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INTRODUCTION

Environment is defined as *'the sum total of all conditions and influences that affect the development and life of organisms'*. The development of a country depends on its geographical and environmental conditions. The natural environment affects the people of that area in their way of living. The needs of life depend upon the interaction between organism and the environmental complex.

Today, man has emerged as the most successful and dominant animal of the biosphere. His mental capabilities have enabled him to explore, understand and interpret the natural phenomenon in the world around him. He manipulates the environment according to his needs. He consumes larger amount of material and energy from the environment than any other organism. The interference of man in shaping the environment has become increasingly

detrimental and reached a critical stage. The main social issues related to the environment are described below.

SUSTAINABLE DEVELOPMENT

The term 'sustainability' refers to *'keeping an effort going continuously'* or *'the ability to last out and keep from falling'*. It denotes the characteristic of a process or state that can be maintained indefinitely. In the context of development, sustainability can be treated as a dynamic concept.

Sustainable development may be defined as *'the successful management of resources for development to satisfy, the changing human needs, while maintaining or enhancing the ability of environment and conserving natural resources'.*

G.H. Brundtland (1987), former Prime Minister of Norway and the Director of World Health Organisation (WHO), defined sustainable development as *"meeting the needs of the present without compromising the ability of future generations to meet their own needs."*

Sustainability of a system depends largely upon the carrying capacity of the system. If the carrying capacity of a system is crossed (*i.e.*, by over exploitation of a resource), environmental degradation starts and continues till it reaches a point of no return.

Carrying capacity has two basic components : (*i*) **Supporting capacity** (the capacity to regenerate) and (*ii*) **Assimilative capacity** (the capacity to tolerate different stresses). In order to attain sustainability, it is important to utilize the resources based upon the above two properties of the system.

The issue of sustainable development was discussed in detail for the first time at international level in the UN conference on "Environment and Development" held at **Rio de Janeiro (Brazil)** in 1992. The Rio conference is popularly known as **'The Earth Summit'**. Its declaration aims at "a new and equitable global partnership through the creation of new levels of cooperation among states". **Agenda-21** is one of its five significant agreements, which proposes a global programme of action on sustainable development for the 21st century in social, economic and political spheres.

There are two aspects of sustainable development (*i*) **Inter-generational equity** (*i.e.*, to hand over a safe, healthy and resourceful environment to our future generations) and (*ii*) **Intra-generational equity** (*i.e.*, technological developments which promote economic growth of the poor countries so as to narrow wealth-gap between different nations).

The Indian Context. Though, India has made a lot of progress since independence, yet the increasing needs and aspirations of expending human population have forced a change in land use and imposed excessive demand on the natural resources if the current practice of utilising natural resources continues, the coming generation will have less chance of getting sufficient food to eat, space to live and pure air to breathe. Thus, besides increase in production, the protection of environment and conservation of natural resources are equally essential.

Strategies for Sustainable Development

The strategies suggested for sustainable development are as follows:

(*i*) To use locally adaptable, eco-friendly and resource efficient technology, which will use less of resources and produce minimum wastes.

(*ii*) To adopt **3-R approach (Reduce, Reuse, Recycle approach)** which emphasizes minimization of resource use, using them again and again and recycling the materials so as to decrease pressure on our existing natural resources and reduce generation of wastes.

(*iii*) To promote environmental education and awareness at all levels of education right from school stage to the university level so as to inculcate a feeling of belongingness to the earth (*i.e.,* earth thinking). It will greatly help in changing the thinking and attitude of the people towards our earth and environment.

(*iv*) To utilize resources as per carrying capacity of the environment *i.e.,* consumption of resources should not exceed their regeneration and changes should not be allowed to occur beyond the tolerance capacity of the environment.

URBAN PROBLEMS RELATED TO ENERGY

Today we need energy for agriculture, industry, transport, communication, comfort and defence. Energy plays a vital role in the socio-economic development of a society. Presently, no one can think of a comfortable life without energy. As compared to rural areas, the energy requirement is very high in urban areas.

The energy demanding activities of urban areas include:

(*i*) Regular supply of electricity has become indespensable in high rising buildings, multiplexes and shoping malls of the cities. The activities come to stand still in such establishments, when there is an interruption in power supply. Therefore, most of such establishments have their own very high capacity generator sets for power back up. These generator sets cause hazardous air and noise pollution.

(*ii*) In many cities and towns, water supply is dependent on electricity. Acute shortage of drinking water is faced by the people living in these areas during the peak summers due to short supply of electricity.

(*iii*) These days, many of the house jobs such as cooking of food, washing of clothes, cleaning of houses etc. have become electricity based in urban areas. Shortage of electricity makes the life miserable, of the people living in the cities.

(*iv*) The modern life style of cities uses a large number of electrical gadgets in houses, offices and business establishments which become non-operational when electricity is not available.

(*v*) Means of transportation (*i.e.,* automobiles, trains, metro-rails, etc. used for the movement of people needs energy. Shortage of fuel and electricity make people's movement difficult.

(*vi*) Industrial plants use a big proportion of energy. The industrial production is badly affected in shortage of energy.

(*vii*) The disposal of urban wastes in many cities is also affected as it uses energy based techniques.

Measures to Save Electricity

Following measures can be taken to save electricity:

(*i*) Turn off lights and fans as soon as you leave the room.

(*ii*) Use tube lights and energy efficient bulbs that save energy rather than bulbs. A 40 W tube light gives as much as a 100 W bulb.

(*iii*) Switch off the television or radio as soon as the program of interest is over.

(*iv*) Use pressure cooker, as it can save up to 70% of the energy required for cooking. It is also faster.

(*v*) Keep the vessel covered with a lid during cooking, as it helps to cook faster, thus, saves energy.

(*vi*) Regular dusting of bulbs and tubes as dust deposited on these equipments decreases the lighting levels by 20–30%.

WATER CONSERVATION

Water is an essential natural resource for sustaining life and environment. The available water resources are under tremendous pressure due to increased demands. The time is not far when water, which is the free gift of nature, will become a scare commodity.

The world is heading towards a water crisis. Africa and West Asia are likely to be worst affected by water scarcity, but with increasing population, water may fall short even in other parts of the world. According to a recent UN report, the supply of clean and fresh water is depleting at such an alarming rate in some regions, that within 30 years, about two third of population will suffer moderate to severe water stress.

We often face water scarcity during the summer seasons. As a result, the municipal water supply is restricted. Our wells and handpumps become dry resulting into water crisis. Such frequent situations of water crisis alarm us to conserve water and avoid its misuse.

Case Study

Pani Panchayat, Pune District, Maharashtra. In the Pune district of Maharashtra, the village Mahur is situated in a drought prone area. The villager were not able to grow good crop in most years, clean drinking water was also scare. A man named Vilasrao Salunkhe initiated a movement, called **Pani Panchayat** to conserve water in this drought prone area. He initiated a watershed development on a barren and uncultivated piece of land belonging to a temple. Soil conservation and water harvesting brought about through a comprehensive micro-watershed management programme, gradually led to a surplus of water. Some land was afforested and a part was converted into percolation tanks. Wells and field bunds were built. While 200 quintals of grains were produced on 24 acres of salunkhe's land 40 acres in the same area yielded only 10 quintals. This made other villagers to follows the water harvesting practice, and the area rapidly turned green and productive.

Following strategies may be adopted for conservation of water:

1. **Prevention of Run Off Losses.** The run off losses of water can be reduced by allowing most of the water to infiltrate into the soil. It can be achieved by using contour cultivation, terrace farming, mulching, developing water storage structures (such as farm ponds) etc. The addition of chemical wetting agents (surfactants) and chemical conditioners (such as gypsum hydrolysed polyacrybnitrile etc.,) to the soil, improve soil permeability and prevent run off.

2. **Reduction of Irrigation Losses.** The irrigation losses of water can be reduced by drip irrigation, early morning or late evening irrigation, cultivation of crop varieties with low water requirement and reducing the seepage by lining and covering the canals.

3. **Prevention of Wastage of Water.** The wastage of water in households, commercial buildings and public places can be prevented by closing taps when not in use, repairing any leakage from pipes and using small capacity flush in toilets.

4. **Re-use of Water.** The treated waste water can be used for watering lawns and gardens, washing vehicles and floors of the buildings. It also helps in saving fresh water.

Apart from above methods, rainwater harvesting and water shed management are also important measures for the management and conservation of water.

Rainwater Harvesting

Rainwater harvesting is a technique of collecting rainwater and storing it by constructing special water harvesting structures for later use. It not only increases water availability but also checks the declining water-table. Water management has always been practised in our communities since ancient times. But such practices have faded away during the past few decades mainly due to lack of awareness. Ecologists feel that a return to traditional methods of water harvesting practices is urgently required to overcome the problem of water crisis. In our country. The Ministry of Water Resources, is endeavouring to make rainwater harvesting a part of everyday life in our villages and cities as a people's movement.

Objectives

Rainwater harvesting has following objectives:

(*i*) It checks the run off water and avoids flooding.

(*ii*) It helps in meeting the increasing demand of water.

(*iii*) It helps in raising the water-table by recharging groundwater.

(*iv*) It supplements groundwater supplies during lean season.

(*v*) It also reduces groundwater contamination.

Methods of Rainwater Harvesting

1. The rainwater that falls on the roofs of buildings or in courtyards is collected and stored in underground tanks or diverted to some abandoned well. The collected water may be drawn from the tank or well by using hand pump or motor pump for future use (*Fig. 7.1*).

2. In foothills water flowing from springs is collected in embankment type water storage. The collected water can be supplied to the towns through pipes.

3. **Artificial Recharging** is an indigenous technique of harvesting rainwater by collecting the rainwater in earth check dams (bandhs) and ponds (Johads) to increase water level in wells and tubewells. It helps in protecting water resources and assures a constant supply of clean water. In ancient times rainwater was collected in **talabs, Baawaris, Johads, Hauz** etc., in villages and cities and the stored water was used during the lean season.

4. In arid and semi-arid regions artificial recharging is done by constructing shallow percolation tanks.

5. Rainwater from large catchment areas is collected in **check dams.** This technique was nicely used in Rajasthan by Magasaysay Award winner **Sh. Rajender Singh** popularly known as **"Water man".**

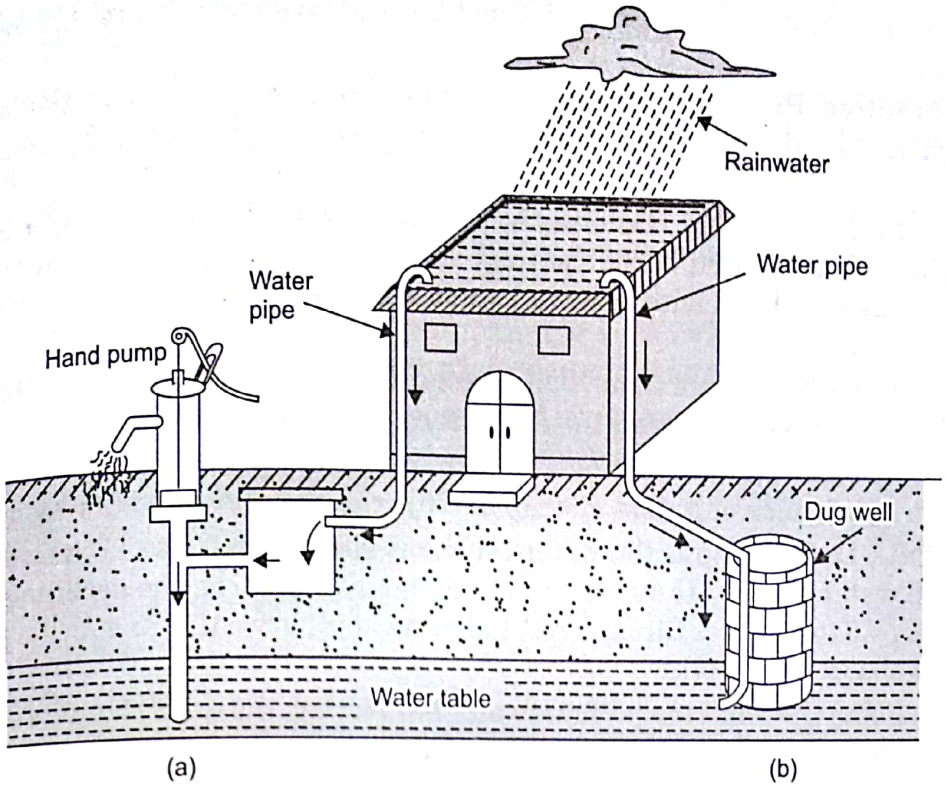


Fig. 7.1. Roof-top rainwater harvesting by recharging (*a*) through hand pump or (*b*) through abondoned dugwell.

Case Studies

Water harvesting in Mewar, Rajasthan. The Mewar region of Rajasthan has a rich legacy of traditional water harvesting systems to share the available water for cultivation.

Medhbandi. It is a method of making stone embankment built on a hill slope to make a level field for cultivation. It controls erosion and conserve moisture.

Naada/Bandha. It is method of making stone check dams across streams or gullies to capture runoff on a stretch of fertile land that is submerged in water during the monsoon. The land not only becomes more fertile after trapping silt, but also retains substantial quantities of water in the soil. These dams are constructed in phases over several years.

Chaks. These are big plots of land, usually a village pasture land, enclosed by a stone boundary wall called a kot. Tree plantations, seeding a grass for fodder, contour bunds with trenches and loose stone check dams are developed in the chaks. The chaks are used for fodder and fuel wood. It reduces soil erosion and enhances the recharge of groundwater.

Talab. Man-made reservoirs or talabs are quite common in Mewar region. Udaipur city is famous for its large number of talabs, and is called the lake city. A small reservoir of less than five bighas is called **talai**, a medium sized lake is called **talab**, and a bigger lake is called **sagar** or **samand.**

Sajha Kuvas (Common Wells). These are open dug wells, which have several owners. It is an important method for irrigation in the Aravalli hills. District udaipur–alone has about 70,000 such wells which provide water for 80% of the area under irrigation and provide water for their owners. These are considered common property resources.

Some of the examples of rainwater harvesting and artificial recharging of groundwater are given below:

(*i*) In **Madhya Pradesh**, more than 1000 check dams, and 1050 tanks have been constructed in Jhabua district alone. This has increased food production by 38% in the past 5 years.

(*ii*) In Jodhpur district of **Rajasthan**, Gramin Vigyan Vikash Samity motivated the residents of 25 villages and built 2000 storage tanks (a water collection structure) in their houses. These tanks are lined with lime and alum, which keep the stored water fresh for 4 to 5 months.

(*iii*) In **Maharashtra** more than 7000 percolation tanks have been built after the severe drought of 1971–72. It has converted the drought hit areas into green lands.

(*iv*) Roof top rainwater harvesting and recharging of wells as a movement initiated by the Saurashtra Lok Manch of Rajkot district of **Gujarat** has prevented drying up of wells.

(*v*) In **JNU, Delhi** campus the water-table has risen from 0.8 to 1.0 metre after it was recharged with water trapped through four check dams. Similarly, the declining water-table has been raised by 3 to 4 metres through roof top rainwater harvesting and recharging through two injection wells in **IIT, Delhi**.

After realising the importance of rainwater harvesting, the town planners of many cities have amended building laws to have provisions for rainwater harvesting.

Watershed Management

Watershed management is defined as "*the rational utilization of land and water resources for optimum production that causes minimum damage to the natural resources*".

Watershed is the land area from which water drains under gravity to a common drainage channel. Thus, watershed is a delineated area with a well defined topographic boundary and one water outlet. Watersheds vary in their size from a few sq. km to a few hundred sq. km. The Himalayas are one of the most critical watersheds in the world. Most of the watersheds of our country lie in this region.

Importance of Watersheds. Watersheds supply water for irrigation, hydro-power generation transportation, domestic use and reduce the chances of floods and droughts. They play significant role in the productivity of land and economy of the country.

Degradation of Watersheds. Watersheds are often degraded due to uncontrolled unplanned, unscientific land use, over grazing, deforestation, mining, construction activities, shifting cultivation, fires, soil erosion etc. Our watersheds in Himalayan ranges are threatened resulting in the depletion of water resources due to damage of reservoirs and irrigation systems and misuse of slopes of the mountain. Therefore, watershed management treating them as a basic functional unit, is extremely necessary for perennial supply of water and economy of the nation. The first such **'Integrated watershed management'** was adopted in 1949 by the **'Damodar Valley Corporation'.**

Methods of Watershed Management

The practices of watershed management are taken up with respect to their suitability for people's benefit as well as sustainability. The important measures taken up for the management of watersheds are as follows.

1. **Water harvesting.** In low rainfall areas, rainwater is stored in water harvesting structures for the use in dry seasons.

2. **Promotion of afforestation and agroforestry (crop plantation).** Plantation of trees prevents run off loss and soil erosion, and also increases soil moisture. In high rainfall areas rows of woody trees such as Sheesham (*Dalbergia*), Teak (*Tectona*), Kikar (*Acacia*) Safeda (*Eucalyptus*) etc., are grown in between crop to reduce the run off and loss of fertile soil.

3. **Mechanical measures.** The measures like terracing, banding, contour cropping, etc., are promoted in the slopy reasons of watersheds.

4. **Scientific mining and quarrying.** Mining and quarrying the hills in planned and scientific manner can minimize the destructive effects in watershed areas.

5. **People's participation.** Participation of local people including farmers and tribals should be promoted in the soil and water conservation programmes. People should be properly educated about the benefits of watershed management programmes.

RESETTLEMENT AND REHABILITATION OF PEOPLE : THEIR PROBLEMS AND CONCERNS

Though developmental projects like construction of dams, mining, creation of National Parks, etc., provide manifold benefits to the society and raise the quality and standard of life of the people. But quite often, the native people of the project sites are displaced from their homeland.

Causes of Displacement

The main cause of displacement of people are described below.

1. **Displacement Due to Dams.** Big river valley projects like Hirakund dam (Orissa), Bhakra Nangal dam (Punjab), Tehri dam (Uttaranchal), Sardar Sarovar Project (Gujarat) and Damodar Valley project (West Bengal) etc., have caused large scale displacement of local people (*Fig. 7.2*). In the last 50 years more than 20 million people have been displaced by dams.

2. **Displacement Due to Mining.** Mining operations cover thousands of hectares of land and cause displacement of native people. **Jharia coal fields (Jharkhand)** have been posing a big problem to the local residents due to underground fires and they are asked to vacate the area.

3. **Displacement Due to Creation of National Parks.** When a forest area is converted into a National Park, it deprives the local dwellers of their ancestral rights of collection of forest products. As a result, the local people retaliate by starting destructive activities.

4. **Displacement Due to Natural Disaster.** Every year natural disasters like earthquake, landslides, droughts, floods etc., displace millions of people from their homeland.

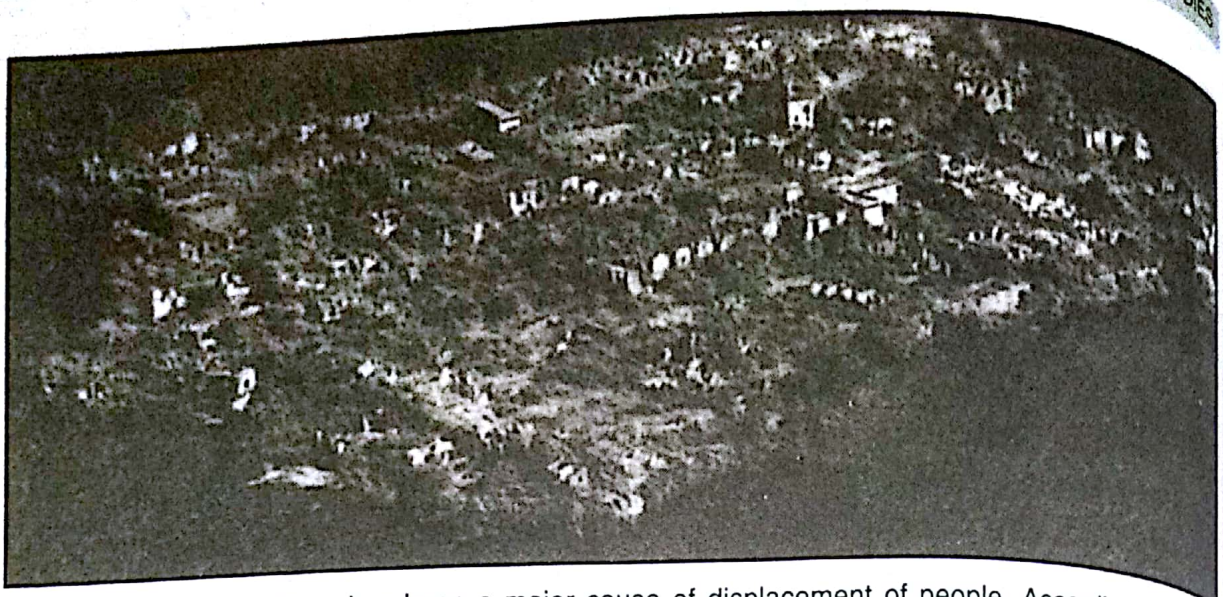


Fig. 7.2. Tehri Dam has been a major cause of displacement of people. According to Hindustan Times article dt. 17 Nov. 2005, —37 villages surrounding the Old Tehri town are already submerged. 1 lakh people and over 125 villages have been shifted. Entire town will be under water over the next few days.

Problems of Displacement

1. Displaced people lose their land homes, jobs and property, which often leads to social isolation and increased morbidity and mortality.

2. The joint families and tribal communities often face disintegration as the people are resettled at different places.

3. The social and cultural activities and kinship systems of tribal people vanish with their displacement.

4. The displaced people lose their identity and intimate link with the environment.

5. The inherited knowledge and experiences of the local people about the plants and animals of that area and their uses get lost with the displacement.

The well known environmentalist, Sundar Lal Bahuguna says, "The big dams are being constructed everywhere in tribal or hilly areas. The people of these regions are being uprooted to provide power to big cities, industries and irrigation water to comparatively more prosperous areas. This is unethical. The locals are affected by sudden rise in prices of essential commodities. Their scarce resources of water, fuel etc. are exploited leaving nothing for them."

Rehabilitation Policy. There is a need for a Comprehensive National Rehabilitation Policy. 'Land for land' is a better policy than cash settlements of displaced people. Following objectives should be kept in mind for the rehabilitation programmes.

1. The displaced people should get an appropriate share in the fruits of development.

2. The displaced people should be rehabilitated within their own environment.

3. Removal of poverty should be an objective of the rehabilitation policy and therefore some land for all should be provided.

4. Even the landless oustees should be given assurance of employment.

5. While dealing with tribals, their traditions, culture and rights in land and forests should be preserved.

6. Training facilities should be set up to upgrade the skills of affected people and reservation in jobs should be made for the willing adults among the evacuees.

7. Special attention should be given to the rehabilitation of artisans and village crafts people.

8. Villagers should be taken into confidence at every stage of implementation and they should be educated, through open meetings and discussion, about the legalities of the Land Acquisition Act and other rehabilitation provisions.

9. The aid of voluntary agencies should be taken in the planning and implementation of the rehabilitation programme.

Case Studies

1. **Sardar Sarovar Project.** This project plans to build several big and small dams on the river Narmada and its tributaries. It is going to effect several villages in the states of Gujarat, Maharashtra and Madhya Pradesh. It is estimated that about 3 lakh people are going to be affected due to submergence of their land and homes under water.

2. **Pong Dam.** The Pong dam was constructed on Beas river in Himachal Pradesh to provide water to Rajasthan. In return, Rajasthan agreed to provide land to the oustees in camand area of Indira Gandhi Canal. But till now only about 50 per cent of the displaced families could be settled and that too in the desert bordering Pakistan. The Governments of Rajasthan and Himachal Pradesh are trying to settle the matter.

3. **The Tehri Project.** The Tehri Dam in the outer Himalayas in Uttar Pradesh, when completed, will submerge Tehri town and nearly 100 villages. Ever since the dam was sanctioned in 1972, local people have been opposing the dam and resisting its construction. Scientists, environmentalists and other groups have also opposed this dam.

Little have been done to ensure the proper rehabilitation and compensation for nearly a lakh of people, who will be uprooted from their homes as a result of this dam, as no alternative land is available. There is also emotional and psychological trauma caused by forcibly removing people from their homeland where their families have lived for centuries.

4. **Jharia Coal Fields.** There are frequent underground fires in the coalfields of Jharia (Jharkhand). Crores of rupees have been spent to put off these fires, still the problem persists. There is a proposal to evacuate the residents of this area, but still there is no alternative land and rehabilitation package for the displaced people.

5. **Wayanad Wildlife Sanctuary.** The creation of Wayanad wildlife sanctuary in Kerala displaced about 53500 tribal families, but till 2003, only 843 families have been provided alternative land. The tribal felt betrayed, and have started encroachment into the forest. This led to many bloody encounters with the forest officials.

ENVIRONMENTAL ETHICS AND RESOURCE USE

Environmental ethics or earth ethics refers to *the issues, principles and guidelines relating to human interactions with their environment.* Environmental crisis is, in reality, the crisis of ethics. We are over-exploiting out right and failing in our duty towards the environment. Nature has provided us with all the resources for leading a beautiful life. She nourishes us like a mother, we should respect her and nurture her.

Eco-Centric Thinking (Environmental Ethics)

Eco-centric thinking urges us to live on this earth as a part of it, like any other creature of Nature. If we want to check environmental crisis, we will have to change our thinking and attitude to be eco-friendly. The basic beliefs of eco-centric thinking are as follows:

1. Nature exists not for human beings alone, but for all the species.
2. The earth resources are limited and they do not belong only to human beings.
3. Economic growth is good till it encourages earth-sustaining development and discourages earth-degrading development.
4. A healthy economy depends upon a healthy environment.
5. The success of mankind depends upon how best we can cooperate with the rest of the nature while trying to use the resources of nature for our benefit.

Guidelines for Environmental Ethics

1. We should love and honour the earth since it has blessed us with life and governs us our survival.
2. We should be grateful to the plants and animals which nourish us by giving food.
3. We should not waste our resources.
4. We have no right to drive other living things to extinction by holding ourselves above them.
5. We should not overburden the earth and should stick to the two children norm.
6. We should not run after gains at the cost of nature.
7. We should not prohibit the right of future generation to live in a clean and safe environment.
8. We should not conceal from others the effects on earth caused by our activities.
9. We must celebrate as sacred day the turning of the seasons of earth.
10. We must consume the natural resources in such a manner that all may share this treasure.

Our ancient vedic literature and upanishads also describe ecological and environmental values. The **Atharva veda** solemnly recognises an enduring allegiance of human kind to Mother Earth. **Isho upanished** has emphasized on ecological and environmental values in a stanza, which states : *"The whole universe together with its creatures belong to the Lord (Nature).....Let no one species encroach over the rights and privileges of other species. One can enjoy nature by giving up greed"*. Living in harmony with nature has always been emphasized with the philosophy to take from nature only what we actually need and not more. In our ancient literature *Khsitij* (soil), *Jal* (water), *Pawak* (energy), *Gagan* (space) and *Samira* (air) are recognised as the basic resources of the earth. Our classical literature emphasizes with the message that resources should not be used wastefully but should be conserved. **Kautilaya** in his famous treatise **Arthshashtra** describes the world's first forest conservation and wildlife management programme. Contemporary Chandra Gupta Maurya maintained forests for different purposes like elephant domestication, hunting and forests as reserves. History tells, that Indian people have been utilizers of nature and not the exploiters. India has been under the influence of humans and agriculture for about 10,000 years even then the resource depletion has not been proportional to our very long history. This has been mainly due to the compassion for the living and non-living and the principle of **Ahinsa parmo dharma** that is ingrained in

our culture. There is a need to incorporate these principles in regulating resource use. Modern man must re-establish an unbroken link with nature and with life. He must again learn to invoke the energy of growing things and to recognise, as did the ancients in India centuries ago, that one can take from the earth and the atmosphere only so much as one puts back into them. The hymn from **Atharvaveda** which runs as follows:

"What of thee I dig out, let that quickly grow ever,
Let me not hit thy vitals or thy heart".

This shows India's age old concern over ecological values.

Resource Use

The pattern of resource consumption differs in economically developed and developing countries. The people in developed countries have higher demand for resources than necessary for reasonable living due to their aspirations for better quality of life. Therefore, they exploit the resources to the level that degrade the global environment seriously. On the other hand people in developing countries have lesser demand for resources due to their simpler quality of life. However, their increasing population, less environmental awareness and aspirations for rapid upgrading their living conditions, causes reckless destruction of resources. The consumerism based pattern of resource use which is prevalent in developed countries, is also spreading fast in developing countries.

GLOBAL ENVIRONMENTAL CHANGES

The mad rat race among nations over the globe for development have resulted into unlimited exploitation of every bit of natural resources. The unlimited exploitation of nature by man has disturbed the delicate ecological balance of the biosphere. Rapid urbanisation and industrilisation have posed a great threat to the global environment. The conversion of a forest to grazing land or a cropland through deforestation causes loss of carbon stored in soil and vegetation to the atmosphere and affects the global carbon cycle. Biomas burning associated with agricultural practices also releases CO_2 into the atmosphere. In recent times, due to domestic and industrial coal burning, huge amounts of CO_2 are being pumped into the atmosphere. Similarly, the concentrations of gases like methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs) are increasing in the lower atmosphere. These gases (CO_2, CH_4, N_2O and CFCs) are **radiatively active gases** (also called **greenhouse gases**) because they can absorb long wave infrared radiation. The increased amount of greenhouse gases in the atmosphere are affecting the global climate and this phenomenon is called **global change**. The major global environmental changes brought about by human developmental activities are discussed below.

GREENHOUSE EFFECT

A glass house used for raising delicate plants is called **greenhouse.** A greenhouse has higher temperature inside than outside though the interior receives less radiations, it is called **greenhouse effect**. The factors which contribute to this effect are (*i*) glass walls (*ii*) high carbondioxide content and (*iii*) high water vapour content of the air in the greenhouse. They let the shortwave radiations (wavelength 0.15-4.0 mm) pass through them but prevent the

passage of long wave (infra red) radiations emitted by the earth's surface. This makes inside of the greenhouse warmer than outside.

In the context of environment, greenhouse effect refers to '*selective energy absorption by some atmospheric gases, which allow short wavelength energy to pass through but absorbs longer wavelengths and reflect heat back to earth*'. The atmospheric gases which are permeable to short wave solar radiations, but are strong absorber of long wave radiations emitted from the surface of earth are called **greenhouse gases**. These include **carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), ozone (O_3)** and **water vapour (H_2O)**. Though carbon dioxide contributes maximum to the greenhouse effect on the earth, methane (CH_4) and chlorofluoro carbons (CFCs) are potent greenhouse gases even though their contributions in the atmosphere are much less than that of carbon dioxide. The mean annual temperature of the earth is about 15°C, however, in the absence of greenhouse gases in the atmosphere, earth's mean temperature would drop sharply to about – 20°C. This capacity of the atmosphere to keep the earth warm depends upon the concentration of greenhouse gases. The excessive increase in concentrations of these gases in the atmosphere would retain more and more of the infrared radiation, resulting in **inhanced greenhouse effect** (*Fig. 7.3*). The consequent increase in the global mean temperature is referred to as **global warming**. The **Inter governmental Panel on Climatic Change (IPCC)** periodically makes an asessment of the atmospheric abundance of greenhouse gases and its possible impact on climate and related issues. The trends in the increase in concentrations of greenhouse gases since pre-industrial times (*Table 7.1*) are briefly described below.

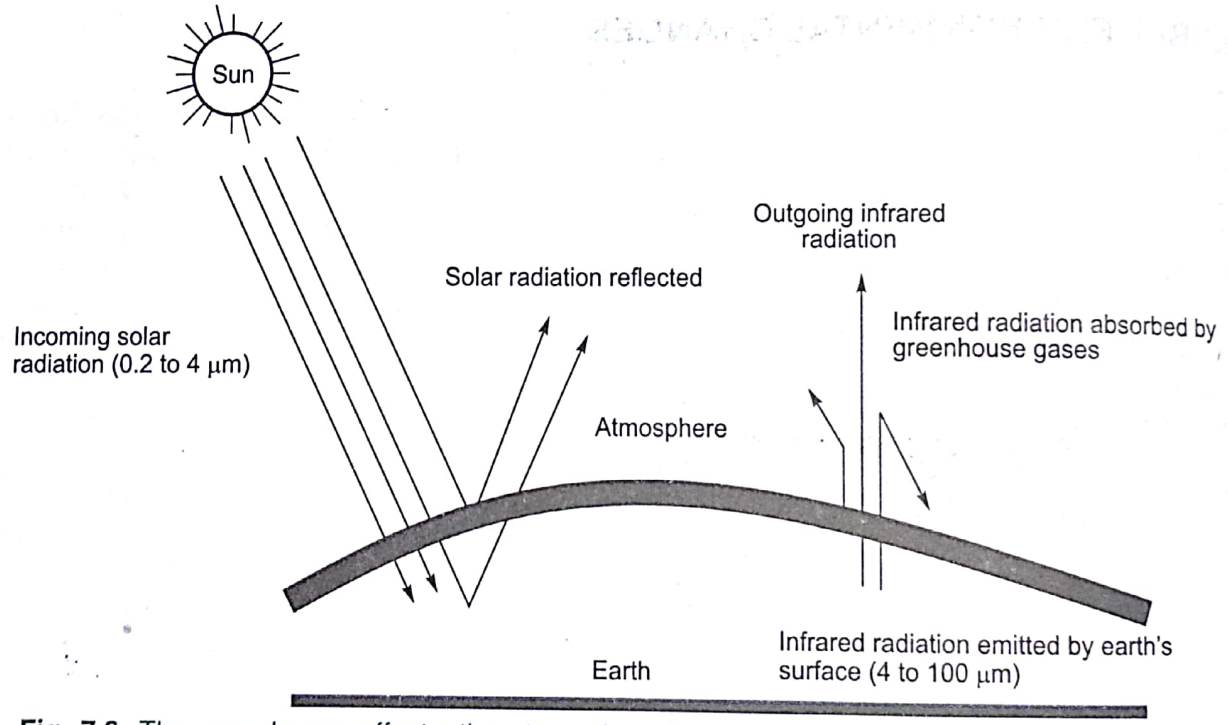


Fig. 7.3. The greenhouse effect : the atmosphere is transparent to the incoming short-wave radiations ; it is translucent to the long-wave infrared radiations which are absorbed by the greenhouse gases to make the earth warm.

1. **Carbon dioxide (CO_2).** Carbon dioxide is the most abundant greenhouse gas in the atmosphere. It is chiefly produced by the burning of fuels. It is also released by plants and animals during the process of respiration. The level of CO_2 in the atmosphere has increased

from the pre-industrial level of 280 ppm to 368 ppm in 2000. This has been largely due to fossil fuel burning, deforestation and change in land use.

2. **Methane (CH_4).** Methane is a product of incomplete decomposition caused by a group of bacteria called methanogens, under anaerobic conditions. It is produced from garbage dumps, fresh water wetlands (swamps), flooded rice fields and enteric fermentation in cattle. It is also produced by biomass burning. The concentration of methane in atmosphere has become more than double in 2000 (1750 ppb) than its concentration during the pre-industrial times (700 ppb).

3. **Chlorofluorocarbons (CFCs).** CFCs are synthetic gaseous compounds of carbon and halogens. They are non-toxic, non-flammable and highly stable compounds. These compounds were synthesized during the 20th century and are extensively used as refrigerants, aerosol propellants, insulators and fire extinguishers. The main sources of CFCs in the atmosphere are leacking air conditioners and refrigeration units, evaporation of industrial solvents, production of plastic foams and propellants in aerosol spray cans. CFCs can persist for 45 to 260 years or more in the atmosphere. The concentration of CFC-11 HFC-23 has become about 282 ppt in recent times.

4. **Nitrous oxide (N_2O).** The main source of N_2O are agriculture, biomass burning and industrial processes. It is produced by the breakdown of nitrogen rich fertilizers in the soil and nitrate contaminated groundwater, burning of nitrogen rich fuels, livestock waste and during nylon production. The concentration of N_2O in the atmosphere has increased from about 270 ppb in pre-industrial time to about 316 ppb in 2000.

Table 7.1. *Increase in the Concentrations of Greenhouse Gases in the Atmosphere Since Pre-industrial Times*

Greenhouse Gases	*Pre-Industrial Concentration 1750 AD*	*Concentration in 2000 AD*	*% increase since 1750 AD*	*Atmospheric Life Time (years)*
Carbon dioxide (CO_2)	280 ppm	368 ppm	31	5—200
Methane (CH_4)	700 ppb	1750 ppb	151	12
Nitrous oxide (N_2O)	270 ppb	316 ppb	17	114
Chlorofluorocarbons (CFC-11) + Hydrofluorocarbons (HFC-23)	0	282 ppt	—	45—260

ppm = part per million
ppb = part per billion
ppt = part per trillion

RELATIVE CONTRIBUTION AND EFFECTS OF GREENHOUSE GASES

Different greenhouse gases do not contribute equally to the global warming. According to an estimate CO_2 contributes the maximum, which amounts to be about 60 per cent of the total global warming. The contribution of CH_4 and CFCs is 20 per cent and 14 per cent respectively. A smaller contribution *i.e.,* 6 per cent is made by N_2O (*Fig. 7.4*).

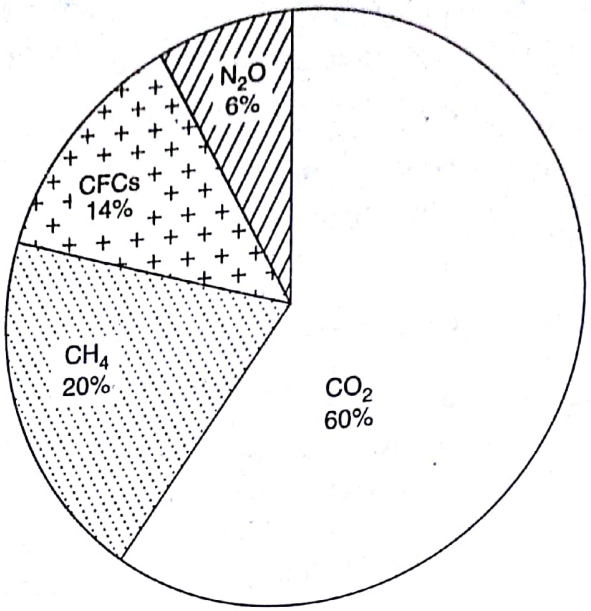


Fig. 7.4. The relative contribution of different gases to global warming.

The increasing concentration of greenhouse gases in the atmosphere has three possible effects. These are (*i*) CO_2 fertilization effect on plants, (*ii*) Global warming, and (*iii*) Depletion of ozone layer in the stratosphere.

1. CO_2 Fertilization Effect on Plants

The studies made at Mauna Loa Observatory in USA have shown that the concentration of CO_2 in the atmosphere has been rising rapidly since 1959 (*Fig. 7.5*). If this increase continues, the atmospheric CO_2 concentration shall increase to the level between 540 and 970 ppm by the end of the 21st century. A number of favourable responses of plants are expected due to increase in atmospheric CO_2 concentration. *The response of plants to elevated concentrations of CO_2 is known as the carbon dioxide fertilization effect.* The important responses of plants which are expected to the increased atmospheric CO_2 concentration are as follows:

(*i*) The growth of many plants, particularly the C_3 species, under favourable conditions of water, nutrients, light and temperature, may increase by about 30 per cent on average in the short term (*i.e.,* upto a few years).

(*ii*) The rate of photosynthesis will increase and the stomatal conductance will decrease due to partial closure of the stomata.

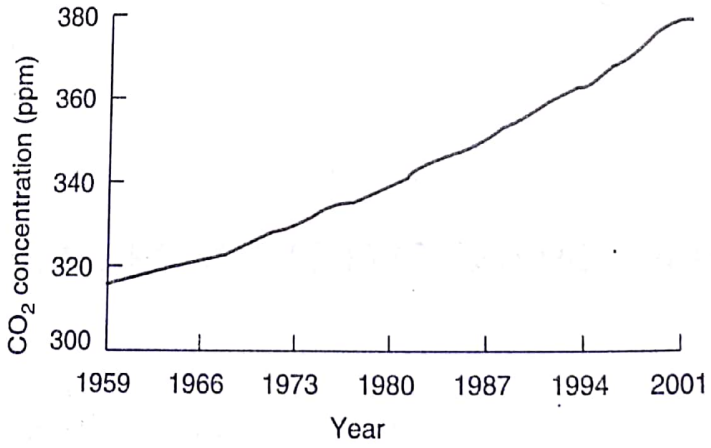


Fig. 7.5. The increase in mean carbon dioxide concentration in the atmosphere from 1959 to 2001.

(*iii*) The rate of transpiration may be reduced due to partial closure of stomata and consequently water use efficiency will increase. This may allow many species to grow successfully in regions of water scarcity.

(*iv*) Plant shall allocate a greater proportion of photosynthate to roots.

(*v*) Greater root production is expected to enhance mycorrhizal development and fixation of N_2 in root nodules, thereby enabling the plants to grow in nutrient poor soils.

Although increased CO_2 concentration in the atmosphere may have a number of beneficial effect on plants, but these effects may not be realized because of negative effects of global warming.

2. Global Warming

The increasing concentration of greenhouse gases in the atmosphere leads to global warming. Some of the predicted effects of global warming are described below:

(*i*) **Effects on Weather and Climate.** In the 20th century, the global mean temperature has increased by about 0.6°C. The average temperature of the earth may increase by 1.4°C to 5.8°C by the year 2100 from year 1990. It is expected that the rise in temperature will be more marked in the regions of middle and higher latitudes. The moisture carrying capacity of the atmosphere is also expected to increase due to warming of the atmosphere. The troposphere will warm up and the stratosphere will cool down. This would cause a wide-spread change in precipitation patterns due to changed pattern of air mass movements. The precipitation will increase at higher latitudes but will decrease at lower latitudes. The frequency of extreme drought and floods will increase. The human disease will increase, particularly in tropical and sub tropical countries due to increase of disease vectors, water borne pathogens etc.

(*ii*) **Rise in Sea Level.** The global warming also contributes to rise in sea level due to thermal expansion of ocean and melting of glaciers and Greenland ice sheets. The level of sea has been rising by 1 to 2 mm per year during the 20th century. If the rise in sea level goes on with the present rate, the global mean sea level will increase upto 0.88 m from the year 1990 level. A rise of even half a meter in sea level would affect human population, one-third of which lives within 60 km of a coast line. Many of the world's important cities and coastal areas will likely to be hit by storms and floods. Several low lying islands may be submerged. Many important birds and fishes inhabiting in coastal salt marshes and esturies, will become extinct due to inundation of their breeding grounds. Thus, rise in sea level will have a negative impact on human settlements, tourism, fisheries, agriculture, water supplies and coastal ecosystems.

(*iii*) **Effect on Range of Species Distribution.** Each plant and animal species occurs within a specific range of temperature. The global warming will shift the temperature ranges, which would affect altitudinal and latitudinal distribution pattern of organisms. Many species may shift slowly poleward or towards high elevations of mountain areas. It is predicted that the temperate region vegetation may extend 250–600 km poleward with the rise in global temperature by 2 to 50°C during the 21st century. Rapid rise in temperature may cause large scale death of many trees, as they are sensitive to temperature stress, and the area may be occupied by scrub vegetation. Many species may disappear, as they are unable to migrate fast enough to track temperature change.

(*iv*) **Food Production.** Global warming will reduce crop production due to increased incidence of plant diseases and pests, explosive growth of weeds and enhanced basal rate of respiration of plants. In temperate regions, small rise in temperature may enhance the crop

productivity slightly but larger temperature change will decrease the crop productivity there. However, in tropical and subtropical regions, even a small rise in temperature, will have detrimental effect on crop productivity. It is estimated that the yield of rice along in South East Asia will decrease by 5 per cent for each 1°C rise in temperature. Thus, the overall world's crop productivity will decrease due to global warming despite of beneficial CO_2 fertilization effect.

Global Warming

Global warming is accelerating faster than what climatologists had calculated a few years ago. In 1995, the Intergovernmental Panel on Climate Change (IPCC) predicted that global warming would raise temperatures by 3.5–10°C during the 21st century, if the present trends continue. It is now believed that it could be much greater. This would lead to not only to change in temperature but also in the amount of rainfall. India may see great annual fluctuations in rainfall leading to floods and droughts.

Approaches to Deal with Global Warming. Some of the strategies, which could reduce global warming are given below:

(*i*) Reduction in greenhouse gas emission by reducing the use of fossil fuels and by developing alternative renewable sources of energy like solar energy, wind energy etc.

(*ii*) Increase of the vegetation cover, particularly forest for photosynthetic utilization of CO_2.

(*iii*) Reduction in N_2O emission by minimising the use of nitrogen fertilizers in agriculture and

(*iv*) Development of substitutes for chlorofluorocarbons.

3. Depletion of Ozone Layer in the Stratosphere

Stratospheric ozone plays a vital role by protecting the living organisms from the harmful effects of ultraviolet radiations. The UV radiation causes photo dissociation of ozone into O_2 and O in the stratosphere. But O_2 and O quickly recombine to form O_3. This ozone dynamics dissipates the energy of UV as heat. There is an equilibrium between generation and destruction of O_3, which leads to a steady state concentration of ozone layer in the stratosphere between 20 and 26 km above the sea level. If this stratospheric ozone layer is condensed vertically to standard temperature and pressure, its thickness averages 0.29 cm above the equator and may exceed 0.40 cm above the poles at the end of winter season. The concentration of O_3 in the stratosphere changes with season. It is highest during the spring season (February–April) and lowest during the fall season (July–October). The ozone layer acts as **ozone shield** and protect the earth's organisms from harmful effects of strong UV radiations (*Fig. 7.6*). The absorption of UV radiation by ozone layer increases exponentially with its thickness. Therefore, maximum amount of UV radiations are absorbed in the tropics (*i.e.* near the equator) and this amount decreases towards poles.

Ozone Hole (Ozone Depletion). Ozone hole refers to the thinning of stratospheric ozone layer during the spring time. It was first discovered in 1985 over Antartica. The existence of ozone hole was also confirmed above Arctic in 1990. During the spring time, in the year 1956–1970, the thickness of O_3 layer above Antartica varied from 280–325 Dabson unit (1 DU = 1 ppb). It reduced sharply to 225 DU in 1979 and to 136 DU in 1985. It continued to decline to about 94 DU in 1994. This decline was termed as **ozone hole**. During the period 1997–2001, the global average total ozone column was about 3 per cent below the pre 1980 average value.

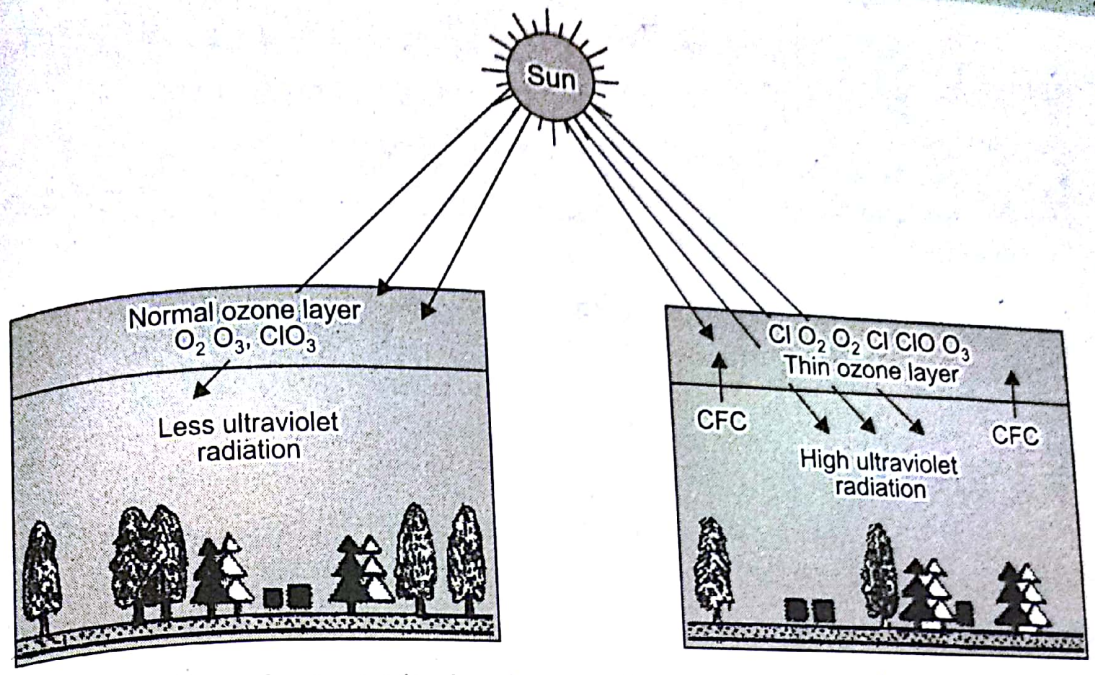


Fig. 7.6. The effect of man-made chemicals on the ozone layer in the stratosphere ; Left : less UV-radiation reaches the earth's surface due to intact ozone layer ; Right : high amount of UV-radiation reaches the earth's surface (ozone hole) due to thinning of ozone layer by the ozone-depleting substances.

A number of pollutants enter into the stratosphere and deplete the ozone layer. These include CFCs, CH_4 and N_2O. Among these CFCs are the most damaging agents of ozone layer. They produce '**active chlorine**' (Cl and ClO radicals) in the presence of UV radiation. The active chlorine catalytically destroy ozone by converting it into oxygen.

Formation of ozone

$$O_2 + O_2 \xrightarrow{\text{UV radiation}} O_3 + O$$

Production of active chlorine (Cl and Clo radicals)

$$CF_2Cl_2 \xrightarrow{\text{UV radiation}} CF_2Cl + Cl$$

$$CF_2Cl \longrightarrow CF_2O + ClO$$

Ozone depletion by active chlorine

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

leakage of radioactive materials from them. However, no nuclear plant is hundred per cent leakage proof. There are high chances of nuclear accidents at any stage of nuclear cycle in the nuclear reactors and atomic power plants. Such accidents release large amount of radio-isotopes like Uranium-235, Iodine-131 etc. which may reach the human body directly through water or food chains and have many serious ill effects. The leakage of radio-nuclides (radioactive substances) from **Three Mile Island nuclear power plant** U.S.A. in 1979 and **Chernobyl nuclear power plant** in USSR in 1986, are the examples of nuclear power plant accident. There is no suitable and cheap method of disposal of radioactive wastes such as spent nuclear fuel, and also, there is no reliable method of storing the radioactive wastes, hundreds of tonnes being produced each year. At any time radioactivity is likely escape from the wastes in the atmosphere and may prove disasterous.

Above all the manufacturing of nuclear bombs is the graveyards dug out by man for himself. Nuclear explosion produces large amount of radioactive particles like strontium-90, Iodine-131, Cesium-137 etc. which are thrown high up into the air as huge clouds, carried to distant places by wind and finally fall on ground with rainwater (called **nuclear fall out**). These radioactive elements may reach the human beings through food chains and cause serious health hazards. In case of nuclear war the whole of the world and the entire biological community including human beings will be destroyed due to **nuclear holocaust** (large scale destruction of human lives) within no time.

Case Study

Nuclear Holocaust in Japan. During the World War-II, two nuclear bombs were dropped by USA on **Hiroshima** and **Nagasaki** cities of Japan in 1945. These nuclear bombs had a force equal to 12 kilotons of trinitrotoluene (TNT) and released neutrons, gamma radiations and radioactive Strontium (Sr 90). This holocaust killed about 1 lac people and crippled many others. The inhabitants of these cities are suffering from serious bone deformities even today because radioactive strontium replaces calcium of the bones..

WASTELAND DEVELOPMENT AND RECLAMATION

The land which is not in use is called **wasteland.** In other words "*economically unproductive lands suffering from environmental deterioriation are known as wastelands*". About one half of our country's land is considered wasteland. Rajasthan has the maximum wasteland area (about 36 million ha) followed by Madhya Pradesh and Andhra Pradesh. In Haryana about 8.4% of the total land area is wasteland. The wasteland can be broadly classified into two types : culturable and unculturable.

1. **Culturable Wastelands.** These include ravinous and gullied lands, water logged and marsh lands, saline lands, lands with lateritic soils, shifting cultivation areas, degraded forest lands, mine spoils and industrial wastelands.

2. **Unculturable Wastelands.** These include baren rocky areas, steep slopes, snow capped hills and glaciers.

Wastelands are formed by natural processes and anthropogenic activities. The major anothropogenic activities leading to wasteland formation are deforestation, overgrazing, mining and wrong agricultural practices.

Reclamation of Wasteland

Some important reclamation practices of wastelands are as follows :

1. **Leaching.** Reclamation of salt affected soil can be achieved by leaching *i.e.* applying excess amount of water to wash down the salts.

2. **Drainage.** By this method, water logged soils are reclaimed by removing excess of water by **artificial drainage.** Artificial drainage can be done by two methods (*i*) **Surface drainage.** It is done by making 30–45 m deep ditches lying parallel to each other at 20–60 m distance to remove water stands from the field after heavy rains and (*ii*) **Sub-surface drainage.** In this method a horizontal sub-surface drainage system consisting of a network of perforated PVC pipes is laid down 2–3 m below the land surface to flush out excess of water and salts. This method has been successfully used in Sampla (Haryana) *i.e.* at the experimental station of the Central Soil Salinity Research Institute (CSSRI), Karnal.

3. **Proper Irrigation Practice.** The irrigation practices such as thin and frequent irrigation with good quality of water on levelled lands prevent water logging and salinity.

4. **Sowing of Tolerant Crops.** Salt tolerant crops can be grown on saline soils. Barley, sugar beet and date palm are highly tolerant crops. While wheat, sorghum pearl millet, soyabean, mustard and coconut are salt tolerant crops. Rice, millets, maize, pulses, sunflower, sugarcane and vegetables like brinjal, gourd etc., are semi-tolerant.

5. **Addition of Gypsum.** Sodicity of soil (excess of sodium) can be removed by the addition of gypsum. Gypsum contains calcium which replaces sodium from the soil.

6. **Use of Green Manures, Organic Manures and Biofertilizers.** Saline soils can be improved by the application of organic manures and biofertilizers. Growing green manure crops like dhaincha (*Sesbania aculeata*) sunhemp or guar helps in improving salt affected soils.

7. **Afforestation programmes.** Plantation of trees on degraded forest lands, river and canal sides, road and railway track sides helps in reclamation of wastelands.

Our government has constituted an apex body called the **National Wasteland Development Board (NWDB).** The Board was established in 1985 to formulate action plans to arrest land degradation and deforestation. In the initial four years the Wasteland Development Programme was focused on tree planting. However, after an indepth review in 1989–90, the programme was suitably reconstructed. The current mission of NWDB is to check land degradation bring wastelands into sustainable use, increase biomass availability and restore ecological balance.

CONSUMERISM AND WASTE PRODUCTS

Technological development has been a key factor in the development of human society right from stone age to the present century, but the earlier technologies were less destructive than the modern technologies as the latter are meant for accelerated rate of explosion of natural resources and their production into various forms to raise the material standard of human beings. Modern technologies have enabled the man to produce a huge amounts of consumer items. The manufacturing and use of several luxury items such as refrigerators, air-conditioners, spray can dispensers etc. release subtantial quantity of chlorofluorocarbons into atmosphere which deplete the life saving ozone layer of the stratosphere. The production and use of electronic items, synthetic materials and biologically non-degradable materials have increased generation of wastes beyond manageable limit. The problem of disposal of several products of modern

technologies such as used batteries, plastics, polythene etc. has become headache even for the industrially developed and technologically advanced countries.

Consumerism and waste generation varies from country to country. More the consumption of resources more is the waste generation and greater is the degradation of the environment. In more developed countries (MDCs), though the population size is small but due to luxurious life style per capita consumption of resources is very high and so the generation of wastes.

THE ENVIRONMENTAL LAWS AND PROTECTION ACTS

The important provisions and legislations which are meant for the protection of environment in India are given below:

Constitutional Provisions

India is the first country in the world to have provisions for the protection and conservation of environment in its constitution. The provisions for environmental protection in the constitution were made after the 'UN conference on Human Environment' held in Stockholm on 5th June, 1972. (Thereafter **5th June** is celebrated as **World Environment Day** all over the world). The provisions were made through 42nd amendment of the constitution in 1976 which are as follows:

(*i*) ***Article 48-A.*** It declares that *"the state shall endeavour to protect and improve the environment and to safeguard forests and wildlife of the country."*

(*ii*) ***Article 51A(g).*** It declares that *"It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures."*

Before 1976, environment was in the state list but after 42nd amendment, it was included in concurrent list.

(*iii*) ***Article 47, 48 and 51A.*** According to these articles, *It is the duty of state to protect and improve the environment and duty of state to protect and improve the environment and public health and provide pollution free water, air and environment for the public.*

The Environment (Protection) Act 1986

This act came into force on Nov. 19, 1986, the birth anniversary of our Late Prime Minister Indira Gandhi. She took keen interest in environmental issues of the country. This act aimed to protect and improve the quality of environment by Central Government with coordination of the State Government.

Powers and Functions of Central Government

(*i*) To set up the standards of quality of air, water or soil for various areas and purposes.

(*ii*) To set up maximum permissible limits of concentration of various environmental pollutants (including noise) for different areas.

(*iii*) To lay procedures and safeguards for the handling of hazardous substances.

(*iv*) To set up prohibition and restrictions on the handling of hazardous substances in different areas.

(*v*) To restrict the areas where industry, operations or processing shall not be allowed.

(*vi*) To lay procedures and safeguards for the prevention of accidents, which may cause environmental pollution and to provide remedial measures for such accidents.

(*vii*) To examine manufacturing processes, materials and substances which are likely to cause environmental pollution.

(*viii*) To carry out and sponsoring investigations and research relating to problems of environmental pollution.

(*ix*) Establishment and recognition of environmental laboratories.

(*x*) Preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution.

(*xi*) Collection and dissemination of information in respect of matters relating to environmental pollution.

(*xii*) Such other matters as the Central Government may deem necessary for the purpose of securing effective implementation of this act.

Under **Section 3** (3) of this act, the Central Government may constitute an authority to exercise powers and perform functions as mentioned above.

Under **Section 5** of this act, the Central Government can issue directions to any person, officer or any authority and empower him/it to (*a*) close, prohibit or regulate of any industry, its operation or processing (*b*) stop or regulate the supply of electricity/water/any other service.

Under **Section 11** of this act, the Central Government or any officer on its behalf is empowered to inspect and take samples of air, water, soil or any other substance in a prescribed manner from any factory, premises or other place, in order to make the analysis of any sample admissible in the evidence in any legal proceedings.

Functions of State Government

Under the Environmental (Protection) Rules, 1986 the State Pollution Control Boards have to follow the guidelines provided Under Schedule VI. The important guidelines are as follows.

(*i*) Advise industries in the state to treat their wastes before their release in the environment.

(*ii*) Encouraging industries to recycle and reuse their wastes.

(*iii*) Promoting implementation of clean technologies by the industries in order to increase fuel efficiency and reduce the generation of environmental pollution.

(*iv*) Granting permission of the discharge of effluents and emissions into the environment only after assessing the assimilative capacity of the receiving atmosphere/water body.

The Environment (Protection) act 1986 was amended in 1994 to include **Environmental Impact Assessment (EIA)** of various developmental projects. These projects have to take clearance from the central Government prior to establishment.

The Water (Prevention and Control of Pollution) Act, 1974 (Amended 1988)

The Water Act was enacted under article 252(1) of the constitution as a social welfare measure.

(*i*) To prevent and control water pollution.

(*ii*) To establish Central and State boards for the prevention and control of water pollution and

(*iii*) To provide and confer powers and functions to the Central and State boards to restore wholesomeness of water.

Functions of Central Board

(*i*) To advise the Central Government on matters concerning with prevention and control of water pollution.

(*ii*) To provide technical assistance and guidance to State Boards and sponsor investigation and research relating to water pollution.

(*iii*) To plan and organize the training of persons engaged in prevention, control or abatement of water pollution.

(*iv*) To collect, compile and publish technical and statistical data relating to water pollution.

(*v*) To lay down the standards for a stream or well waters.

(*vi*) To plan and organize nation-wide programme for the prevention and control of water pollution.

(*vii*) To establish or recognise laboratories for analysis of water samples/trade effluent/ any sewage.

Functions of State Board

(*i*) To advise the State Government on matters relating to the prevention and abatement of water pollution.

(*ii*) To plan a comprehensive programme for the prevention, control or abatement of water pollution.

(*iii*) To encourage and conduct investigations and research relating to the problems of water pollution.

(*iv*) To collaborate with the Central board in organizing training programmes relating to the Control of water pollution and to organize related mass education programme.

(*v*) To evolve efficient methods of disposal of sewage and trade effluents on land or into a water body.

(*vi*) To lay down effluent standards to be complied with by persons while discharging sewage or sludge or both.

(*vii*) To advise the State Government with respect to the location of any industry which is likely to pollute a stream or well.

(*viii*) To establish or recognize laboratories for analysis of water of any sewage or trade effluents.

(*ix*) To perform such other function as may be prescribed by the Central or State Government.

The Air (Prevention and Control of Pollution) Act 1981 (Amended, 1987)

This act was enacted by the parliament to implement the decisions taken at the UN Conference on the 'Human Environment' held at Stockholm in June, 1972. The main objectives of this act are:

(*i*) To prevent and control air pollution.

(*ii*) To establish Central and State boards for the prevention and control of air pollution, and

(*iii*) To provide and confer powers and functions to the Central and State boards to restore wholesomeness of air.

Functions of Central Boards

(*i*) To advise Central Government and State boards about improvement in the quality of air and issues related to air pollution.

(*ii*) To plan and supervise implementation of nation wide programme for prevention and abatement of air pollution.

(*iii*) To provide technical assistance and guidance to State boards and industries for prevention and control of air pollution.

(*iv*) To utilize the services of mass media in educating public about the causes, effects, prevention and control of air pollution.

(*v*) To lay down standards for quality air.

(*vi*) To establish or earmark laboratories for the analysis of air samples.

(*vii*) To plan and organize training of persons in the field of air pollution.

(*viii*) To collect, compile and publish technical and statistical data relating to air pollution.

Functions of State Board

(*i*) To advise State Government on matters concerning air pollution.

(*ii*) To plan programmes for prevention and control or abatement of air pollution.

(*iii*) To identify the areas or industries causing or likely to cause air pollution.

(*iv*) To inspect air quality in air control area from time to time and take steps to reduce the pollution.

(*v*) To lay down standards for air quality in consultation with central board.

(*vi*) To collect and disseminate information related to causes, prevention and control of air pollution.

Wildlife (Protection) Act 1972 (Amended 1991)

This act safeguards wild animals, birds and plants. Under the Wildlife Protection Act, Indian board of wildlife was established which is chaired by the Prime Minister of India, and wildlife advisory boards were constituted for each state. The wildlife act has the following objectives :

(*i*) Restriction and prohibition on hunting and trapping of wildlife.

(*ii*) Protection of rare and specified plant species.

(*iii*) Preparation of lists of endangered, rare and threatened species by the Botanical survey of India (BSI) and Zoological Survey of India (ZSI).

(*iv*) Preservation of biological diversity by setting up and managing National Parks, Wildlife Sanctuaries and Biosphere reserves.

(*v*) Empowering zoo authority with control of zoo and captive breeding of the endangered species.

(*vi*) Control of trade and commerce in some wildlife species, wildlife products and trophies.

(*vii*) Setting up of guideline for issuing licence for arms in surrounding areas of wildlife sanctuaries.

(*viii*) Impounding of all weapons, tools and vehicles used for committing wildlife offences.

Several Conservation Projects for individual endangered species like Lion (1972), Tiger (1973), Crocodile (1974) and Brown antlered Deer (1981) were started under this Act. The Act is adopted by all states in India except Jammu and Kashmir, which has its own Act.

Some Drawbacks of the Wildlife (Protection) Act 1972

(*i*) It does not have any locally evolved conservation measures.

(*ii*) In this act the ownership certificates for animal articles (like tiger, Leopard skins etc.) are permissible which very often serve as a tool for illegal trading.

(*iii*) The Jammu and Kashmir state has its own wildlife Act which does not follow the Central Wildlife Act, and hunting and trading of several endangered species which are prohibited in other states are allowed in J & K. As a result the wildlife traders in J and K can get wildlife articles illegally from other states.

(*iv*) The offender of the Act is not subjected to very harsh punishments. The offender can be fined of ₹ 25,000 or imprisoned for 3 years or both which is not enough to deal with the poachers and wildlife traders.

Forest Conservation Act 1980 (Amended 1988)

The forest conservation Act was enacted to safeguard forests and their conservation. The important provisions of this act as follows:

(*i*) To check deforestation which causes ecological imbalance and leads to environmental deterioration.

(*ii*) Puts restrictions on the use of forest land for non forest purpose or conversion of reserved forest into non-reserve forest, without a prior approval of the Central Government.

(*iii*) Provides provision of compensatory afforestation of an equivalent area of non-forest land or double the area of degraded forest for the diversion of a forest land.

(*iv*) Exercises control over shifting cultivation and encroachments on the forest lands.

(*v*) Provides protection to hilly catchment areas, steep slopes and other areas which are under erosion and landslides, and forest areas to save natural biodiversity.

(*vi*) Puts restrictions on felling of trees above 1000 m altitude.

(*vii*) Provides provision for the constitution of an advisory committee to advise the Central Government with regard to matters connected with conservation of forests.

(*viii*) Empowers the State Government to declare any forest or wasteland as reverse forest where grazing and felling is not allowed. Grazing and felling for cultivation can also be prohibited on any piece of land for protecting the same from erosion and maintenance of ground water.

Public Environmental Awareness

Environmental awareness means making people conscious about the physical, social and aesthetic aspects of environment. Environmental awareness are the handy tool to fight and face the environmental crisis. It changes and modifies man's attitude towards nature. As 'environment belongs to all' and every individual matter, when it comes to conservation and protection of environment. Therefore, all sections of society should be made aware about conservation and protection of the environment in the following ways.

(*i*) To make students environmentally aware, environmental education should be imparted at all stages of education right from school to university level.

(*ii*) Environmental awareness among public can be propagated through mass media like newspapers, radio, television, cinema, street plays, stories etc.

(*iii*) Environmental orientation and training programmes should be organised for planners, decision makers.

(*iv*) Non-government organisations (NGOs) can also help in spreading environmental awareness among masses.

What can you do?

Many of us always talk about the deteriorating environment and blame the government for inaction. However, one can do a lot to protect the environment. You can make others to follow your environment friendly actions. A famous dictum is to *'think globally and act locally'* to improve your own environment. You can make a difference to our world.

Biodiversity Conservation. Following are some of the steps that can be taken to contribute towards our ecological security and biodiversity conservation :

(*i*) Plant more trees of local or indigenous species around your home and your workplace and encourage your friends to do so. Plants are vital to our survival in many ways.

(*ii*) If your urban garden is too small for trees, plant local shrubs and creepers instead. These support bird and insect life that form a vital component of the food chains in nature. Urban biodiversity conservation is feasible and can support a limited but valuable diversity of life.

(*iii*) If you live in an apartment, grow a terrace or balcony garden using potted plants. Window-boxes can be used to grow small flowering plants, which also add to the beauty of your house.

(*iv*) Whenever and wherever possible prevent trees from being cut, or if it is not possible for you to prevent this, report it immediately to the concerned authorities. Old trees are especially important.

(*v*) Insist on keeping our hills free of settlements or similar encroachments. The degradation of hill slopes leads to severe environmental problems.

(*vi*) When shopping, choose products in limited packaging. It will not only help cut down on the amount of waste in landfills, but also helps reduce our need to cut trees for paper and packaging.

(*vii*) Look for ways to reduce the use of paper. Use both sides of every sheet of paper and send your waste paper for recycling.

(*viii*) Buy recycled paper products for your home; *e.g.*, sheets of paper, envelopes, etc.

(*ix*) Reuse cartons and gift-wrapping paper. Recycle newspaper and waste paper instead of throwing it away as garbage.

(*x*) Donate used books and magazines to schools, hospitals or libraries. The donations will not only help these organizations, but also will reduce the exploitation of natural resources used to produce paper.

(*xi*) Participate in the events that highlight the need for creating sanctuaries and national parks, nature trails, open spaces, and saving forests.

(*xii*) Support Project Tiger, Project Elephant, etc., and join NGOs that deal with environmental protection and nature conservation.

(*xiii*) Involve yourself and friends in activities carried out during Wildlife week and other public functions such as tree plantation drives and protests against destruction of the environment.

(*xiv*) Present a potted plant instead of flower bouqets and encourage your friends to do so.

Soil Conservation. There are many ways that each of us can do to prevent environmental degradation due to soil erosion:

(*i*) Cover the soil in your farm or garden with a layer of mulch to prevent soil erosion in the rains and to conserve soil moisture. Mulch can be made from grass-clippings or leaf-litter.

(*ii*) If you plan to plant on a steep slope in your farm or garden, prevent soil erosion by first terracing the area. Terraces help in slowing the rainwater running downhill so it can soak into the soil rather than carry the soil away.

(*iii*) If your collage is surrounded by open space, evaluate how well the soil is being conserved. Look for places where soil can run off, like on an unplanted steep slope or stream bank, or where the soil is exposed rather than covered with mulch. These areas need special care and must be carefully replanted.

(*iv*) Add organic matter to enrich your garden soil; *e.g.*, compost from kitchen scraps and manure from poultry and cowshed are good source of nutrients. Make sure the manure is not too fresh and that you do not use too much. Healthy soil grows healthy plants, and it reduces the need for insecticides and herbicides.

(*v*) In your vegetable garden, rotate crops to prevent the depletion of nutrients. Legumes like peas and beans put nitrogen back into the soil.

(*vi*) Set up a compost pit in your college or garden, so that you can enrich your soil with the organic waste from the kitchen and cut down on the amount of waste it sends to a landfill. Set up buckets in your collage or lunchroom where fruit and left-over food can be put. Empty the buckets daily into a compost pit, and use the rich compost formed in a few weeks to enrich the soil around the collage.

(*vii*) Support environmental campaigns in your state and community. Cutting down of irresponsible development can protect soil, biodiversity and enhance our quality of life.

(*viii*) Do not use toxic pesticides in your garden. They often kill the beneficial organisms your soil need to stay healthy.

Water Conservation. Water is the precious natural resource, conservation of this precious resource is the need of the hour. Following are some of the things you can do to conserve this precious natural resource:

(*i*) Reduce the amount of water used for daily activities; *e.g.*, turn off the tap while brushing your teeth to save water.

(*ii*) Reuse the rinsing water for house-plants. Reuse the water that vegetables are washed, into water the plants in your garden or your potted plants.

(*iii*) Always water the plants early in the morning or evening to minimize evaporation.

(*iv*) Soak the dishes before washing them to reduce water and detergent usage.

(*v*) Look for leaks in the toilet and bathroom, to save several litres of water a day.

(*vi*) While watering plants, water only as rapidly as the soil can absorb the water.

(*vii*) Use a drip irrigation system to water more efficiently.

(*viii*) When you need to drink water, take only as much as you need to avoid wastage. So many people in our country don't even have access to clean drinking water!

(*ix*) Saving precious rainwater is very important. Harvest rainwater from rooftops and use it sustainably to recharge wells to reduce the burden on rivers and lakes.

(*x*) Use bucket of water for bathing instead of shower. A 10-minute shower wastes many litres of water as compared to using water from a bucket.

(*xi*) Do not pollute sources of water or water bodies by throwing wastes into them. This is the water you or someone else has to drink.

Energy Conservation. Following are some of the things you can do to conserve energy:

(*i*) Turn off the lights, fans and air-conditioning when not necessary.

(*ii*) Use low voltage lights.

(*iii*) Use tubelights and energy-saver bulbs as they consume less electricity.

(*iv*) Switch off the radio and television when not required.

(*v*) Use alternative sources of energy like solar power for heating water and for cooking food.

(*vi*) Cut down on the use of electrical appliances.

(*vii*) In summer, shut the windows, curtains and doors early in the morning to keep the house cool.

(*viii*) Use a pressure cooker as much as possible to save energy.

(*ix*) Turn off the stove immediately after use.

(*x*) Plan and keep things ready before you start cooking.

(*xi*) Keep the vessels closed while cooking and always use small, narrow-mouthed vessels to conserve energy.

(*xii*) When the food is almost cooked, switch off the gas stove and keep the vessel closed. It will get completely cooked with the steam already present inside.

(*xiii*) Soak rice, pulses etc., before cooking to reduce cooking time and save fuel.

(*xiv*) Get your family to eat together, it will save re-heating fuel.

(*xv*) Select a light shade of paint for walls and ceilings, as it will reflect more light and reduce electrical consumption.

(*xvi*) Position your reading tables near the window and cut down on your electricity bill by reading in natural light.

(*xvii*) Use a bicycle—it occupies less space, releases no pollutant and provides healthy exercise.

(*xviii*) Try using public transport systems like trains and buses as far as possible.

(*xix*) Plan your trips and routes before setting out.

(*xx*) Walk rather than drive wherever possible. Walking is one of the best exercises for your health.

(*xxi*) Get your vehicles serviced regularly to reduce fuel consumption and reduce pollution levels.

(*xxii*) Do not put food in the refrigerator when it is still hot.

ENVIRONMENTAL DISASTERS AND THEIR MANAGEMENT

The environmental disasters may be defined as *'the extreme events either natural or man induced, which exceed the tolerable magnitude within or beyond certain limits, make adjustment difficult and results in catastrophic losses of property, income and lives.* The environmental disasters always viewed in terms of human beings. The enviornmental events that cause disaster for human society include cyclones, earthquakes, volcanic erruptions, droughts and floods. The intensity of environmental disasters always viewed in terms of the quantum of damages done to the human society. Thus, the hazardous environmental processes always create extreme events but not all the extreme events become disasters. These may become disasters only when they adversely affect human society. For example, a very strong tropical cyclone (typhoon, hurricane or tarnado) does not become disaster, when it occurs and dies in the midst of an ocean. However, it becomes disaster, when it strikes the inhabited coastal areas and inflicts colossal loss to human property and lives.

Tropical Cyclones (*Fig. 6.41*)

Tropical cyclones are the most powerful, destructive, dangerous and deadly atmospheric storms on the earth. The cyclones move like a spining top at the speed of 120-400 km/hour. These can last for a week or so and have a diameter varying between 100 to 1500 km. They are variously called in different parts of the world as **hurricanes** in the Caribbean Sea and south-eastern USA, **Typhoons** in North Pacific Ocean and southern coast of China, Japan and Phillipines, **cyclones** in Bangladesh and eastern coastal areas of India, and **Willy Willy** in Australia. Tropical cyclones become more disastrous because of their high speed, high tidal surges, high intensity of rainfall, very low atmospheric pressures causing unusual rise in sea level, and their persistance for several days. The destructions caused by tropical cyclones include loss of human lives and property in terms of destruction of buildings, transport and communication systems, agricultural crops, domestic and wild animals and so on.

Mitigation of Cyclones. The severity of cyclones can be minimised by taking following steps :

(*i*) Tree plantation on coastal belts.

(*ii*) Construction of dams, dykes, embankments and wind breaks.

(*iii*) Installation of better warning systems.

(*iv*) Construction of proper drainage and wide roads for quick evacuation of affected people.

Management in Cyclone Hit Areas. Following measures could be of great help in cyclone hit areas :

(*i*) Identification of safe buildings in the area for providing safe shelters to the affected people.

(*ii*) Listening to the weather bulletins broadcasted/telecasted over radio/television.

(*iii*) In coastal areas, warning should be sent to the fishermen not to venture into the sea during the course of storm.

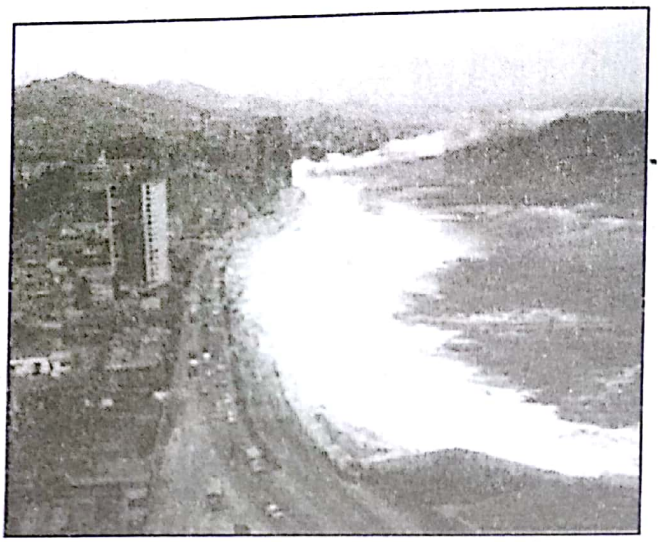
(*iv*) Emergency phone numbers and addresses should be kept ready and remain in touch with responsible members of the community.

(*v*) Keep away from fallen electric poles, damaged bridges and flood water areas.

(*vi*) Transportation and movements should be stopped during the coarse of storm.

(*vii*) People who have evacuated from their places must wait for the official declaration to come back to their homes.

(*viii*) Relief and rehabilitation should be immediately provided to the effected people.



Tsunami

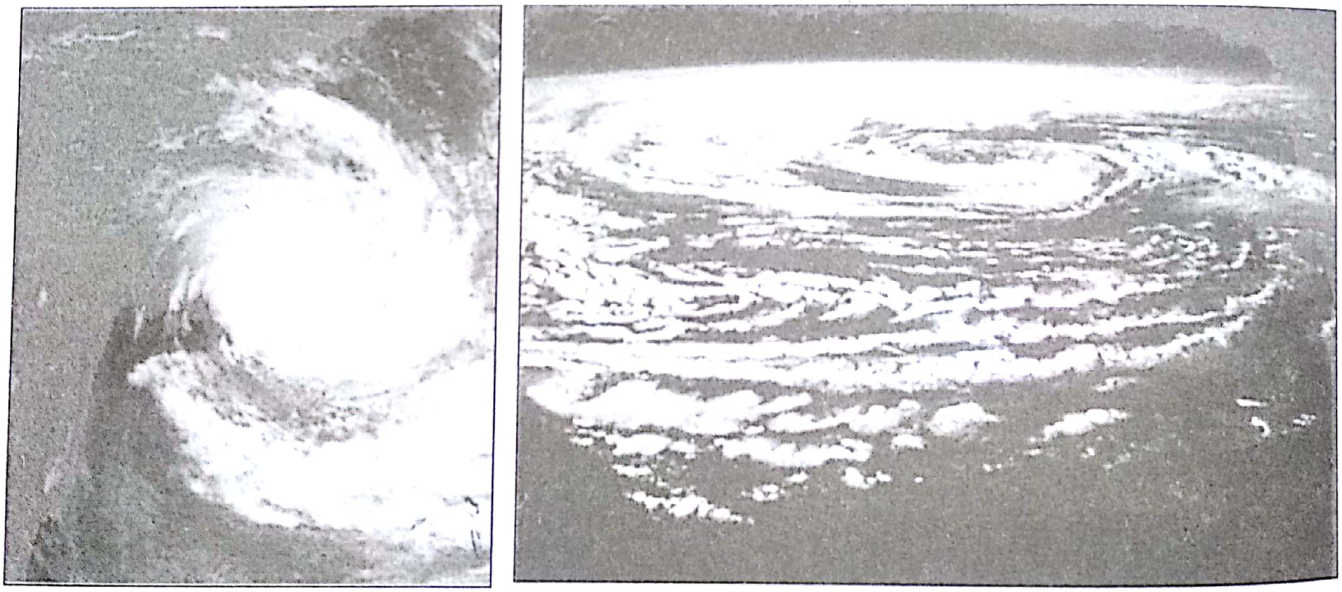
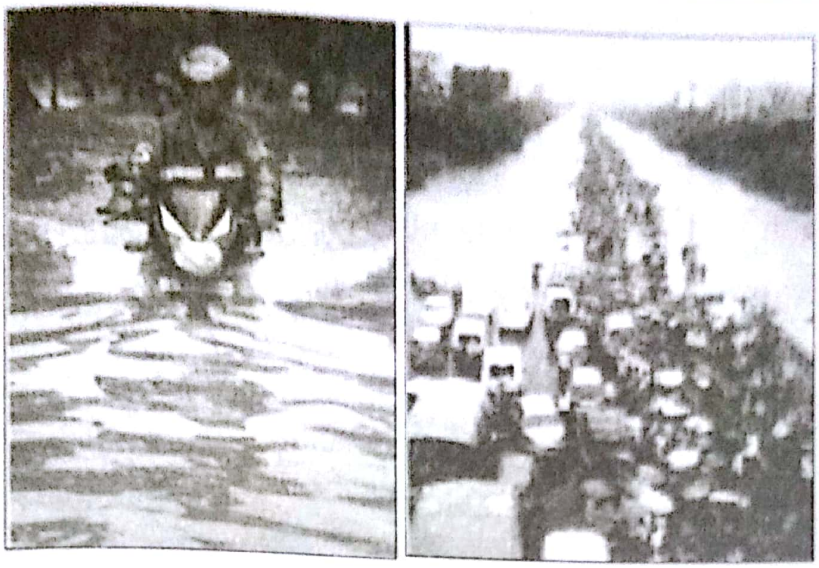


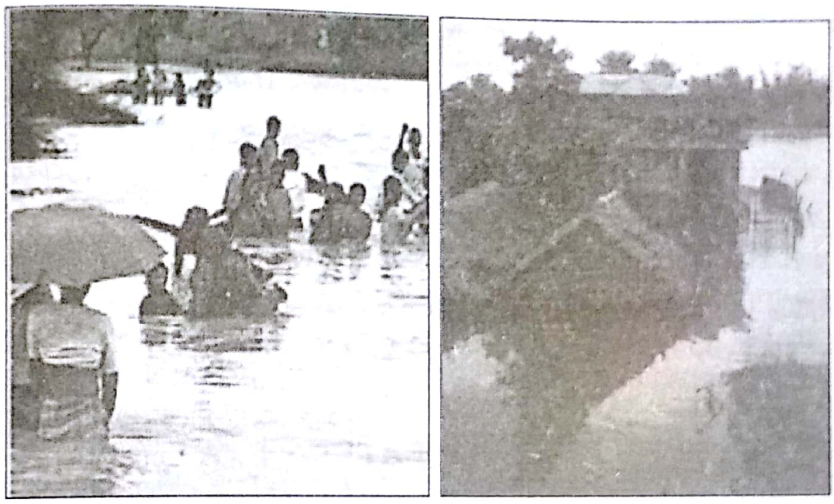
Fig. 6.41. Cyclone.

Floods (*Fig. 6.42*)

Flood simply means inundation of extensive land area with water for several days in continuation. People conceive floods when water from heavy rains or sudden snow melt, overflows the banks of rivers, submerging the surrounding land. Floods often cause colossal loss to human lives and property.



Floods in Mumbai.



Floods in Gujarat

Floods in Bihar

Floods cause destruction

Flood waters caused by heavy rains and lack of drainage affecting life in Mumbai city

Fig. 6.42. Scenes of flood.

Causes of Floods. Floods are caused by natural as well as anthrophogenic (human) factors. Among the natural factors, important are prolonged high intensity rainfalls, meandering courses of the rivers, break in slope in the long profiles of the rivers, blocking of free flow of the

rivers due to enormous debris provided by landslides or volcanic eruptions etc. The anthropogenic activities such as building activities, channel manipulation through diversion of river course, construction of bridges barrages and reservoirs, deforestation, changes in land use etc., invite several hazards in the river system including floods, landslides, massive erosion along the river banks and deposition of sands, silts and clays in the flood plains (*Fig. 6.12*).

Flood Control Measures. The floods are natural phenomenon and one cannot entirely get rid off them, but their impact can be minimised by taking a series of steps such as:

(*i*) By delaying the return of run off resulting from rainfall to the rivers

(*ii*) By hastening the discharge of water.

(*iii*) By diverting the flow of water.

(*iv*) By forewarning the occurrence of floods.

Flood disaster can be mitigated by taking following measures:

(*i*) Forecast, warnings and advice should be provided through media (radio or television) to educate and aware people about the steps to be taken in the event of disaster.

(*ii*) Elderly people and children should be evacuated to safer places on priority basis.

(*iii*) Valuable household items, animals and other necessary materials (*e.g.*, food, clothes, medicines etc.) should be shifted to safer places.

(*iv*) Government agencies and non-governmental organisations (NGOs) should help the flood affected people in the control of epidemic diseases and maintaining proper sanitation.

Droughts (*Fig. 6.43*)

The term 'drought' refers to the condition of dryness for prolonged period. Droughts are more deadly natural environmental hazards because these are directly related to one of the basic requirement of life *i.e.* water. Droughts cause famine and starvation of human and animal population of the region concerned. Prolonged drought conditions in a given region change the biotic component of the natural ecosystem due to death of several plant and animal species, migration of certain animal species to other places and stiff competition among the remaining individuals of plants and animals thereby eliminating the weaker ones.

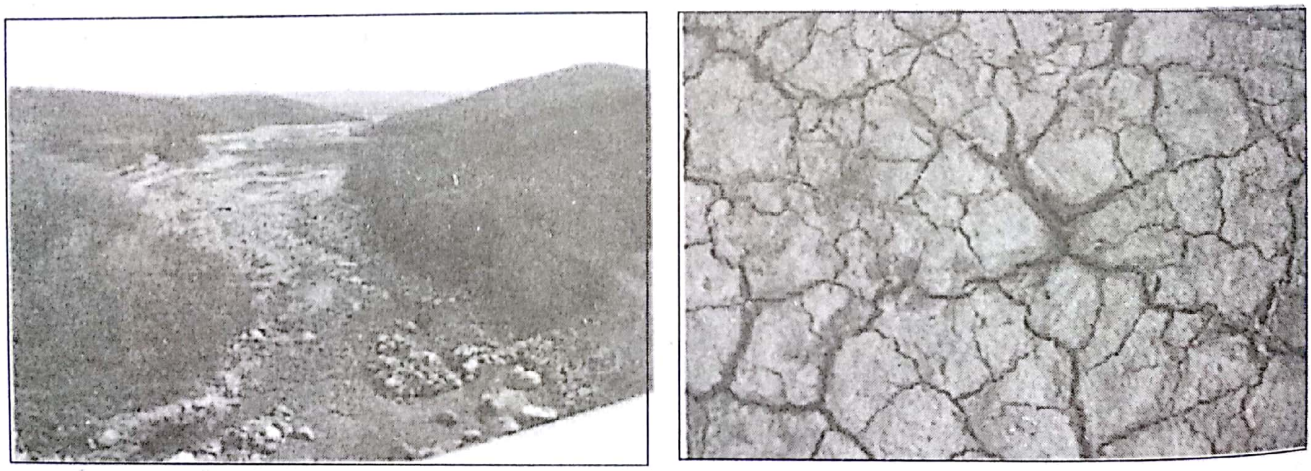


Fig. 6.43. Drought condition.

Drought Control Measures. The drought control measures include :

(*i*) Afforestation to increase the content of air moisture, the amount of precipitation, the rate of infiltration of rainwater and hence the replenishment of groundwater and rise of water-table.

(*ii*) Introduction of dry farming techniques to reduce the dependence of farming on rain-water.

(*iii*) Checking of desertification or desert spread.

(*iv*) Introduction of water conservation schemes. and

(*v*) Construction of water reservoirs and digging of wells etc.

Earthquake (*Fig. 6.44*)

An earthquake is a motion of the ground surface, ranging from a faint tremor to a wild motion capable of shaking buildings apart and causing gaping fissures to open in the ground. The earthquake is a form of energy of wave motion transmitted through the surface layer of the earth in widening circles from a point of sudden energy release, called **focus** or **hypocentre.** Hypocentre is always hidden inside the earth. The place on the ground surface (which is perpendicular to the buried focus) recording the seismic waves for the first time is called **epicentre.** The magnitude or intensity of energy released by an earthquake is measured by the **Richter scale** devised by **Charles F. Richter** (1935). The seismic waves move away from the source of earthquake which can be recorded with the help of an instrument called **seismometer.** The severity of an earthquake is generally measured by its magnitude on Richter scale as shown below.

Table 6.10

S. No.	*Richter Scale*	*Severity of Earthquake*
1.	< 4	Insignificant
2.	4—4.9	Minor
3.	5—5.9	Damaging
4.	6—6.9	Destructive
5.	7—7.9	Major
6.	> 8	Great

A view of collapsed building in Islamabad on 8th Oct, 2005

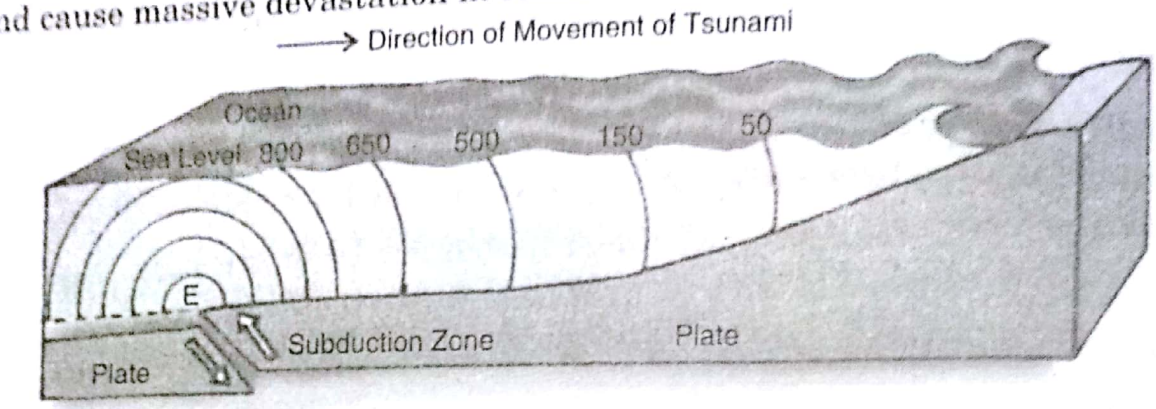
Bhuj (Gujarat) earthquake

People look at a 3-km-long crack in Simbal, near Jammu, which also recorded quake with epicentre in Pakistan on Oct 8, 2005

Fig. 6.44. Effects of Earthquake.

Tsunamis (*Fig. 6.45*)

The seismic waves caused by earthquakes travelling through sea water, generates high sea waves called **tsunamis.** These giant sea swells can move at a speed upto 1000 km/hr or even faster. While approaching the sea shore they may often reach 15 m or sometimes 65 m in height and cause massive devastation in coastal areas.



E : Epicentre of the Earthquake
800 Speed of Tsunamis in KMPH
⟹ Direction of Movement of Plates

Formation of Tsunami

Tsunami in Chennai

A general view of the scene at Marina beach in Chennai after tidal waves devastated the southern Indian coastline on 26th December, 2004.

Causes of Earthquake. The earth's crust has several tectonic plates of solid rock which slowly move along their boundaries. Sometimes friction prevents these plates from slipping resulting in building up a stress. This leads to sudden fractures along the boundaries of the plates or fault lines (planes of weakness), resulting in an earthquake.

Human Activities and Earthquake. Certain human activities may cause or enhance the frequency of earthquakes. These activities are:

(*i*) Underground nuclear testing, and

(*ii*) Collection of huge quantities of water behind a dam.

Effects of Earthquake. The earthquakes inflict great damage to human structures such as buildings, roads, factories, dams, bridges and thus cause heavy loss of human property. The tremors of higher magnitudes shake the ground to such an extent that the large buildings collapse, water supply is totally disrupted and electric supply and telecommunication systems are completely disturbed. Severe tremors due to earthquake result in deformation of ground surface and cause damages to dams resulting in severe floods. The shocks produced by earthquakes in hilly and mountainous areas may cause landslides, which damage the settlements and transport systems on the lower slope segments.

Some Historic Earthquakes

- The earthquake occurred on **May 22, 1960 in Chile** was the largest with the magnitude of 9.5 on Richter scale. It affected 90,000 square miles and killed 6,000 people.
- A devastating earthquake hit **Bhuj town** and its surrounding area in Gujarat on **Jan. 26, 2001.** It caused massive damage to the property and took away lives of 25000 people.
- In **China**, tsunami waves killed 8,30,000 people in 1556 and 50,000 in 1976.
- On **December 26, 2004** tsunami waves hit **Indonesia**, **Sri Lanka** and **India** and killed more than 1 lac people and made several others homeless and jobless.

Mitigation of Earthquakes. Damage to property and life can be minimised by taking following steps:

(*i*) By constructing earthquake resistant buildings by keeping weak spot in houses to absorb vibrations or by making pads or floats beneath the buildings.

(*ii*) By making wooden houses in seismic zones.

During tremors, following measures can be taken to minimise the losses due to an earthquake :

(*i*) People should come out of their houses and stay in the open till the tremors subside.

(*ii*) Those who are already out of the houses should stay away from buildings, electric poles, trees and any tall object that has chances of falling down.

(*iii*) In case there are tremors, when you are in some public building, then you should stay in the corner or near a piller. You should not move about or create chaos, and remain away from heavy objects.

(*iv*) In the event of tremors while you are driving, you should park the vehicle on the roadside and wait in the open till the vibrations subsides.

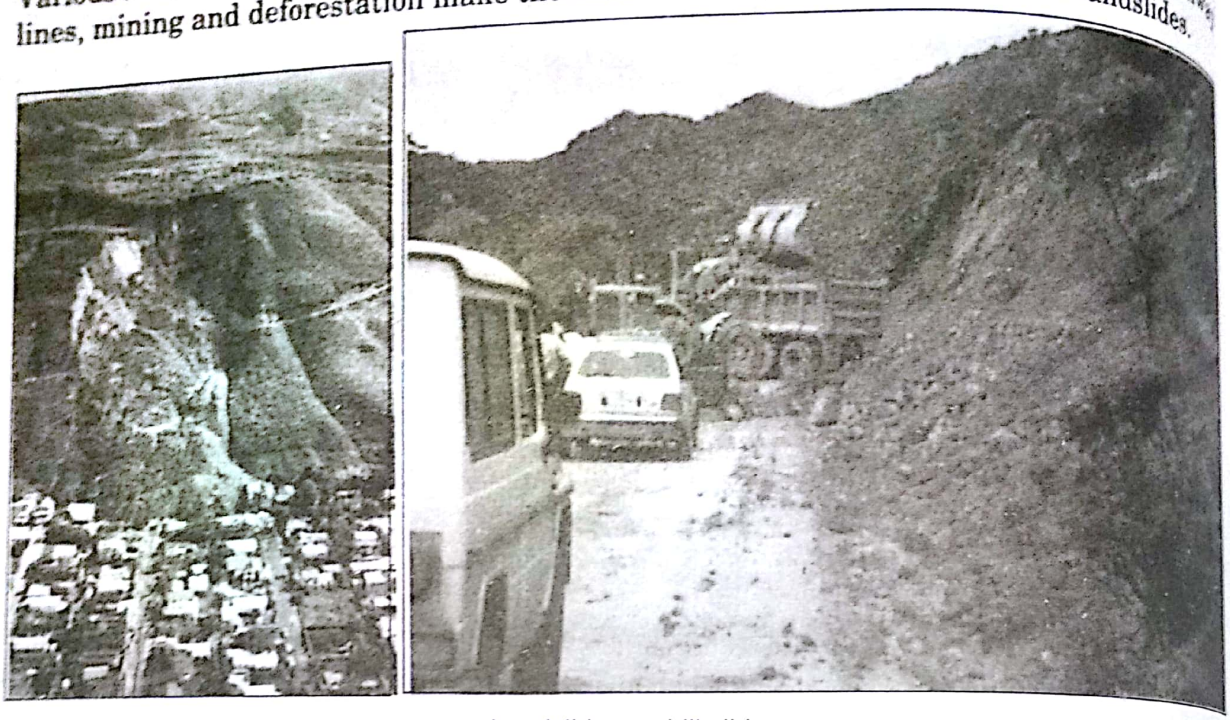
(*v*) After the subside of tremors, one should inform the Police Control Room, Fire Control Office, Red Cross Office and Non-Government Organisations (NGOs) about the disaster immediately for the help.

(*vi*) The people who are trapped inside the buildings should be evacuated and those injured should be given first aid immediately. The seriously injured persons should be shifted to the nearby hospitals.

(*vii*) Relief camps should be set up by the government and NGOs for the people who have lost their houses and properties.

Landslides (*Fig. 6.46*)

Landslide is the moving down of coherent rock of soil mass due to gravitational pull. Various human activities like hydroelectric projects, dams, construction of roads and railway lines, mining and deforestation make the mountain slopes fragile, leading to landslides.



Landslides on hill slides

Rescue operations at the site of a landslide in Saki Naka, Mumbai

People affected by landslide

Fig. 6.46. Scenes of landslide.

Mitigation of Landslides. Landslides can be minimised by stabilizing the slopes by adopting following measures.

(*i*) Afforestation in landslide prone areas to prevent soil erosion.

(*ii*) Providing slope supports by wired stone blocks.

(*iii*) Draining the surface and sub-surface water.

(*iv*) Providing concrete support at the base of slope.

The disaster prone areas of our country are shown in *Table 6.11.*

Table 6.11. ***Natural Disaster Prone Areas in India***

S. No.	*Type of Disaster*	*Disaster Prone Areas*	*Affected Population (in Million)*
1.	Cyclones	Entire 5700 km long coastline of Southern Peninsular India covering 9 States viz. Gujarat, Maharastra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal and Union Territory of Pondicherry besides Islands of Lakshadweep and Andaman and Nicobar	10
2.	Floods	8 major river valleys spread over 40 million hectares of area in the entire country	260
3.	Drought	Spread in 14 states of Andhra Pradesh, Bihar, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal and Himachal Pradesh covering a total of 116 districts and 740 blocks	86
4.	Earthquake	Nearly 55% of the total area of the country falling in the seismic zone IV and V.	400
5.	Landslide	Entire sub Himalayan region and Western Ghats	10

DISASTER MANAGEMENT

The natural disaster management involves the following steps:

1. **Relief Measures.** Relief measures should be provided immediately to the disaster victims. The high density areas of the affected locality must be given priority in the remedial and relief measures. Special rescue tools, communication equipments, heavy machines to remove debris, water pumps, cement and technicians are more important than drugs and doctors because the health dangers after a disaster are predominantly environmental in character and not medical. Relief measures should be provided by foreign countries only after they are requested by the affected country because unsolicited and unwanted supplies of men and material create confusion and complicate the problems.

2. **Disaster Predictions.** The predictions of natural hazards may be made on the basis of past history of the area prone to a particular hazard. There should be regular monitoring of the environmental changes caused by human activities to asses the genesis of natural disasters.

3. **Disaster Research.** It include the study of the contributing factors and mechanisms of natural disasters and identification of **terrain risk areas** on the basis of remote sensing, engineering and electronic techniques.

4. **Education.** Disaster education plays a significant role in disaster reduction. It arouse awareness about the hazards of disasters, help the people to improve the standard of constructions to escape the disasters.

5. **Geographic Information Systems and Aerospace Surveys.** These help in natural disaster reduction and management programmes by providing maps of the problem areas, historic informations from local people, a planning framework for local politicians and past experiences of the disasters.