planet, though they may also be located high up on mountain peaks.

3.9.4 Aquatic Ecosystems

In the broadest sense, there are two major types of ecosystems-aquatic and terrestrial. Among which aquatic ecosystems are further classified into freshwater, marine and estu-arine ecosystems based on their salt content. Composing more than 70% of the Earth's surface, aquatic ecosystems are not only the dominant feature of earth but are also very diverse in species and complexity of interaction among their physical, chemical and bio-logical components.

3.9.4.1 Fresh water ecosystems

Fresh water ecosystems cover about 2% of the earth's surface, an area of about 2.5 million Km2. These ecosystems are characterized by running water or still water. The running water ecosystems are also known as lotic ecosystems and still water as lentic ecosystems.

Lotic ecosystems

Fresh water streams (Springs, rivulets, creeks, brooks etc.) and rivers can change over their course from being narrow, shallow, and relatively rapid to become increasingly broad, deep and slow moving. A river is a lotic ecosystem that is formed because of gravity and acts as a catchments delivery/removal system. They are Mother Nature's pipelines. The water in a lotic ecosystem, from source to mouth, will

have atmospheric gases, turbidity, longitu-dinal temperature gradation and material dissolved in it. Lotic ecosystems have two main zones:- rapids and pools. Rapids are the areas where the water is fast enough to keep the bottom clear of materials, while pools are deeper areas of water where the currents are slower and silt builds up. Temperature is a major abiotic factor for life in these systems. Water found in these systems will freeze much quicker, and thaw much faster than the deep waters of lentic systems. Lotic ecosystems depend on precipitation, snow melt, and springs to keep the water flowing. In time of drought these shallow systems will dry up and many organisms will die.

Lentic ecosystems

Lentic water systems consist of still bodies of water, such as lakes, ponds and seas. During periods of drought, these systems will often last longer than their smaller counterparts and organisms can continue to live despite the shortened supplies. These bodies often experience many things that lotic water systems do not. Lentic water systems are made up of multiple zones: littoral, limnetic, vertical, and benthic.

The epilimnion, or surface water, is the area in which most life can be found. This zone is high in oxygen content during the summers; the warmer waters that receive the most sun-light will hold the most oxygen, thus allowing the greatest amount of life to flourish here.

The metalimnion, or middle mass of water is where the temperature of the water begins to decrease; life is not as plentiful as in the surface waters but there are still many organisms that can be found here. Very often, this is where the thermocline will begin. A thermocline is a point at which the water temperature decreases approximately one degree Celsius per meter.

The hypolimnion is the warmest zone during the winter time and the coldest during the summer. It is the bottom most part of the body, where sometimes light does not reach. This zone is where the least amount of life will be found throughout most of the year.

Overturns occur when water is stratified in bodies; the water from the bottom of the mass is mixed with the water close to the surface. This occurs during spring and fall.

3.9.4.2 Marine ecosystem

Marine ecosystems are among the largest of Earth's aquatic ecosystems. Examples include salt marshes, intertidal zones, estuaries, lagoons, mangroves, coral reefs, the deep sea, and the sea floor. They can be contrasted with fresh water ecosystems, which have a lower salt content. Marine waters cover two-thirds of the surface of the Earth. Such places are considered ecosystems because the plant life supports the animal life and vice versa.

Marine ecosystems are essential for the overall health of both marine and terrestrial en-vironments. According to the World Resource Center, coastal habitats account for about one-third of marine biological productivity. Estuarine ecosystems, such as salt marshes, sea grass meadows and mangrove

forests, are among the most productive ecosystems on the planet. Coral reefs provide food and shelter to the highest levels of marine diversity in the world. Marine ecosystems usually have a large biodiversity and are therefore thought to have a good resistance against invasive species.

Marine habitats can be divided into coastal and open ocean habitats. Coastal habitats are found in the area that extends from as far as the tide come in on the shoreline out to the edge of the continental shelf. Most marine life is found in coastal habitats, even though shelf area occupies only seven percent of the total ocean area. Open ocean habitats are found in the deep ocean beyond the edge of the continental shelf.

Alternatively, marine habitats can be divided into pelagic and demersal zones. Pelagic hab-itats are found near the surface or in the open water column, away from the bottom of the ocean. Demersal habitats are near or on the bottom of the ocean. An organism living in a pelagic habitat is said to be a pelagic organism, as in pelagic fish. Similarly, an organism living in a demersal habitat is said to be a demersal organism, as in demersal fish. Pelagic habi-tats are intrinsically shifting and ephemeral, depending on what ocean currents are doing.

Marine habitats can be modified by their inhabitants. Some marine organisms, like corals, kelp, mangroves and sea grasses, are ecosystem engineers which reshape the marine en-vironment to the point where they create further habitat for other organisms.

3.9.4.3. Estuaries

An estuary is a partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea.

Estuaries form a transition zone between river environments and maritime environments. They are subject both to marine influences-such as tides, waves, and the influx of saline water-and to reverie influences-such as flows of fresh water and sediment. The inflows of both sea water and fresh water provide high levels of nutrients both in the water column and in sediment, making estuaries one among the most productive natural habitats in the world.

Most existing estuaries formed during the Holocene epoch with the flooding of river erod-ed or glacially scoured valleys when the sea level began to rise about 10,000-12,000 years ago. Estuaries are typically classified according to their geomorphological features or to

water-circulation patterns. They can have many different names, such as bays, harbors, lagoons, inlets, or sounds, although some of these water bodies do not strictly meet the above definition of an estuary and may be fully saline.

The banks of many estuaries are amongst the most heavily populated areas of the world, with about 60% of the world's population living along estuaries and the coast. As a result, many estuaries suffer degradation by many factors, including sedimentation from soil ero-sion, deforestation, overgrazing and other poor farming practices; overfishing; and filling of wetland; eutrophication due to excessive nutrients from sewage and animal wastes; pol-lutants including heavy metals, polychlorinated biphenyls, radionuclides and hydrocarbons from sewage inputs; and damming for flood control or water diversion.

Questions

Part A (5 marks)

1. What is an ecosystem?
2. Explain the structure of an ecosystem.
3. What are the functions of an ecosystem?
4. Which are the functional components of an ecosystem?
5. Write briefly on the biotic components of an ecosystem.
6. Which are the abiotic components in an ecosystem?
7. Explain with examples producers, consumers and decomposers.
8. What do you mean by 'web of life'?
9. Explain the energy cycle in an ecosystem.
10. What do you mean by ecological succession. Explain.
11. Which are the different types of food chain ?
12. What do you mean by an ecological pyramid. Name the different types of ecological pyramids.
13. What is meant by pyramid of numbers?
14. Which are the different types of forest ecosystems. Give examples for each.
15. List the characteristic features of forest ecosystems.
16. Why is a forest ecosystem important to the world?
17. What is a desert ecosystem ?
18. Name the different types of a desert ecosystem. Explain each.
19. Explain lotic and lentic ecosystems.
20. Write a short note on freshwater ecosystem.
21. What are pelagic and demersal zones ?
22. 22.\ What is an estuary?
23. Part B (15 marks)
24. Explain its structure and functions.

25. Write a note on the biotic and abiotic components of an ecosystem explaining the functions of each with examples.
26. Explain the energy flow in an ecosystem. What is an energy cycle?
27. Explain the terms food chain and food web.
28. Describe ecological pyramid.
29. Explain a forest ecosystem focusing on the different types, its importance and char-acteristics.
30. Which are the different types of ecosystems? Explain the features of each.
31. Describe aquatic ecosystems. Which are the different types ? Explain each.

**Part B (10 marks)**

1. Define an ecosystem. Explain its structure and functions.
2. Write a note on the biotic and abiotic components of an ecosystem explaining the functions of each with examples.
3. Explain the energy flow in an ecosystem. What is an energy cycle?
4. Explain the terms food chain and food web.
5. Describe ecological pyramid.
6. Explain a forest ecosystem focusing on the different types, its importance and char-acteristics.
7. Which are the different types of ecosystems? Explain the features of each.
8. Describe aquatic ecosystems. Which are the different types ? Explain each.

# CHAPTER 4

# BIODIVERSITY AND ITS CONSERVATION

**4.1 Introduction**:

It is really amazing , if we divide the whole mother earth into 10 billion parts, it is only one part where life exists and the surprising variety of living organisms which could be about 50 million species are all restricted to just about a kilometer –thick layer of soil, water and air. It is indeed wonderful to see that so much diversity has been created by nature on this earth from so little physical matter. Biodiversity refers to the variety and variability among all groups of living organisms and the ecosystem complexes in which they occur. Biodiversity constitutes the biological wealth.

**Importance of biodiversity**

Biodiversity conservation, the practice of protecting and preserving the wealth and variety of species, habitats, ecosystems, and genetic diversity on the planet, is important for our health, wealth, food, fuel, and services we depend on. Biodiversity conservation is vital for economic growth and poverty reduction.This has created a great imbalance in nature. Thus, the importance of biodiversity has to be understood and actions have to be taken to maintain all the three levels of diversities.

**4.2. Biogeographic Classification of India:**

India is country of vast biodiversity. It is divided into different regions based on the geography, climate and pattern of vegetation seen and the communities of mammals, birds, reptiles, amphibians, insects and other invertebrates that live in them. Each of these regions contains a variety of ecosystems such as forests, grasslands, lakes, rivers, wetlands, mountains and hills, which have specific plant and animal species.

**Biogeographic classification of India** is the division of India according to biogeographic characteristics. Biogeography is the study of the distribution of species (biology), organisms, and ecosystems in geographic space and through geological time. There are ten biogeographic zones in India.

1. Trans Himalayan zone.
2. Himalayan zone
3. Desert zone.
4. Semiarid zone.
5. Western Ghat zone.
6. Deccan plateau zone.
7. Gangetic plain zone.

8. North east zone.
9. Coastal zone.
10. Islands present near the shore line.

***Trans-Himalayan region***

The Himalayan ranges immediately north of the Great Himalayan range are called the Trans- Himalayas. The Trans-Himalayan region with its sparse vegetation has the richest wild sheep and goat community in the world. The snow leopard is found here, as is the migratory black-necked crane.

***Himalayas***

The Himalayas consist of the youngest and loftiest mountain chains in the world. The Himalayas have attained a unique personality owing to their high altitude, steep gradient and rich temperate flora.

The forests are very dense with extensive growth of grass and evergreen tall trees. Oak, chestnut, conifer, ash, pine, deodar are abundant in Himalayas. There is no vegetation above the snowline. Several interesting animals live in the Himalayan ranges. Chief species include wild sheep, mountain goats, ibex, shrew, and tapir. Panda and snow leopard are also found here.

***Semi-Arid Areas***

Adjoining the desert are the semi-arid areas, a transitional zone between the desert and the denser forests of the Western Ghats. The natural vegetation is thorn forest. This region is characterized by discontinuous vegetation cover with open areas of bare soil and soil-water deficit throughout the year.

Thorny shrubs, grasses and some bamboos are present in some regions. A few species of xerophytic herbs and some ephemeral herbs are found in this semi-arid tract. Birds, jackals, leopards, eagles, snakes, fox, buffaloes are found in this region.

***Western Ghats***

The mountains along the west coast of peninsular India are the Western Ghats, which constitute one of the unique biological regions of the world. The Western Ghats extend from the southern tip of the peninsula (8°N) northwards about 1600 km to the mouth of the river Tapti (21°N).

The mountains rise to average altitudes between 900 and 1500 m above sea level, intercepting monsoon winds from the southwest and creating a rain shadow in the region to their East.

The varied climate and diverse topography create a wide array of habitats that support unique sets of plant and animal species. Apart from biological diversity, the region boasts of high levels of cultural diversity, as many indigenous people inhabit its forests.

The Western Ghats are amongst the 25 biodiversity hot-spots recognized globally. These hills are known for their high levels of endemism expressed at both higher and lower taxonomic levels. Most of the Western Ghat endemic plants are associated with evergreen forests.

Expansion of traditional agriculture and the spread of particularly rubber, tea, coffee and forest tree plantations would have wiped out large pockets of primary forests in valleys. The Western Ghats are well known for harboring a large number of endemic species of caecilians (i.e., legless amphibians) out of 15 recorded from the region so far.

***North-West Desert Regions***

This region consists of parts of Rajasthan, Kutch, Delhi and parts of Gujarat. The climate is characterized by very hot, dry summer and cold winter. Rainfall is less than 70 cm. The plants are mostly xerophytic. Babul, Kikar, wild palm grows in areas of moderate rainfall. Indian Bustard, a highly endangered bird is *found here. Camels, wild asses, foxes, and snakes are found in hot and arid deserts.*

***Deccan Plateau***

Beyond the Ghats is Deccan Plateau, a semi-arid region lying in the rain shadow of the Western Ghats. This is the largest unit of the Peninsular Plateau of India. The highlands of the plateau are covered with different types of forests, which provide a large variety of forest products. The Deccan plateau includes the region lying south of the Satpura range.it extends up to the southern tip of peninsular India. Anaimudi is the highest peak of this region.The Deccan plateau is surrounded by the Western and the Eastern Ghats. These Ghats meet each other at the Nilgiri hills. The Western Ghats includes the Sahyadri, Nilgiris, Anamalai, and cardamom hills. Many rivers such as Mahanadi, Godavari, Krishna, and Kaveri originates from Western Ghats and flow toward the east.The Eastern Ghats are broken into small hill ranges by river coming from the Western Ghats. Most of these rivers fall into the bay of Bengal.The Godavari is the longest river in the Deccan plateau .Narmada and the Tapi flow westwards and fall into the Arabian sea.

***Gangetic Plain***

In the North is the Gangetic plain extending up to the Himalayan foothills. This is the largest unit of the Great Plain of India. Ganga is the main river after whose name this plain is named. The aggradational Great Plains cover about 72.4mha area with the Ganga and the Brahmaputra forming the main drainage axes in the major portion.

The thickness in the alluvial sediments varies considerably with its maximum in the Gangetic plains. The physio geographic scenery varies greatly from arid and semi-arid landscapes of the Rajasthan Plains to the humid and per-humid landscapes of the Delta and Assam valley in the east.

Topographic uniformity, except in the arid Western Rajasthan is a common feature throughout these plains. The plain supports some of the highest population densities depending upon purely agro-based economy in some of these areas. The trees belonging to these forests are teak, sal, shisham, mahua, khair etc.

***North-East India***

North-east India is one of the richest flora regions in the country. It has several species of orchids, bamboos, ferns and other plants. Here the wild relatives of cultivated plants such as banana, mango, citrus and pepper can be grown.

***Islands***

The two groups of islands, i.e., the Arabian Sea islands and Bay Islands differ significantly in origin and physical characteristics. The Arabian Sea Islands (Laccadive, Minicoy, etc.) are the foundered remnants of the old land mass and subsequent coral formations. On the other hand, the Bay Islands lay only about 220 Km.

Away from the nearest point on the main land mass and extend about 590 Km. With a maximum width of 58 Km the island forests of Lakshadweep in the Arabian Sea have some of the best-preserved evergreen forests of India. Some of the islands are fringed with coral reefs. Many of them are covered with thick forests and some are highly dissected.

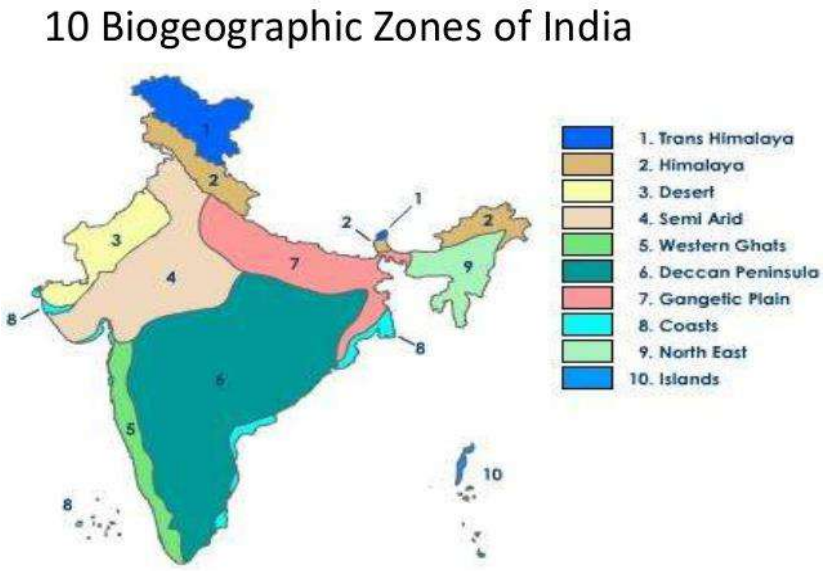
***Coasts***

India has a coastline extending over 5,500 km. The Indian coasts vary in their characteristics and structures. The west coast is narrow except around the Gulf of Cambay and the Gulf of Kutch. In the extreme south, however, it is somewhat wider along the south Sahyadri.

The backwaters are the characteristic features of this coast. The east coast plains, in contrast are broader due to depositional activities of the east-flowing rivers owing to the change in their base levels.

Extensive deltas of the Godavari, Krishna and Kaveri are the characteristic features of this coast. Mangrove vegetation is characteristic of estuarine tracts along the coast for instance, at Ratnagiri in Maharashtra.

Larger parts of the coastal plains are covered by fertile soils on which different crops are grown. Rice is the main crop of these areas. Coconut trees grow all along the coast.




### 4.3 Value of Biodiversity

As all the organisms in an ecosystem are interlinked and interdependent, the value of biodiversity in the life of all the organisms including humans is enormous.

- Loss of biodiversity contributes to climatic change.
- Forest converts carbon dioxide into carbon and oxygen. Loss of forest covers due to release of carbon dioxide and other gases due to industrialization, contributes to 'Green House Effect'. This leads to Global warming which results in raise in sea-level submerging the low-lying areas in the world and causing atmospheric changes.
- Biological diversity is also essential for preserving ecological processes.
- Tribal communities who directly gather resources from the forest or fisher folk who catch fish in marine or freshwater ecosystems are directly or indirectly linked to the biological variety present in the biosphere.
- For agricultural communities, biodiversity is used to grow their crops to suit the environment.
- Urban communities generally use the greatest amount of goods and services, which are all indirectly drawn from natural ecosystems.
- Preservation of biological resources is essential for the well-being and long-term survival of mankind.

Biodiversity everyday around the globe is being lost and some species are being pushed towards extinction. Evolution also brought forth new life forms, replacing species that were lost. Today we are losing about 1500 species every two months.

Some of the major values of biodiversity are as follows:

1. Consumptive value 2. Productive Value 3.Social Value 4.Ethical Value 5.Aesthetic Value and 6.Option value.

### *4.3.1 Consumptive use*

The value of Nature's Products that are consumed directly such as firewoods , fodder and meat. In other words the products which are consumed directly without passing through the market .Consumptive use value seldom appear in National income accounts.

• A straight forward example is the direct utilization of timber, food, fuel wood and fodder by local communities.

• The biodiversity contained in the ecosystem provides forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products. They are well-known about the qualities and different uses of wood from different species of trees, and collect a large number of local fruits, roots and plant material that they use as food, construction material or medicines.

• Fisher folks are completely dependent on fish and know where and how to catch fish and other edible aquatic animals and plants.

### *4.3.2 Productive use*

These are the direct use values where the product is commercially sold in national and international market. Many industries are dependent upon these values. Example: Textile, leather, silk, paper and pulp industry etc. There is an international ban on trade of products from endangered species like tusks of elephants, wool from sheep, fur of many animals etc.

### *4.3.3 Social values*

Social value of Biodiversity in India is particularly important for its religious,spiritual and other cultural uses. Many plants and animals have ritual significance. The entire ecosystem is utilized for cultural and spiritual purposes.Some examples among auspicious flowers offered in temples are *Hibiscus* (Shoe flower) offered to the goddess Kali, *Datura* (Ummam) flowers to God Siva. A network of sacred groves is still in evidence in some parts of India.

### *4.3.4 Ethical values*

Ethical values are economic arguments that can be advanced to justify the protection of biological diversity. Ethical arguments assert that humans have a duty to protect species based on their intrinsic value, unrelated to human needs.

People do not have the right to destroy species and should take action to prevent their extinction.

### *4.3.5 Aesthetic value*

Regardless of our own material self-interest, we should treat nature respectfully. Enlightened self-interest, arguing that preserving biodiversity and developing our knowledge of it will make us better and happier people. Symbols from wild species such as the lion of Hinduism, the elephant of Buddhism and the vehicles of several deities are animals that have been venerated for thousands of year. The sacred Basil or the 'Tulsi' has grown in the courtyards of household for centuries.

### *4.3.6 Option values*

Keeping future possibilities open for their use is called the option value. It is impossible to predict which of our species or traditional varieties of crops and domestic animals will be greatest use in the future.

## 4.4 India as a Mega-Diversity Nation

India is very rich in the diversity of plants and animals, so it is called as mega diversity center.Mega means large, so mega diversity means a large number and wide range of species present in an ecosystem.

India recorded:

- 45,000 + species of wild plants
- 89,000 + species of wild animals
- 320 species of wild relatives of crops have been originated here.
- 1,39,000 species of plants, animals and microbes are recorded ϖ More than 4 lakh species are yet to be identified

## 4.5 Hot-Spots of Biodiversity

It is a biogeographic region with a significant reservoir of biodiversity, that is under threat from humans. Concept was first introduced by Norman Myer. Twenty five hotspots have been identified all over the world.

Important hot spots are

1 .Western Ghats and Sri Lanka

2. Eastern Himalaya

3. Mediterranean basin

4. Indo-Burma

5. Horn of Africa

6. Madagacsar and Indian Ocean islands
7. Sundaland
8. Forests of Australia
9. Caucasus
10. Mesoamerica

Two out of ten hot spots are located in India ( Western Ghats and hilly regions of north east Himalaya).

## 4.6. Threats to Biodiversity

### *4.6.1. Habitat loss*

Habitat loss can be described when an animal loses their home. Every animal in the animal kingdom has a niche (a comfortable or suitable position).

Reasons of habitat loss caused by humans:

- Agriculture and farming
- Harvesting natural resources for personal use
- For industrial and urbanization development

Habitat destruction is currently ranked as the primary causes of species extinction worldwide.Example: The impact upon China's panda, once found across the nation. It is now only found in fragmented and isolated regions in the south west of the country as a result of wide spread deforestation in the 20th century.

Natural causes of habitat are volcanic eruption,, fire and climatic changes.

Solutions for habitat loss are:

- Protecting the remaining sections of natural habitats.
- Reduce human population and expansion of urbanization and industries.
- Educating the public about the importance of natural habitat and bio diversity.

### *4.6.2 Poaching of wildlife*

Poaching is the hunting and harvesting, taking of wild plants or animals. It is for large profits gained by the illegal sale or trade of animal parts, and meat. Many cultures believe that certain animal parts have medicinal value. Poaching or illegal hunting endangers animals. If more animals becomes extinct there's a disruption in the food chain, and that will cause major problems in our ecosystem, resulting eventually in new adaptations of animals, and or species beyond human control.

### *4.6.3 Man-wildlife conflicts*

Any conflict that arises where the behavior of one (human or wildlife) is unacceptably disadvantageous to other.Increase in man wildlife conflict is due to resource limitations such asfood, shelter and space. It is also due to increasing population of human beings, loss of forest, and decrease in the quality of forest and development activities.

### 4.7 Endangered and Endemic Species of India

The **endangered species** are those living organisms which are almost on the critical level of being extinct. Thousands of species of plants and animals are endangered and the number increases each year. World Wildlife Federation (WWF) published a book containing the details of endangered and threatened species of Flora and Fauna called as RED DATA BOOK or RED LIST BOOK. The RED DATA BOOK symbolizes a warning signal for those species which are endangered and have to be protected. Otherwise they are likely to become extinct in the near future. Some examples for animals are red panda, Red fox, Python and Golden monkey. Plants like *Cycasrevoluta, Rauwolfiaserpentina, Nepenthes* etc.

An **Endemic Species** is one that is only found in that region and nowhere else in the world. As such they are of conservation concern, because they are not widespread and may be confined to only one or two protected areas. Some examples for endemic species of plants in India are:

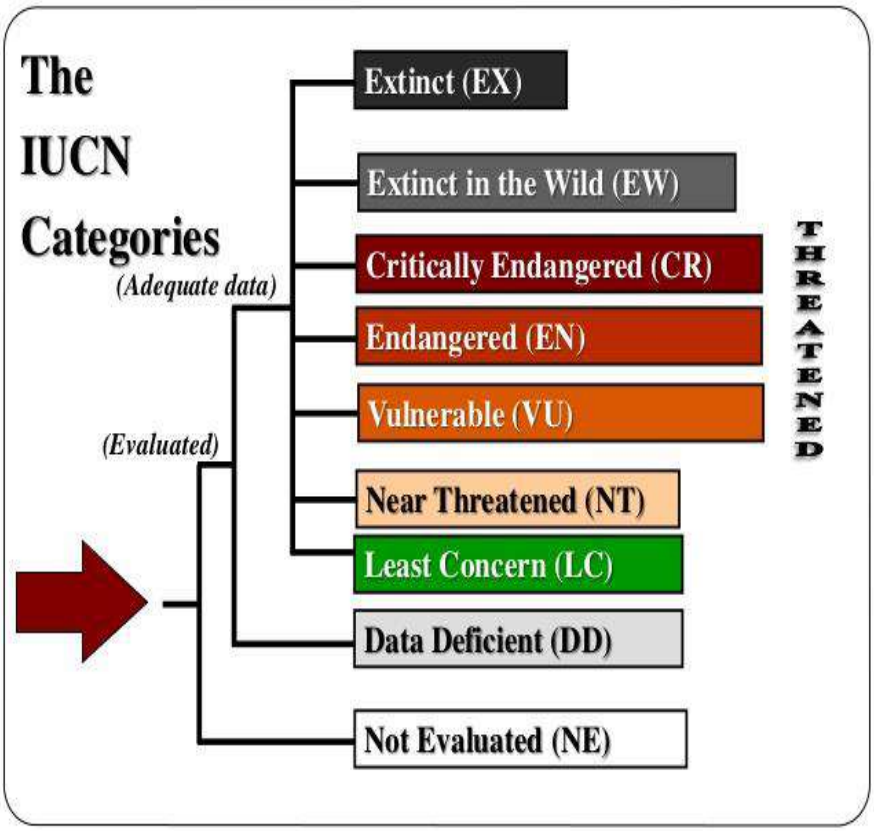
| ***Binomial of the plant*** | **Common name** | **Place** |
|---|---|---|
| *Polygala irregularis* | Milkwort | Gujarat (rare) |
| *Lotus corniculatus* | Bird's foot | Gujarat (rare) |
| *Amentotaxus assamica* | Assam catkin yew | Arunachal Pradesh (threatened) |
| *Psilotum nudum* | Moa, skeleton, fork fern, and whisk fern | Karnataka (rare) |
| *Diospyros celibica* | Ebony tree | Karnataka (threatened) |
| *Actinodaphne lawsonii* | Malavirinji | Kerala (threatened) |
| *Acacia planifrons* | Umbrella tree, kudaivel (Tamil) | Tamil Nadu (rare) |

| | | |
|---|---|---|
| *Abutilon indicum* | Indian mallow | Tamil Nadu (rare) |

### *4.7.1 IUCN Threat Categories*

International Union for Conservation of Nature (IUCN)**,** is a network of environmental organization for the Protection of Nature. The IUCN maintains the IUCN Red List of Threatened Species, a comprehensive assessment of the current risk of extinction of thousands of plant and animal species.The main aims of IUCN are;

- To convey the urgency of conservation issues to the public and policy makers.
- To help the international community to try to reduce species extinction.
- To provide scientifically based information on the status of species and subspecies at a global level.
- To provide information to guide actions to conserve biological diversity.



### *4.7.2 Red Data Book*

The IUCN Red List of Threatened Species also known as the IUCN Red List or Red Data List. The **Red Data Book** is the state document established for documenting rare and endangered species of animals, plants and fungi as well as some local sub-species that exist within the territory of the state or country. It uses a set of criteria to evaluate the extinction risk of thousands of species and subspecies.

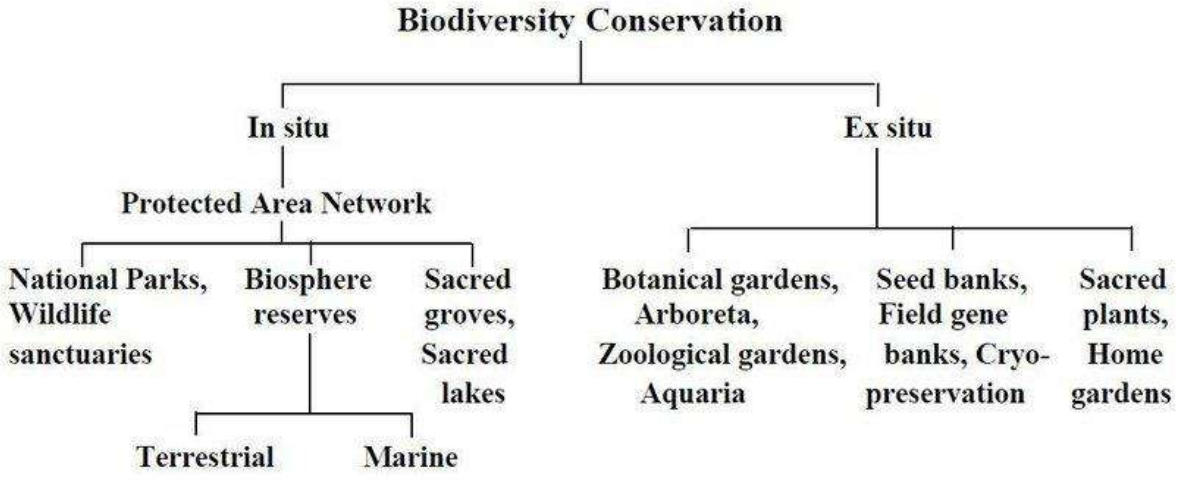
## 4.8. Conservation of Biodiversity

Conservation of biological diversity is essential for the survival of the human race.

**Objectives and advantages of biodiversity conservation**

- Conservation of biological diversity leads to conservation of essential ecological diversity to preserve the continuity of food chains.
- The genetic diversity of plants and animals is preserved.
- It ensures the sustainable utilisation of life support systems on earth.
- It provides a vast knowledge of potential use to the scientific community.
- A reservoir of wild animals and plants is preserved, thus enabling them to be introduced, if need be, in the surrounding areas.
- Biological diversity provides immediate benefits to the society such as recreation and tourism.
- Biodiversity conservation serves as an insurance policy for the future

### *4.8.1 Types of conservation*




**In situ conservation:** Faced with the conflict between development and conservation, many nations find it unrealistic and economically not feasible to conserve all their biological wealth. Invariably, the number

of species waiting to be saved from extinction far exceeds the conservation resources available. On a global basis, this problem has been addressed by eminent conservationists. They identified for maximum protection, certain 'biodiversity hotspots' regions with very high levels of species richness and high degree of endemism (that is, species confined to that region and not found anywhere else). Although all the biodiversity hotspots put together cover less than 2 percent of the earth's land area, the number of species they collectively harbour is extremely high and strict protection of these hotspots could reduce the ongoing mass extinctions by almost 30 per cent.

In India, ecologically unique and biodiversity-rich regions are legally protected as biosphere reserves, national parks and sanctuaries. India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries. India has also a history of religious and cultural traditions that emphasized protection of nature. In many cultures, tracts of forest were set aside, and all the trees and wildlife within were venerated and given total protection. Such sacred groves are found in Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh. In Meghalaya, the sacred groves are the last refuges for a large number of rare and threatened plants.

**Ex situ Conservation:**

In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care. Zoological parks, botanical gardens and wildlife safari parks serve this purpose. There are many animals that have become extinct in the wild but continue to be maintained in zoological parks. In recent years ex situ conservation has advanced beyond keeping threatened species in enclosures. Now gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques, eggs can be fertilised in vitro, and plants can be propagated using tissue culture methods. Seeds of different genetic strains of commercially important plants can be kept for long periods in seed banks. Biodiversity knows no political boundaries and its conservation is therefore a collective responsibility of all nations. The historic Convention on Biological Diversity ('The Earth Summit') held in Rio de Janeiro in 1992, called upon all nations to take appropriate measures for conservation of biodiversity and sustainable utilisation of its benefits. In a follow-up, the World Summit on Sustainable Development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local levels.

## QUESTIONS

### SECTION A (2 MARKS)

1. What do you mean by Hotspots?
2. Name the hotspot centers of India.
3. What are the reasons of habitat loss caused by humans?
4. Give the solutions for habitat loss.
5. What is poaching? How does it affect biodiversity?
6. Explain endangered species with two examples.
7. What is Red data book? Give its importance.
8. Describe endemic species. What is IUCN?
9. Name the in-situ conservation centers of India.
10. List the ex-situ conservation centers in India.

### SECTION B (5 Marks)

1. Enumerate the importance of Biodiversity.
2. What are the different biogeographic zones of India?
3. Write notes on species diversity of Himalayan zone.
4. Briefly describe “Trans Himalayan regions”.
5. Explain the biodiversity of Western Ghats.
6. Discuss the biodiversity of Gangetic plains.
7. Write notes on species diversity of “Islands”.
8. Enumerate the biodiversity of “Coast”.
9. What are the consumptive use values of biodiversity?
10. Describe productive values of biodiversity.
11. State the social values of biodiversity.
12. List out the ethical values of biodiversity.
13. What are the aesthetic values of biodiversity?
14. List out different hotspots of biodiversity centers in India.
15. How habitat loss affect biodiversity. Give example.
16. What is IUCN? Give its objectives.

## SECTION C (15 Marks)

1. Write an essay on Biogeographic classification of India and explain “Biodiversity at Global, National and local levels”.
2. Enumerate major values of biodiversity. Explain with examples.
3. What are the threats to biodiversity. Write short notes on endemic species of India? Explain its significance
4. Discuss biodiversity conservation. Describe Ex-situ conservation and In-situ conservation in detail.
5. Describe different types of biodiversity conservation with examples.

# CHAPTER 5

# ENVIRONMENTAL POLLUTION

## 5.1. INTRODUCTION

The air we breathe, the water we drink and the place we live in may be polluted with unwanted toxic substances. The tremendous increase in industrial activity during the last few decades and the release of toxic industrial wastes into the environment, have been of considerable concern in the recent years from the point of view of environmental pollution.

It is well known that the outcome of the human activity in the last 200 years on nature (after the industrial revolution) is very damaging and disrupts natural phenomena and ecological balance. Many incidents and issues like the death of thousands of people in Minamata in Japan after eating fish from the local Bay (mercury poisoning), Itai-Itai' disease (due to cadmium pollution), Bhopal gas tragedy(due to poisonous gas, MIC), London smog in 1952, the emergence of new ocean currents like El-Nino, Global warming, Depletion in Ozone umbrella, the nuclear accidents of Three mile island, Chernobyl and recently in Fukushima, Japan have forced mankind to have a second look on the impact of industries on nature. Thus, environmental pollution on one hand and deforestation and population explosion on the other, are threatening the very existence of life on earth. Hence to stimulate awareness of the environment and to enhance political attention and public action United Nations General Assembly in 1972 established ***June 5$^{th}$ as World Environment Day***.

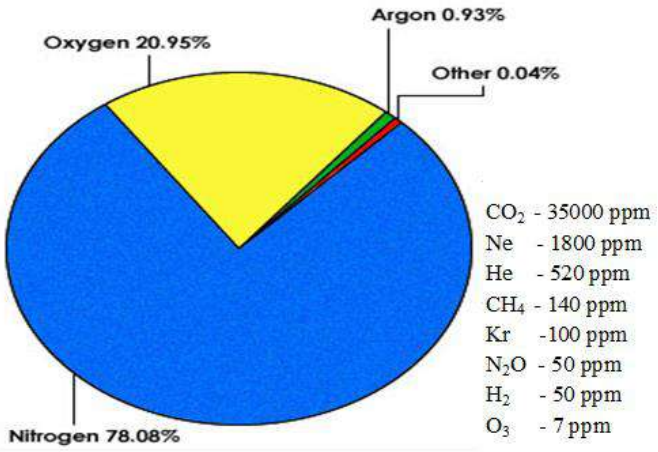
**Pollutants and Contaminants**

The term pollution was derived from the Latin word 'pollotioneum' which means to make dirty. A substance present in the environment in greater proportion than its natural abundance and resulting in harmful or detrimental effect is called a ***pollutant*** and this phenomenon is called ***pollution***. For example, carbon monoxide, sulphur dioxide, ozone and nitrogen oxide are present in air, but if their percentage increases because of human activities, they are likely to cause pollution. In addition to this, there are certain substances which are not present in the environment, but the release of which as a result of chemical reactions can lead to pollution. They are called as ***contaminant.*** Examples: oil spills in sea, methyl isocyanate (MIC) –the gas responsible for Bhopal gas tragedy.

The major forms of environmental pollutions, their cause, effects and control measures are discussed below:

## 5.2. AIR POLLUTION

The atmosphere is a gaseous envelope held to earth by gravity. It extends from earth's surface to about 1000 km. The composition of the air varies from place to place. The composition is Nitrogen 78%, Oxygen 21%, Argon less than 1%, and others include carbon dioxide, water vapour, ozone, helium, methane etc in trace amount.




***Composition of air***

The main layers of atmosphere from the surface of earth upwards are troposphere, stratosphere, mesosphere and thermosphere. As far as atmospheric pollution is concerned, only troposphere and stratosphere are important. Troposphere extends to a height of about 10 km from the sea level. It contains air, water vapour, clouds etc. The pollution in this region is caused by poisonous gases, fumes and smog. Examples include photochemical smog, acid rain*, global warming and green house effect*.

Stratosphere, which is the seat of ozone is above troposphere. It extends from the height of 10 to 50 km above the sea level. It is the ozone layer at stratosphere that acts as the protective blanket of the earth from the injurious effects of the ultraviolet rays from the sun. Ozone layer depletion* is the pollution that affects the stratosphere.

[ *refer section 5.5.2, 5.5.3 and 5.5.4 for more details]

The World Health Organization defines air pollution as ***"the presence of materials in the air in such concentration which are harmful to man and his environment."***Or ***it is the occurrence or addition of foreign particles, gases and other pollutants into the air which have an adverse effect on human beings, animals, vegetation, buildings, etc.***

Pollutants are classified into primary and secondary pollutants. ***Primary pollutants***: they are emitted into the atmosphere directly from the source and retains the same chemical form. Examples are carbon monoxide, sulphur oxides, nitrogen oxides, hydrocarbons, suspended particulate matter(SPM).***Secondary pollutants****:* they are formed by the inter mingling and reactions of primary pollutants. Examples are photochemical smog, acid rain, PAN etc.

The sources of air pollution are classified into two groups: Natural and Man- made sources. Natural process of air pollution includes dust storms, forest fires, ash from volcanoes, decay of organic matter, pollen grains floating in air etc. Manmade sources include population explosion, deforestation, urbanization and industrialization.

### 5.2.1. Causes of Air Pollution

Important causes of air pollution include:

- Pollutants emitting from vehicles, carbon monoxide formed by improper or incomplete combustion which are emitted from vehicles is a major pollutant.
- Pollutants from industries, like sulphur dioxide, oxides of carbon, nitrogen oxide, chlorine, asbestos dust, hydrocarbons and chemicals deplete the quality of air.
- Use of fertilizers and pesticides in agriculture.
- Particulate matter from mining activities.
- Household cleaning products, carpets, paints emit toxic chemicals into the air and cause indoor air pollution.
- Suspended particulate matter (SPM) produced due to burning of coal.
- Nuclear power plants pollute air by releasing radioactive radiation.
- Indiscriminate cutting of trees and clearing of forests increases the amount of carbon dioxide in the atmosphere.
- Acid deposition due to acid rain may lead to damaged trees, soils and aquatic life.
- Use of chlorofluorocarbons in refrigeration, fire extinguishers and aerosol sprayers pollute air by depleting the ozone layer.
- Smoking pollutes air by emitting carbon monoxide and nicotine.

### 5.2.2. Effects of Air Pollution

Important effects of air pollution include:

- It affects respiratory system causing breathing difficulties and diseases such as bronchitis, asthma, lung cancer, tuberculosis and pneumonia.

- Inhaling carbon monoxide results in respiratory problems, muscular weakness, mental impairment, and dizziness in human beings. At high concentration, it will harmfully affect the plants causing leaf drop, reduction in leaf size, and premature aging.
- Carbon dioxide causes mild narcotic effects and affects respiratory systems. Increased concentration in the atmosphere causes green house effect and global warming.
- Air pollution causes acid rain which damages crop plants, trees, buildings, monuments, statues and metal structures. It also makes the soil acidic.
- Ozone layer depletion due to which ultraviolet radiations can reach the earth and cause skin cancer, damage to eyes and immune system.
- Excess nitrogen oxides in the atmosphere results in respiratory problems and bronchitis. It also causes harmful effects on nylon, rayon and causes cracks in rubber.
- Excess sulphur oxides are extremely harmful to plants and animals. It causes eye irritation, respiratory problems, lung cancer etc. In plants, it kills leaf tissues, reduces plant productivity, and bleaches leaf pigments.
- Pesticides like DDT which are toxic, enter into our food chain and gets accumulated in the body causing kidney disorders, problems of brain and circulatory system.
- Excess pollen and microbes in the atmosphere directly damage the vegetation, food articles and cause diseases in plants, animals and human beings.

### 5.2.3. Control Measures of Air Pollution

The atmosphere has several built-in self-cleaning processes such as dispersion, gravitational settling, flocculation, absorption, rain-washout, etc to cleanse the atmosphere. However, control of contaminants at their source level is a desirable and more effective method.

- Use of public transportation facilities and using unleaded petrol or using fuels with low sulphur and ash content.
- Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons.
- Planting trees along busy streets remove particulates, carbon dioxide and absorb noise.
- Renewable and non- polluting sources of energy like solar energy, wind energy etc. should be used.
- Automobiles should be properly maintained and adhere to emission control standards.

- Industries and waste disposal sites should be situated outside the city preferably on the downwind of the city. It should also be fitted with equipment for removal and recycling of wastes.
- Emission rates should be restricted to permissible levels by industries.
- Tall chimneys should be installed in factories.
- Better designed equipment and smokeless fuels should be used in houses and industries.
- Large amount of fossil fuels are burnt to produce electricity. So conserve energy by switching off fans and lights when not in use.
- Understand the concept Reduce, Reuse and Recycle.
- Use energy efficient devices like LEDs, CFL lights etc.
- Growing plants capable of fixing carbon monoxide. Example: Phaseolus vulgaris, Daucus carota
- Growing plants capable of metabolizing nitrogen oxides and other gaseous pollutants. Example: Vitis, Pimis, Pyrus etc.

## 5.3. WATER POLLUTION

Water is undoubtedly the most precious natural resource that exists on our planet. It is essential for the survival of any form of life. Water pollution is a major global problem, both in developed and developing countries, as more and more wastes are being disposed in oceans, rivers and lakes. This increase in pollution is harming our food supplies, drinking water and environment. Water pollution is defined as the ***"the alteration in physical, chemical and biological characteristics of water which may cause harmful effects on humans and aquatic life".***

***Point and non-point sources:***

Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds. ***Point source pollution*** refers to contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant to rivers, lakes etc. ***Non-point source pollution (NPS)*** refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. Run-off and under-drainage from agricultural land into rivers are typical examples.

### 5.3.1. Causes of Water Pollution

Important causes of water pollution include:

- *Sewage and waste water:* Raw sewage contaminates water with pathogens. Microorganisms causing degradation of sewage take up most of the oxygen present in water. Untreated sewage water is a major problem in developing countries with insufficient sanitation.
- *Industrial waste*: Many industrial plants use fresh water to dispose their waste, polluting rivers, lakes, and oceans. Toxic chemicals, acids, alkalis, metallic salts, phenols, cyanides are released into water bodies. They also cause thermal pollution of water.
- *Organic contaminants:* They include detergents, disinfection byproducts like chloroform, food processing wastes, insecticides, herbicides, petroleum products, industrial solvents, cosmetic products etc.
- *Inorganic contaminants:* They include industrial discharge, ammonia from food processing waste, fertilizers containing nutrients like nitrates and phosphates, heavy metals from motor vehicles, acid mine drainage, runoff from construction sites. The major inorganic pollutants in water are arsenic, cadmium, lead, chromium, cyanides, nitrates, phosphates etc.
- *Radioactive waste:* Produced during industrial, medical, and scientific processes, and through mining and refining of nuclear fuels like Uranium and Thorium. Nuclear processing plants give off wastes that can pollute the marine environment.
- *Oil Pollution:* Large oil spill events account for only 12% of total oil pollution. The remaining is through routine shipping, land run-off, and intentional oil dumping.
- *Eutrophication:* It occurs when ocean waters and other aquatic habitats are enriched with excess nutrients, such as phosphates and nitrogenous compounds caused by agricultural runoff. Excess nutrients cause algal blooms in the ocean, lakes and other freshwater bodies.
- *Run-off from many different sources (non-point source pollution):*Rainfall and snowmelt can wash natural and man-made pollutants into rivers, lakes, wetlands, and coastal waters.
- *Agricultural Run-off:* Agricultural pollutants include excessive nutrients, ammonia and nitrates, pathogens, antibiotics and hormones, heavy metals and salts. Manure, animal bedding, wasted feed, soil, dust, hair and feathers can be mixed together and can end up in waterways.

### 5.3.2. Effects of Water Pollution

Important effects of air pollution include:

- Organic pollutants like sewage, industrial waste, wastes from slaughtering units, paper mills and tanneries, run off from agricultural activity etc causes the depletion of oxygen. Low oxygen levels

cannot support most marine organisms and hence the natural ecological balance in rivers and lakes is disturbed.

- Groundwater contamination from pesticides causes reproductive damage within the wildlife in ecosystems. Most of the pesticides are non-biodegradable and persistent. They will remain in the water bodies for a fairly long time and results in environmental hazards. Pesticides, show biomagnification* by reaching the food chain. Organophosphorous pesticides cause Eutrophication*resulting in algal bloom and lowering of DO, thereby threatening aquatic life.
- Excess fluoride in water causes defects in teeth and bones called fluorosis, while arsenic can cause significant damage to the liver and nervous system.
- Oil spills in the water cause animals to die when they ingest or encounter it.
- Excess sediments in water cause cloudiness reducing photosynthetic ability, which disrupts the aquatic food chain.
- Drinking contaminated water causes health problems like cancer, reproductive problems, typhoid fever, stomach sickness and skin rashes in humans.
- Excess radioactive materials in water cause genetic mutations, birth defects and cancer.
- Excess of nitrates in drinking water produces ***Blue baby syndrome***, a disease that affects the oxygen carrying capacity of infant's blood, usually resulting from the consumption of high levels of nitrate.

### 5.3.3. Control Measures

- Setting up effluent treatment plants to treat waste water.
- Planting more trees will reduce the amount of sulphur dioxide and nitric oxide.
- Oxidation pond can be useful in removing low level radioactive wastes.
- Sewage pollutants are to be subjected to chemical treatment to convert them into non-toxic substances.
- Laws, standards and practices should be established to prevent water pollution and these laws should be modified from time to time based on current requirements and technological advancements.

- No type of waste (treated, partially treated or untreated) should be discharged into any natural water body. Industries should develop closed loop water supply schemes and domestic sewage must be used for irrigation.
- Industrial plants should be based on recycling operations as it helps prevent disposal of wastes into natural waters but also extraction of products from waste.
- Thermal pollution can be reduced by employing techniques like cooling ponds, wet/dry cooling towers etc.
- Water hyacinth (plant) can purify polluted water. It can also filter out heavy metals like cadmium, mercury, lead, nickel as well as other toxic substance from industrial waste.
- The government has undertaken several projects to clean the rivers, the first of which was the Ganga Action Plan.
- Increase public education and awareness around the world concerning the causes and impacts of water pollution.

**5.3.4. Eutrophication***

Eutrophication is the enrichment of an ecosystem with chemical nutrients, typically compounds containing nitrogen and phosphorous and other nutrients from detergents, fertilizers, sewage and agricultural runoff. Eutrophication can be a natural process in lakes, occurring as they age through geological time. The process of eutrophication can be both natural and human-induced.

Steps involved in Eutrophication include:

(i) Excess nutrients are applied to soil.
(ii) Some nutrients leach into the soil where they will remain for years or get drained into the water bed.
(iii) The excess nutrients result in algal bloom.
(iv) Algal bloom blocks the sunlight from reaching the bottom of the water body.
(v) Plants beneath the algal bloom die due to non-availability of sunlight.
(vi) Algal bloom dies and sinks to the bottom of lakes.
(vii) Bacteria decomposes the dead remains, using up the oxygen for respiration.
(viii) Due to decomposition water gets depleted with oxygen, larger life forms like fish suffocate to death.

(ix) Water body cannot support any forms of life.

Human activities can accelerate the rate at which these nutrients enter the ecosystem. Phosphorous is regarded as the main culprit of eutrophication. With the phasing out of phosphate-containing detergents in the 1970s, industrial/domestic run-off and agriculture have emerged as the dominant contributors to eutrophication.

**5.3.5. Biomagnification or bioaccumulation***

It is the process by which a pollutant or pesticide moves up the food chain, works their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances/toxins become concentrated in tissues or internal organs as they move up the chain. Each successive step up in the food chain causes a stepwise concentration of pollutants such as heavy metals like mercury or persistent organic pollutants like DDT. Bioaccumulants are usually accumulated and collected in certain part of living organisms so that their concentration increases because the substances are slowly metabolized or excreted.

Substances that biomagnify include DDT, hexachlorobenzene, polychlorinated biphenyles, monomethyl mercury and heavy metals. For example, DDT is stored up in the fatty tissues of breast so that the breast milk is contaminated by DDT. The shell fish collects and stores heavy metals like cadmium.

***Process of Biomagnification includes:***

(i) Release of toxic chemicals and pollutants into environment.

(ii) Absorption of toxins by phytoplankton (small plants that float on sea) – once absorbed, the toxin stays in their tissues without being excreted or broken down.

(iii) Consumption of phytoplankton by zoo plankton (small marine animals that float in sea) – hence they take up the toxin, which stay locked in the organism tissue without being excreted or broken down.

(iv) Small fish consume the zooplankton.

(v) Large fish consume the smaller fish.

(vi) The top food chain organism consumes the fish – these toxins get accumulated in the liver of sea birds, dolphins, humans etc.

### *Effects of Biomagnification*

(i) Impact on human health.

(ii) Reproduction and development of marine creatures.

(iii) Destruction of the coral reefs.

(iv) Disruption of the food chain.

### 5.3.6. Water Quality parameters

The parameters for water quality are determined by the intended use. The parameters that are important to drinking water are alkalinity, colour, pH, taste, odour, dissolved metals, microorganisms like fecal coliform, dissolved metals, dissolved organic compounds, heavy metals, pharmaceuticals etc. The water quality parameters important in environmental concerns are salinity, dissolved oxygen (DO), BOD (Biochemical Oxygen Demand), nitrate, orthophosphates, COD (Chemical oxygen demand), pesticides, pH, temperature, total suspended solids (TDS) and turbidity.

(i) **Dissolved Oxygen (DO)**

Dissolved oxygen is the amount of gaseous oxygen dissolved in an aqueous solution. DO enter water through the air or as a plant by-product. From air, oxygen can slowly diffuse across the water surface from the surrounding atmosphere.

Dissolved oxygen is essential for aquatic life. It is an important parameter in assessing the water quality because it influences both plant and animal population in water. It is expressed in parts per million (ppm) or mg/L. The optimum value of DO in water is 4-6 ppm. Low value of DO indicates water pollution. Pollutants like sewage, industrial waste, wastes from slaughtering units, paper mills and tanneries, run off from agricultural activity etc reduces DO. All these materials undergo bacterial activity in the presence of DO, converting the carbon in the waste to carbon dioxide, thus deoxygenating the water. Aquatic life is made impossible in water with low DO. Dissolved oxygen should be analyzed immediately after collecting the sample. Hence, this is a field test that should be performed on site.

Consequence of unusual DO level include fish mortality, fish kill, gas bubble disease (bubbles block the flow of blood through blood vessels causing death), creation of dead zone (it is an area of water with little or no dissolved oxygen), water column stratification (which is the separation of water body into layers) etc.

### (i) Biological Oxygen demand [BOD] and Chemical Oxygen Demand [COD]

| No | Biological Oxygen demand [BOD] | Chemical Oxygen Demand [COD] |
|---|---|---|
| 1 | It is an important parameter used in estimating the degree of organic pollution in wastewater | It is an important parameter used in estimating the degree of organic pollution in wastewater |
| 2 | BOD is milligram of oxygen used by microorganism to decompose the organic material in one liter of waste water | COD is an index of inorganic and organic content of water. It is the amount of oxygen required to degenerate all pollution in a chemical way (by adding oxidizing agents and heating). |
| 3 | It measures the dissolved oxygen consumed by organisms to oxidize organic compounds | It measures all organic compounds that can be chemically oxidized. |
| 4 | BOD will be lower than COD | COD will be higher than BOD |
| 5 | BOD is only a measurement of consumed oxygen by aquatic microorganisms to decompose or oxidize organic | COD refers the requirement of dissolved oxygen for both the oxidation of organic and inorganic constituents |
| 6 | BOD measurements take five days to complete | COD measurements can be made in a few hours |
| 7 | Less reproducible results | COD is more scientific, more reproducible and accurate |
| 8 | Increased BOD can be due to domestic sewage, petroleum residues and organic wastes etc | Increased COD can be due to industrial waste |
| 9 | The determination of BOD is time consuming and depends on biochemical factors | Determination of COD is precise, saves time and is completely chemical in nature |

**5.3.7. Quality of Drinking Water**

The following parameters must be followed before water is supplied for drinking

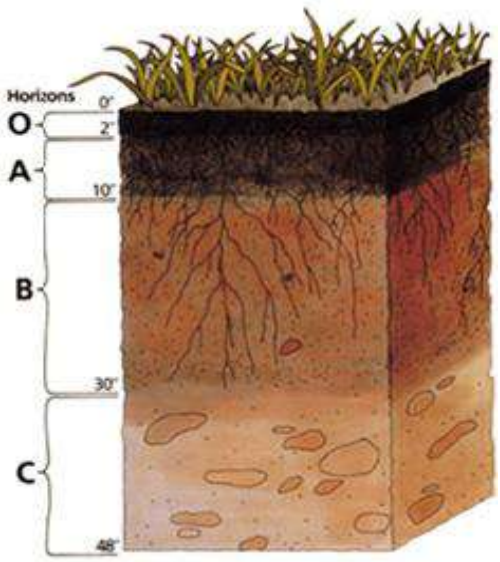
- It must be colourless and free from any odour or smell.
- It must be free from suspended particles and turbidity.
- It must be free from microorganisms.
- Its pH must be between 6 to 9.
- It may have harmless dissolved salt to impart good taste.
- It must be free from harmful chemicals.

## 5.4. SOIL POLLUTION

Soil is a very important constituent of the lithosphere. It is a complex physio-biological system containing water, mineral salts, nutrients and dissolved oxygen. It is a resource for which there is no substitute. Fertilizers are not a substitute for a fertile soil. Several factors contribute for the formation of soil like weathering of rocks due to temperature changes, abrasion, wind, moving water, glaciers, etc. Climate and time are also important in the development of soil. Soil is a natural body consisting of layers of various thicknesses called **soil horizon**. Depending upon the type of soil there are different horizons like O, A, B and C.

The top layer or surface layer is called O horizon. It consists mostly of dead leaves, twigs, animal waste, fungi and other organic wastes. Normally it is brown or black in colour. Below the O layer is A horizon, also called surface soil. This layer has maximum fertility because it contains microbes and microorganisms. Below A horizon is B, also called subsoil which contains less organic materials and fewer organisms than surface soil. The parent rock is called C horizon which is below B. It contains inorganic materials and large unbroken rocks.

***Soil pollution is defined as the presence of toxic chemicals (pollutants or contaminants) in soil, in high enough concentrations to pose risk to human health and ecosystem***. Soil pollution is the adverse alternation in the properties of the soil due to dumping of solid and semi-solid waste from agriculture, industry and urban areas. It also results because of washing down of pollutants by rain and faulty sanitation in the soil. However, soil pollution is different from air and water pollution in following respects




- Soil pollutants do not get dispersed unlike air and water pollutants.
- The pollution is localized unlike air and water pollution.
- The pollutants remain at a particular place for relatively longer period.

### 5.4.1. Causes of Soil Pollution

Important causes of soil pollution include:

- Agrochemicals: Agricultural activities involving the diffusion of herbicides, pesticides, insecticides and fertilizers.

- Industrial wastes: Industrial activity has been the biggest contributor to the soil pollution in the last century due to increased mining and manufacturing units. It also includes the release of harmful gases and chemicals.
- Petroleum wastes: Contamination of soil by petroleum products is a current problem in several countries in the world. Oil leakage during transportation and storage of petroleum liquids in underground tanks are the main cause.
- Electronic wastes or E-waste: it is a complex, non-biodegradable waste which is generally dumped in soil. They have large quantities of lead, cadmium, arsenic etc. Electronic waste include cell phones, computers, gadgets, printers, radio, camera, video games, scanners, DVDs, Land phones etc.
- Unfavorable and harmful irrigation practices.
- Indiscriminate dumping of untreated domestic waste on land .
- Improper septic system, leakages from sanitary sewage, underground tanks and underground pipe lines.
- Accidental oil spills which can happen during storage and transport of chemicals.
- Construction and mining activities.
- The storage of waste in landfills, as the waste products may leak into groundwater or generate polluted vapors.
- Radioactive waste from laboratories, nuclear reactors and nuclear explosions.
- Soil erosion results in the loss of topsoil and makes the soil less fertile and reduces it water holding capacity.

**5.4.2. Effects of Soil Pollution**

Some of the serious problems caused by soil pollution are:

- Reduction in soil fertility.
- Soil pollution has major consequences on human health. Consumption of crops and plants grown on polluted soil cause health hazards. This could explain small and terminal illness.
- Imbalance in the flora and fauna of the soil.
- Excess use of chemical fertilizers may result in reducing the ability of plants to fix nitrogen.

- Increase in salinity of the soil makes it unfit for cultivation.
- Pollutants in soil cause alteration in soil structure, causing death of many soil organisms which can affect the food chain.
- Decline in the microorganisms found in the soil creating additional problems of soil erosion.
- Emissions of toxic gases and foul odour from the landfills pollute the environment and causes serious health effects.
- Contamination of underground and surface drinking water.

### 5.4.3. Control Measures

- Reducing the use of chemicals and fertilizer and encouraging the use of biopesticides in the place of toxic chemical pesticides.
- Recycling and Reuse of wastes: To minimize soil pollution, wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc should be recycled and reused.
- Prevention of erosion and silting.
- Create dumping ground away from residential area.
- Launching extensive afforestation and community forestry programmes
- Proper treatment of liquid wastes from industries and mines.
- People should be trained regarding proper sanitary practices.
- Effective treatment of domestic sewage by suitable biological, chemical and adopting modern method of sludge disposal.
- Public awareness programmes should be implemented to educate people on health hazards due to soil pollution.
- Ban should be imposed on chemicals and pesticides which are fatal to plants and animals.
- Nuclear explosions and improper disposal of radioactive wastes should be banned.
- Bioremediation: It uses microorganisms (yeast, fungi or bacteria) to breakdown, or degrades hazardous substances into less toxic or nontoxic substances (such as $CO_2$ and $H_2O$).
- Waste water from industries should not be used for irrigation without eliminating toxic chemicals from the effluent. This will also reduce the concentration of unwanted substances in the soil.

- Enforcing environmental audit for industries and promoting ecolabelled products.
- Municipal waste should be properly collected, segregated, treated and disposed scientifically in land fills.

## 5.5. MARINE POLLUTION

Seas are the unlimited source of water and main source of food and sustenance for persons living in coastal areas. When the marine water is polluted, it affects the animals and other food chain components. ***Marine pollution can be defined as the introduction of substance to marine environment directly or indirectly by man resulting in adverse effects such as hazards to human health, obstruction to marine activities, and lowering the quality of sea water***.

### 5.5.1. Causes of Marine Pollution

While the cause of marine pollution may be similar to that of water pollution, there are some very specific causes that pollutes marine water.

- Toxic chemicals like chemical run-off from industries, industrial wastes, household cleaners, nuclear power stations etc.
- Rivers carry waste in the drainage and joins sea/ocean. The drainage includes sewage effluents, sludge, industrial effluents, agrochemicals, plastics, metal scraps etc.
- Petroleum and oil washed off from roads normally enter sewage system and finally into the seas.
- Oil spillage is usually an accidental form of releasing oils by ships, which can devastate marine life.
- Testing of atomic weapons, space aircrafts, missiles and other radioactive wastes when dumped in seas, cause heavy loss to aquatic life.
- Oil drilling in seas, tourism activities and heat released from industries.
- Plastic bags, aluminium cans, trash and other human waste constitute major marine pollutant.
- Greenhouse gases from human fossil fuel consumption are making sea more acidic.

### 5.5.2. Effects of Marine Pollution

Important effects of marine pollution include:

- Oil is the most dangerous pollutant when afloat on sea or mixed with water, a great threat to marine life specially fish, birds, invertebrates and algae. Oil also affects sensitive flora, fauna, phytoplankton, zoo plankton, and other animals.

- Oil slicks damage salt marshes and mangrove ecosystem and liquid oil contaminates birds' plumage and its water repellant properties diminishes.
- Presence of sewage and other bio-matter in sea will result in oxygen depletion, which destroys marine life.
- Toxic chemicals make the sea/ocean more acidic which harms marine animals, plants and corals.
- Plastic materials are dumped into seas by commercial ships or from drainage. Animals take it through their food in stomach which may cause ulcer or reduced hunger.
- Heavy metals like mercury, lead, factory materials, mineral oils, are also hazard to marine life when mixed with sea water.
- Presence of detergents is responsible for the high mortality of marine animals.
- Marine pollution affects the food chain in seas. Serious diseases like cancer are caused when affected animals are consumed by man from ocean.

### 5.5.3. Control Measures

- Recycling the plastics and proper disposal is our key responsibility to reduce marine pollution.
- Authorities should take effective measures to check oil leakage from ships and tankers.
- Urban and coastline corporations should check the dumping of wastes from human activities and municipalities.
- Introduction of sewage treatment plants to reduce BOD of the final product before discharging into sea.
- Port authorities should take anti-pollutant measures to reduce pollution.
- Cleaning oil from surface water and beaches can be done by spraying chemical dispersants, suction device or by spreading high density powder over oil spill.
- Developmental activities in coastal areas should be minimized.
- Nuclear explosion and nuclear activities in sea should be minimized.
- Drilling should not be allowed in coastal areas.

## 5.6. NOISE POLLUTION

Sound that is unwanted, unpleasant or that disrupts the activity of living beings is called noise. When there is lots of noise in the environment, it is called noise pollution. The word noise comes from the Latin word nauseas, meaning seasickness. ***The unwanted, unpleasant sound which causes irritation to ears and pollution caused by heavy noise is called noise pollution.***

The unit of sound intensity is Decibel (dB), which is the standard for the measurement of noise. It is not an absolute physical unit, but it is a ratio expressed as logarithmic scale relative to a reference sound pressure level. People are generally exposed to noise levels ranging from 65 to 80 dB which is the tolerable noise level forthe human ear. Exposure to noise level greater than 80 dB leads to stress and is referred as noise pollution. The sensitivity of the ear is lost if the sound intensity exceeds 150 dB level.

### 5.6.1. Cause of Noise Pollution

There are several sources of noise that contribute to both indoor and outdoor noise pollution.

- Industries/ Factories
- Poor urban planning
- Construction activities
- Household chores
- Transportation/ vehicles
- Playing of loud speakers during festivals/ social events
- Fire crackers
- Microphones
- Television
- Loud music
- Home appliances
- Barking dogs
- Service sirens

### 5.6.2. Effects of Noise Pollution

The most direct harmful effect of excessive noise is the physical damage to our ears causing temporary or permanent hearing loss. People suffering from this condition will be unable to detect weak sounds. 125 dB give the sensation of pain in the ear and 150 dB might kill a human being. The various effects of noise pollution in human beings can be classified as auditory and non-auditory effects.

*1. Auditory effects:*

The impairment of hearing which may cause immediate auditory fatigue finally leading to deafness is known as auditory effects.

*2. Non-auditory effects:*

These effects include interference with speech communication, ill-temper, mental disorientation, violent behaviour and a series of health hazards.

In addition to hearing loss, the effect of noise on human being can be physiological or psychological in nature.

The physiological disorders include progressive hearing loss, nausea, dizziness, hypertension, reduced heart beat, variations in blood pressure and breathing problems. The continuous noise can generate resonance in the skull and affect the brain and nervous system. It can have an impact on thinking and coordination of limbs and induce pain and numbness. Moderate noise/ vibration can lead to pain, numbness and cyanosis (blue coloration in fingers). Severe vibrations results in damage to bone, joints with swelling and stiffness. Exposure to low frequency noise can reduce heart beat, variation in blood pressure and breathing difficulties.

It is difficult to assess psychological noise effects on human beings. The psychological effects include sleep disturbances, physical and mental fatigue, lower efficiency, reduced work rate, increased absenteeism, forgetfulness, higher potential for accidents and injuries. Children exposed to excess noise show signs of behavioral disorder in later age. Recent reports suggest that blood is thickened by excessive noise.

The effect on living beings can be summarized as:

- Health issues – Effect psychological health, aggressive behaviour, stress, fatigue, hypertension, work efficiency and behaviour etc.
- Pediatric problems – hearing problems associated with children.
- Gynecological problems – pregnant women are vulnerable to high noise levels.
- Heart problems – hypertension and cardiovascular problems.
- Hearing problems – auditory fatigue caused by noise levels above 80 dB.
- Sleep disorders – exposure to noise reduces duration of sleep, diminish quality of sleep, Psychic disorders.
- Wild life issues - noise bring about changes in the behavioral aptitude of birds and animals. They become inefficient in hunting and hence disturb the balance of ecosystem. For example, noise pollution discourages the annual visit of migratory birds to Alipore Zoo at Kolkata.

### 5.6.3. Control Measures

Noise produced from different sources has created a catastrophe. Hence necessary steps should be taken to minimize the level of noise and protect the living world from detrimental effects.

- Create public awareness.

- Antipollution laws should be enacted and enforced.
- Planting coniferous trees (they have pointed leaves which reflect minimum sound).
- Regular servicing and tuning of automobiles.
- Reduction of traffic density in residential areas and giving preference to public transport system.
- Preference to petrol engines over diesel engines.
- The use of microphones should be controlled and regulated.
- Ban on fire crackers.
- Proper lubrication and sound proofing of machineries.
- Minimum use of loudspeakers.
- Creation of green vegetation covers in highway, streets and industrial areas.
- Usage of ear plugs and mufflers.
- Buildings can be designed with noise absorbing materials on walls, windows and ceilings.

## 5.7. THERMAL POLLUTION

***It is defined as the sudden increase or decrease in temperature of a natural body of water like oceans, lakes, rivers or ponds by human influence. It can also be defined as the degradation of water quality by any process that changes ambient temperature of water.*** Many industries generate their own power and use water to cool their generators. This hot water is released into the system from where it was drawn, causing a warming trend of surface water. It creates a disturbance in the oxygen level of water bodies. This will disturb the marine life and local ecosystems.

### 5.7.1. Causes of Thermal Pollution

Important causes of thermal pollution include:

1. *Nuclear power plants:* They emit a large amount of unutilized heat and traces of toxic radio nucleotides into nearby water streams. Emission from nuclear reactors and processing instruments are also responsible for increasing the temperature of water bodies.
2. Industries: Industries generating electricity require large amount of cooling water for heat removal. Industries like textile, paper-pulp and sugar industry also release heat in water, but to a lesser extent.

3. *Coal- fired power plants:* Some thermal power plants use coal as fuel. Coal- fired power plants constitute one of the major sources. Their condenser coils are cooled with water from nearby lakes or rivers and discharges hot water.
4. *Hydroelectric power plant:* The generation of hydroelectric power may result in the release of warm water into water bodies.
5. *Domestic sewage:* It is often discharged into rivers, lakes, canals or streams without waste treatment. The municipal water sewage normally has a higher temperature than receiving water.
6. *Deforestation and soil erosion:* Removal of trees along the shore line increases solar incidence
7. *Natural and Geothermal activities:* Natural geothermal activities like volcano can stimulate lava and can cause a rise in water temperature, leadingto thermal pollution
8. *Chemical pollutants discharged into water:* There are factories that discharge their chemical waste directly into natural water bodies.

### 5.7.2. Effects of Thermal Pollution

Important effects of thermal pollution include:

- The concentration of dissolved oxygen decreases with increase in temperature.
- The increase in temperature increases toxicity of poison (pesticides, detergents, chemicals) present in water.
- A rise in temperature changes the physical and chemical properties of water.
- The physiology, metabolism and biochemical process of aquatic organisms are affected with increase in temperature.
- It influences the reproductive cycle, digestion rate, respiration rate and many enzymatic activities of living organisms.
- Economic and environmental damage.
- Thermal pollution may permit the invasion of organisms that are tolerant in warm waters and are highly destructive in nature.
- The egg of fish may hatch early or fail to hatch at all.
- Thermal pollution results in low dissolved oxygen levels thereby perishing aquatic organisms.

### 5.7.3. Control of Thermal Pollution

Heat must be removed from the condenser cooling water prior to their disposal into water bodies

- *Cooling ponds:* This is the simplest and cheapest method which cools water to a considerably low temperature. Heated effluents on the surface of water in cooling ponds maximize dissipation of heat to the atmosphere and minimize the water area and volume.
- *Spray ponds:* In spray ponds, the water is sprayed in the cooling ponds with the help of spray nozzles to convert it into fine droplets which provide more surface area to facilitate efficient heat transfer to atmosphere.
- *Artificial lakes:* Artificial lakes are manmade water bodies that offer once-through cooling. The heated effluents can be discharged into the lake at one end and water for cooling purposes may be withdrawn from the other end. The heat is eventually dissipated through evaporation.
- *Plantation of trees* upon the banks of rivers, seas and other water bodies: Trees not only help in controlling thermal pollution but also aid in a better environment
- *Recycling used water:*New ideas to be developed on recycling the used water in factories. Every plant or industry should make it a rule that water used as coolant will not be spilled back into water bodies.
- *Co-generation:* Co-generation is also a wonderful idea to combat thermal pollution. In the process of co-generation, the useless heat from hot water can be recycled and used smartly in many tasks by industries.

### 5.8. NUCLEAR HAZARDS

**Nuclear pollution is the pollution that contains radioactive materials**. **It can spread in air, land or water.** It is created by the mishandling and inappropriate storage of nuclear fuels, contaminated tools, insecure transportation of highly radioactive materials, nuclear explosions etc. It is the only type of pollution which *"we can't see, we can't smell and we can't touch"*. The effect of which may not show up in this decade, this generation or in this century. However, the nuclear impacts on us are far beyond our imagination.

Nuclear energy is both beneficial and harmful depending on the way in which it is used. We use the science of radioactivity in the treatment of cancer, diagnosis of diseases, electricity generation, industrial, commercial, food processing and agriculture applications. Approximately 17 % of electricity generated in the world comes from nuclear power plants. However, on the other hand, it is impossible to forget the hazards caused by the nuclear explosion at Hiroshima and Nagasaki (1945), Three Mile Island accident (1979), Chernobyl disaster (1986), Tokaimura nuclear accident(1999), Fukushima Daiichi nuclear disaster(2010).

The two main sources of nuclear pollution are natural and manmade. Natural sources include cosmic rays from outer space, emission from radioactive materials from earth's crust. Manmade sources include nuclear waste produced during mining and processing from nuclear power plants, nuclear weapon, use of radioisotopes in medical, industrial and research applications.

### 5.8.1. Causes of Nuclear Pollution

Important causes of nuclear pollution include:

- Nuclear waste comes from nuclear power stations. They release tritium (an isotope of hydrogen) into air and water. Tritium has a half-life of 12.3 years and emits beta particles. Inhalation of tritium can cause mutation.
- Cosmic rays from outer space.
- Mining and refining of radioactive materials like uranium and thorium.
- Nuclear fuel cycle (used in many industrial, medical and scientific processes).
- The advent of nuclear medicines to cure and for precise diagnosis, with the help of radio isotopes.
- Use of various radioactive derivatives to produce nuclear weapons for mass destructions
- Use of radio isotopes in industrial activities and various detectors.
- Nuclear accidents or any leaks.
- Disposal of nuclear wastes.
- Nuclear tests carried out by defense sectors.
- Radioisotopes coming from scientific research institutions contains various radioactive materials which causes water pollution.
- Television set, radiographic equipment's.

***Fallout:*** The radioactive pollution that will spread through the earth's atmosphere is called fallout. The best example of fallout is the nuclear bomb attack at Hiroshima and Nagasaki, Japan in 1945 by US during World War II. As a result of these nuclear bomb explosion, more than two lakh people died owing to radiation effect and cancer.

### 5.8.2. Effects of Nuclear Pollution

Important effects of nuclear pollution include:

- The effects of radioactive pollutants depend upon half-life, energy releasing capacity, rate of diffusion and rate of deposition of the contaminant. Various atmospheric conditions and climatic conditions such as wind, temperature and rainfall also determine their effects.

- As long as the radiations continue, nuclear wastes are dangerous for living being. The effects may be somatic (individual exposed is affected) or genetic (future generation) damage.
- No physical, chemical or biological process can influence the process of radioactive emissions. The unstable nuclei have to decay and acquire a stable state.
- Exposure of human beings to low doses of radiations, may begin to suffer from fatigue, nausea, vomiting and loss of hair. But recovery is possible.
- Exposure of human beings to medium doses of radiation may result in bone marrow disorder, reduction in blood cells,reduction in natural resistance against germs and failure of blood to clot.
- Higher radiation doses will kill the organisms by damaging tissues, brain etc.
- Radiations may cause skin burns which may lead to skin cancer.
- Radiation at pelvic regions of pregnant ladies, cause damage to the fetus**.** Infants between eight and fifteen weeks of pregnancy who were exposed to the atomic attack at Hiroshima and Nagasaki during World War II were reported to have a greater incidence of brain damage with side effects including lower Intelligent Quotient (IQ) and severe mental retardation in some cases.
- The radiation weakens the immune system of the body.
- Delayed effects of radiation include cataracts, leukaemia, malignant tumours, cardiovascular disorders, premature ageing and reduced life span.
- In spite of all these hazards, nuclear reactors and tests are still continuing and increasingly large amounts of radioactive wastes are accumulated every day while no solution to the problem of their safe disposal is in sight till date.

**5.8.3. Control Measures**

Control of natural radioactive pollution may not be possible. On one hand, the peaceful uses of radioactive materials are so wide and effective that modern civilization cannot go without them; on the other hand, there is no cure for radiation damage. The only option against nuclear hazards is to check and prevent radioactive pollution. For this:

- Waste disposal must be careful, efficient and effective. Low level wastes should be subjected to treatment for the removal of radioactivity and then discharged to water bodies or landfills.

- Medium level wastes (e.g., filters, reactor components, etc.,) are solidified and mixed with concrete in steel drums before being buried in deep mines or below the sea bed in concrete chambers.
- High level wastes should be concentrated, contained (ceramics) and stored out of the reach of human environment or buried deep into earth or stored in deep salt mines.
- Leakages from nuclear reactors, careless handling, transport and use of radioactive fuels, fission products and radioactive isotopes have to be totally stopped.
- There should be regular monitoring and quantitative analysis through frequent sampling in the risk areas.
- Prevention of erosion of radioactive waste disposal sites.
- Prevention of any drilling activity in and around the waste disposal site.
- Laboratory generated nuclear wastes should be disposed off safely and scientifically.
- Appropriate protection against occupational exposure.
- Nuclear medicines and radiation therapy should only be applied when absolutely necessary.
- Nuclear tests should be banned.
- Nuclear reactor should be perfectly maintained to avoid accidental leakage.
- High chimney and ventilations should be used at working places where radioactive contamination is high.
- Protective garments must be worn by the workers who work in the nuclear power plants.
- The nuclear power plants must follow all the safety instructions.
- Production of radio isotopes should be minimized.
- In nuclear mines, wet drilling may be employed along with underground drainage.

## 5.9. SOLID WASTE MANAGEMENT

Industrialization across the world has brought a lot of good as well as bad things as well. One of the negative effects of industrialization is the creation of solid waste and consequent environmental degradation.

According to ***Britannica, "Solid-waste management is the collecting, treating and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to the outbreaks of vector-borne disease"***

Human and animal activities generate different kinds of wastes. These wastes are generally in solid form, and may cause pollution of land, water and air unless treated and disposed off. The process of collection, transportation, treatment and disposal can be grouped under solid waste management. The increase in the quantity of solid waste is due to overpopulation, affluence and technological advancement.

### 5.9.1. Causes of formation of solid waste

| Sources | Waste generators | Types of solid waste |
|---|---|---|
| Urban / Residential wastes | Single and multifamily dwellings | Food wastes, cloth, waste paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes like consumer electronics, batteries, used oil, tires and household hazardous wastes. |
| Industrial | Light and heavy manufacturing, fabrication, power and chemical factories. | Packaging, food wastes, hazardous chemical wastes, ashes, medical wastes and special wastes. |
| Commercial / institutional | Stores, hotels, restaurants, markets, office buildings, schools, hospitals etc. | Paper, cardboard, plastics, wood, food wastes, glass, metals, medical wastes, hazardous wastes. |
| Construction and demolition | New construction sites, road repair, renovation sites, demolition of buildings | Wood, steel, demolition materials, concrete, dirt, metals etc. |
| Municipal services | Street cleaning, landscaping, parks, beaches, other recreational areas and wastewater treatment plants. | Street sweepings, tree trimmings, general wastes from parks, beaches, plastics and other recreational areas. |
| Process (manufacturing, etc.) | Heavy and light manufacturing units, refineries, chemical plants, power plants, mineral extraction and processing. | Industrial process wastes, scrap materials. |
| Agriculture | Crops, dairies, feedlots, farms. | Spoiled food wastes, agricultural wastes, hazardous wastes (e.g., pesticides). |

### 5.9.2. Effects of Waste Pollution

- Due to improper disposal of municipal solid waste on the roads and immediate surroundings, biodegradable materials undergo decomposition and may create unsanitary conditions. This may lead to the outbreak of epidemic, producing foul smell and becoming a breeding ground for disease vectors.
- Burning of industrial and domestic wastes (plastics, batteries) produce furans and dioxins which are harmful to human beings.
- Toxic substances may percolate into the ground and contaminate the groundwater.
- Solid waste from industries like toxic metals, hazardous wastes and chemicals, when released to the environment can cause biological and physicochemical problems to the environment and may affect the productivity of the soil in that particular area.
- Direct dumping of untreated waste in rivers, seas, and lakes results in the accumulation of toxic substances in the food chain through the plants and animals that feed on it.
- Waste treatment and disposal sites can also create health hazards for the neighborhood. Improperly operated incineration plants cause air pollution.
- Improperly managed and designed landfills attract all types of insects and rodents that spread disease. Ideally these sites should be located at a safe distance from all human settlements.
- Recycling wastes also carries health risks if proper precautions are not taken.
- Eye and respiratory infections resulting from exposure to infected dust, especially during landfill operations.
- Intestinal infections that are transmitted by flies feeding on the waste.
- Skin and blood infections resulting from direct contact with waste and from infected wounds.
- Incineration operators are at risk of chronic respiratory diseases including cancer and skin diseases.

***Coloured Plastics….. they are dangerous !!!!!***

The unhygienic use and disposal of plastics and its effects on human health has become a matter of concern. Coloured plastics are harmful as their pigments contain heavy metals like copper, lead, chromium, cobalt, selenium and cadmium. In

### 5.9.3. Control Measures

***i) Sanitary Landfill:*** This is the most popular solid waste disposal method used today. Disposing of waste in a landfill involves burying the waste, in abandoned or unused places. In this method garbage is spread out in thin layers, compacted and covered with clay, sand or plastic liner. The liners protect the

ground water from being contaminated. When the landfill is full, it is covered with layers of sand, clay, top soil and gravel to prevent seepage of water.

*Advantages:* Simple, economical, cheap equipment, no residue or by-products, skill labour not required, segregation of waste not required, natural resources are returned to soil and recycled.

*Disadvantages:* Large area is required, continuous evolution of foul smell from the site, use of insecticide is required, may cause ground water pollution, cause fire hazard due to formation of methane gas in wet weather.

***ii) Incineration*:** It is the hygienic way of disposing solid waste. It is a thermal process (controlled combustion) in which the waste material is converted to heat, gas, steam and ash, which can be used for electrical generation and domestic heating. It is suitable for hazardous, organic and medical wastes. Combustible substance should be separated and removed before incineration process. Wet municipal waste should be preheated before incineration process. It reduces the volume of waste up to 20 or 30% of the original volume.

*Advantages:* Safest and hygienic method, requires very little space, residue is only 20-30% of the original amount and can be used as cement clinker after treatment, an incinerator plant of 3000 tones per day capacity can generate 3MW of power.

*Disadvantages:* Its capital and operating cost is high, operation needs skilled personnel, formation of smoke, dust and ashes needs further disposal and that may cause air pollution, ordinary incinerators cannot be used for radioactive wastes.

***iii) Composting:*** It is a popular method by which bulk organic matter is converted into fertilizer by biological action. Microorganisms like fungi, bacteria convert degradable organic waste into broken, odourless mass called humus, which is a good fertilizer. Separated compostable waste is dumped in underground trenches in layers of 1.5m and finally covered with soil of 20 cm and left for decomposition. Sometimes, actinomycetes are introduced for active decomposition. Biological action will start within two to three days. Good quality environmental friendly manure is formed from the compost and can be used for agricultural purpose.

*Advantages:* Environmentally effective than landfill and incineration, manure can be sold thereby reducing cost of disposing wastes, recycling can be done, this method can be used to treat several industrial solid wastes, controls growth of weeds in garden, make soil easier to cultivate.

*Disadvantages:* Non-consumables have to be disposed separately; the technology has not caught-up with the farmers and hence does not have an assured market.

***iv) Vermi Composting:***It has become very popular in the last few years. In vermi composting, earthworms are added to the compost. These help to break the waste and the added excreta of the worms makes the compost rich in nutrients. It is very useful biofertilizer and soil conditioner.

### 5.9.4. Reduce, Reuse, and Recycle is the new answer to the problem of environmental pollution

The aim of waste management is to collect, treat, utilize and dispose solid waste in an economic manner protecting public health. Its major consideration, apart from health, is to adopt three R's-reduce, reuse and recycle strategy.

**(i) Reduction in use of raw materials:**

This will correspondingly decrease the production of waste. Reduced demand of any metallic product will decrease the mining of their metal and cause less production and less waste.

**(ii) Reuse of waste materials:**

Reuse of paper, cardboard, glass, metal, plastic, discarded cycle tubes, auto-parts of vehicles considerably reduces the waste of generation.

**(iii) Recycling of materials:**

Recycling is the reprocessing of discarded materials into new useful products. Examples include formation of new cans, bottles from broken aluminium cans and glass, fuel pellets from kitchen waste, cellulose from waste paper etc.

### 5.9.5. Green Chemistry

***Green Chemistry, also known as sustainable chemistry, is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry is a powerful approach to pollution prevention, waste minimization and hazard reduction.***

The focus of Green Chemistry is on

1. Source reduction/prevention of chemical hazards
2. Reuse or Recycle chemicals
3. Treat chemicals to render them less hazardous
4. Dispose chemicals properly

# CHAPTER 5

# ENVIRONMENTAL POLLUTION

## 5.10. ROLE OF AN INDIVIDUAL IN THE PREVENTION OF POLLUTION

Pollution is a man-made disease that can be cured only by man and remedies adopted by them. Incomplete and inefficient technology coupled with increased population is the main cause of man-made pollution. In fact, the role of individuals in prevention of pollution is of critical importance because it is the individual that makes a community or country.

Environment awareness programme should be organized and individuals should be encouraged to modify the life style and living habit, if that are not healthy for environment. Over population and pollution are potent ecological forces impinging upon man by affecting the quality of the environment.

The main causes of pollution in developing countries

i. Increasing population
ii. Illiteracy and poverty
iii. Rapid industrialization
iv. Failure in pollution management

***Ways in which an individual/NGO can help in prevention of pollution***

- Development of nonpolluting sources of energy.
- Effective use of water resources.
- Usage of cloth bags instead of plastics.
- Usage of rechargeable batteries.
- Avoid burning plastics.
- Switch off electrical appliance when not in use.
- Make use of public transport system.
- Periodic pollution check should be done for vehicles by approved authorities.
- Reuse items whenever possible.
- Use renewable source like solar heaters, solar cookers etc.
- Cells, batteries, pesticide containers should be disposed properly.
- Quit smoking.

- Reduce the use of air conditioners, refrigerators etc.
- Reduce deforestation.
- Use handkerchief instead of paper tissues.
- Purchase recyclable, recycled and environmentally safe products.
- Organize environmental awareness programme.
- Implement environment protection law.
- Use unleaded gasoline in your cars.
- Never use open fires to dispose of wastes.
- Do not litter in public places.
- Organic waste should be dumped in places far from residential areas.
- Use of chemical pesticides, weedicides, insecticides etc. should be minimized. Promote the use of bio-pesticides, bio-fertilizers etc.
- Non -biodegradable waste should be collected and disposed for recycling processes.
- Start individual or community vermin-composting plant in your neighborhood and motivate people to join.
- Advocate organic farming.
- Develop respect for all forms of life.

## 5.11. POLLUTION CASE STUDIES

### Case study 1: Love Canal incident [New York]

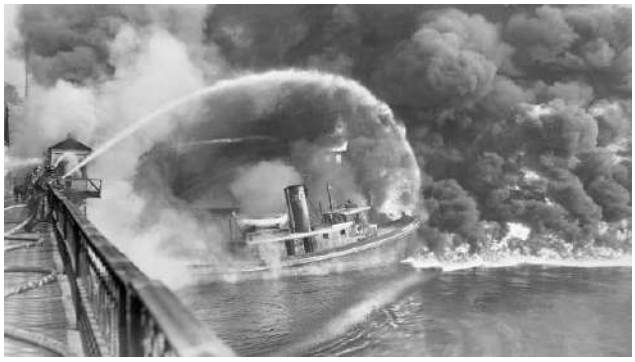
It was the most widely quoted example for ground water pollution. In 1978, residents of love canal neighborhood in New York city noticed high rates of cancer and alarming number of birth defects. This was found to be due to the organic solvents and dioxins from an industrial land fill. These contaminants have infiltrated into water supply and evaporated in basements to further contaminate air. During 1930-53, New York city municipal waste and industrial waste was dumped in love canal dumping site. Later this site was filled up with soil and sold to build an elementary school and residential area. Survey of air sample around the area showed the presence of 26 different organic compounds including chloroform, benzene, toluene, perchloroethylene etc. Eight hundred families were reimbursed for their homes and moved, after extensive legal battles and media coverage.

**Case study 2: Minamata Tragedy [Japan]**

A case of human mercury poisoning which occurred in May 1956 in the Minamata in Japan, which is a typical example of the pollution related health damage. A large plastic plant located near the Minamata Bay used a mercury containing compound in a reaction to produce polyvinyl chloride (PVC), a common plastic material. The left-over mercury was dumped into the Bay along with other waste from the plant. Though mercury was in its inorganic state when dumped, the microorganism at the bottom of the bay converted the mercury into its organic form. This organic mercury entered into the tissues of fish which were in turn consumed by the people living in the area. The contaminated fish thus caused an outbreak of poisoning, killing and affecting several people. Mothers who had eaten the contaminated fish gave birth to infants who showed the signs of mercury poisoning. Mercury poisoning is thus called 'Minamata Diseases'.

**Minamata disease**, is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech.

**Case study 3: Exxon Valdez oil spill- worst oil spill disaster [Alaska, US]**



On March 24, 1989 Exxon Valdez, a tanker in an attempt to avoid iceberg, ran aground and released 11 million gallons of crude oil into a wide channel in Prince William Sound near Valdez in Alaska. It was the worst environmental disaster in Alaska history, and occurred in a very sensitive coastal ecosystem. It contaminated 1300 miles of shoreline and stretching over 470 miles from the crash site. The site was in a remote location and lack of oil skimming equipment and ineffective chemical dispersants made a speedy response very difficult. The cleaning operation involved 11,000 people and 1000 boats. The fast spreading oil proved deadly for wild life in the region. Countless fishes, along with more than 2,50,000 sea birds and thousands of otters and seals perished. Exxon spent more than $2 billion for cleaning up the spill, but some oil still remains. In a civil case Exxon was hit with a $ 5 billion civil judgment for its role in the accident.

**Case study 4: Kuttanadu Wetland [ Kerala, India]**

It is a low-lying area near the coast and is known as the rice bowl of Kerala. Kuttanadu is a wetland ecosystem located in the southern coastal part of Kerala State, and spread across the districts of Alappuzha, Kottayam and Pathanamthitta; that is in an extreme state of ecological decay and environmental degradation. Wetlands are one of the most productive ecosystems and play a significant role in the ecological sustainability of a region.

Kuttanadu is a complex system of brackish lagoons, marshes, mangroves, reclaimed land and a network of canals. Vembanadu Lake is identified as an important bird area, which supports the third largest wintering waterfowl of the country. It is also one of the 15 mangrove areas. The most significant eco-system services of Vembanadu include fishery, agriculture, navigation, port facility, tourism and coir industries. The environmental conditions of this lake are in a steady state of decline due to various anthropogenic activities which leads to severe livelihood crisis for the dependent communities. The major ecological consequences in this region is the fall in soil fertility, increased incidence of pest and diseases, use of large quantities of pesticides, and extinction of mangroves that used to function as favoured nursery areas of fishery resources.

All this makes water pollution the major environmental problem of Kuttanadu region. The residues of pollutants such as fertilizers and pesticides, animal and human wastes etc accumulate in water. Pollutants from industrial and agro-chemical residues, municipal sewage, effluents from motor boats, and coir retting to open water bodies, deteriorates the quality of the lake ecosystem. Kuttanadu area is found to have very high occurrence of cancer of the lip, stomach, skin and brain, lymphoma, leukemia, vision and multiple myloma. The other health problems include breathing problems, dehydration, vomiting, cramps and diarrhea.This intense pollution and environmental degradation is adversely affecting the flora and fauna of the area. For example, many of the fish varieties that were common in the area are already extinct.

## 5.12. DISASTER MANAGEMENT

The Indian subcontinent is traditionally vulnerable to natural disaster on account of its unique geo-climatic conditions. Floods, cyclones, earthquakes and landslides have been recurrent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares are prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought. Among all the disasters that occur in the country, floods are the most frequently occurring natural disaster due to the irregularities of the Indian Monsoon. ***The term disaster management includes all aspects of preventive and protective measures, preparedness and organization of relief operations for mitigating the impact of disaster on human beings and socioeconomic aspects of the disaster-prone areas***. At the

global level, there has been considerable concern over natural disasters. Even as scientific progress is made, loss of lives and property due to disaster is increasing. Disaster management occupies an important place in our country's policy framework as it is the poor and under-privileged who are the worst affected on account of calamities and disaster.

### 5.12.1. Flood

India is one of the most flood prone countries in the world. Floods occur in almost all rivers basins in India. Most of the flood affected areas lie in the Ganga basin, Brahmaputra basin,the northwestern river basin, peninsular river basin and the coastal regions of Andhra Pradesh, Tamilnadu, Orissa, Kerala, Assam, Uttar Pradesh and Bihar. Twenty-three of the 35 states and union territories in the country are subject to floods and it affects an average area of around 7.5 million hectares per year. According to the National Commission on Floods, the area susceptible to floods was estimated in 1980 to be around 40 million hectares and it is possible to provide reasonable degree of protection to nearly 80 per cent.

Flood is a state of high-water level reaching land in a short span of time, causing land surface to be submerged under water. Floods may happen gradually and also may take hours or even happen suddenly without any warning due to spill over, heavy rains etc. There are different types of floods namely: flash flood, river line flood, urban flood, etc.

**Causes**

There are several causes of floods and they differ from region to region. The causes may vary from a rural area to an urban area. Some of the major causes are:

- Heavy rainfall and deforestation.
- Heavy siltation of the river bed reduces the water carrying capacity of the rivers/stream.
- Blockage in the drains leads to flooding of the area.
- Landslides blocking the flow of the stream.
- Construction of dams and reservoirs.
- In areas prone to cyclone, strong winds accompanied by heavy down pour along with storm surge leads to flooding.

**Adverse Effects**

- The most important consequence of floods is the loss of life and property. Structures like houses, bridges, roads etc. get damaged. There is huge loss to life and livestock caused by drowning.

- Lack of proper drinking water facilities, contamination of water (well, ground water, municipal water supply) leads to outbreak of epidemics, diarrhoea, viral infection, malaria and many other infectious diseases.
- Flooding also leads to huge crop loss. This results in shortage of food, and animal fodder. Floods may also affect the soil characteristics. The land may be rendered infertile due to erosion of top soil or may turn saline if sea water floods the area.
- 121 people were killed due to floods across the state of Kerala during August 2019. Over 2 lakh people have been directly affected by flood and were shifted to 1318 relief camps in different parts of Kerala.

**Control measures:**

- Mapping of flood prone areas using Satellite and remote sensing-based imageries are found to be the best tool.
- As soon as the information of a flood event is obtained, the earliest available satellite is programmed to collect the required data for the explanation of flooded areas. Both optical and microwave satellites data can be used.
- Land use control will reduce danger of life and property when water enters the flood plains and the coastal areas.
- Construction of engineered structures in the flood plain will strengthen the structures to withstand flood forces like flood walls, flood levees, coastal protection works, etc.
- Reforestation will help in flood control by decreasing the amount of run-off.
- Diversion of flood water and improvement in drainage facilities.
- The National Flood Control Programme was launched in 1954. Since then, sizeable progress has been made in the flood protection measures.
- Flood insurance, public health awareness, and disaster relief.

### 5.12.2.Cyclones

The major disaster that affects the coastal region of India is cyclone. India has a coastline of about 7516 Km and it is exposed to nearly 8% of the world's tropical cyclones. About 71% of this area falls in ten states (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Puducherry, Andhra Pradesh, Orissa and West Bengal). The islands of Andaman, Nicobar and Lakshadweep are also prone to cyclones.

Cyclone is a region of low atmospheric pressure surrounded by high atmospheric pressure resulting in swirling atmospheric disturbance accompanied by powerful winds blowing in anticlockwise direction in the Northern Hemisphere and in clockwise direction in the Southern Hemisphere. They generally move

300-5000 Km per day over the ocean. They occur mainly in the tropical and temperate regions of the world. The main dangers from cyclones are very strong winds, torrential rains and high storm tides. The development of a cyclone covers three stages namely formation and initial development state, fully matured and weakening/decay. Although one cannot control cyclones, the effect can be mitigated through effective mitigation policies and strategies.

**Adverse effect:**

- Major damage to infrastructure and housing
- Causalities due to flooding and flying elements in air
- Contamination of water supplies may lead to diarrhea, malaria etc
- Contamination of ground and pipe water
- Loss of crops and food supplies
- Disruption of communication towers, electricity, telephone cables etc
- Roads and rails may be damaged

**Control measures:**

- Hazard mapping/ early warning system - Using appropriate models and satellite data, ISRO is supporting the efforts of India Meteorological Department to predict the tropical cyclone track, intensity and landfall. After the formation of cyclone, its future tracks are regularly monitored and predicted by ISRO. These experimental track predictions are regularly posted on departmental web portal (http://www.mosdac.gov.in/scorpio/) as part of information dissemination.
- Using the wind pattern generated by the Oceansat-2 Scatterometer, data models have been developed for predicting the formation of a cyclone even before the depression turns into a cyclone.
- Coastal belt plantation and land use control.
- Engineered structures which can withstand high wind forces.
- Protect river embankment.
- Construction of permanent houses.
- Communication lines should be installed underground.
- Provide strong halls for community shelter in vulnerable locations.
- Land use control and settlement planning.
- Public awareness programme /training /education.

### 5.12.3. Earthquakes

Earthquake is one of the most destructive natural hazards. They may occur at any time of the year with sudden impact and little warning and involves violent shaking of the ground. An earthquake struck Gujarat on 26 January 2001 on a massive scale. Remote Sensing and GIS provide a database from which the evidences left behind by disaster can be combined with other geological and topographical database to arrive at hazard map. The areas affected by earthquakes are generally large, but they are restricted to well-known regions (Plate contacts).

Earthquakes results from the release of accumulated stress of the moving lithospheric or crustal plates. The earth's crust is divided into seven major plates, that are about 50 miles thick, which move slowly and continuously over the earth's interior and several minor plates. Earthquakes are tectonic in origin; that is the moving plates are responsible for the occurrence of violent shakes.

**Cause:**

India's increasing population and extensive unscientific constructions mushrooming all over, including multistoried luxury apartments, huge factory buildings, gigantic malls, supermarkets as well as warehouses and stonework buildings keep - India at high risk. During the last 15 years, the country has experienced 10 major earthquakes that have resulted in over 20,000 deaths.

**Adverse Effects**

- Damage to structures, human life.
- The occurrence of an earthquake in a populated area may cause numerous casualties and injuries as well as extensive damage to property.
- Sea activity-water level in the sea could rise suddenly.
- Landslides will be caused due to impacts, changed topography, blocked roadways etc.

**Control measures:**

- Satellite data gives a synoptic overview of the area affected by the disaster. These data can be made use to create a very large scale base information of the terrain for carrying out the disaster assessment and for relief measures.
- Community preparedness.
- Construction of buildings should be based on the guidelines of the Bureau of Indian standards to with stand ground shaking.
- Public education through sensitization and training programme for community, architects, engineers, builders, masons, teachers, government functionaries, teachers and students.

### 5.12.4. Landslide

Landslides are downward and outward movement of slope materials such as rock debris and earth, under the influence of gravity. Landslides are one of the natural hazards that affect at least 15 per cent of the land area of our country—an area which exceeds 0.49 million $Km^2$. They are recurring phenomena in Himalayan region.

**Cause:**

- Earthquake
- Volcanic eruption
- Weakness in the composition of the structure of rock or soil
- Erosion
- Intense rainfall
- Human excavation

**Adverse effects:**

- For a long time, landslides have had disastrous consequences causing enormous economic losses and affecting the social fabric. In 2005 alone, more than 500 human lives were lost due to this hazard in our country.
- Loss of buildings, roads, communication lines etc.
- On August 2019 in Kerala, incessant rainfall triggered major landslides at Ipadi, Puttupala, Wayanad, Neelambur and Mallapuram, which trapped several people under debris. 64 land slides happened in the state in the recent disastrous spell. Unlike in 2018, where around 400 people were killed, mostly due to floods, in 2019, majority of the 103 deaths have happened due to landslides.

**Control measures**

- Remote sensing data have been proved to be useful for landslide inventory mapping both at local and regional level.
- Engineered structures with strong foundations.
- Strong vegetation cover.
- Department of Space has prepared Landslide Hazard Zonation maps (LHZ) along tourist and pilgrim routes.
- Hazard mapping will locate areas prone to slope failures. These maps will also serve as a tool for mitigation planning.

- The surface drainage control works are implemented to control the movement of landslides accompanied by infiltration of rain water and spring flows.

### 5.12.5. Role of public/community participation in disaster management

The government of different countries, international, national and local (also voluntary) agencies have adopted comprehensive disaster management plans and programs, emphasizing on public participation with an intention of reducing the pains and sufferings of victims, shorten the number of loss of human lives and livestock. As it is the public which is going to face the disaster, it is very important that community should be part of the complete disaster management process in all three phases- rescue, relief, and post-disaster recovery. Communities are the first responders in case of a disaster. Therefore, community-based disaster risk reduction (CBDRR) should be the core of any risk reduction approach.

Public is a largely untapped resource in the emergency management field. Engaging the public dialogically in early policy stages and emergency management phases is essential to successful inclusion for both administrators and communities. Public inclusion creates expanded knowledge, shared learning, personal responsibility, and increased social capital. Faced with the growing threat from disasters, emergency management can create communities that are both more resilient and sustainable by increasing public participation.

## QUESTIONS

### Part A (2 marks)

1. Define pollutants. Give example.
2. What are contaminants? Give example.
3. List the main segments of atmosphere.
4. Define air pollution. List two important causes of air pollution.
5. What is blue baby syndrome? What are the causes
6. What is photochemical smog? Why it is dangerous?
7. Why is CFCs dangerous?
8. What are indoor air pollutants? Give examples.
9. Name two inorganic pollutants in water
10. What is noise pollution? Name the unit formeasuring noise pollution.
11. Outline BOD

12. What is primary pollutant? Give examples
13. Define water pollution
14. What is secondary pollutant? Give examples.
15. Differentiate point and non-point sources
16. What is greenhouse effect. How can it be reduced?
17. Suggest two control measures for marine pollution
18. What are the essential qualities of drinking water?
19. Discuss two factors responsible for nuclear pollution
20. What is Eutrophication
21. What is dissolved oxygen. What does it indicate?
22. How can you reduce water pollution?
23. Which region of soil has maximum biological activity? Why?
24. What is meant by COD?
25. Outline Love canal incident
26. Discuss the cause of soil pollution
27. What is marine pollution. How can it be reduced?
28. How isthermal pollution different from marine pollution?
29. What is nuclear fallout. How is it dangerous
30. Why solid waste management is essential?
31. What is vermin-composting?
32. Define bioaccumulation.
33. Why is disaster management necessary?
34. What are earthquakes? How is it caused?
35. List four important causes of noise pollution
36. What are landslides? How can it be prevented?
37. Solid waste management is an essential perquisite for a healthy living. Discuss.
38. Name any two nuclear accidents
39. What is the effect of biomagnification?
40. How can noise pollution be prevented?
41. What are water quality parameters?
42. Reduce, Reuse and Recycle is a new answer to environmental pollution. Explain.

**Part B (5 marks)**

1. What are the control measures adopted to minimize air pollution?
2. Discuss global warming and greenhouse effect.
3. What are the adverse effects of water pollution?
4. How can we control water pollution?
5. Differentiate between BOD and COD.
6. What is soil horizon? Explain.
7. How can soil pollution be reduced?
8. What are the causes of land degradation/soil pollution? Suggest few techniques to reduce soil pollution.
9. Discuss the preventive measures which can be adopted for nuclear pollution
10. Comment on the Love canal incident –a case study of ground water pollution.
11. What are the different types of water pollution? What are the major sources?
12. What is pollution? Explain the different sources of air pollution
13. Write briefly on marine pollution
14. What is biomagnification? What the effects?
15. What is noise pollution? How can it be controlled?
16. What are the health effects of noise pollution?
17. What are nuclear hazards? How can you control nuclear pollution?
18. Comment on the environmental degradation of Kuttanadu wetland
19. Write briefly on solid waste disposal.
20. Discuss following methods adopted for waste management a) sanitary landfills b/ incineration c) composting
21. What is thermal pollution? How can it be controlled?
22. What are causes and effects of nuclear pollution?
23. Discuss the important methods adopted for solid waste disposal
24. Write notes on Minamata tragedy
25. What is disaster management? What the measures opted for the prevention of landslides.
26. Discuss the cause, effects and control measures for flood
27. How can cyclone be prevented? What are its adverse effects?
28. Discuss the role of community in disaster management
29. Write a note on nuclear pollution, its source and impact on environment
30. Outline the role of individual in the prevention of pollution.

**Part C (15 marks)**

1. Analyze critically the factors responsible and remedial measures for a) air pollution b) noise pollution
2. Explain the cause, effects and control measures of a) water pollution b) soil pollution
3. Outline the cause, effects and control measures of thermal pollution. How is it different from marine pollution?
4. What is nuclear pollution? Briefly describe its causes, effects and control measures
5. Write an essay on the causes, effects and control measures employed for solid waste management.
6. What is pollution? Which are the different types? Explain the role of NGO/individual in the protection of environment.Outline the role of public/community participation in disaster. management
7. What is disaster management? Write explanatory note on the cause, effects and control measures adopted for a) floods b) earthquakes
8. Discuss the cause, effects and control measures adopted for a) landslides b) cyclone c) earthquakes
9. What is water pollution? What are it causes? How can it be controlled? Explain with the help of a case study.
10. Discuss the factors responsible and remedial measures for a) nuclear pollution b) solid waste management.

# CHAPTER 6
# SOCIAL ISSUES AND THE ENVIRONMENT

## 6.1. URBAN PROBLEMS RELATED TO ENERGY

Economic growth and urbanisation cause serious damage to the environment. In Asia and Africa most of the population lives in cities. The rate of urbanisation and population growth in these continents exceed incredibly when in comparison to other continents. As the cities develop our use of energy also increases. Virtually, all industrial nations get the energy they need from non-renewable energy sources. On an average, they receive about 85% of their energy from fossil fuels, 5% from nuclear power and 10% from solar and wind energy. In the less developed countries, biomass (wood and cow dung) play an important role in supplying demand, satisfying about 40%of energy requirements. Non-renewable fossil fuels supply about 60% of the total energy. But this is not sufficient to meet the growing demands.

World Primary energy demand is expected to increase in future. The International Energy Agency's (IEA), projects energy demand growth rate of 1.4% per year up to 2030.The fastest growth is expected in non- OECD countries with a projected rate of 2.2% per year particularly in China and India and other emerging economies in Asia and the Middle East. Many non-OECD countries are also expected to see large increase in imports of oil or gas or both. In 2006, the European Union (EU) pledged to cut its annual consumption of primary energy to 20% by 2020.

The global community and the governments are faced with four major challenges with respect to the energy sector: 1) Concerns about energy security, 2)Combating climate change, 3)Reducing pollution and public health hazards 4) Addressing energy poverty.

## PROBLEMS RELATED TO ENERGY

The burning of fossil fuels emits carbon to the air. Accelerating carbon emissions indicate a mounting threat of climate change. The causes of the energy crisis vary but they all share a common feature: the gross misallocation of capital. During the last two decades, much capital was poured into property, fossil fuels and structured financial assets. However, relatively little in comparison was invested in renewable energy, energy efficiency, public transportation, sustainable agriculture, eco-system and biodiversity protection and land and water conservation. There is a link between energy-water and pollution. Production and consumption of energy results in various pollution and it is a threat to environment. (Chart 3.1)

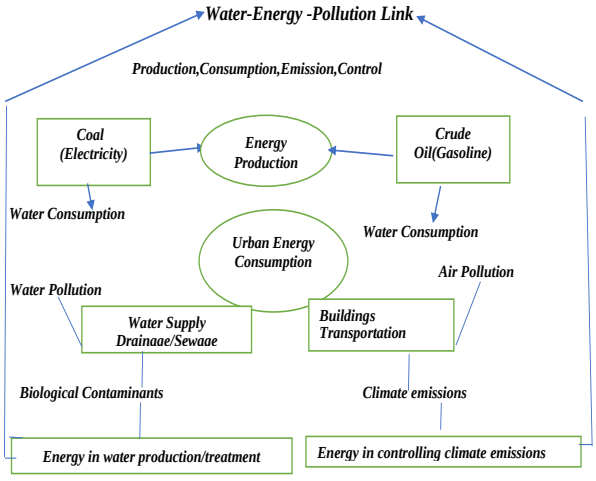



**Chart 3.1**

**Reasons for increase in energy consumption in the cities**:

1. ***The increase in the household use****:* Earlier firewood and other things were used forcooking. But today it has given natural gas, kerosene etc. In older days, the kitchen of houses was arranged to use firewood. But today, it is not possible in the flats and apartments in the cities. This is one of the reasons for shifting firewood ovens to electric and natural gas. This results in a higher energy loss.

2. ***Using of electricity / Air-conditioning****:* The development of cities leads to different types of climatic changes. The buildings in most of the cities are using glass roofing's because of climatic changes and global warming. It creates greenhouse effect by absorbing Sun's heat during warm climate. But it causes to increase the heat two-fold during summer season. So, most of the buildings use centralised air conditioning. Moreover, due to the increase of heat due to global warming leads to the use of more fans.AC has more consumption of energy than fans. Also, the loss of electricity is more in the urban sector than the rural because of obvious power consumption by the former.

**Goals**

Improve the energy efficiency of all machines, homeappliances, buildings, factories, motorvehicles, airplanes and so on.

Find clean, renewable replacements for oil because its supplies are limited. Also find replacements for fuel because it is such an environmentally costly fuel.

Find a replacement for natural gas (which is primarily used for heating and industrial processes).

3. ***Transportation:*** Today people in the cities use their private vehicles and avoid public transport system. The increase in number of vehicles depict this. These vehicles mainly use fossil fuels. The carbon monoxide that forms due the emitting of these fuels leads to lot of respiratory diseases.

Creating sustainable energy for future will require a careful analysis of options for factors such as efficiency, environmental impacts, renewability and affordability.

**What individuals can do?**

As citizens, it is our duty to preserve energy. Therefore, reduce the energy consumption to maximum. For that:

- Use LED bulbs
- Control the use of electricity
- Use public transportations
- Our aim should be "efficient use of energy". For example: insulating a home allows a building to use less heating and cooling energy and to achieve and maintain a comfortable temperature. It also lowers energy cost by preventing future resource depletion. Some countries employ energy or carbon taxes to energy users to reduce their consumption. Citizens can take any number of additional actions to promote a sustainable future.
- Drive fuel-efficient vehicles, carpooling, riding in public buses, bicycling or walking – all make significant contributions.

Energy conservation can be made possible by limiting the use of energy in residential sections, urban transport sector and commercial industrial sector. National energy policy also plays a dominant role in this.

## 6.2. WATER CONSERVATION, RAIN WATER HARVESTING, AND WATERSHED MANAGEMENT

*Why is our source of water vanishing these days? Is it because of deforestation and urbanisation? Why are the rivers drying up at phenomenal rates? Why are India's rivers in such a pathetic state? How should India manage its water?*

*It's not too far for that day to come where mankind awaits the day of reckoning – world war for water! Yes, we cannot rule out a possibility of such a war if exploitation continues at this rate.*

### 6.2.1. Water Conservation

Water is essential to human existence and ecosystems and a vital element for human development. Thus, water availability is a global issue. Although, water is the most widely occurring substance on Earth, it is a well-known fact that only about 2.5% is fresh water and the rest is salt water. Of the 2.5% of freshwater, its biggest portion is locked up in glaciers and permanent snow cover. Thus, in reality, only about 1 % of the world's freshwater is readily available and accessible for direct human use.

Water availability is becoming an increasingly crucial issue for Asia. In recent years, evidence indicates that water is becoming increasingly affected by erratic weather patterns, as has already happened to countries such as Indonesia and China, which have experienced droughts and inevitable food shortages.

***Climatic changes, misuse of water by industries, population growth etc are the reasons for shortage of water***.Factors such as climate change have increased the pressure on natural water resources, especially in agricultural and manufacturing irrigation. The people who used rivers and wells once for agriculture and domestic purposes, now depending on private water taps. The loss of water during distribution is also a great problem. The British had constructed dams for the development of cities but Indian Govt. constructed dams for agriculture purpose. Though this agricultural development especially green revolution has taken us to food sufficiency but it has led to loss of natural manure, soil and salinization. In the past, the farmers in North India collected and preserved water in tanks known as "Jheels" and "Talabs". It has lost its importance due to the introduction of new irrigation techniques. The quantity of water consumed and exploited by the industries also creates problems and it need to be controlled. These industries are in the forefront of water pollution also. The agitation at Plachimada against Coca-Cola in Kerala is an example for this.

Studies show that by 2025 more than half the people around the world will not have enough water. Preservation of water is very essential for the existence of mankind. ***Water conservation includes all***

***the policies, strategies and activities made to sustainably manage the use of fresh water and to meet its future human demand.***

**Goals & Strategies**

The goals of water conservation efforts include:

*1. Ensuring availability of water for future generations.*

*2. Energy conservation: because by introducing new water pumping techniques, delivery and waste water treatment facilities which consumes a significant amount of energy.So, energy conservation is also a part of water conservation policy.*

*3. Habitat conservation by minimising human water use which helps to preserve fresh water habitats for local wildlife and water quality.*

Strategies:

Continuing current practices of water use will lead to a massive and unsustainable gap between global supply and demand for water. This is exacerbated by failure to collect and treat used water to enable subsequent uses. With no improvement in the efficiency of water use, water demand is projected to overshoot supply by 40 per cent in 20 years' time. Improvement in water productivity, as well as increases in supply (such as through the construction of dams and desalination plants and increased recycling) are expected to address 40 percent of this gap, but the remaining 60 percent needs to come from investment in infrastructure, water policy reforms and in the development of new technology.

Water conservation programmes are in need to be initiated at the local level, by either municipal or local governments. Common strategies include public outreach campaigns, charging higher price as water use increases, restrictions on outdoor water use such as car washing etc. And one of the fundamental conservation goals is *Universal metering*. At the same time, the quantity of pure water used by industries should be controlled and accurate monitoring also to be done.

**6.2.2. Rain water harvesting**

***Rainwater harvesting is the system of collecting water from its source itself. It is the accumulation and deposition of rainwater for reuse rather than allowing it to run off.***It can be collected from rivers or roofs and in many places, the water collected is redirected to a deep pit reservoir with percolation. The harvested water can be used as drinking water, for irrigation, long term storage and for other purposes such as ground water recharge. Generally, check dams are constructed across the streams to enhance the percolation of surface water into subsoil strata.

**Why is it important?**

- When people do not have access to water, either large amounts of their disposable income have to be spent on purchasing water from vendors which in turn erodes their capacity to engage in other activities.
- When sanitation services are inadequate, the risk of water-borne diseases increase. Cambodia, Vietnam, Indonesia and Philippines have lost many lives because of poor sanitation. Access to reliable, clean water and adequate sanitation services for all is a foundation of a green economy.
- The drought that affected Maharashtra in 2013 tells us that our water management strategies are skewed. Water must be managed in a way to enable its equitable and distributed access. Rain has to be harvested.

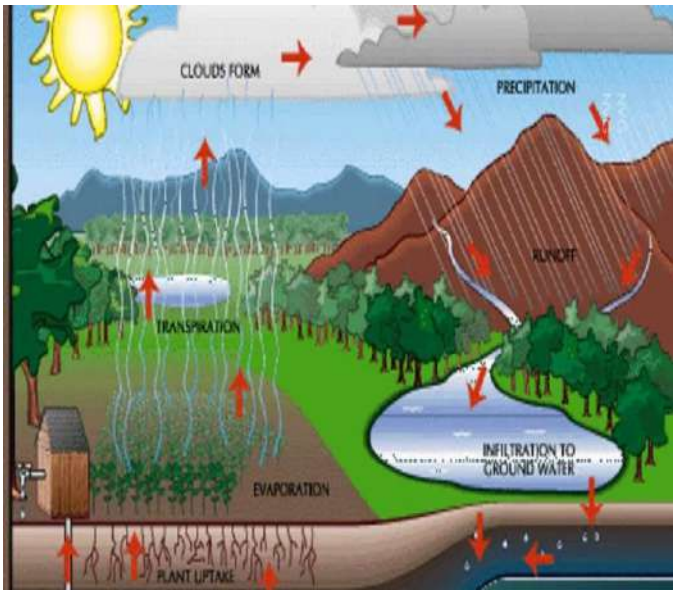
Rainwater is one of the simplest and oldest methods of self-supply of water for house-holds.

- It provides an independent water supply.
- It provides water when there is a drought and can help to mitigate flooding of low-lying areas.
- It helps in the availability of potable water as it is substantially free of salinity.

Today, most of the nations are effectively using rainwater harvesting. It is a cheap and reliable source of clean water.

**6.2.3. Watershed Management**

***Watershed Management seeks to manage water supply, the quality of water, drainage, water rights and the overall planning and utilisation of watersheds.*** It is the study of the relevant characteristics of a watershed aimed at sustainable distribution of its resources and creating and implementing plans and programmes that affect the plant animal and human communities within the watershed boundary. It is an integrated and interdisciplinary approach.




It must consider the social, economic and institutional factors operating within and outside the watershed.

- It relates to soil and water conservation in the watershed which includes proper land use, protection of land against all forms of degradation, flood protection, water conservation and harvesting, proper management of surface and ground water. The requirement of watershed management has increased in this time of water shortage.

- It helps to recharge groundwater. Afforestation of degraded areas is an important aspect of watershed management.
- Watershed management can preserve water for the existence of a human race and environmental protection.

## 6.3. RESETTLEMENT AND REHABILITATION OF PEOPLE: ITS PROBLEMS AND CONCERNS

Resettlement and rehabilitation of the people is one of the challenges faced by nations who rush in the path of development.

**What is Resettlement and Rehabilitation?**

***Resettlement refers to the process of settling again in a new area. Rehabilitation means restoration to the formal state.***

When there are natural disasters and the government acquires land for development purpose, the populations of that place have to be shifted to another place. This arrangement of providing shelters in other places is known as resettlement. Though dams, express highways, metros, container terminals etc. are essential for development, the problems of the rehabilitees cannot be neglected. Especially, the state of marginalised tribal community who are removed due to the construction of dams and hydroelectric projects. The problems faced by the people who are rehabilitated because of natural calamity and development programmes are the same everywhere. The adverse social and economic impacts include: people losing their homes, land and livelihood and are often left to face their own and uncertain future in unfamiliar places.

**Reasons for Resettlement and Rehabilitation**

1.Due to natural disasters & manmade disasters.
2.Developmental projects like dam construction, irrigation canals, reservoirs etc.
3.Infrastructural projects like bridges, roads, metros etc.
4. Energy related projects like power plant, mining activities etc.
5. Projects related with the conservation of wild life like national park, sanctuaries etc.

**Problems and Concerns:**

According to the statistics of World Bank, around 10 lakh people have been rehabilitated due to various reasons. The main challenge of the government is to find out a sustainable place to rehabilitate. There is also emotional and psychological trauma caused by forcibly removing people from their homeland where their families have lived for centuries. Experience has shown that most people who are forcefully relocated are unable to regain their losses, and end up worse off than before. In India the track record of efforts undertaken to resettle displaced people remains quite small.

**Main problems faced by the displaced ones are:**

1. Meagre compensation
2. Lack of facilities in the new place.
3. Loss of livelihood
4. Stress and health problems
5. Loss of identity
6. Lack of political support

Thus, as a result of development efforts that are intended to improve living conditions, millions have become worse off, a situation in direct opposition to what development stands for.

In India, laws specifically to deal with resettlement issues, do not exist. It is still based on land acquisition law and not intended to address the problems faced due to acquisition of the land for dams, thermal power stations, SEZs, highways, mining, airports and other development projects. Protest of people in West Bengal against Tata, Singur-Nandigram issues, Muthanga and Wyanad incidents in

Kerala are all related to land acquisition. Finally, in 2007, the Government of India notified the National Rehabilitation and Resettlement Policy. The main *objectives of rehabilitation policy* are:

1. Allow the people, especially the tribal, to live their lives in their own patterns.
2. Ensure employment opportunities to the displaced.
3. Resettlement should be in the neighbourhood of their own environment.
4. The people displaced should get an appropriate share in the fruits of development.

**Case Study 1: Tehri Dam Project, Uttarakhand**

The Tehri dam project is located at the confluence of Bhagirathi and Bhilganga rivers in the Himalayan region of the state of Uttarakhand. The Tehri dam is the highest dam in India and one of the highest in the world. The construction of the dam in 1972 was one of the giant steps of political leaders to convert the state into an 'Urja Pradesh' (energy state). The dam has come under criticism for several reasons, such as economic viability, environmental degradation, safety concerns, and population displacement. Scientists, environmentalists and local people were against the construction of this dam. Construction of the dam at such a location has resulted in massive population dislocation. Environmental activist Sundarlal Bahuguna led the Anti-Tehri dam movement for years. This region was the site of a 6.8 magnitude earthquake in October 1991. If a catastrophe occurs, the potentially resulting dam-break would submerge numerous towns downstream.

**Case Study 2: Narmada BachaoAndolan (NBA)**

The Narmada Valley Development Project is the single largest river development scheme in India. It is one of the largest hydroelectric projects in the world and displaces more than 41,000 families (over 200,000 people) in the three states of Gujarat, Maharashtra, and Madhya Pradesh. Over 56 per cent of the people affected by the dam are adivasis. Of the 30 big dams proposed along the Narmada, Sardar Sarovar Project (SSP) and Narmada Sagar Project (NSP) are the mega dams. The SSP in the Narmada River Valley is one of the largest and most controversial of the large dams in India.The 30 large, 135 medium and 3000 small dams planned on the river and her tributaries, are collectively called the Narmada Valley Development Project (NVDP). For the last two decades, the people affected by this

project have been challenging many issues related to the dam, primarily displacement and rehabilitation.

## 6.4. ENVIRONMENTAL ETHICS: ISSUES & POSSIBLE SOLUTIONS

*Environmental Ethics*is connected with the fundamental rights of man for life and welfare. Its need is to keep nature's resource for today's requirement and also preserving it for the future generation. ***Environmental ethics deals with how we utilise and distribute resources.It includes the rights of all living beings to live and maintain the ecosystem.***

- It recognise plant and animal rights.
- It realize the intrinsic worth of nature.

It implies:

- Humanity's relationship to the environment.
- Its understanding and responsibility towards the nature
- Its obligations to leave some of nature's resources to future generations
- The preservation of the wilderness and of species diversity
- It asks comprehensive, global questions, develop metaphysical theories and applies its principles to the daily lives of men and women everywhere on earth.

Therefore, it deals mainly with the following:

1. Resource conservation
2. Equity concerns - (between countries and between urban and rural).

### 6.4.1. Resource conservation and equitable distribution

It is the inequality of the distribution of nature's resource that leads to competitions. This inequality is the reason for the differences between nations, haves and the have nots, rural and urban communities, the rich and the poor. The acquisition of resources by exploiting the marginalised and tribal communities is not justified. "The report of **'Status of India's Environment'** published by Anil Agarwal in 1985, throws light on this pathetic situation. The reason for all environmental problems is the consumption of the rich and the developmental activities by exploiting the poor. He brought forth the following propositions which are of great relevance to the ethical issues that are related to environmental concerns."

Propositions related to the **ethical** issues:

1. Environmental destruction is largely caused by the consumption of the rich.
2. The worst sufferers of environmental destruction are the poor. Even among the poor, the worst sufferers are the marginalised communities and women.
3. Even where nature is being 'recreated', as in afforestation, it is being transformed away from the needs of the poor.

4. There cannot be proper economic and social development without a holistic understanding of society and nature.
5. If we care for the poor, we cannot allow the Gross Nature Product to be destroyed any further. Gross Nature Product will be enhanced only if we can arrest and reverse the growing alienation between the people and the common property resources.
6. It is totally inadequate to talk only of sustainable rural development, as the World Conservation Strategy does. We cannot save the rural environment or rural people dependent on it unless we can bring about sustainable urban development.

Who is really suffering the environmental degradation and who pays for the environmental degradation? Certainly, they are village folks, tribal people and rural women. Village Community is already aware about the preservation of our valuable natural resources. So urban people should be taught the importance of preservation of natural resources than the village folk. The conservation of common property resources also should be one of our aims.

**Equity issues**

Daniel D Chirasin "*Environmental Science –Creating a sustainable future*" explains ***3 ethical principles*** related to environment. They are:

1. *Intergenerational equity:* Fairness to future generations. Present generations have anobligation to meet their needs in ways that do not foreclose on future generations.

2. *Intra-generational equity:* Present generations also have an obligation to act in waysthat do not prevent others who are alive today from meeting their needs.

3. *Ecological Justice:* Human actions should not endanger other species, which also havean inherent right to resources they need to survive.

It is also concerned with who owns the resources. Today, economically advanced nations areexploiting the worlds' resource, along with the developing countries. Divisions such as North-South, rich and poor aggravate this. Growing urbanisation also intensifies it.

**What are the possible solutions?**

For the preservation of nature's resources, equal division is needed. There should be appropriate efforts from the part of government for this conservation of natural resources. We need an institutional management policy to preserve the resources of village areas and to provide the necessary things to the urban society also.

1. The urban population should be made aware of the preservation of natural resources. At the same time, village folk should be taught about global warming, climate change and the selection of suitable cropping pattern.

2. A sustainable ecosystem that preserves the resources for the future generation should be framed and things be executed.

3. All the living beings also have rights to enjoy the earth as human beings do. As Mahatma Gandhi stated, “Human beings are the trustees of the lower animal kingdom”. The existence of human beings in an ecosystem depends onthese living beings also.

4. Plastic that harms the nature must be reduced. Awareness regarding the necessity of energy and water conservation, waste management and pollution control must be created people and local government, educational institutions and others must take the leadership and act.

## 6.5. CLIMATE CHANGE, GLOBAL WARMING, ACID RAIN, OZONE LAYER DEPLETION, NUCLEAR ACCIDENTS AND HOLOCAUST

### 6.5.1 Climate Change

***Climate change is a change in the global or regional climate patterns.*** It is caused by factors such as biotic processes, variations in solar radiation received by the earth, platonic and volcanic eruptions. Certain human activities have also been identified as significant causes of climate change often referred to as **‘Global Warming’**.

According to Intergovernmental Panel on Climate Change(IPCC) Fourth Assessment, climate change will create more stress on the sustainable development capabilities of countries like India. IPCC studies shows that in near future, the global mean surface temperature will rise by 1.4° to 3.8°C. Warming will be greatest over land areas and at high latitudes. The projected rate of warming is greater that has occurred in last 10,000 years.

**Reasons for Climate Change:**

- Global concentration of carbon dioxide in the atmosphere
- Unscientific land usage
- Pollution
- Deforestation

The predictions for the Indian subcontinent suggest that there would be an increase in precipitation in the summer monsoons and decrease in rainfall during the winters. This could lead to increase in floods in the summer monsoons and droughts in the winter season. India ranks second among the world’s countries with the highest population in the Low Elevation Coastal Zone (LECZ). Mumbai, Visakhapatnamand Kochi have shown a sea-level rise of slightly less than 1 mm/year, while Chennai showed a rate of decrease. A sea level rise of even 1 mm would pose stress for the inhabitants of the coastal regions. A rise in temperature is likely to accelerate the hydrological

During the 1980’s a number of international scientific research initiatives dealing with nature emerged, including:

- The World Climate Research Programme (WCRP) in 1980.
- The International Geosphere and Biosphere Programme (IGBP) in 1986.
- DIVERSITAS (on biodiversity and ecology) in 1990.
- The United Nations Intergovernmental Panel on Climate Change (IPCC) by World Meteorological Organization (WMO) and UNEP in 1988.
- International Human Dimensions to Global Environmental Change (IHDP) with global scientific expertise in 1996.
- Millennium Ecosystem Assessment (MA) launched by UN Secretary-General Kofi Annan in 2001.

cycle, altering rainfall and magnitude. Climate change could have an impact on soil moisture, groundwater and surface water availability, and occurrences of floods and droughts.

**Effects:**

1. Global mean sea level is projected to rise by 9 to 88cm by the year 2100.This will seriously affect various Nations especially Nile delta in Egypt, Ganga -Brahmaputra delta in Bangladesh, Maldives Island, etc.
2. It leads to different types of health problems. It may affect the distribution of vector species (eg: mosquitos) which in turn will increase the spread of diseases like Malaria and Dengue. Contaminated water, damaged sewage system, etc. are also the reasons for the above illness.
3. Human societies will be severely affected by extreme climatic conditions such as droughts and floods. The situation of non-availability of food, shelter and safe drinkingwater will lead to the disaster of mankind.
4. It will seriously affect the agricultural production and also cause reduction of food leading to starvation and malnutrition.
5.It leads to destruction of our biodiversity and ecosystem.

**Effects:**
1. Increase of temperature
2. Rise of sea level & cause climate change
3. Cause for Acid Rain
4. Health problems.
5. Droughts and Floods
6.Affect agricultural production
7.Destruction of biodiversity and ecosystem

**How to control and what are the strategies to be adopted?**

1.People should be enlightened. Our misuse of natural resources is main reason for this. We need to protect it by creating public awareness.
2. Monitoring infectious diseases to detect early changes in incidence of diseases and take proper measures to prevent it.
3. Take environmental management and institutional measures to reduce risk and to face disaster preparedness for floods, droughts and health related consequences.
4. Enact proper legislations specially to control pollution and protect environment.

### 6.5.2 Global Warming

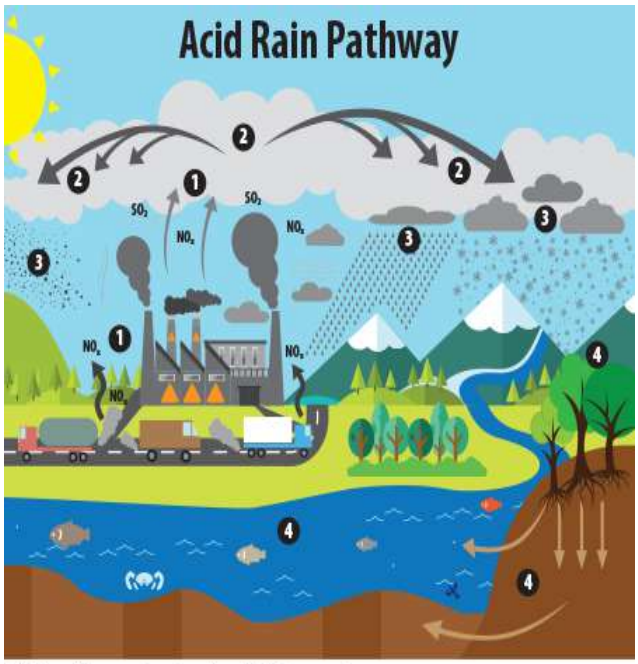
***Global warming means increase in the average temperature of the Earth's near-surface air and the oceans.*** Climate change results from the global warming and caused in turn the presence and accumulation of greenhouse gases in the atmosphere. The gases like carbon dioxide ($CO_2$) and methane ($CH_4$), are released into the air by the burning of fossil fuels such as coal, oil and gas as well as biomass. The emission of these greenhouse gases is a main reason for global warming. Global warming is also caused by land use change, for example in the burning of forests that reduces forest cover and leads to deforestation. The IPCC warned that by the end of the 21$^{st}$century, it is possible that the earth's temperature would rise by $2.4^0$ to $6.4^0$C.

The Conference of the Parties (COP) of the UN Framework Convention on Climate Change (UNFCCC) held in Kyoto in 1997 agreed on a plan to reduce the emission of $CO_2$ and there-by control greenhouse gas emissions.

### 6.5.3 Acid Rain

Due to the burning of fossil fuel (coal, oil & natural gas) chemicals such as Sulfur Dioxide, Nitrogen dioxide, etc. are formed in the atmosphere, and they mix with atmospheric air and other chemicals resulting in sulfuric acid, nitric acid and other harmful pollutants like sulfates and nitrates which are highly soluble in water. During the rains, these oxides react with large quantities of water vapour of the atmosphere and becomes acidic resulting in a condition called ***acid rains***. Eventually, the rain hits earth and the acid pollutants changes into dry particles and become acidic deposits.

**Effects:**




This image illustrates the pathway for acid rain in our environment:
(1) Emissions of $SO_2$ and $NO_x$ are released into the air, where (2) the pollutants are transformed into acid particles that may be transported long distances. (3) These acid particles then fall to the earth as wet and dry deposition (dust, rain, snow, etc.) and (4) may cause harmful effects on soil, forests, streams and lakes.

1. Dissolves and washes away nutrients in the soil.
2. Dissolves naturally occurring toxic substances and pollutes water.
3. Destroys our aquatic ecosystems by making water acidic and this affects plant and animal life.
4. It affects wildlife, species and the entire ecosystem.
5. Acid deposition damages buildings, automobiles, and other structures made of stone and metal and causes extensive damage and ruins historic buildings.
6. Adversely affects human life by creating health issues.

**What are the solutions?**

Acid rain is a potential threat that affects the existence of mankind. Acid rain can be controlled up to a certain extent by avoiding or limiting the use of sulphur dioxide and nitrogen oxide that leads to air pollution and also by reducing the burning of fossil fuels. Using of public transportation instead of private motor vehicles brings down the atmospheric pollution and also prevent acid rain. If industries use smoking stacks, atmospheric pollution can be prevented by blocking smoke.

### 6.5.4 Ozone layer depletion

**Causes for Ozone layer depletion**
**Natural Causes**
Stratospheric winds
Sun-Spots

**Man-made causes**
Chlorofluorocarbons
Methyl Chloroform
Hydrochlorofluorocarbons
Carbon Tetrachloride

Ozone layer depletion is yet another challenge that needs to be addressed. It is one of the main reasons for global warming. Ozone is formed by the action of sunlight on oxygen and forms a layer 20 to 50 km above the surface of the Earth. Ozone is highly poisonous gas with a strong odour. Ozone in the upper atmosphere is vital to all life as it protects the earth from the sun's harmful ultraviolet radiation (UVR). UVR are high energy electromagnetic waves emitted by the Sun which on entering earth's atmosphere can lead to various environmental and health issues such as Asthma and Bronchitis. It is this ozone layer in the atmosphere that prevents ultraviolet rays falling from the sun to the earth.

The studies conducted in 1970 by the scientists confirm that Chlorofluro Carbons (CFC) used as the refrigerators and aerosol spray propellants, pose a threat to the ozone layer. It is proved in Antarctic and Austria that ozone layer there becomes thinner.

Ozone depletion causes disease such as skin cancer, cataracts, etc. It also affects our agricultural practices and food products. It leads to the increase percentage of certain dioxide in the atmosphere. Reducing the quantity of CFC is the remedy for preventing ozone layer depletion. The world has come forward for this and has enacted various laws. But apart from CFC, bromine an industrial component, and halocarbons and nitrous from fertilisers and many such chemical elements are also responsible for ozone depletion.

### 6.5.5 Nuclear Accidents and the Holocaust

Nuclear Energy is one of the important inventions of mankind. But the stroke of a nuclear accident will be more dreadful than all other calamities. Even a slight leak due to an accident will lead to a terrible terrific disaster that would last for years. It is because nuclear devices have radioactive elements that emit harmful radiations. It causes thermal pollution and the by-products of radioactive fatally affects human life.

Long term illness, genetic disorder, cancer and death results because of nuclear accident. Bhopal gas tragedy (1984), Three Mile Island (American reactor failure 1979), The Mount Pinatubo Volcano (1991), Chernobyl (1986) etc., are few examples for this dreadful disaster.

Nuclear holocaust refers to the use of nuclear energy in the II World War. The dropping of nuclear bomb by the U.S. in Nagasaki and Hiroshima of Japan in 1945, destroyed an entire population. Its aftereffects are still being borne by victims. Six countries – US, China, the Soviet Union, Britain, France and India have already tested nuclear weapons.

**Case Study 1: Chernobyl Nuclear Accident**

The 1986 Chernobyl nuclear accident, according to United Nations (UN), was 'the greatest technological catastrophe in human history'. It occurred on 26$^{th}$April 1986 at the Chernobyl Nuclear power plant near Pripyat. It was then part of the USSR. There was a sudden and unexpected power surge. Nearly 7 tons of irradiated reactor fuel was released into the environment. We humans cannot protect ourselves from such radiation because we are biologically not equipped to do so. Its effects are silent but deadly. Six years of the accident there has been a hundredfold increase in thyroid cancers in Belarus, Russia and Ukraine. Apart from cancers, blood disorders and immune system problems are also seen,

Chernobyl survivors face a high number of mental disorders. Effects on them are similar to those that have occurred in Hiroshima and Nagasaki. Chernobyl fatalities are disturbing not only because of their sheer magnitude but also because they exhibit environmental injustice on a global scale. On the one hand, the Soviet, the French, UN agencies and many proponents of nuclear power claim that Chernobyl caused only a smaller number of causalities but IAEA (International Atomic Energy Agency), places the number of Chernobyl fatalities are more than what they claimed. In 1995 UNESCO warned that the radioactivity released by Chernobyl would never disappear completely from the biosphere.

**Case Study 2: Bhopal Disaster**

Union Carbide India Limited's (UCIL's) Bhopal, Madhya Pradesh plant operated for barely 15 years (1969-1984), but it has left behind a legacy like no other industrial plant. This plant caused the world's worst industrial disaster that killed thousands. Over 5,00,000 people were exposed to methyl isocyanate gas and other chemicals. The highly toxic substance made its way into and around the city located near the plant. People affected by the gas leak on the fateful nights of December 2-3, 1984 are still suffering and dying. What most people don't realize is that the legacy of that plant continues to spill toxins into the city's land and water. In 2009 a study by Centre for Science and Environment pointed towards widespread contamination of soil and groundwater in and around the Union Carbide plant site.

## 6.6. CONSUMERISM AND WASTE PRODUCTS

Consumerism is related to the constant purchasing of new goods. There is little regard for the true utility of what is bought. The inordinate amount of waste that is generated by consumer-oriented societies around the world is now a serious environmental issue. Despite the hike in the county's income after emerging as a consumer state, the damage it brings to environment is greater than the income. The over using of disposable items in the urban areas is very high today. The augmentation of non-degradable item like plastic is a potential threat not just to humans but also to the plants and animals alike. The rise of motor vehicles leads to various kinds of pollutions and health issues. It paves way to the harmful phenomenon such as global warming, ozone layer depletion, etc. The

growth of consumer items without proper waste management brings many kinds of diseases. When consumption increases, production also increases and natural resources are exploited for this. The garbage expelled by the industries pollutes water. It is, therefore, essential that the domestic and industrial effluents are not allowed to be discharged into water courses without adequate treatment. As a result, the discharges would render the water unsuitable for drinking, marine life and irrigation. Dumping wastes into oceans and rivers create more damages to the environment. Therefore, reuse of goods, waste reduction should become part of the production-consumption cycle.

**What we can do?**

1. Do not use what is not needed. The aim should be a waste-free society.
2. Make durable quality products. Also, make products that can be recycled and re-used. Campaigns to make people capable to preserve and protect natural resources and stop the over using of products that harm the nature. Also, the violators of law be punished.
3. Large quantities of liquid waste expelled by the industries, pathological waste and plastic waste from hospitals, agricultural waste, human and animal waste cause different kinds of pollution and health problems. So, its environmental impact also should be assessed along with economic value before giving sanctions.
4. Our waste management principle should be 'Reduce, reuse and recycle'. What we need now is a proper recycling method.
5. Avoid the use of non-biodegradable materials.
6. Dematerialisation, i.e., the shift in consumption and production in favour of less material intensive products, using advanced technology and recycling will boost efficiency in material use. New Generation Environmental Technologies (NEGTs) support a new approach to environmental protection.

Resources must be conserved by proper selection, production and recycling and reducing unnecessary demand for consumption and inventing technologies which would make it possible for reusing the waste resources so as to reduce over exploiting our existing resources.

### 6.7. ENVIRONMENT PROTECTION ACT

This is an act to provide for the protection and improvement of environment and for matters connected therewith.

The Act came into force in 1986 and it is intended to remedy the gaps noticed in the earlier laws and to serve as a single environmental legislation.

It empowers the Central government to take **all measures as is deemed necessary for the protection and improvement of the environment and preventing, controlling and abating environmental pollution**.

In this Act, the term "***environment***" includes water, air and land and the interrelationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property. "***Environmental pollution***" means the presence in the environment of any environmental pollutant such as any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment.

Some of the important matters in this Act are as follows:

1.Planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution.

2. Laying down standards for the quality of environment.

3.Laying down procedures and safeguards for the prevention of accidents

4.Restriction of areas in which polluting activities shall not be carried out.

5.Inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and take steps for the prevention, control and abatement of environmental pollution.

6. Collection and dissemination of information in respect of matters relating to environmental pollution.

7. Preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution.

Whoever fails to comply with or breaks any of the provisions of this Act, or the rules made shall be punishable with imprisonment.

The National Environmental Tribunal Act has also come into force from 1995 to provide for strict liability for damages arising out of any accident occurring while handling any hazardous substance.

### 6.7.1. AIR (PREVENTION AND CONTROL OF POLLUTION) ACT

This act was enacted by the Parliament under Article 253 of the constitution of India to implement decisions of 1972 Stockholm conference on human environment and it came into force in 1981 as Air (Prevention and Control of Pollution) Act,1981.

This is an act to provide for the prevention, control and abatement of air pollution.

The main objectives of the Act are as follows:

- To provide for the Prevention, Control and abatement of air pollution. In this Act the term "air pollutant" means any solid, liquid or gaseous substance [including noise] present in the atmosphere in such concentration and tend to be injurious to human beings or other living creatures or plants or property or environment.
- The establishment of Central and State Boards with a view to implement the Act, and to confer on the Boards the powers to implement the provisions of the Act.
- Set up of Pollution Control Boards (PCBs) to measure pollution levels in the atmosphere.

**Powers and functions of Central and State boards**

Advise the Central Government on any matter concerning the improvement of the quality of air

- Co-ordinate the activities of the State and resolve disputes among them.
- Provide technical assistance and guidance to the State Boards to carry out functions.
- Collect, compile and publish technical and statistical data relating to air pollution
- Lay down standards for the quality of air.

**State Pollution Control Boards:**

- To plan a comprehensive programme for the prevention, control or abatement of air pollution
- To collect and disseminate information relating to air pollution.
- Organising the training and mass-education programmes relating prevention and control of air pollution.

**6.7.2. WATER (PREVENTION AND CONTROL OF POLLUTION) ACT**

The main objectives of the Water Act 1974 are to provide prevention and control of water pollution. The Central Government and State Governments have set up Pollution Control Boards that monitor water pollution.

The Central Pollution Control Board (CPCB) which forms part of the Ministry of Environment and Forests (MOEF) is a body consisting of experts in water and air pollution abatement drawn by the Central Government to protect the interest of key sectors like industry, agriculture, fishery, trade etc.

**The CPCB has to perform the following functions:**

- Advise the Central Government on any matter concerning the prevention and control of water pollution.
- Co-ordinate the activities of the State Boards and resolve disputes among them.
- Provide technical assistance and guidance to the State Boards to carry out functions.
- Plan and organise the training programs for the prevention, control or abatement of water pollution.
- Organising comprehensive programme through mass media.
- Collect, compile and publish technical and statistical data relating to water pollution.
- Lay down, modify the standards for water quality.

**State Pollution Control Board (SPCB) functions are as follows:**

- To plan a comprehensive programme for the prevention of pollution in the State.
- To advise the State Government on matters concerning the control and abatement of water pollution.
- To collect and disseminate information relating to water pollution.

- To encourage, conduct and participate in investigations and research related to water pollution.
- Organising the training of persons.
- Lay down and modify standards for water quality.
- To evolve economical and reliable methods of treatment of effluents and utilisation of sewage and suitable trade effluents in agriculture.
- The Board may establish a laboratory to perform its functions including the analysis of samples of water from any stream or well or of samples of any sewage or trade effluents.

The Water Cess Act enacted by the Parliament in 1977 and its amendments in 1988 provides levying a tax or cess on water consumed by certain industries and by local authorities. The objective of this tax is to increase the resources of the Central and State Pollution Control Boards for the prevention and control of water pollution. Penalties are charged for acts that have caused pollution.

### 6.7.3. WILDLIFE PROTECTION ACT 1972

This is an act to provide for the protection of wild animals, birds, and plants and also their habitats.

- It deals with the declaration of National Parks and Wildlife Sanctuaries and their notification.
- It establishes the structure of the State's wildlife management.
- It provides for setting up Wildlife Advisory Boards.
- It prohibits hunting of all animals specified in Schedules I to IV of the Act.
- This act defines animals as "amphibians, birds, mammals, and reptiles, and their young, and also includes, in the cases of birds and reptiles, their eggs".
- Under this Act, comprehensive listing of endangered wildlife species was done for the first time and prohibition of hunting of the endangered species was mentioned.
- The act imposes a ban on the trade or commerce in scheduled animals.

The Amendment to the Wildlife Protection Act in 2002 and 2013 prevents the commercial use of resources by local people. It has brought in new concepts such as the creation of Community Reserves.

The 42$^{nd}$ Constitution Amendment, 1976 provides protection and improvement of the environment and safeguarding of forest and wildlife in the Directive Principles of State Policy and declares that it is the fundamental duty of every citizen to protect and improve natural environment including forest and wildlife.

The State Governments may declare any area to be a sanctuary or national park, if they consider the area to be of adequate ecological significance for the purpose of protecting, propagating or developing wildlife and its environment.

The wild life protection policy looks into the following matters:

1. Formulation of National Wildlife Action Plan.

2. Establishment of National parks and Sanctuaries.
3. Eco-development plans for Sanctuaries and National parks.
4. Identification of bio-geographical zones in the country.
5. Full and correct rehabilitation of poor/tribal population displaced due to creation of national parks/biosphere reserves/tiger reserves.
6. Maintenance of corridors between national parks, sanctuaries, forests and other protected areas.

A person who breaks any of the conditions of any license or permit granted under this Act shall be guilty of an offence against this Act. The offence is punishable with imprisonment.

### 6.7.4. FOREST CONSERVATION ACT

India's first Forest Policy was enunciated in 1952. The Indian Forest Act of 1927 consolidated all the previous laws regarding forests that were passed before the 1920's. The Act gave the Government and Forest Department the power to create Reserved Forests, and the right to use Reserved Forests for Government use alone. This Act was enacted mainly to control deforestation. It ensured that forestlands could not be de-reserved without prior approval of the Central Government.

The Act made it possible to retain a greater control over the frightening level of deforestation in the country and specified penalties for offenders.

The Act remained in force till the 1980s and Forest Conservation Act came into force in 1980 and its amendment in 1988.

The 42$^{nd}$Constitution Amendment,1976, forests were removed from the State list and included in the concurrent list (list of rights and duties common to State and Central Government).

The Scheduled Tribes and Other traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, is a key piece of forest legislation passed in India in 2006. It has also been called the Forest Rights Act, the Tribal Rights Act, the Tribal Bill, and the Tribal Land Act. The law concerns the rights of forest-dwelling communities to land and other resources, denied to them over decades as a result of the continuance of colonial forest laws in India.

The **basic objectives of the forest policy** are as follows:

- Maintenance of environmental stability. Preservation and restoration of the ecological balance.
- Conserving the natural heritage of the country
- Increasing substantially the forest/tree cover in the country through massive afforestation and social forestry programmes.
- Encouraging efficient utilization of forest produce and maximizing substitution of wood.
- Creating a massive people's movement to achieve these objectives and to minimize pressure on existing forests.
- Preventing the use of forest land for any other purpose.

- Setting up of National Wastelands Board to guide the wastelands development programme.

  A person who commits any of the offences like felling of trees, or strips off the bark or sets fire to protected forests shall be punishable with imprisonment.

### 6.8. ISSUES INVOLVED IN THE ENFORCEMENT OF ENVIRONMENT LEGISLATION

Various legislations have been passed in our country to protect the natural resources. For example, Environment Protection Act, Wildlife Protection Act, Water & Air Pollution Prevention Act, etc. But we cannot protect the nature with statues alone. It becomes meaningful, only if itis implemented effectively. We need people capable of executing it. Today, government organisations and NGO's are taking leadership for it. We need the preservation of nature with the participation of the public; the problem is in the effective execution of these laws and rules.

We can protect the nature by formingthe development projects suitableto that particular area. The foremost thing required for that is the assessment of the environmental impact due to the project.

**Individual actions count**:

1. Be Frugal-Buy only what you need. Be a conscientiousconsumer.
2. Be Efficient- Support legislation and non-profit organisations that promote energy efficiency. Use all resources inyour day to day life efficiently.
3. Be a Recycler- Support legislation that promote recycling.Recycle all wastes that you can and buy products madefrom recycled materials too.
4. Support Renewable resource use- Promote and supportrenewable energy. Wherever possible use renewable energy.
5. Help to Restore the environment – take an active part in restoring damaged ecosystems. (Raven & Bero).

Any developmental project both private and government should get the green signal from Environment Impact Assessment (EIA) committee. The EIA must look into physical, biological and social parameters. The projects that may bring destruction to the nature, should not get the license. Ministry of Environment and Forest (MOEF) should give permission only if there is assurance from EIA that the project will not cause harm to the nature. EIA must define what impact it would have on water, soil and air. It also requires that a list of flora and fauna identified in the region is documented and to specify if there are endangered species whose habitat or life could be adversely affected. Already it is listed that 30 industries require a clearance before they set up. 'Greenfield 'projects (new projects where no development has been done) and brown projects (projects that already exist but require expansion) must also get clearance from MOEF. Now environmental clearance for a project has become mandatory.

Besides this, the permission of State Pollution Control Board is also necessary,at local level. Public hearing should be conducted for certain projects especially that need resettlement.

Our problem is not the lack of rules, but the impediment to using the existing rules. Proper compensation should be fixed if the projects harm the environment. Moreover, resettlement and

rehabilitation should be done for those who face displacement. Equitable resource distribution, proper compensation etc. should be observed.

Each citizen should do his duty along with the engagement of his rights. We can protect our environment by forming a collective action or action group. An individual has the right to bring an environmental offence to the attention of concerned authorities. Narmada Bachao Andolan, Silent Valley Project, Protest against Athirappilly hydroelectric project especially Kadar tribe, etc. are the examples for the public collective action to protect the legal battles.

### 6.9. PUBLIC AWARENESS

Enlightening the people is also important as making the legislation for protecting the nature. This can be executed through media, documentaries, educational institutions, campaigns and through local governments, etc. We celebrate various kinds of environmental days, such as World Wetland day (February 2), World Health day (April 7), Earth day (April 22), World Environment day (June5), World Ocean day (June 8), World Ozone day (September16) etc. But we must be get ready to protect nature by understanding its proper meaning and value, instead of confining it into calendar. Everybody should know what is happening around them.

We can protect the environment through public participation and education.

## QUESTIONS

### Part A (2 marks)

1. What individuals can do to preserve energy?
2. Why preservation of water is essential?
3. Define Rainwater harvesting.
4. What is Acid rain?
5. What is Ozone layer depletion?
6. What is global warming?
7. Explain Watershed Management.
8. What do you mean by resettlement?
9. What is Rehabilitation?
10. What are the main problems faced by the displaced?
11. Write reasons for resettlement and rehabilitation.
12. What is Environmental Ethics?
13. What is Intergenerational equity?
14. What is Ozone layer depletion?

15. State the meaning of environmental protection act.

**Part B (5 marks)**

16. What are the reasons for the increase of energy consumption in urban areas?
17. Explain the need for Water conservation and its goals.
18. Why Rain water harvesting is important?
19. Write importance of watershed management.
20. Write a short note on objectives of rehabilitation policy.
21. Briefly state the ethical principles related to the environment and what are its solutions?
22. Explain the effects and strategies to control climate change.
23. Describe the need for public awareness to protect our environment.
24. Comment on global warming & its effects.
25. What are the causes and effects of acid rain?
26. Write a note on environmental protection.
27. Explain Wildlife protection Act?
28. State the basic objectives of the forest policy.
29. Briefly explain Air prevention and control of pollution Act?
30. Explain Water Prevention and Control of Pollution Act.
31. What are the issues involved in the enforcementof environment legislation?Describe the role of an individual in conservation of environment.

**Part C (10 marks)**

32. Discuss various environmental protection act in India related to air and water.
33. Explain forest and wild life environmental protection act.
34. Analyse various environmental issues related to climate change, global warming and acid rain.
35. Explain the concept of 'Environmental Ethics', its issues and possible solutions.
36. What is Resettlement and Rehabilitation? Discuss the reasons and problems related to Resettlement and Rehabilitation policies in India.

# CHAPTER 7

# HUMAN RIGHTS

## 7.1. Introduction to human rights -meaning, concept, development

Human right means **"*the basic rights and freedom to which all humans are entitled*".**

All human beings are born free and equal in dignity and rights. Irrespective of his or her race, nationality, caste or gender, it recognize the dignity inherent in each person as a human being. The Oxford English Dictionary defines a *right* as *"a justifiable claim, on legal or moral grounds, to have or obtain something, or act in a certain way"*. The notion of human rights in the 20th century extended the idea of individual rights to include all human beings, regardless of citizenship or state affiliation.

Human rights include civil and political rights, such as:

- The right to life, freedom, and property
- Freedom of expression
- Quest of happiness and equality before the law
- Social, cultural and economic rights, including the right to participate in science and culture, the right to work, and the right to education etc.

The primary element consistent throughout each of the above definitions is "**Universality**" - human rights are unchallengeable.

### 7.1.1. Development of Human Rights: Natural law to Human Rights

Human rights are considered the offspring of natural rights, which themselves progressed from the concept of natural law. Natural law is a standard of higher-order morality against which all other laws are ruled. It provided a basis for curbing excessive power of state over society. Eventually this concept of natural law evolved into natural rights; this change reflected a shift in emphasis from society to the individual.

John Locke, a famous Philosopher, in his *Second Treatise on Government* (1690), states that "prior to the creation of society each person possessed a set of natural rights including the rights to life, liberty and property." Locke's principles were adopted by the founding fathers of the United States in the Universal Declaration of Independence (1776). To secure rights such as life, liberty and the pursuit of happiness, governments are instituted among men, deriving their just powers from the consent of the governed. These principles were further expounded and enshrined in the U.S. Constitution (1787) and Bill of Rights (1789).

A series of international human rights treaties and other instruments adopted since 1945 have expanded the body of international human rights law. **The Universal Declaration of Human Rights (1948)** was the first legal document protecting universal human rights.

The Universal Declaration of Human Rights, International Agreement on Civil and Political Rights and the International Agreement on Economic, Social and Cultural Rights were the three instruments which form the so-called **International Bill of Human Rights**.

**7.1.2. Three Generations of Human Rights** (Civil and Political Rights, Economic, Social and Cultural Rights).

The division of three generations of human rights was introduced **by a Czech Jurist, KarelVasak**in **1979**. The three categories fall in line with the three doctrines of the French Revolution such as: ***liberty, equality, and fraternity***.

The three generations of human rights divisions are:

- *Civil-Political (First-generation )*
- *Socio-economic (Second-generation)*
- *Collective-developmental (Third-generation)*


*First-generation, "civil-political" rights* deal with liberty and participation in political life. They are strongly individualistic and constructed to protect the individual from the state. These rights draw from the United States Bill of Rights and the Declaration of the Rights of Man and Citizen in the 18th century.

*Second-generation, "socio-economic*" *human rights* guarantee equal conditions and treatment. They are not rights directly possessed by individuals but constitute positive duties upon the government to respect and fulfil them. It began to be recognized by governments after World War II and, like first-generation rights, is embodied in Articles 22 to 27 of the Universal Declaration. They are also enumerated in the International Agreement on Economic, Social, and Cultural Rights.

*Third-generation, "collective-developmental" rights* of peoples aligns with the final principle of "fraternity." They constitute a broad class of rights and that have gained acknowledgment in international agreements and treaties (Twiss, 2004). They have been expressed largely in documents advancing aspirational "soft law" such as the 1992 Rio Declaration on Environment and Development, and the 1994 Draft Declaration of Indigenous Peoples' Rights.

In short, the first two represent the potential claims of individual persons against the state and its norms accepted in international treaties and conventions. The third type, which represents potential claims of peoples and groups against the state and it lacks both legal and political recognition.

Each of these types includes two further subtypes.

*Sub type of Civil-Political human rights*:

- Norms relating to physical and civil security (for example, equality before the law, no torture, slavery, inhumane treatment, uninformed arrest etc)
- Norms relating to civil-political liberties or empowerments (for example, freedom of thought, conscience, and religion, political participation in one's society ,freedom of assembly and voluntary association etc).

*Sub type of Socio-economic human rights*:

- Norms relating to the provision of goods to meet social needs (for example, shelter, health care, nutrition, education etc)
- Norms relating to the provision of goods to meet economic needs (for example, minimum standard of living, work and fair wages, a social security net etc)

*Sub type of Collective-developmental human rights:*

- The self-determination of people (for example, Political status of people and their economic, social, and cultural development etc)
- Special rights to certain national and religious minorities (for example, to the enjoyment of their own cultures, languages, and religions etc).

The framework of three generations covers many of the key debates about the nature of rights. It also encourages us to take a critical approach in challenging our own assumptions about rights as we begin to think about some of the real-world problems involved in the application of human rights.

## 7.2. HUMAN RIGHTS AND UNITED NATIONS

*"Human right means rights inherent to all human beings, whatever our nationality, place of residence, sex, national or ethnic origin, colour, religion, language, or any other status"- **The United Nations Office of the High Commissioner for Human Rights.***

### 7.2.1. Protecting human rights: Role of UN offices

The Charter of the United Nations was signed on 26th June 1945 and came into force on 24th October 1945.The UN Charter expressed a commitment to uphold human rights of citizens and outlined a set of principles relating to achieving 'higher standards of living', addressing 'economic, social, health, and related problems,' and universal respect for, and observance of, human rights and fundamental

freedoms for all without any distinction such as race, sex, language, or religion.The Statute of the International Court of Justice is an integral part of the Charter.

Main Bodies of UN system includes:

- General Assembly
- Security Council
- Economic and Social Council
- Trusteeship Council
- International Court of Justice
- Secretariat

In UN System, the Office of the ***UN High Commissioner for Human Rights*** **(OHCHR)** has lead responsibility for the promotion and protection of human rights. The office supports the human rights components of peace keeping missions in several countries, and has many regional offices and centres in different countries.

- The *Human Rights Council* replaced the **UN Commission on Human Rights** in 2006 and it is a key independent UN intergovernmental body responsible for human rights.
- The UN Development Group's Human Rights Mainstreaming Mechanism (*UNDG-HRM*) also advances human rights mainstreaming efforts within the UN development system.
- The *UN Security Council* deals with grave human rights violations, often in conflict areas.
- *The General Assembly's Third Committee* (Social, Humanitarian and Cultural) also examines a range of issues, including human rights questions. The Committee discusses questions relating to the advancement of women, the protection of children, indigenous issues, the treatment of refugees, the promotion of fundamental freedoms through the elimination of racism and racial discrimination, and the right to self-determination.

| **UN Organisations:** |
|---|
| **UNESCO** (4th November 1946).It helps in advancing cooperation in education, sciences, culture, communication and information when societies across the world face the rising pressures of change and the international community faces new challenges. |
| **UNICEF(** 11th December 1946).It provide emergency food and healthcare to children in countries that had been devastated by World War II.It believes that "All children have a right to survive, thrive and fulfill their potential – to the benefit of a better world". |
| **WHO (** 7th April 1948) .The organisation is concerned with international public health. WHO works worldwide to promote health, keep the world safe, and to serve the vulnerable. |
| **ILO (**1946).It sets international labour standards and promotes social protection and work opportunities for all. |

Various other UN intergovernmental bodies and interdepartmental mechanisms address a range of human rights issues. Human rights issues are also addressed in the context of the post-conflict UN peace building support activities.

- The '*Human Rights Up Front*' is an initiative by the UN Secretary-General to take early and effective action to prevent /respond to serious and large-scale violations of human rights or international humanitarian law.
- The *United Nations Permanent Forum on Indigenous Issues (UNPFII),* an advisory body to the Economic and Social Council, has a mandate to discuss indigenous issues, including human rights.
- The *Commission on the Status of Women* (CSW) is the principal global intergovernmental body to ensure the promotion of gender equality and the advancement of women rights. UN Women, established in 2010, serves as its Secretariat.

### 7.2.2. Main Human Right Related Organs (UNESCO,UNICEF,WHO,ILO)

#### I. UNESCO *(United Nations Educational, Scientific and Cultural Organization)*

**UNESCO** is a specialized agency of the United Nations (UN) based in Paris and established on 4th November 1946. It helps in advancing cooperation in education, sciences, culture, communication and information when societies across the world face the rising pressures of change and the international community faces new challenges. It's duty remains to reaffirm the humanist missions of education, science and culture. Its seeks to build peace through international cooperation in education, sciences and culture. UNESCO's programmes contribute to the achievement of the Sustainable Development Goals defined in Agenda 2030, adopted by the UN General Assembly in 2015. UNESCO has a unique role to play in strengthening the foundations of lasting peace and equitable and sustainable development.

**Functions:**

1. Develops educational tools to help people.
2. Fosters scientific programmes and policies for development and cooperation.
3. Strengthens bonds among nations, promoting cultural heritage and the equal dignity of all culture.
4. Works for access to quality education to all citizens.
5. Stands up for freedom of expression, as a fundamental right and a key condition for democracy and development.
6. Helps countries to adopt international standards and manages programmes that foster the free flow of ideas and knowledge sharing.

**II. UNICEF** *(The United Nations International Children's Emergency Fund)*

UNICEF was created by the United Nations General Assembly on 11$^{th}$December 1946 , to provide emergency food and healthcare to children in countries that had been devastated by World War II. In 1950, UNICEF's mandate was extended to address the long-term needs of children and women in developing countries everywhere. It believes that "All children have a right to survive, thrive and fulfil their potential – to the benefit of a better world". UNICEF headquarters in New York. It works in 190 countries and territories to save children's lives, to defend their rights, and to help them fulfil their potential, from early childhood through adolescence. For the past 73 years, UNICEF has worked to improve the lives of children and their families.

**Functions:**

1. It fights for the rights of every child seeking safe shelter, nutrition, protection from disaster and conflicts, and equality.
2. It works with partner countries around the world to promote policies and expand access to services that protect all children.
3. It helps to reduce child mortality all over the world by working to reach the most vulnerable children, everywhere.
4. It works around the world to support quality learning for every girl and boy, especially those in greatest danger of being left behind.
5. It works to reach children and families who need lifesaving aid and long-term assistance.
6. Works all over the world to empower girls and women, and to ensure their full participation in political, social, and economic systems.
7. Works with partners in every sector to co-create innovative solutions that accelerate progress for children and young people.
8. It delivers sustainable access to lifesaving supplies where they are most needed, accelerating results for the most vulnerable children.

**III. WHO** *(The World Health Organization)*

WHO is a specialized agency of the United Nations concerned with international public health. It was established on 7$^{th}$April 1948, and its headquarter is in Geneva, Switzerland. WHO works worldwide to promote health, keep the world safe, and to serve the vulnerable. The WHO is a member of the United Nations Development Group.

The constitution of the WHO was signed by 61 countries on 22$^{nd}$ July 1946.Since its establishment, it has played a leading role in the eradication of various communicable diseases such as smallpox, malaria etc. It ensures Universal Health Coverage and tries to protect people from health emergencies and provides people with better health and well-being.WHO defines health as "a state of complete

physical, mental and social well-being and not merely the absence of disease or infirmity" and the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition. In the Sustainable Development Goals, all countries have committed to achieving Universal Health Coverage (UHC) by 2030.Governments have a responsibility for the health of their peoples which can be fulfilled only by the provision of adequate health and social measures.

**WHO's priorities include:**

1. Strive to combat communicable diseases, in particular HIV/AIDS, Corona Virus (Covid 19), Ebola, malaria and tuberculosis; and non-communicable diseases like cancer and heart disease.
2. Mitigation of the effects of non-communicable diseases such as sexual and reproductive health.
3. For Universal Health Coverage, WHO focus is on primary health care to improve access to quality essential services.
4. WHO helps mothers and children to survive and thrive so that they can look forward to a healthy old age.
5. It ensures the safety of the air people breathe, the food they eat, the water they drink and the medicines and vaccines they need.
6. It works towards sustainable financing and financial protection to improve access to essential medicines and health product.
7. Detects and responds to acute health emergencies. For health emergencies, WHO identifies, mitigates and manages risks, prevent emergencies and support development of tools necessary during outbreaks.
8. Supports by delivery of essential health services in fragile settings.
9. Publishes the World Health Report, a worldwide World Health Survey, and celebrates World Health Day on 7$^{th}$ April.

**IV. ILO** *(The International Labour Organization)*

ILO is a United Nations agency that sets international labour standards and promotes social protection and work opportunities for all. The ILO was established as an agency of the League of Nations following World War I, in 1919, to pursue a vision-based idea that the universal lasting peace can be established only if it is based on social justice. The ILO became the first specialized agency of the UN in 1946 and its headquarters in Geneva, Switzerland.

ILO is the only tripartite U.N. agency, brings together governments, employers and workers to seta system of international labour standards, develop policies and devise programmes for promoting

decent work for all women and men.187 member States joined in ILO. The International Labour Office is the permanent secretariat of the ILO.

In 1969, the organization received the Nobel Peace Prize for improving fraternity and peace among nations, pursuing decent work and justice for workers, and providing technical assistance to other developing nations. The ILO is devoted to promoting social justice and internationally recognized human and labour rights.

**The main goals of the ILO are:**

- Set and promote work standards and fundamental principles.
- To promote rights at work.
- Create greater opportunities for women and men to decent employment and income.
- Enhance the coverage and effectiveness of social protection for all and strengthen dialogue on work-related issues.
- It gives equal voice to workers, employers and governments to ensure that the views of the social partners are closely reflected in labour standards and in shaping policies and programmes.
- Promotes social dialogue between trade unions and employers in formulating, implementing national policy on social, economic, and many other issues.
- To protect the right of labours for fixing minimum wage. ILO has created various minimum wages act including minimum wage law of 1970.

### 7.2.3. Declarations for Women and Children

In 1974, UN adopted the Declaration on the Protection of Women and Children in Emergency and Armed Conflict. It was proposed by the United Nations Economic and Social Council, on the grounds that women and children are often the victims of wars, civil unrest, and other emergency situations that cause them to suffer "inhuman acts and consequently suffer serious harm". The Declaration states that women and children suffer victimization during armed conflict due to "suppression, aggression, colonialism, racism, alien domination and foreign subjugation".

**Main Points in the declaration:**

- The Declaration specifically prohibits attacks and bombing of civilian populations (Article 1) and the use of chemical and biological weapons on civilian populations (Article 2).
- Article 3 of Declaration states to abide by the Geneva Protocol of 1925 and the Geneva Convention of 1949. The Geneva Conventions proposed some rules that seek to protect people who are not or are no longer taking part in conflicts.

- The Declaration also states that countries take measures to end "persecution, torture, punitive measures, degrading treatment and violence" especially when they are targeted against women and children, as well as recognizing "imprisonment, torture, shooting, mass arrests, collective punishment, destruction of dwellings, and forcible evictions" as criminal acts.
- Certain rights are also protected in the Declaration, such as access to food, shelter, and medical care, which are to be provided to women and children caught in emergency situations.

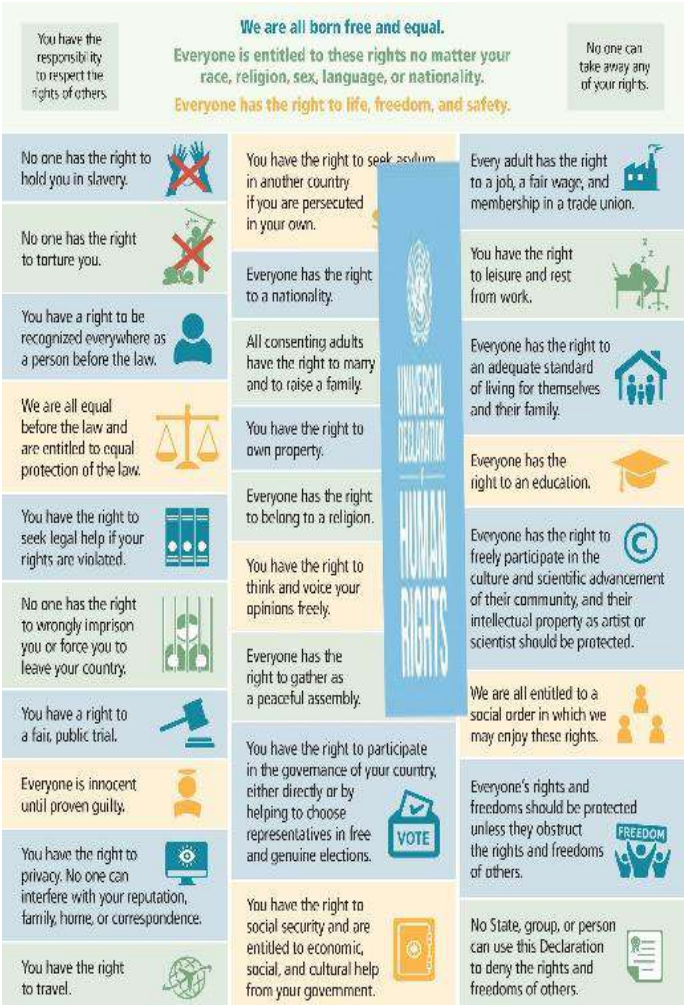
### 7.2.4. The Universal Declaration of Human Rights

The Universal Declaration of Human Rights (UDHR) is a historic document that was adopted by the United Nations General Assembly on 10$^{th}$December 1948.The Universal Declaration of Human Rights was the first legal document protecting Universal Human Rights.

It drafted by representatives with different legal and cultural backgrounds from all regions of the world with the objective of protection of fundamental rights universally. The power of the Universal Declaration is the power of ideas to change the world. It ensures all people freedom, equality and dignity.

The Declaration was the first step in the process of formulating the International Bill of Human Rights, which was completed in 1966, and came into force in 1976. One of the three instruments of International Bill of Human Rights was the Universal Declaration of Human Rights.

The Universal Declaration of Human Rights consists of 30 articles confirming an individual's rights. They are pointed in the Box.7.1.



**Box 7.1. The Universal Declaration of Human Rights 30 Articles**:

1. Free and equal in dignity and rights
2. Freedom from discrimination
3. Right to life, liberty and security of person
4. Freedom from slavery
5. Freedom from torture
6. Right to recognition before the law
7. Right to equality before the law
8. Access to justice
9. Freedom from arbitrary detention or exile
10. Right to a fair trial by an independent and impartial tribunal
11. Presumption of innocence -Everyone charged with a penal offence has the right to be presumed innocent until proved guilty according to law in a public trial at which he has had all the guarantees necessary for his defence.
12. Right to privacy
13. Freedom of movement-1) Everyone has the right to freedom of movement and residence within the borders of each state. (2) Everyone has the right to leave any country, including his own, and to return to his country.
14. Right to asylum -Everyone has the right to seek and to enjoy in other countries asylum from persecution.
15. Right to nationality
16. Right to marry- Men and women of full age, without any limitation due to race, nationality or religion, have the right to marry and to found a family. They are entitled to equal rights as to marriage, during marriage and at its dissolution.
17. Right to own property
18. Freedom of religion or belief- Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance.
19. Freedom of opinion and expression
20. Freedom of peaceful assembly and association
21. Right to partake in public affairs
22. Right to social security-and is entitled to realization, through national effort and international co-operation and in accordance with the organization and resources of each State, of the economic, social and cultural rights indispensable for his dignity and the free development of his personality.
23. Right to work, to free choice of employment, to just and favourable conditions of work and to protection against unemployment.
24. Right to leisure and rest
25. Right to adequate standard of living
26. Right to education -Education shall be free, at least in the elementary and fundamental stages
27. Right to take part in cultural, artistic and scientific life
28. Right to a free and fair world
29. Duty to your community in which alone the free and full development of his personality is possible.
30. Rights are inalienable- Nothing in this Declaration may be interpreted as implying for any State, group or person any right to engage in any activity or to perform any act aimed at the destruction of any of the rights and freedoms set forth herein.

## 7.3. HUMAN RIGHTS IN INDIA

### 7.3.1. Fundamental Rights and Indian Constitution

The Constitution of India is the highest law of India. The document lays down the framework defining fundamental powers, structure, political code, procedures and duties of government institutions. Dr. B. R. Ambedkar, Chairman of the drafting committee, is widely considered to be its chief architect. The Constitution declares India a sovereign, socialist, secular, democratic republic, assuring its citizens justice, equality and liberty and endeavours to promote fraternity.

Rights are claims that are essential for the existence and development of individuals. The rights which are recognized by the State(includes the Government and Parliament of India and the Government and the Legislature of each of the States and all local or other authorities within the territory of India or under the control of the Government of India) and protected in the Constitution are called fundamental rights.

**Fundamental Rights**

Fundamental rights are provided in Part III of the Indian Constitution. The Constitution guarantees six fundamental rights to Indian citizens.

| | |
|---|---|
| Right to equality | Right to freedom of religion |
| Right to freedom | Cultural and educational rights |
| Right against exploitation | Right to constitutional remedies |

The Fundamental Rights are defined as the basic human rights of all citizens and applied irrespective of race, place of birth, religion, caste, creed, or gender. These rights are fundamental because of two reasons:

1) These are mentioned in the Constitution of India which guarantees them.
2) These are justiciable, i.e. enforceable through courts.

The Fundamental Rights, Directive Principles of State Policy and Fundamental Duties are sections of the Constitution of India that recommend the fundamental obligations of the states to its citizens and the duties and the rights of the citizens to the State.

Fundamental rights are provided in Part III of the Indian Constitution. The Constitution guarantees six fundamental rights to Indian citizens as follows:

i) Right to equality
ii) Right to freedom
iii) Right against exploitation
iv) Right to freedom of religion
v) Cultural and educational rights, and
vi) Right to constitutional remedies.

***Right to equality***

Equality before law.

Prohibition of discrimination on grounds of religion, race, caste, sex or place of birth.

Equality of opportunity in matters of public employment.

Abolition of Untouchability.

Abolition of titles.

***Right to freedom***

Protection of certain rights regarding freedom of speech, expression etc.

Protection in respect of conviction for offences.

Protection of life and personal liberty.

Right to education.

Protection against arrest and detention in certain cases.

***Right against exploitation***:

Prohibition of traffic in human beings and forced labour.

Prohibition of employment of children in factories, etc.

***Right to freedom of religion***

Freedom of conscience and free profession, practice and propagation of religion.

Freedom to manage religious affairs.
Freedom as to payment of taxes for promotion of any particular religion.

Freedom as to attendance at religious instruction or religious worship in certain educational institutions.

***Right to constitutional remedies***

Remedies for enforcement of rights conferred by this Part.
Power of Parliament to modify the rights conferred by this Part in their application to Forces, etc.

Restriction on rights conferred by this Part while martial law is in force in any area.

Legislation to give effect to the provisions of this Part.

***Cultural and Educational rights***

Protection of interests of minorities.

Right of minorities to establish and administer educational institutions.

Originally, there were 7 Fundamental Rights in the Constitution. There was the Right to Property also besides above 6 rights. Since 1978, it was removed from the list of Fundamental Rights by 44th constitutional amendment. The right to property is still a Constitutionally recognised right, but is now considered outside the Part on Fundamental Rights.

India with its Federal structure has National Commission for Protection of Human Rights (NCPHR) at the Centre and State Commission for Protection of Human Rights (SCPHR) at the state level. There are also offices at district level to protect the human rights.

### 7.3.2. Rights for Children and Women

The Constitution not only grants equality to women, but also empowers the State to adopt positive measures in favour of women. The Constitution of India has also taken care of the children and there are various article in our Constitution to protect the rights of the children. Each child is having the right to protection from all form of violence. Apart from the Constitution of India ,the Central and State Government has passed many act to protect the rights of the women and children. Some of the Constitutional Privileges are as follows:

**Constitutional Privileges for Women**

- Equality before law for women - Article 14.
- The State not to discriminate against any citizen on grounds only of religion, race, caste, sex, place of birth or any of them - Article 15 (i).
- The State to make any special provision in favour of women and children -Article 15 (3).
- Equality of opportunity for all citizens in matters relating to employment or appointment to any office under the State -Article 16.
- The State to direct its policy towards securing for men and women equally the right to an adequate means of livelihood. Article 39(a).
- Equal pay for equal work for both men and women -Article 39(d).
- Equal justice and free legal aid -Article 39 A.
- The State to make provision for securing just and humane conditions of work and for maternity relief -Article 42.
- It is the duty of the State to raise the level of nutrition and the standard of living of its people and to improve public health - Article 47.
- To promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional and to renounce practices derogatory to the dignity of women -Article 51(A) (e).

- Not less than 1/3 (including the number of seats reserved for women belonging to the SC and ST) of the total number of seats to be filled by direct election in every Panchayat/Municipalities to be reserved for women and such seats to be allotted by rotation to different constituencies in a Panchayat- Article 243 D(3), Article 243 T (3) and not less than 1/3 of the total number of offices of Chairpersons in the Panchayats at each level to be reserved for women -Article 243 D (4) .

To uphold the Constitutional command, the State has passed various legislative measures to ensure equal rights, to counter social discrimination and various forms of violence and atrocities and to provide support services especially to working women. 'Crime against Women' is punishable under the Indian Penal Code (IPC) and the State has also passed some acts which have special provisions to safeguard women and their interests such as the Maternity Benefit Act, 1961 (Amended in 1995) , Dowry Prohibition Act, 1961,The Prohibition of Child Marriage Act, 2006, Indecent Representation of Women (Prohibition) Act, 1986 ,Commission of Sati (Prevention) Act, 1987 ,The Protection of Women from Domestic Violence Act, 2005etc.

**7.3.3. Rights for Children:**

Human rights of children gives particular attention to the rights of children and protection and care afforded to minors. On November 20, 1989, the United Nations General Assembly adopted the Convention on the Rights of the Child, that gives a landmark for human rights of children.

Children's rights includes their right to human identity ,food, equal protection of the child's civil rights, freedom from discrimination on the basis of the child's race, gender, sexual orientation, nationality, religion, disability, colour, ethnicity, or other characteristics.

All people under the age of 18 are entitled to the standards and rights guaranteed by the laws that govern our country and the international legal instruments. The Constitution also provides provision for early childhood care and education to children below the age of six years. The State shall endeavour to provide early childhood care and education for all children until they complete the age of six years.

The Constitution of India guarantees all children certain rights, which includes:

- Right to free and compulsory elementary education for all children in the 6-14 year age group -Article 21 A.
- Right to be protected from any hazardous employment till the age of 14 years -Article 24.
- Right to be protected from being abused and forced by economic necessity to enter occupations unsuited to their age or strength -Article 39(e).

- Right to equal opportunities and facilities to develop in a healthy manner and in conditions of freedom and dignity and guaranteed protection of childhood and youth against exploitation and against moral and material abandonment -Article 39 (f).
- Right to equality. Rights as equal citizens of India, just as any other adult male or female - Article 14.
- Right to being protected from being trafficked and forced into bonded labour - Article 23.

Besides the Constitution, there are several laws that specifically apply to children.

- To get proper health services.
- Not to be separated from parents against the will of the child.
- To be cared for by the parents.
- To get basic education in mother tongue.
- To be protected from physical punishment.

**7.3.4. Scheduled Castes, Scheduled Tribes , Other Backward Castes and Minorities:**

The framers of the Constitution found that certain communities in the country were suffering from social, educational and economic backwardness due to age-old practice of untouchability, primitive practices, lack of infrastructure facilities and geographical isolation and they need special consideration for protection their interests and for their socio-economic development. These communities were notified as Scheduled Castes and Scheduled Tribes as per provisions contained in Clause 1 of Articles 341 and 342 of the Constitution respectively.
"Scheduled Castes"(SC) means “such castes, races or tribes or parts of or groups within such castes, races or tribes as are deemed under article 341 of the Constitution”.

The term 'Scheduled Tribes' (ST)first appeared in the Constitution of India. Scheduled Tribe is defined as "such tribes or tribal communities or parts of or groups within such tribes or tribal communities as are deemed under Article 342 of the constitution".

Other Backward Class (OBC) is a collective term used by the Government of India to classify castes which are educationally or socially disadvantaged. It is one of several official classifications of the population of India, along with Scheduled Castes and Scheduled Tribes (SCs and STs). In the Indian Constitution, OBCs are described as "socially and educationally backward classes".

The deep concern of the framers of the Constitution for the uplift of the Scheduled Castes and Scheduled Tribes and Other Backward Classes is reflected in the elaborate constitutional mechanism set-up for their uplift.

Directive Principles of State Policy states the State shall promote with special care the educational and economic interests of the weaker sections of the people, and, in particular, of the Scheduled Castes and the Scheduled Tribes, and shall protect them from social injustice and all forms of exploitation. There shall be a Commission for the Scheduled Castes to be known as the National Commission for the Scheduled Castes.

**Constitutional Privileges:**

***Scheduled Castes***

1. Fundamental Rights : Abolishes Untouchability-Article 17.
2. Directive Principles of State Policy: Directs state to promote with special care the educational and economic interests of the weaker sections of the people, and, in particular, of the SC and STs, and to protect them from social injustice and all forms of exploitation - Article 46.
3. Public Service Commissions: Special provisions relating to certain classes- Article 320,335 provides that the claims of the members of the SCs and STs shall be taken into consideration, consistently with the maintenance of efficiency of administration, in the making of appointments to services and posts in connection with the affairs of the Union or of a State.
4. Special provisions for SC/STs advancement- Article 15(4). Article 16(4A) speaks of "reservation in matters of promotion to any class or classes of posts in the services under the State in favour of SCs/STs, which are not adequately represented in the services under the State".
5. Political Safeguards: Constitution provides reservation of seats in favour of the SC and ST in the House of the People and in the legislative assemblies of the States-Article 330,332. Under Part IX relating to the Panchayats and Part IXA of the Constitution relating to the Municipalities, reservation for Scheduled Castes and Scheduled Tribes in local bodies has been envisaged and provided.

***Scheduled Tribes***

1. Reservation in educational institutions has been provided in Article 15(4) while reservation in posts and services has been provided in Article 16(4), 16(4A) and 16(4B) of the Constitution.
2. Article 23 which prohibits traffic in human beings and other similar forms of forced labour has a special significance for Scheduled Tribes. In pursuance of this Article, Parliament has enacted the Bonded Labour System (Abolition) Act, 1976.
3. Article 24 which prohibits employment of Children below the age of 14 years in any factory or mine or in any other hazards activity is also significant for Scheduled Tribes as a substantial portion of child labour engaged in these jobs belong to Scheduled Tribes.

4. Constitution provides reservation of Seats for Scheduled Tribes in Panchayats- Article 243D and Article 330,332.

***Other Backward Classes and Minorities***

1. Constitution safeguards rights relating to Educational & Public Employment.
2. Prohibition of discrimination on grounds of religion, race, caste, sex or place of birth.
3. Not preventing the State from making any special provision for the advancement of any socially and educationally backward classes of citizens or for the SC/STs.
4. Equality of opportunity in matters of public employment – There shall be equality of opportunity for all citizens in matters relating to employment or appointment to any office under the State.
5. Article 46 of the Constitution provides that the State shall promote with special care the educational and economic interests of the weaker sections of the society.

Article 338 provides a National Commission for the Scheduled Castes and Scheduled Tribes to investigate and monitor all matters relating to safeguards provided for them, to inquire into specific complaints and to participate and advise on the planning process of their socio-economic development etc and it is known as the National Commission for the Scheduled Castes, National Commission for the Scheduled Tribes and National Commission for the Other backward classes respectively. The Ministry of Social Justice & Empowerment is entrusted with the empowerment of the disadvantaged and marginalized sections of the society. The target groups of the Ministry are: Scheduled Castes, Other Backward Classes, Senior Citizens, Victims of Substance Abuse, Denotified, Nomadic and Semi-Nomadic Tribes, Beggars and Transgenders. The Ministry has been implementing various programmes/schemes for social, educational and economic development of the target groups.

For the Socio-economic and overall development of the Tribal people, special provisions and safeguards have been provided in the Constitution of India and some initiative have also been taken by the Government of India, including Tribal Sub Plan (TSP) strategy. The Tribal Sub Plan (TSP) strategy was aimed for the rapid socio-economic development of tribal people.

In addition to this various scholarships are provided to the students belonging to the SC,ST and Other backward classes and minorities to ensure that education is not denied due to the poor financial condition of their families. Various scheme of assistance also provided to these groups to finance income generating activities and various acts like the 'Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, Scheduled Castes and the Scheduled Tribes (Prevention of Atrocities) Amendment Act, 2015(Amendment 2016),protection of Civil Rights rule, incentive for inter-caste marriages, awareness generation, setting up of exclusive Special courts, etc guaranteed by the constitution.

## 7.4. ENVIRONMENT AND HUMAN RIGHTS

### 7.4.1. Right to Clean Environment and Public Safety

The right to a clean environment is an important concept and it is necessary for public safety. The conservation of the environment is necessary for the enjoyment of the rights to health, to food, and to a dignified life. The right to a clean environment is not just an individual right. It is relevant for the future generations and indigenous people depend on the environment for their existence.

A clean environment is an essential aspect not only for human beings but also for other animals on the planet. Environmental deterioration can endanger life of not only the present but also future generations. Article 21 of the Indian Constitution states: 'No person shall be deprived of his life or personal liberty except according to procedures established by law.' The Supreme Court expanded this in two ways. Firstly, any law affecting personal liberty should be reasonable, fair and just. Secondly, the Court recognised several unarticulated liberties that were implied by article 21. It is by this second method that the Supreme Court interpreted the right to life and personal liberty to include the right to a clean environment.

The human conference on human environment held at Stockholm in 1972 stated that the "natural resources of the Earth including air, water, land, flaura and fauna and especially the representative sample of natural ecosystem must be safeguarded for the benefit of the present and future generations through careful planning or management as appropriate." The report on the World Commission on Environment and Development suggested several legal principles for environmental protection and sustainable development. 'Caring for the Earth 1991' and the 'Earth Summit' of 1992 also declared that human beings are entitled to a healthy and productive life in harmony with nature.

The air we breathe, the water we drink and the place we live in may be polluted with toxic substances. The tremendous increase in industrial activity during the last few decades and the release of toxic industrial wastes into the environment, have been of considerable concern in the recent years.

It is now known that the outcome of the human activity in the last 200 years on nature (after the industrial revolution) is very damaging and disrupts natural phenomena and ecological balance. Many incidents and issues like the death of thousands of people in Mnamata in Japan after eating fish from the local Bay (mercury poisoning), 'Itai-Itai' disease (due to cadmium pollution), Bhopal gas tragedy (due to poisonous gas MIC), London smog in 1952, the emergence of new ocean currents like El-Nino, Global warming, Depletion in Ozone umbrella, the nuclear accidents of Three mile island, Chernobyl and recently, in Fukushima Japan, have forced mankind to take a second look on the impact of industries on nature. Thus environmental pollution on one hand and deforestation and population explosion on the other, are threatening the very existence of life on earth. Hence, to stimulate awareness of the environment and to enhance political attention and public action United Nations General Assembly in 1972 established *June 5$^{th}$ as World Environment Day*.

**Environmental Rights:**

The right of individuals to use unspoiled natural resources that enable their survival are called Environmental Rights. This includes access to land, shelter, food, water and air.

There are many dimensions in the interrelationship between human rights and environmental protection:

- Human rights obligations of States should include the duty to ensure the level of environmental protection necessary to allow the full exercise of the rights of the citizens.
- Human rights must be implemented in order to ensure environmental protection.

Some of the basic environmental rights have been listed below:

**Substantive Rights** ensure the rights to:

- Enjoy a safe, clean and sustainable environment.
- Protection against discrimination and have equal protection of the law, in relation to the enjoyment of a safe, clean, healthy and sustainable environment.
- Freedom of expression and to seek, receive and impart information and ideas through any media and regardless of frontiers.

**Procedural Rights**

- To seek, receive, and impart environmental information.
- To be a participant in decisions about environmental matters.
- To effective legal remedies for violations of these rights.

**State Obligations**

States have an obligation to protect environmental rights. This involves ensuring the provision of the above rights as well as the obligations:

- To require the prior assessment of the possible environmental and human rights impacts of policies and projects.
- To ensure that they comply with their obligations to indigenous peoples and members of traditional communities.
- To ensure the effective enforcement of their environmental standards against public and private actors.

**Private Sector Obligations**

Business houses have a responsibility to respect environmental rights. This means that they should avoid infringing on the human rights of others and should address adverse human rights impacts, which they may have caused.

### 7.4.2. Issues of Industrial Pollution and Prevention

Industrial pollution is the undesirable outcome caused by factories that emit harmful by-products and waste into the environment. Such emissions could cause air pollution, water pollution, land pollution.

Industries cause pollution in many ways. Some of them are:

- Emission of toxic chemicals into the atmosphere causes air pollution. The toxic chemicals used by industries in processing and manufacturing are harmful to human health and the environment. Industrial facilities across the world generate more than 25 million tonnes of toxic chemicals as production-related wastes and pollutants. These toxic chemical pollutants are released into the environment resulting in various forms of pollution.
- Industries need a consistent supply of raw materials and so metals, minerals and oils are extracted from beneath the earth thereby depleting the natural resources. This degrades land and water resources. Lands are left bare or destroyed owing to deforestation or clearance of vegetation cover to pave the way for industrial raw material extraction. Raw material extraction also causes pollution to the soil, air, and water. For instance, oil spills during oil extraction have led to the widespread death of marine birds, fish, mammals and amphibians.
- Industrial products like electronics, automobiles and their parts, plastics, metals, and chemical utilities such as petroleum, paints, sprays, and cleaning solvents created for human consumption are a major cause of pollution. All these industrial products at some point in their lifetime become obsolete, and are deposited in landfills or water bodies. This causes land and water pollution. These products sometimes contain poisonous chemical elements that can have an adverse effect on the environment.
- Carbon dioxide is commonly known as a greenhouse gas due to its ability to absorb thermal radiation leading to global warming and climate change. Industrial production emits carbon dioxide gas into the atmosphere. CO2 emissions around the world are caused by energy use in commercial, production, processing, and power producing industries.
- A number of industries still utilize out dated technologies in their production processes instead of embracing cleaner and green technologies. This is one of the factors that cause industrial pollution.
- Anti-pollution Policies are not implemented. In many countries, especially in developing nations, industrial pollution activities continue due to lax anti-pollution policies. Industries continue to pollute the environment with impunity affecting the lives and health of many people. Plants and wildlife have also been badly affected in these regions.

***Steps to Prevent Industrial Pollution***

1. **Control at Source:** Suitable alterations in the choice of raw materials will help in controlling pollution.

2. **Selection of Industry Site:** The industrial site should be properly examined considering the climatic and topographical characteristics.

3. **Treatment of Industrial Waste**: The industrial wastes should be subjected to proper treatment before their discharge.

4. **Plantation**: Intensive planting of trees in the site where the industry is located considerably reduces the dust, smoke and other pollutants.

5. **Government Action**: Government should take stringent action against industries which discharge higher amount of pollutants into the environment than the level prescribed by Pollution Control Board.

6. **Environmental Audit**: Environmental impact assessment should be carried out regularly to identify and evaluate the potential and harmful impacts of the industries on natural eco-system.

7. **Strict Implementation of Environmental Protection Act:** Environment Protection Act should be strictly followed and violators should be punished.

### 7.4.3. Rehabilitation and Safety aspects of use of new technologies such as Chemical and Nuclear Technologies

***Nuclear Technology.***

Nuclear technology involves the nuclear reactions of atomic nuclei. It uses the energy that is stored in the nucleus of an atom. Nuclear reactors, nuclear medicine and nuclear weapons use this technology. The controlled use of nuclear fission releases energy for work including propulsion, heat, and the generation of electricity. Nuclear fission is the process that is used in nuclear reactors to produce high amount of energy using uranium.

Nuclear energy is produced by a controlled nuclear chain reaction, which creates heat this is used to boil water, produce steam, and drive a steam turbine. The turbine is used to generate electricity and/or do mechanical work. Nuclear energy is considered to be one of the most environmentally friendly sources of energy.

**Advantages of nuclear power generation:**

- Nuclear power generation emits relatively low amounts of carbon dioxide ($CO_2$).
- This technology is readily available.
- Nuclear power produces relatively inexpensive electricity. The cost of the uranium, which is utilized as a fuel in this process, is low. Even though the expense of setting up nuclear power plants is moderately high, the expense of running them is quite low.

- Nuclear energy is a more feasible choice than others. They have high energy density as compared to fossil fuels. The amount of fuel required by a nuclear power plant is comparatively less than what is required by other power plants.
- It is possible to generate a high amount of electrical energy in one single plant.

**Disadvantages of nuclear power generation:**

- The problem of radioactive waste is still an unsolved one.
- Despite high security standards, accidents can still happen. It is technically impossible to build a plant with 100% security.
- The energy source for nuclear energy is Uranium. Uranium is a scarce resource; its supply is estimated to last only for the next 30 to 60 years depending on the actual demand.

***Chemical Technology***

Chemical energy refers to the stored energy inside chemical bonds, and it is released by way of exothermic reactions. Some of its sources include crude oil, coal, organic material and wood.

**Advantages of Chemical Energy**

- Almost all sources of chemical energy, such as crude oil, wood, organic materials like wax and coal, can be found around the world, and humans are very dependent on these energy sources. This is the reason why worldwide economies are being affected when prices of these energy sources fluctuate.
- One of the most common chemical energy sources available is crude oil, which is extracted from underlying sedimentary layers of the earth's crust. It is produced from the process of chemical conversion that occurs in the fossilized remains of dead plants and animals under great pressure that is exerted by the Earth.
- Easy combustibility is a great advantage of chemical energy. As compared to other sources of energy, chemical energy produces fuels that are capable of giving out instant energy. It only requires the availability of air to ignite the source with sufficient oxygen content.

**Disadvantages of Chemical Energy**

- It can be harmful to the environment. Combustion is required to produce energy and this can produce harmful by-products, which causes pollution.
- It can produce radioactive waste. The radiations emitted by this kind of waste can last upto hundreds of years.
- It is non-renewable. Most sources of chemical energy cannot be replenished.
- Chemical energy increases pollution. This is seen as the biggest disadvantage of chemical energy. This is also the main reason why researchers and scientists are searching for alternative sources of energy that are less or totally not harmful to humans and the

environment. Global warming has worsened in recent years because of heavy pollution in the different parts of the world.

### 7.4.5. Issues of Waste Disposal

**Waste Management**

Waste management involves the activities required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process. Waste management is intended to reduce adverse effects of waste on human health, the environment and aesthetics.

Waste can be solid, liquid, or gaseous and each type has different methods of disposal and management. Waste management deals with all types of waste, including industrial, biological and household wastes.

Waste management practices cannot be uniformly practiced in different areas. Developed and developing nations, urban and rural areas, residential and industrial sectors have to take different approaches.

**Tips for Waste management*( for more details refer section-5.9)**

- Preventing or reducing waste generation: Extensive use of new or unnecessary products is a major cause of unchecked waste formation.
- Recycling: Recycling serves to transform waste into products of their own genre through industrial processing. Paper, glass, aluminium, and plastic are commonly recycled.
- Incineration: Incineration features combustion of wastes to transform them into base components, with the generated heat being trapped for deriving energy.
- Composting: It involves decomposition of organic wastes by microbes by allowing the waste to stay accumulated in a pit for a long period of time. The nutrient rich compost can be used as plant manure.
- Sanitary Landfill: This involves the dumping of wastes into a landfill. The base is prepared of a protective lining, which serves as a barrier between wastes and ground water, and prevents the separation of toxic chemicals into the water zone. Landfills should be created in places with low groundwater level that are far removed from sources of flooding.

**Protection of Environment**

Environmental protection is the practice of protecting the natural environment through activities initiated by individuals, organizations and governments. Its objectives are to conserve natural resources and if possible, to repair damage that has been caused to the eco system.

Due to the pressures of population growth and increased use of technology, the environment is being degraded, sometimes permanently. Governments have now begun placing restraints on activities that cause environmental degradation.

Protection of the environment is needed for sustainable development. Industrial pollution, degradation of forests, depletion of ozone layer, the green house gases results in global warming and climate which will have an adverse impact on environment and human health. There is a need for conservation of Biodiversity, protection of wetlands and prevention of environmental pollution.

***Forest Conservation***

India defines forest management as one where the needs of indigenous communities are not ignored. Forests are sustained while at the same time ensuring that the nation's economic needs are satisfied through scientific forestry.

***Protection of Wetlands***

Wetlands are complex ecosystems and encompass a wide range of inland, coastal and marine habitats. They share the characteristics of both wet and dry environments. They include flood plains, swamps, marshes, fishponds, tidal marshes natural and man-made wetlands. Among the most productive life support, wetlands have immense socio-economic and ecological importance for mankind. They provide suitable habitats for endangered and rare species of birds and animals. India has a wealth of wetland ecosystems distributed in different geographical regions. These wetlands need to be preserved.

## 7.5. CONSERVATION OF NATURAL RESOURCES AND HUMAN RIGHTS

### 7.5.1. *Conservation of Biodiversity in India*

The Biological Diversity Act, 2002 is a federal legislation enacted by the Parliament of India for preservation of biological diversity in India, and provides mechanism for equitable sharing of benefits arising out of use of traditional biological resources and knowledge.

**Wildlife Conservation**

Wildlife conservation is the practice of protecting endangered plant and animal species and their habitats. Among the goals of wildlife conservation are to ensure that nature will be around for future generations to enjoy and to recognize the importance of wildlife and wilderness lands to humans. Many nations have government agencies dedicated to wildlife conservation, which help to implement policies designed to protect wildlife. Numerous independent non profit organizations also promote various wildlife conservation causes.

**Environmental Impact Assessment**

An environmental impact assessment (EIA) is an assessment of the possible impacts that a proposed project may have on the environment, consisting of the environmental, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether or not to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made."

**Protection of the Environment as outlined in the Indian Constitution**

The Indian Constitution guarantees justice, liberty and equality to all citizens of the country. Article 51-A (g) says that “it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife.”

The 42nd amendment act of 1977 obligates the government to protect and improve environment for the good of society as a whole. It also makes environmental protection an obligation of the state and individual citizen and reads, "The state shall endeavour to protect and improve the environmental and to safeguard forests and wildlife of the country."

Article 51-A (9) states "It shall be duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers, wildlife and to have compassion for living creatures."

The Directive Principles under the Indian constitution are meant to lead towards building a welfare state. Healthy environment is also one of the components of a welfare state. Article 47 provides that the State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties. The improvement of public health also includes the protection and improvement of environment without which public health cannot be assured.

Article 48 deals with organization of agriculture and animal husbandry. It directs the State to take steps to organize agriculture and animal husbandry on modern and scientific lines.

Article 48 -A of the constitution says that “the state shall endeavour to protect and improve the environment and to safeguard the forests and wild life of the country”.

The Constitution of India under part III guarantees Fundamental Rights, which are essential for the development of citizens. Right to environment is of utmost necessity for the development of an individual and realisation of his or her full potential. Articles 21, 14 and 19 of this part have been used for environmental protection. Right to environment, freedom from danger of disease and infection is

inherent in it. Right to healthy environment is an important attribute of right to live with human dignity.

Many Acts like Biodiversity Conservation Act, Environment Protection Act, Wildlife Preservation Act, Water Pollution Prevention Act, Air Pollution Prevention Act etc. are enacted from time to time for environment preservation.

The National Green Tribunal was established in 2010 under the National Green Tribunal Act 2010. This has helped in the effective disposal of cases relating to environmental protection and conservation of forests and other natural resources. It is a specialized body equipped with the necessary expertise to handle environmental disputes.

### 7.5.2. Conservation of the Western Ghats

The Western Ghats is an extensive region spanning over six States. The forests, rivers, and grasslands in the Western Ghats are home to diverse species, including rare and threatened species. It is recognised by UNESCO as one of the world's eight most important biodiversity hotspots. The Western Ghats acts as a huge water tank supplying water to six states. The ecosystem here is severely threatened due to the increasing human settlements, mining, pollution and the drop in genetic diversity. The Western Ghats of India is facing severe threats to its ecosystem.

**Madhav Gadgil Committee Report on the Western Ghats:**

Gadgil Commission, an environmental research commission is named after its chairman Madhav Gadgil. The commission is formally known as Western Ghats Ecology Expert Panel (WGEEP). The commission submitted the report to the Government of India on 31 August 2011.

**Gadgil Committee Recommendations:**

- The Western Ghats Ecology Expert Panel (WGEEP) designated the entire hill range as an Ecologically Sensitive Area (ESA).
- The panel, in its report, has classified the 142 taluks in the Western Ghats boundary into Ecologically Sensitive Zones (ESZ) 1, 2 and 3.
- ESZ-1 being of high priority, almost all developmental activities mainly mining and thermal power plants was restricted in it.
- Gadgil report recommended that "no new dams based on large-scale storage be permitted in Ecologically Sensitive Zone 1".
- Gadgil Committee report specifies that the present system of governance of the environment should be changed. It asked for a bottom to top approach (right from Gram sabhas) rather than a top to bottom approach.
- It also asked for decentralization and more powers to local authorities.

**Criticisms of Madhav Gadgil Report**

The major criticism faced by Gadgil Committee report was that it was not in tune with the ground realities. The recommendations were cited as impractical to implement.

Gadgil report asked for a complete eco-sensitive cover for the Western Ghats which hamper different states on energy and development fronts.

### 7.5.3. Kasturirangan Committee Report

The Kasturirangan committee report has sought to balance the two concerns of development and environment protection. The Kasturirangan report seeks to bring just 37% of the Western Ghats under the Ecologically Sensitive Area (ESA) zones — down from the 64% suggested by the Gadgil report. Kasturirangan report on the Western Ghats has made several pro-farmer recommendations, including the exclusion of inhabited regions and plantations from the purview of ecologically sensitive areas (ESAs). The Kasturirangan report had said 123 villages fall under the ESA purview.

**Criticisms of Kasturirangan Committee Report**

- The Kasturirangan panel used remote sensing and aerial survey methods for zonal demarcation of land in the Western Ghats. The usage of such techniques, without examining the ground reality, has caused many errors in the report.
- The power is vested with the bureaucrats and forest officials and not with gram sabhas.
- Many fear that the farmers would get evicted if the Kasturirangan Committee report is implemented.

## 7.6. Overexploitation of ground water resources, marine fisheries, sand mining etc

### 7.6.1. Natural Resources

It is also called over harvesting and refers to utilizing a renewable resource to the utmost possible extent. Continued overexploitation can lead to the destruction of the resource. The term applies to natural resources such as wild medicinal plants, grazing pastures, game animals, fish stocks, forests, and water aquifers.

Ecologists use the term over exploitation to describe resources that are harvested at a rate that is unsustainable. Overexploitation can lead to resource destruction, including extinction of species. In the context of fishing, the term overfishing can be used instead of overexploitation, as can overgrazing in stock management, overlogging in forest management, overdrafting in aquifer management, and endangered species in species monitoring.

***The overuse of ground water***

Groundwater is the largest source of usable, fresh water in the world. In many parts of the world, especially where surface water supplies are not available, domestic, agricultural, and industrial water needs can only be met by using the water beneath the ground. Sustained groundwater pumping causes groundwater depletion.

**Some of the negative effects of groundwater depletion are:**

- Lowering of the Water Table

Excessive pumping can lower the groundwater table, and cause wells to no longer be able to reach groundwater.

- Increased Costs

As the water table lowers, the water must be pumped farther to reach the surface, using more energy.

- Reduced Surface Water Supplies

Groundwater and surface water are connected. When groundwater is overused, the lakes, streams, and rivers connected to groundwater can also have their supply diminished.

- Land Subsidence

Land subsidence occurs when there is a loss of support below ground. Overusing groundwater, leads to the collapse of soil.

- Water Quality Concerns

Excessive pumping in coastal areas can cause saltwater to move inland and upward, resulting in saltwater contamination of the water supply.

**7.6.2. Marine life**

The exponential growth in human population has lead to an overexploitation of marine living resources to meet growing demand for food. The use of modern techniques to facilitate harvesting, transport and storage has accelerated this trend. The public need to be sensitised about the conservation of the marine environment. There are many marine conservation organisations throughout the world that focus on funding conservation efforts, educating the public and stakeholders, and lobbying for conservation law and policies.

Over exploitation of mineral resources resulted in many environmental problems like:

1. Conversion of productive land into mining and industrial areas.

2. Mining and extraction process are one of the sources of air, water and land pollution.

3. Mining involves huge consumption of energy resources like coal, petroleum and natural gas which are non renewable sources of energy.

4. Surface mining directly degrades the fertile soil surface.

### 7.6.3. Sand mining

Sand mining is the extraction of sand from sand dunes, beaches. Sometimes it is dredged from river and ocean beds. The main reason is to provide sand for concrete, which due to the urbanisation and industrialisation is in high demand. Sand has many uses. It is used to make concrete, paved roads, ceramics and petroleum fracking. These are only some of the uses. River sand is considered to be the best: grains of desert sand are often too rounded to serve as industrial binding agents, and marine sand is corrosive. Today, sand has become so valuable that it is shipped enormous distances.

Illegal sand mining is a perennial problem in India. The mine owners and hoarders try to dig out as much sand as possible, through illegal means. Excessive sand mining causes the degradation of rivers. The depletion of sand along coastal areas and in the river beds causes the deepening of rivers and estuaries, and the enlargement of river mouths. It may also lead to saline-water intrusion from the nearby seas.

**Case Study**

Due to the efforts of The Forest Advisory Committee (FAC) of the Ministry of Environment and Forests (MoEF), and the Karnataka Forest Department, a 25 km long wildlife corridor disrupted by a 220 KVA power transmission line in Kudremukh National Park has been restored.

Based on the ecological analysis by the experts, FAC proposed a unique ‘conservation swap’ scheme for the first time in India. They recommended that to compensate for the loss of 8.3 km wildlife corridor value because of the power line, the Karnataka government must dismantle an existing 25 km power transmission line passing through Kudremukh National Park, thereby restoring a corridor of major connectivity value.

This precedent-setting order of the FAC has enabled the restoration of 25 km of lost wildlife corridor, to compensate for the loss of a corridor one third that length.

Kudremukh National Park is recognized as the largest intact block of tropical evergreen forests in Western Ghats, which are now known as one of 38 global biodiversity hotspots. It is an astonishing treasure house of biological resources, and the watershed of Tunga, Bhadra and Nethravathi rivers. A proposed tiger reserve, Kudremukh is home to many endangered species like the tiger, elephants, lion-tailed macaques, king cobra and great Indian hornbills.

The FAC decision not only prioritized the core conservation objective, but also met the development imperatives as Karnataka faces a severe power crunch, and the fact that over Rs 2,000 crore have already been invested in the power plant.

## QUESTIONS

### Part A(2 Marks)

1. What do you mean by Human Rights?
2. What is Collective-developmental generations of human right?
3. Name 4 UN office Systems that protect human rights.
4. Write the role "Human Rights Up Front Initiative".
5. Write a note on UNICEF.
6. What is UDHR?
7. What you mean by Fundamental Rights?
8. List out 6 fundamental human rights.
9. Explain Right to equality.
10. Why is World Environment day celebrated?
11. What is Industrial Pollution?
12. Define Environmental Rights.
13. What are substantive rights?
14. What are procedural rights?
15. Write any 3 disadvantages of nuclear power generation.

### Part B (5 marks)

16. Explain the three generations of human rights .
17. Briefly write functions of UNSECO and UNICEF.
18. What is ILO and write its functions?
19. Write a note on WHO.
20. Write about the Universal Declaration of Human Rights.
21. Discuss on "Declarations for Women and Children".
22. Write constitutional privileges for Women and Children.
23. Write constitutional privileges for Scheduled Caste and Scheduled Tribes.
24. What are the causes of industrial pollution?
25. How is chemical energy utilized?
26. How is nuclear energy produced?

27. What are the different steps of waste management?
28. Why is the conservation of wetlands important?
29. What are the provisions in the Indian Constitution to protect the environment?

**Part C (15 marks)**

30. Discuss the constitutional provisions for Scheduled Castes, Scheduled Tribes and other marginalised groups.
31. Discuss the Fundamental Rights guaranteed in our Indian Constitution.
32. Briefly write various UN agencies that stand for humanist missions.
33. Outline the causes of industrial pollution and the measures to be taken to control it.
34. What are the advantages and disadvantages of using (i) nuclear energy (ii) chemical energy?
35. Briefly outline the reports of Gadgil and Kasturirangan regarding the conservation of the Western Ghats.
36. Write explanatory notes on (i) Environment and Human rights (ii) Rights for women and children in India.