Ecology and Environment Management

UNIT 3

Global Issues

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Contents:

1. http://www.dbc.uci.edu/~sustain/global/sensem/Einsteinw99.htm
2. http://en.wikipedia.org/wiki/Oil_Spills

GLOBAL ISSUES

Man and environment are interdependent and interrelated and therefore man forms an integral part of the environment. In the prehistoric times, the human populations were small, and the needs of the people were limited, as a result, their impact on the environment was not much. Slowly, the human population began to increase, largely because of industrialization, urbanization and agricultural advancement coupled with better health facilities. It also resulted in an increase in the needs of the people and their dependence on the environment. However, till the 18th century, the dependency on the environment was mainly on a regional / local scale. But in the 20th century and particularly its latter part, the extent of human interaction with the environment expanded on a global scale. The environmental problems, we face today, are mainly anthropogenic in nature. There has been a slow build up of certain gases in the atmosphere, which are responsible for climatic changes and green house effect, ozone hole in the atmosphere and acid rain. The main cause of these environmental problems is the increased industrial activity and transportation, which are basically coal and oil driven but necessary for growth and development. Deforestation, degradation of soil, fire and floods also are deteriorating the environment. The problem is further aggravated by calamities like earthquake, tsunamis, volcanic activities, explosion, war and civil strife, which may be natural or anthropogenic. So at a time when we are reaping rich dividends of our economic development, simultaneously we have to bear with the consequences of their deleterious effects on the environment. The effects warn us of the impending danger of mass extinction due to global warming or cooling, which can occur at any time.

The first conference to draw global attention to the gravity of environmental deterioration was the "Unitied Nations Conference on Human Environment" in Stockholm, 1972. It was followed by the **"Earth Summit"** in Rio de Janeiro, in 1992. The summit was attended by politicians, scientists and non-governmental organizations. The summit helped in increasing concern of the delegates for the global environmental issues. The **"Kyoto Treaty"(**1997) in Japan was successful in gathering 220 delegates from 161 nations to discuss and suggest means of slowing global warming. In 2001, President George W. Bush withdrew U.S. participation from the Kyoto Treaty. He feared that certain restrictions in it would affect the economy of USA. Again in December 2005, delegates from 189 nations met in Montreal, Canada to find solution to global warming. The attending countries agreed to launch formal talks on mandatory post 2012 reductions in green house gases. However, USA did not become a party to the decision though the highest concentration of green house gases responsible for global warming emitted in the atmosphere is by USA.

In the following pages, an attempt has been made to discuss the causes and consequences of the global environmental problems, as they concern all of us and need immediate attention. The problems need a solution if at all man has to exist on this planet –the Earth.

ACID RAIN

Most natural systems are slightly acidic. Even rainfall in the absence of any industrial contamination is slightly acidic with a pH of 5.6, because of the formation of a weak solution of carbonic acid in the atmosphere, when carbon dioxide reacts with water. If it rains with a pH of 5.5 or less, it is called acid rain. The pH of the acid rain vary in different areas, depending upon the industrial activity in an area and pH as low as 1.5 has been recorded in West Virginia, USA.

The English scientist, Robert Angus Smith coined the term "**Acid rain**" in the 1850's, while he was investigating the air chemistry of Britain's industrial heartland. The pH scale runs from 1 to 14 with pH 7 being the neutral. pH 1 represents highly acidic and pH 14 represents highly alkaline. Since the number of hydrogen ions varies greatly from one solution to another, the scale of acidity i.e. the pH of a substance is calculated on a logarithmic scale. A change of 1 pH unit is equivalent to ten-fold change in the number of hydrogen ions and is expressed as the negative logarithm of the number of free hydrogen ions. The pH of milk, tomato juice and vinegar is 6.5, 4.2 and 2.8, respectively.

Since the pollutants (compounds of SO_2 and NO_x) not only mix with rainwater but also with fog, snow, dew and hail, it is better to call it acid precipitation. Some workers call it **acid deposition**, which is further distinguished into dry and wet deposition. In **wet deposition,** falling pollutants mix with water. If pollutants fall to the surface in the form of dry gases or adsorbed on **aerosols** like soot or flyash, it is called **dry deposition**. Dry deposition usually occurs near the source of pollution and takes 2-3 days to settle.

Acid deposition results from atmospheric pollution. Man has been polluting the atmosphere since the Stone Age when he used to live in caves. Mans activities especially in the past century have increased the pollutants in the atmosphere. Once in the atmosphere, the winds carry the primary pollutants like SO_2 and NO_X away from the source depending upon the velocity of wind, and these pollutants then form secondary pollutants like sulphuric acid and nitric acid and their salts in the atmosphere.

SOURCE OF SULPHUR DIOXIDE AND NITROGEN OXIDES

These pollutants enter the atmosphere in two different ways:

1. Natural source: - It includes the volcanoes, lightening, burning of biomass and microbial activity and they are cosmopolitan in distribution. SO_2 and NO_X have been natural components of the atmosphere since the earliest times but have been in rare concentrations and levels of their natural emissions have remained more or less constant in the last twenty years or so.
2. Anthropogenic source: - Sulphur dioxide and nitrogen oxides enter the atmosphere in large quantities from the industrial regions of the world (Fig. 3.1).

   Nitrogen oxides are released by the combustion of gasoline and inspite of the use of catalytic converters, some escape to the atmosphere and vehicular emissions are the major source of these gases in the atmosphere.

   Emission of sulphur dioxide is associated with burning of coal in electricity generation, smelting of iron ore and as a fuel for domestic heating. It is a major contributor of these pollutants to the atmosphere.

The acid rain does not recognize any geographic boundaries. The pollutants remain in the atmosphere for about two weeks before settling to the earth's surface. The polluting chemicals from the source i.e. power plants and factories are carried by wind movements to the neighbouring countries without any obstructions. Thus Acid deposition in Norway, Switzerland, Austria, Sweden, Netherlands and Finland could be due to acidic emissions from the industries in UK and Germany. In the late 1960s, Swedish scientist Svante Oden found that pollutants from Europe and Great Britain were responsible for the acidification of lakes in Scandinavia. It is believed that Asia suffers from worst acid deposition where China alone gets 59% of its energy from the burning of coal.

EFFECTS OF ACID RAIN: Acid rain is harmful and affects every segment of the environment (Fig. 3.1). Some of the effects of acid rains are listed below:

1. **Human health**:
    a. In dry gaseous or aerosol forms, acid rain causes respiratory problems. Sometimes, it can also lead to death. The pollutants are generally localized in origin. The London Smog of 1952 resulted in 4000 deaths because the people inhaled sulphuric acid, which damaged the lungs and aggravated the breathing problems.
    b. Man is also affected indirectly through biological concentration of certain metals like lead, copper, cadmium, zinc and mercury along the food chain. These metals are liberated free from their compounds in soil by reaction with sulphuric (H_2SO_4) and nitric acid (HNO_3) deposited in the soil by acid rain. They reach the humans through plants via food chain concentration or drinking water supplies. Storage tanks and water pipes are also corroded by acidified water and add metals to the drinking water. Lead from lead pipes and soldering of the joints is very harmful to human health.
    c. Acid rain may cause itching or burning sensation if it falls on the body.
2. **Terrestrial environment**
    a. Acid rain affects the plants directly. At high altitudes, the trees remain surrounded by clouds for long periods and show necrosis and degradation of chlorophyll. In the plains, the acid rain falls on the trees and affects its different parts eg. leaves, flowers and fruits and damage the plants causing necrosis, chlorophyll degradation and leaching of the nutrients. Acid water interferes with soil biology and soil chemistry disturbing nutrient cycles and causing physiological damage to plant root system. Acidity may affect the activity of nitrifying bacteria to fix atmospheric nitrogen.
    b. It weakens the plants and makes them more susceptible to cold, diseases and insect attacks.
    c. It promotes growth of mosses, which have high water holding capacity, killing the roots of the plants and fungi that help the roots in the absorption of nutrients.
    d. Acid deposition helps in the release of certain ions like Al^{3+} from insoluble form and these ions inhibit the uptake of water and nutrients from the soil by the plants. Increased acidity in the soil precipitates phosphorous, as insoluble compounds and they cannot be absorbed by the plants as nutrients. The rate of decomposition is also slowed down due to the death of the decomposers.
    e. The toxic metals like Al, Cd, Zn, Hg, Cu and Fe released in ionic form due to acidification may mix with ground water, lakes and streams or get absorbed by plants and damage them. Low concentrations of iron are useful for the plants but at higher concentration iron is toxic to them.
3. **Aquatic environment**
    a. The lakes get acidified either due to ageing or acid rain and it has a declining effect on the flora and fauna. The poisoning of the food chain starts with the photosynthetic algae and once the food base is affected, the whole system is likely to collapse. Phytoplankton disappears below pH 5.8. However, the lake will be invaded by *Sphagnum* mosses, which are acid tolerant. The acid lakes are unusually clear

and bluish in colour in the absence of phytoplankton and reduced organic activity. They allow more light penetration.

b. Fishes show different degrees of tolerance to acidity eg. Brook trout cannot tolerate pH below 6 and the salmons are much less tolerant. So, the composition of fish population in a lake changes with acidity. The low pH of the lake helps in the release of unavailable metals like aluminum and mercury from the nearby soil into the lake, which is lethal to the fishes. In the presence of these metals, the fishes secrete excessive mucous which asphyxiates them by clogging the gills. Water bodies that show decline in fish populations are called dead or dying. It is believed that in Norway and Sweden about 1600 lakes are without fish due to increased acidity and 1400 lakes in Canada have negligible number of fishes.

c. Water boatman and Whirligig beetles are known to survive at pH 3.5 while some protozoan species survive even at pH 2.

d. **Built up structures** Weathering of rocks occurs due to physical factors like temperature and humidity or chemical factors like sulphur and NO_x compounds in the atmosphere. The acid rain corrodes the rocks gradually. However, the effect of acid rain is more on limestone and marbles, which are commonly used in the construction of buildings. Limestone has calcium and magnesium as main constituents and reacts with H_2SO_4 to form sulphates. Slowly, the building is damaged as the sulphate is washed out of the stone. The crystals of sulphates formed on or below the surface cause cracking, flaking and crumbling of the structure. Though, granite and bricks are resistant to acidity, it damages the lime rich mortar, weakening the brick built structures, steel and other materials in the building. The damages in urban areas are generally due to dry deposition and the acidic particles damaging the buildings originate from nearby smelters and power stations. The oil refinery at Mathura is a cause of concern for the Taj Mahal at Agra.

   Thus, acid rain apart from causing physical and economical damages, threatens the World's Cultural Heritages like the Taj Mahal in India, 37 feet bronze Buddha in Kamakura, Japan and the Cathedrals of Cologne, Cantabury in Europe. The craftsmanship on medieval stones of these buildings may be damaged beyond repair. Faceless statues and falling cornices of the worlds famous buildings are very common in acid rain affected regions of the world.

SOLUTIONS

The solution to the problem of acid deposition lies in controlling the concentration of its constituents in the atmosphere. This can be achieved in the following ways:

1. Reduction in the emission level of SO_2 and NO_x by improving energy efficiency.
2. Reduction in the use of fossil fuels and utilizing alternative source of energy like solar and wind energy.
3. By promoting use of low sulphur fuel like oil and natural gas.
4. SO_2 level in the coal can be reduced by fuel desulphurization and by crushing and washing the coal which removes 8-15% of the sulphur compounds.
5. Tax emissions of the pollutants like SO_2.
6. Remove NO_x from automobile exhaust.
7. Old and acidified lakes can be neutralized by adding limestone and thus made productive again.

THE STRATOSPHERIC OZONE

The earth's atmosphere is divided into several layers. Each layer is characterized by a sharp change in temperature due to differences in the incoming solar energy. The innermost layer is **troposphere**, which extends upto 17 km and has 80% of the earth's air. The tropospheric air has 78.08% nitrogen (N_2), 20.94% oxygen (O_2), 0.035% carbon dioxide (CO_2) and 0.934% argon apart from water vapour and trace amounts of other gases.

The second layer of the atmosphere is **stratosphere** and it extends from 17 to 48 km above the earth's surface. It is quite different from troposphere in the composition of its gases, as it has very small amount of water vapour and a high concentration of ozone. The stratospheric ozone layer helps in absorbing solar radiations entering the troposphere to different extent. The solar radiation has different components and includes the visible light, the UV light and the infrared radiations apart from many other radiations. The UV radiations are of shorter wavelengths and lie near the violet light of the visible spectrum, which are the shortest wavelengths reaching the eyes. The three main components of the UV radiations are UV-A with wavelength 320-400 nanometers, UV-B radiations with 280-320 nanometers wavelength and UV-C with wavelength 100-280 nanometers is lethal to organisms. Since the energy is inversely related to the wavelength, UV-B radiations are more energetic and dangerous.

As mentioned above, when these radiations enter the earth's atmosphere, the stratospheric ozone absorbs 95-99% of the UV radiations. If the full amount of these radiations reaches the earth's surface, it will be lethal to all forms of life. Even small amounts of UV radiations reaching the earth's surface can cause sunburn, skin and eye cancer and cataracts and may damage the immune system. It can also damage plants, increase the rate of any oxidative process like rusting of metal and is a major contributor to the photochemical smog.

The key to the paradox of "love – hate" relationship with ozone lies in where the ozone is formed in the atmosphere. The ozone that we need is stratospheric ozone while tropospheric ozone is a problem gas. The stratospheric ozone protects us from the harmful effects of UV radiations and is rightly called the global sunscreen, the UV filter or the ozone shield. The protection of this stratospheric ozone is linked to the survival of mankind.

OZONE FORMATION

The amount of ozone in the stratosphere is not constant but dynamic, as it is constantly being formed and destroyed. It is thickest in the stratosphere above the poles and thinnest at the equator. The stratospheric ozone shield is formed when some of the oxygen molecules there interact with the UV radiations from the sun. The UV radiations first break the molecule of oxygen (O_2) into free oxygen atom (O). The oxygen atom (O) then combines with molecular oxygen (O_2) to form the ozone.

$$O_2 + \text{UV B} \rightarrow O + O \qquad \text{(i)}$$
$$O + O_2 \rightarrow O_3 \qquad \text{(ii)}$$

However some free oxygen atom (O) also combine with molecules of ozone (O_3) to form two molecules of oxygen (O_2).

$$O + O_3 \rightarrow 2O_2 \qquad \text{(iii)}$$

Also when ozone (O_3) absorbs UV B radiations, again it is broken down to molecular oxygen (O_2) and free oxygen (O).

$$O_3 + \text{UV B} \rightarrow O_2 + O_2 \quad \text{(iv)}$$

Thus the reactions (i) and (ii) lead to the formation of ozone, whereas (iii) and (iv) lead to its destruction.

OZONE DEPLETION

It is an established fact that chlorine molecules released by a number of chemicals in the atmosphere act as ozone destroyer. The most important amongst them is **chlorofluorocarbons (CFCs)** discovered in 1930 by Thomas Midley Jr. The two most commonly used CFCs are CFC-11 (CCl_3F i.e. Trichlorofluoromethane) and CFC-12 (CCl_2F_2 i.e. Dichlorodifluoromethane), known by the trade name **freons.**

Certain characteristics of the freons have been exploited by the chemical industry, as they are nontoxic, stable, non-inflammable and non-corrosive compounds. These gases liquefy under modest pressure becoming cold and because of this property they have been used in refrigerators as a coolant. They are used in the production of plastic foams, for cleaning computer parts, as a propellant in aerosol spray cans, cleaning of hospital instruments and as fumigants for granaries.

Because of excessive use, the CFCs increased in concentration in the troposphere from where they move to the stratosphere by convection current and turbulent mixing of the air and react with the UV radiations as follows (Fig. 3.2):

$$CFCl_3 + UV \rightarrow Cl + CFCl_2$$

Slowly, all the chlorine will be released and attack the stratospheric ozone to form chlorine monoxide (ClO) and molecular oxygen (O_2) as follows:

$$Cl + O_3 \rightarrow ClO + O_2$$

In subsequent reactions, two molecules of chlorine monoxide (ClO) may react to form more chlorine and an oxygen molecule.

$$ClO + ClO \rightarrow 2Cl + O_2$$

Thus chlorine is continuously regenerated as it reacts with ozone and this is called **chlorine cycle**. Since CFCs last for 65-385 years in the atmosphere, each chlorine atom released can convert upto 100,000 molecules of ozone to oxygen and thus CFCs act as global destroyer of ozone. Sherwood Rowland and Mario Molina, 1974 first observed the fact that CFCs were damaging the stratospheric ozone and they were awarded Nobel Prize in 1990 for the same.

Other chemicals, which contribute to the halogens in the stratosphere and deplete the ozone layer, are:

1. Halons and HBFCs used as extinguishers.
2. Methyl bromide (CH_3Br) used as fumigant.
3. Hydrogen chloride (HCl) emitted in the stratosphere by space shuttle.
4. Methyl chloroform, n-propyl bromide, hexachlorobutadiene and carbon tetrachloride are used as cleaning solvents.

Some chlorine is also released by the oceans and volcanic eruptions but is rarely passed to the stratosphere as it is dissolved in rainwater and washed out of the troposphere.

THE OZONE HOLE

The British scientists first observed a gaping "hole" (a thinning of the area) over South Pole in the fall of 1985 with ozone level 50% below the normal but the process of thinning of the area must have started as early as 1960's. The seasonal loss of ozone during the summer above Antarctica has been incorrectly called an "**Ozone hole**" but the accurate term is "ozone thinning" because the ozone depletion varies with altitude and location. Many factors contribute to ozone thinning at the poles. During summer, nitrogen dioxide and methane react with chlorine to form chlorine reservoirs and prevent ozone depletion. But the Antarctic winter in June creates a vortex of stratospheric gases over the Antarctic. The moisture and chemicals present in the stratosphere form stratospheric clouds over South Pole and the cloud particles provide surface on which chemical reaction takes place and release molecular chlorine from the chlorine reservoirs. In spring, when sunlight returns to Antarctica, the sun's heat break up the clouds, UV light attacks the molecular chlorine to release free chlorine and initiates the chlorine cycle (Fig. 3.2).

When the summer arrives in the Antarctic (November), the vortex breaks down and ozone (O_3) rich air return to the area and the ozone poor air then spreads over southern hemisphere including Australia, New Zealand, South America and South Africa. Ozone concentration is measured in **Dobson Units** and values of 400 – 600 DU are considered normal. The area of ozone hole has a concentration of less than 220 DU. On October 12, 1993 ozone hole thinning was 70% and the concentration of ozone at the South pole fell to 96 DU while ozone in the mid-latitudes were about 300 - 400 DU. The Antarctic ozone depletion in 2000 was massive and covered an area of 11 million square miles which is three times the size of USA.

The ozone depletion raises biologically damaging UV-B levels in the affected areas by 3-10%, which is harmful for the organisms. It is reported that during early Australian summer, the UV radiation levels increase up to 20% and can result in high incident of skin cancer in Australians. However, in the year 2001 and 2002, a comparatively small ozone hole was observed.

Similar but less severe ozone thinning has been observed in 1988 in the spring and early summer (February-June) in the Arctic. The loss of ozone has been reported 15% less than the pre 1976 average. When this mass of ozone (O_3) depleted air breakup in spring, it moves southwards over parts of Europe, North America and Asia. According to scientists at NASA, ozone depletion over the Antarctic and Arctic will be at its worst between 2010 and 2019.

EFFECTS OF OZONE DEPLETION

With the thinning of ozone (O_3) layer, more of the UV-A and UV-B radiations will be reaching the earth's surface, harming the plants and animals. The affects of ozone layer thinning can be generalized as follows.

1. In human beings UV radiations will cause sunburns, skin cancers and eye cataracts. The skin cancer may be of squamous cells or basal cells or it may be a malignant melanoma. The squamous and basal cell cancer accounts for 90-95% of the skin cancers. Malignant melanoma occurs in pigmented areas like moles. It spreads quickly to other organs and is very fatal.
2. Exposure to UV radiations may lead to suppression of the immune system in human beings making the body susceptible to infections.

3. People who take antibiotics and women taking birth control pills are more susceptible to UV damage.
4. Exposure to UV radiations results in decreased population of aquatic species and reduced phytoplankton on the surface, affecting the food web of the community.
5. UV rays may enhance photochemical smog and acid deposition and may affect paints and plastics.
6. There may be reduced yield of some crops and decreased forest productivity from UV sensitive tree species.
7. It also contributes to global warming because of decreased ocean uptake of CO_2 from the atmosphere by the phytoplankton and CFCs acting as green house gases.

PROTECTION OF THE OZONE LAYER

There is growing concern amongst scientist that all ozone depleting chemicals should be immediately stopped. Infact, many countries have stopped production and use of CFCs and since 1989, there is a decline of about 80% in CFCs production by industrialized nations of the world. It is believed that CFCs are now being removed from the atmosphere more rapidly than they are added and in about 50 years, the stratospheric ozone level should be back to normal.

Alternatives to CFCs are now available and one such chemical is hydrochlorofluorocarbon (HCFC), which releases much less chlorine molecule. Ray Turner in California has developed citrus-based solvents to clear the circuit boards replacing the CFCs. Many companies like AT&T clean computer boards and chips with acidic chemicals extracted from peach and plums.

In 1987, delegates from 36 nations met in Montreal (Canada) and formulated the **"Montreal Protocol".** The aim was to reduce CFCs emission by about 50% between 1989 and 2000. Representatives of 93 countries again met in London in 1990 and Copenhagen, Denmark in 1992 to accelerate the phasing out of the ozone depleting chemicals. The meetings of representatives of different countries at various forums to solve the environmental problems are the result of their concern for global environmental problems and their intentions to solve them.

OZONE CELL

To meet the countries commitment on **Ozone Depleting Substances (ODS)** phase out, the Ministry of Environment and Forest has established an **Ozone Cell**. It promotes investment in non-ODS technologies. Licensing system has been adopted to regulate import and export of ODS. The Notified Ozone Depleting Substances (Regulation and Control) Rules – 2000 provides a legal framework for ensuring compliance of the Montreal Protocol. It sets the deadline for phasing out of various ODS besides regulating production, trade, and import and export of ozone depleting substances. The rules prohibit the use of CFCs in the manufacture of various products beyond 1st January 2003 except in metered dose inhalers and for other medical purposes. Use of halons is prohibited after 1st January 2001 except for essential uses. Carbon tetrachloride, methyl chloroform and CFCs for metered dose inhalers can be used upto 1st January 2010, while usage of methyl bromide has been allowed upto 1st January 2015.

CLIMATE CHANGE AND GREEN HOUSE EFFECT

The climate of a region is described as the average temperature and precipitation pattern in a particular year. The climate varies in different ecosystems and forms the basis of different biomes in various parts of the world. Change in the climate of the world has been observed throughout the evolutionary history.

Humans probably can adjust to almost any climate but it is not possible for other inhabitants of the same region. A change in climate can be a major threat for the survival of these organisms. For example, a sudden cooling 65 million years ago ended the age of dinosaurs along with 75 % of the species existing at that time. Studies have shown that the climate of the world has not remained constant in the past 4.7 billion years of its history. The change in climate has been either very quick taking a few decades or very slow taking millions of years. In the past 90,000 years, the atmospheric temperature near the earth's surface has witnessed:

1. Long periods of global cooling, with water held up in glaciers and ice sheets and the sea level was lower by as much as 120 m. The phase lasted for about 100,000 years.

2. Short period of global warming lasting 10,000 years to 12,500 years. Melting of glaciers and ice sheets took place in this period.

The possible reasons for these climatic shifts can be:

1. The changes in the intensity of light due to **"Milankovitch cycles",** named after the Serbian scientist in 1920. According to these cycles:
    a. The shape of the earth's orbit around the sun elongates and shortens in 100,000 years cycle.
    b. The axis of rotation changes its angle of tilt in a 40,000-year cycle.
    c. Over a 26,000-year period, the axis wobbles like an out of balance spinning top. The expansion of glaciers every 100,000 years or so can result from orbital shifts.
2. Meteor impacts and sudden shifts in ocean currents causing redistribution of the heat may also have caused rapid climate change.
3. El Nino is another important factor that represents interaction between major Pacific Ocean currents and climate that affects the weather throughout the world. Generally the large pool of warm surface waters in the Western Pacific Ocean between Indonesia and South America is kept in motion for years by the steady equatorial trade winds and at the same time pushing it slowly westward towards Indonesia and Australia. The warm equatorial water results in low pressure in the atmosphere. It results in heavy rainfall in these regions supporting thick forests. But on the eastern side of the Pacific Ocean, the warm water is replaced by cool water coming from the South American coast. The cold water is rich in nutrients and support good amount of fisheries. Although the trade winds blow towards Indonesia on the surface of the ocean but the returning winds from Indonesia to South America in the troposphere sink and cause dry and desert conditions in Chile, Mexico and Southern California.

    However, every three to five years the trade winds weaken and the Indonesian low-pressure system does not operate. The mass of surface waters in the Pacific Ocean then moves eastward towards America. This disturbs the temperature cycle in the Pacific. Therefore, wind direction and precipitation patterns are changed over most of the Pacific and all over the world. Drought

during this phase of El Nino in Indonesia and Australia results in crop failure and forest fires. Fishermen in Peru were the first to notice the irregular cycles of rising ocean temperature and named it **El Nino** (Spanish term for Christ child), as it occurred around Christmas time. The counter part to El Nino, when the eastern tropical Pacific cools is called **La Nina** (little girl). Together these cycles are called. **El Nino Southern oscillations (ENSO)** Climatologists believe that ENSO events are getting more prominent and frequent because of global climate change and spreading of warm surface waters of the Oceans.

4. The anthropogenic climate change however is the most significant of all and Svante Arrhenius 1895 observed that CO_2 released by burning of coal might be responsible for much of the global warming. In its third report in 2001, the Intergovernmental Panel on Climate Change (IPCC) also concluded that human activities contributed to global warming. Since 1861, the average temperature near the earth's surface has risen by 0.6^0C (1.1^0F). More recently, 1980s has witnessed six of the warmest years in the past century and this trend continued in the 1990s when 1998 was the hottest year.

THE EARTH AS A GREENHOUSE

All of us know that the interior of a car heats up when the car is kept in the sun with its windows closed, because the sunlight is absorbed by the interior of the car. The heat energy given off in the form of infrared radiations is blocked by the glass, trapping the heat inside the car leading to increase in the interior temperature of the car. The same phenomenon keeps the green house warmer than the surrounding environment. However, the atmosphere does not behave like a real greenhouse or a car with window closed, as it prevents the air from being carried away by convection to the outside air. Actually the convection currents in the atmosphere-spread heat released by molecules of greenhouse gases and therefore should better be called **Tropospheric-heating effect.**

On a global scale, CO_2, water vapour and other gases in the atmosphere play a role analogous to the glass in a green house and are called **greenhouse gases**. Thus light energy from the sun is absorbed by the earth and converted to heat energy. The short wave infrared heat energy radiate back as longer wavelength radiations through the atmosphere into the space. The greenhouse gases present in the troposphere absorb some of these longer wavelengths of infrared radiations and re-radiate back to the surface keeping the lower atmosphere warm. Thus greenhouse gases insulate the earth and delay the loss of infrared energy (heat) to space (Fig. 3.3).

The French mathematician and scientist J.B. Fourier (1827) first reported the greenhouse effect. In the absence of greenhouse gases, the surface temperature on earth would be about 21^0C colder than present and survival of the organisms would not have been possible. So the earth's climate is dependent upon the concentration of the greenhouse gases in the atmosphere. Without the greenhouse effect, the average temperature for the planet would be about -18^0C (O^oF) and our plant would be a piece of frozen rock covered with ice.

The following activities contribute to increase in greenhouse gases in the troposphere:

1. Increased use of fossil fuels, releasing large amount of carbon dioxide and methane in the atmosphere.
2. Deforestation, clearing and burning of grasslands for agricultural crops, which release CO_2 and N_2O.
3. Cultivation of rice in paddies and use of inorganic fertilizers, which release N_2O into the troposphere.

Scientists believe that increased input of CO_2 and other greenhouse gases into the atmosphere will increase the earth's natural greenhouse effect and raise the average global temperature of the atmosphere near the earth's surface. This enhanced greenhouse effect is called as **global warming**.

Scientists have analyzed the contents of gases in the bubbles trapped at various depths in the ancient glacial ice and it was observed that changes in the tropospheric CO_2 levels correlate with variations in the atmosphere's average global temperature near the earth's surface indicating that some global warming is occurring. The concentration of CO_2 in the troposphere is higher than it has been in the past 42,000 years. The twentieth century has been the hottest century in the past 1,000 years and 1998 was the hottest year.

Mathematical models of global air circulation system are prepared by scientist to analyze the effects of increased greenhouse gases on global temperature and earths climate and then they are verified on super computers. But still it is not a very reliable criterion and the computer models are being continuously improved upon.

The Intergovernmental Panel on Climate Change (IPCC) was constituted in 1988 by UN and World Meteorological Organization. More than 2000 climate experts from 70 countries took part in it. According to IPCC report submitted in 2001, the global warming in the last 50 years has been due to anthropogenic activities and it is assumed that the earth's mean surface temperature will increase by 1.4 to 5.8^0C (2.5-10.4^0F) by 2100. A report by Bush administration in 2002, however expect the temperature to rise by 3^0C (5.4^0F) and the sea level by 9-88 cm (4-35 inches), flooding the coastal wetlands, low lying islands and heavily populated coastal cities. Scientists feel that warming or cooling of the earth's surface by even 1^0C (1.8^0F) per century, will be faster than any temperature change in the last 10,000 years and it will dangerously disturb the earth's ecosystem and the human societies in the near future.

GLOBAL COOLING

Just as certain atmospheric gases are responsible for global warming, certain factors of the environment help in cooling of the environment (Fig. 3.3) as explained below:

1. The clouds cover 50% of the earth's surface and reflect 21% of the solar radiation into space. The reflection of sunlight is called **planetary albedo** and it prevents warming of the atmosphere (indirectly it cools the atmosphere).
2. The particles and aerosols entering the atmosphere as a result of volcanic eruptions reflect and scatter the radiations entering the atmosphere, reducing the global temperature. However, the effect will persist only till the debris is in the atmosphere.
3. SO_2 released in the atmosphere react with aerosols to form **sulphate haze**, which reflect and scatter sunlight and also help in cloud formation. Climatologists believe that these pollutants have been successful in reducing global warming by 20-30%.

Some scientists believe that the term global warming is misleading because although the earth's overall temperature goes up, some parts of the earth may get cooler also. Therefore instead of calling it global warming, it is advisable to call it **"global climate instability".**

GREENHOUSE GASES

They contribute to the warming of the earth's atmosphere. Some greenhouse gases occur naturally in the atmosphere, while others are the result of human activities:

1. **Carbon dioxide**: The industrialized countries using fossil fuel, especially coal, mainly contributes towards CO_2 in the atmosphere. Deforestation and burning of forest trees is another anthropogenic source. These activities may lead to CO_2 concentration in the atmosphere upto 500 ppm by the end of the twenty-first century.
2. **Water vapour**: It is present in the atmosphere as part of the hydrological cycle. It is the most abundant green house gas. It has the capacity to absorb infrared energy (heat). With an increase in temperature over land and oceans evaporation increases leading to increase in water vapour concentration, which may cause even more warming.
3. **Methane**: Methane is a product of microbial fermentation reaction. The main sources of methane are rice paddies, guts of cattle and termites, landfills, coal production and natural gas leaks from oil and gas production and pipelines. The concentration of methane in the atmosphere has doubled as revealed by core samples taken from glacial ice.
4. **Nitrous oxides**: It is a very stable gas and stays in the atmosphere for 114-120 years. It not only contributes to global warming but also to the destruction of ozone layer. The main sources of NO_x in the atmosphere are agriculture and burning of biomass and fossil fuels.
5. **Chlorofluorocarbons (CFCs**): They are also very stable in the atmosphere and are entirely anthropogenic. They have been used extensively in refrigerators and are now banned but CFCs already in the atmosphere will persist for many years. They contribute to global warming in the troposphere and ozone destruction in the stratosphere.

   The other greenhouse gases present in small amount in the atmosphere are Hydrofluorocarbons (HFCs), Halons, and Carbon tetrachloride etc. **The Relative Warming Potential (RWP)** of these gases is measured in comparison to CO_2, which is taken as one. The RWP of methane is 23, nitrous oxide is 296 and of CFCs is 900-8300.

EFFECTS OF GLOBAL WARMING

Global warming will affect different segments of the environment, however, the nature and effect will vary depending upon the vulnerability factor of a particular segment like agricultural system, human beings and oceans etc.

1. It is believed that the largest temperature increase will take place at the earth's pole causing melting of glaciers and thinning of the ice caps. Huge decrease in the thickness and extent of sea ice has been reported in the Arctic. The polar ice caps have lost 40% of its volume since 1958.
2. Many factors will increase global warming by releasing large amount of carbon dioxide in the lower atmosphere e.g. dieback of some forests, wild fires in areas where the climate becomes drier and tree deaths due to diseases and pest which survive well in warmer climate.
3. There can be a change in the structure and location of the wildlife habitat resulting in the expansion of range and population of some plants and animals adapted to warmer climate. But the change will be harmful for those who are unable to migrate to new areas. Change in regional climate may threaten the wildlife sanctuaries, wetlands and coral reefs and hence the diversity of that area.
4. Sea level will also rise due to global warming because water expands slightly when heated. The IPCC in their report submitted in 2001 projected a rise of 9-88 cm (4-35 inches) of sea level during this century. This may threaten the marine life, coastal

estuaries, wetlands and coral reefs. It may also flood agricultural low land in parts of Bangladesh, China and India, affecting the food production in these parts of the world.

5. The coastal cities of the world will be flooded, threatening the survival of the people. Contamination of the coastal freshwater aquifer with salt water due to rising sea level cannot be ruled out in low lying islands of the Pacific and Caribbean.
6. The global warming will have more harmful effect on poor tropical and subtropical nations, as they may not have sufficient resources to meet the challenges of global warming.
7. However, the global warming have brighter spots for some countries and people as winters will be less severe and there can be more plants in some dry areas, accompanied by increased food production. Some species of plants and animals adapted to higher temperature may redefine the range and distribution pattern.

EVIDENCE OF CLIMATIC CHANGE

The evidences from the data available from all over the world suggests that the global climate is already changing. However this change has been basically because of human activities.

1. Precipitation has increased by about 1% in the continental areas in the last century. There has been decline in precipitation in tropical areas while more rainfall is reported from the high latitudes.
2. Severe storms, rainstorms, hurricanes, tornadoes and flood are more frequent now. USA experienced four hurricanes and one drought spell in the Midwest in the year 2005, causing loss to the tune of billions of dollars (H.T. 30 Jan. 2006). Western India suffered worst floods in the century. Mumbai received 940 mm of rain in 24 hours and monsoon rains killed 1039 people (H.T. July 2005, Fig. 3.4).
3. Arctic ice cap covered by summer sea ice is decreasing by 9.2% each decade and arctic wild life like polar bears, walruses, beluga whales, caribou and musk ox are either declining and/or changing the migration and feeding pattern because of changing climatic conditions.
4. Alpine glaciers may disappear from the world in the next 50 years as they are retreating rapidly and the sea level has risen by 15-20 cm in the past century.
5. There have been over 60 worldwide coral bleaching events since 1980s. In 1998, the hottest year of the century, in the Great Barrier reefs of Australia, the temperature of the sea increased from January to March peaking at 32.7^0C. It resulted in bleaching of 90% of the corals and 10% were destroyed completely. In the same year (1998) India experienced temperature of 50.6^0C; its hottest in last 50 years and the heat wave killed more than 2500 people.

SOLUTION

A number of methods have been suggested for slowing down the rate of global warming in the 21st century:

1. The concentration of CO_2 can be regulated in the environment by planting more trees, which will remove more CO_2 from the atmosphere, but at the same time, trees release CO_2 back into the atmosphere by death and decay or when they are burnt. Plants like switch grasses remove CO_2 from the atmosphere and deposit it in the soil. So these grasses can be grown in areas, which are not suitable for ordinary crops. Agricultural methods like, no till cultivation helps in controlling the release of N_2O and CO_2 from the

soil can be practiced. CO_2 collected from the power plants and generators can be pumped into abandoned soil, deep ocean or saltwater aquifer for safe disposal.

2. A reduction in the fossil fuel and shifting to natural gas will cut down CO_2 emission considerably. According to Lovins (1989) improving energy efficiency is the best method to reduce CO_2 emissions and other pollutants. The transfer of the technologies of energy efficiency to the developing countries will further cut CO_2 emissions.
3. Control of population growth, restricting urban sprawl and reducing poverty may also lead to CO_2 reduction in the atmosphere. Promoting sustainable agriculture and reducing deforestation helps in reducing CO_2 concentration in the atmosphere. Cattle feeds can be modified to reduce methane emission by belching cows. Change in the flooding schedule and fertilization techniques can reduce **anoxia (**O_2 depletion) that produces **marsh gas.** Methane from landfills, oil wells and coalmines can be collected and used for generating electricity rather than allowing it to go into the atmosphere.
4. Nuclear power is also promoted as an alternative to fossil fuel but security concerns and storage of wastes makes this option unacceptable to many people around the world.
5. The scientists are worried as the effects to control greenhouse gases may fail and are looking for exotic ways to reverse or slow global warming with the help of geoengineering (H.T. June, 28.2006). Geoengineering is concerned with rearranging the earth's environment to suit human needs and promote habitability. The methods that can be employed in the stratospheric zone of the atmosphere are as follows:
    i. Millions of tones of sulphur dioxide released in the stratosphere will act as sun block and reflect sun light away from the earth. Sulphur dioxide could stay in the atmosphere for 1-2 years but it is an expensive method.
    ii. Trillions of lenses may be placed in a special orbit where the gravity of the sun and the earth are balanced. These lenses could bend away some light from the earth. The lenses would be about 2 feet wide, extremely thin and weighing a little more then a butterfly.

The methods employed in the troposphere can be as follows:

i. Mist of salt water is sprayed in the air and water molecules in the atmosphere would condense on the salt molecules increasing the reflectivity of the clouds. Therefore, the atmosphere has to be partly cloudy all the time. Increased reflectivities of the clouds will lasts for a week; therefore spraying must be a continuous process.
ii. A floating white plastic foam or disc in the ocean could reflect solar radiations back in to the space. Similarly the deserts can be covered with white plastic mulch.
iii. When iron is added to the sea, it stimulates growth of phytoplankton that take up carbon dioxide for the photosynthetic activities. The dead phytoplankton will sink to the bottom of the ocean keeping carbon dioxide at the bottom for centuries.

KYOTO TREATY

The "Earth Summit" at Rio de Janeiro, Brazil in 1992, had an important objective under the frame work "Convention on climate change" to stabilize greenhouse gas emissions in order to reduce the threat of global warming but no agreement on specific emission targets or dates was arrived at.

As a follow up to the above summit, more than 2200 delegates from 161 nations met in Kyoto, Japan in 1997 to formulate a treaty known as "Kyoto treaty". The treaty required 38 developed nations to cut the greenhouse gases; CO_2, methane and nitrous oxides emissions to an average of 5.2 below 1990 levels by 2012.

The other greenhouse gases namely HFCs, Perfluorocarbons and sulphur hexafluoride would also be reduced but their level was not decided. The Kyoto treaty however set different limits for individual nations depending on their output before 1990. Developing countries like China and India were exempted from emission limit to allow development and to increase their standards of living.

In 2002, the European Union and Japan ratified the Kyoto Agreement. However, USA refused to comply with the agreement and the argument from Bush administration is that reducing emissions would be a costly affair for US economy. If current energy consumption pattern persists, it is estimated that USA will be 43% above 1990 emission level rather than 7% below as was promised. 189 nations met in Montreal (Canada) in December 2005 to discuss how to combat global warming. In the Montreal Meet, US chief climate negotiator Harlan Watson showed opposition to Kyoto Treaty and said "A targets and timetables approach will not work for us". Watson said that Washington favoured investment in new technology like hydrogen or research into burying CO_2. However, the development and deployment of technologies does not fit with rigid targets and timetable (H.T. November 30, 2005).

SOLID WASTES

Food, clothing and shelter are the basic requirements of all human beings. Modern man needs a host of facilities like medical, transportation, communication and other technologies. While availing and acquiring these facilities we all produce unwanted by-products and residues in our everyday life. Solid waste is unwanted or discarded material that is neither liquid nor gas. The waste is of two types:

1. Degradable, when it is decomposed and mineralized and gets mixed with the soil like paper, leaves and vegetables.
2. Non-degradable, when it is not degraded and stays as such for long like glass, plastics and metal objects.

The amount of waste produced is related to the needs of the people. If the needs are limited, amount of waste produced is not much and its disposal may not cause much of a problem. Solid waste is an indicator of the status of the society. The large amount of solid waste is considered to be a sign of economic progress. The developed countries like USA with a world population of 4.6% produces 33% of the world's solid waste. The solid waste produced by under developed and developing countries are comparatively less and may not be of much concern but the real problem lies in its management. The solid waste can be grouped into the following categories:

1. **Agricultural waste**: It includes crop residues like fodder and straw and animal manure. It contributes to air and water pollution. It is important as ground cover also as it serves to reduce soil erosion. When fully decomposed, it can be used as fertilizers to improve yield of the crops.
2. **Municipal waste**: All the material thrown away from homes and commercial establishments e.g. construction and demolition waste, yard waste, tires, carpets, sludge, dead animal skeletons, automobile spares and cycle parts, plastic bottles, syringes and polythene bags etc. form the municipal wastes.

3. **Industrial wastes**: It includes different types of residues produced due to mining, metal processing as well as hazardous and toxic waste produced by the industries.

The amount of disposable solid waste has been increasing over the years. This is mainly due to

i Growing population.

ii Changing life styles.

iii Increasing use of disposable materials and

iv Excessive packaging.

Generally, the local government is responsible for collecting and disposing the municipal solid wastes. Proper disposal of solid waste helps in keeping the health of the people and the city in good condition.

SOLID WASTE MANAGEMENT:

Before disposal or recovery, the waste must be collected. The most common method of collecting waste is by covered trucks. However, much time is lost in loading the waste and then transporting it to the dumping or recovery site. The different methods of waste management include:

1. **Dumping**: The waste may be left in the open or thrown in the nearby water body. Dumping may be:
    a. OPEN DUMPS: In developing countries, the practice is still very common. The waste is burnt in the open to reduce its volume and thus more of the solid waste can be accommodated in the dump pit. Trash accumulation along roadside, railway tracks and vacant plots in poorer parts of the cities is a common site. It results in contamination of the ground water apart from polluting the air. So, a change in the attitude and behaviour of the people is required for maintaining a clean and healthy environment.
    b. OCEAN DUMPING: The municipal refuge, industrial waste, sewage and sewage sludge are dumped into ocean by many cities situated by the seaside. But the waste is harmful for the marine flora and fauna and the local population.
2. **Landfills:** The waste is put on or in the ground and is covered with soil. Since there is no burning and each day's fill is covered by at least 6 inches of soil, air pollution and insect attack is minimized. The landfills are usually made away from rivers, lakes and **aquifer** recharge zones but due to increasing urbanization suitable places for waste disposal are becoming rare. The **landfills** are not safer because of **leachate generation,** ground water contamination, methane production and incomplete decomposition of the waste.
3. **Exporting wastes**: The industrialized nations have agreed to stop shipping hazardous toxic waste to less developed countries but illegally the practice is still prevalent.
4. **Incineration**: The waste material is burnt at a temperature of 900-1000^{0}C for a sufficient time to ensure complete burning and 80-90% of the waste is disposed off. The disposal of the burned garbage is an easier task. But if the residual ash contains some toxic components, it will be an environmental hazard, if it is not disposed off

properly. Therefore, waste material has to be sorted out properly before putting it to incineration.

5. **Recycling**: It is reprocessing of the discarded material into new useful products. **Recycling** is of two types

    a. **Closed loop recycling**: The wastes discarded by consumers are recycled to produce new products of the same type.

    b. **Down cycling**: The wastes materials are converted into different and usually lower quality products.

    Recycling reduces pollution, saves energy and lowers the demands for raw resources e.g. recycling one ton of aluminum saves 4 tons of bauxites; paper and paper board can be made into pulp and reprocessed into recycled paper, cardboard and other paper products. However it is better to separate the solid waste into:

    (i) Recyclable wastes such as glass, paper, metal, certain types of plastics. These materials can be picked up by the concerned organization for selling to the scrap dealers. From scrap dealers, the waste is passed on to the manufacturers.

    (ii) Compostable materials that can be picked up by concerned organization for further processing.

    Some obsolete consumer products such as television sets, refrigerators and computers are disassembled and some of their useful components are recycled. This process is known as demanufacturing. Since these products may also contain toxic substances like CFCs in refrigerators and air conditioners, one has to be careful not to come in contact with polluting substances while handling these products. USA is known to dump its used electronics in developing countries like China where it is a source of income for poor people. It is believed that around 100,000 workers **demanufacture** electronics in Southeastern China and are dependent on it for their livelihood.

6. **Composting**: It is biological degradation of organic matter in the presence of oxygen. Organic waste such as paper, food scraps and lawn waste can be composted in the backyard bins or central communities facilities. The resulting **compost** serves as a nutrient rich fertilizer and can be used to slow soil erosion, improve water-holding capacity and crop yields. Depending on the nature of the solid waste, 60-80% can be composted or recycled. The kitchen and garden waste in the underground pit is decomposed by microorganisms releasing methane (natural gas) in biogas plants. Methane is a good source of fuel for cooking and lighting in India and China. Many cities drill methane wells in their landfills to capture the natural gas for usage.

    If it is released into the environment it contributes to global warming.

7. **Reuse and produce less waste**. It saves energy and raw materials; and reduces pollution. Some materials can be cleaned and reused in their present form like auto-parts, fine woodwork and bricks obtained from old houses. Glass and plastic bottles usually find their way to beverage producers for washing and refilling. In India, poor people make a living by scavenging, sorting and reprocessing scraps from cities

waste dumps. The rag pickers can be seen in almost all the urban areas of India picking up all sorts of materials in the morning hours.

The ideal way to manage waste is to generate less waste. This helps in minimizing depletion of raw materials and production of toxins in the manufacturing. We should learn to live with minimum packaging, reusable packaging or recyclable packaging whenever packaging is necessary. The packaging should be compostable or degradable. Now-a-days photodegradable or biodegradable plastics are used in packaging, which can be degraded by exposing to either ultraviolet radiations or decomposed by microorganisms.

Flyash Notification 1999 and the **Recycled Plastics (Manufacture and Usage) Rules 1999**, amended 2003 forms the regulatory framework for the management of solid waste in the country. Use of flyash in construction, laying of roads and **reclamation** of low-lying areas has been made mandatory. Guidelines for the use of **flyash** have been formulated and circulated to the State governments. Manufacture and usage of plastic carry bags less than 8x20 inches in size have been banned.

HAZARDOUS WASTE

Hazardous waste is the discarded solid or liquid material that meets one of the following conditions:

1. It is fatal to humans and laboratory animals in low doses.
2. It contains toxic, carcinogenic, mutagenic or teratogenic compounds harmful to humans or other forms of life at levels that exceed the established limits e.g. Pesticides.
3. It catches fire easily with a flash point less than 60^0C (generally solvents).
4. It is explosive or highly reactive (acids and bases).
5. It is corrosive and affects metal containers as tanks and drums.

Strangely however, certain harmful chemicals used in households like disinfectants and toilet cleaners, varnishes and lacquers used in paints, pesticides, dry cell batteries, gasoline and used motor oil etc. are not governed by the above definition of hazardous waste. Even wastes from small business and factories that generate less than 100kg of waste stored at an approved waste treatment facility for the purpose of being used, recycled, reclaimed, detoxified or destroyed is exempted from regulation as hazardous waste. In India, as per the current assessment 13011 units spread over 373 districts of the country generate 4.4 million tons of hazardous waste. 63% of this waste is generated by states of Maharashtra, Gujarat and Tamil Nadu. The **Hazardous Waste (Management and Handling) Rules 1989** has been amended in 2000 and 2003 in view of the directions of the Supreme Court.

The hazardous waste is disposed off in different ways:

i. It may be released into streams and rivers.

ii. It may be left as orphan waste by abandoned factories.

iii. The waste may be dumped in the open space and allowed to soak in the ground water may cause serious environmental problems.

Generally, the hazardous waste produced is either

i. Recycled

ii. Converted to non-hazardous forms

iii. Stored or

Disposed off by the chemical industries, petroleum refineries or other agencies. This is to ensure that they do not cause any harm to the environment and the organisms.

MANAGEMENT

The objective of **Hazardous Substance Management Division** in the **Ministry of Environment and Forest** is to promote safe handling, management and use of hazardous substances in order to prevent potential damage to health and environment. The activities are carried out under three thrust areas:

i . Chemical safety

ii. Sound management of hazardous waste

iii. Municipal waste.

The rules for the above activities are notified, implemented and amended from time to time by CPCB, SPCB and PCCs (Pollution Control Committees) and to rationalize and streamline the policies and programmes for sound management of hazardous substances.

There is a saying "Charity begins at home". Therefore, people should make efforts to reduce waste generation in the homes and to use less toxic materials. People should be encouraged to buy only essential commodities and use them to finish. For efficient utilization, some of the resources can be used on mutual sharing basis as well.

The different options for hazardous waste management are as follows:

1. **Produce less waste**: The best method is to avoid creating the waste itself. We can redesign the manufacturing processes, which may enable us to use less material and energy and at the same time produce less waste and pollution. Thus paper documents as directories and reference manuals can be addressed in CD-ROMS, DVD-ROMS and internet site and save large amount of money and paper.

   Recycling and reusing materials also eliminate hazardous waste pollution e.g. The waste products from an industry maybe used as raw material for another industry e.g. in USA about 10% of the waste is sent to surplus material exchanges where they are sold as raw materials for use by the industries. It represents double savings because the generator need not pay for disposal of the waste but the recipient has to pays a small amount to get the raw material. "Pay as you throw" system reduces solid waste and encourages recycling. The products should be designed to have a longer life and the packaging should be done to the bare minimum.

2. **Treat waste to reduce toxicity**: Different methods are available to make hazardous materials less toxic.

   a. Physical treatments remove toxic substances either by Physically binding them with some other substances or isolating them from the waste e.g. Charcoal or resin filters absorb toxins. Distillation helps in separating hazardous components from aqueous solutions. Metals and radioactive substances are disposed in silica gel at high temperature to make impermeable glass suitable for long-term storage.

b. In India the low and medium level nuclear waste is treated in ecofriendly ways using various processes, but the high level waste generated in small quantities is fixed in glass matrix. **Vitrification technology** has been developed at Trombay. Bhabha Atomic Research Centre is also constructing an advanced vitrification system for high level immobilization based on **Joule Melter Technology**. Vitrified waste is stored in specially designed storage facility for about 30 years prior to its disposal in deep geological formations. For final disposal of immobilized high-level radioactive waste, a suitable site in deep geological formations is selected.

c. Chemical treatments can transform materials so that they become nontoxic and this can be done by neutralization, oxidation and removal of metals or halogens from the compounds.

d. Bioremediation: A promising alternative for removing hazardous waste is bioremediation or biological waste treatment. Microscopic bacteria and fungi can absorb, accumulate and detoxify a variety of toxic compounds. They can accumulate heavy metals and some can metabolize PCBs even. Mustard plant has been found to be effective in extracting lead, arsenic and zinc from contaminated soils. Sunflower plants are effective in removing radioactive substances from soil. Aquatic plants like water hyacinth and cattails can be used in phytoremediation. Genetically modified plants are now developed to process toxins. Poplar trees have been developed, which can absorb and breakdown toxic organic materials.

e. Incineration: It is applicable to a mixture of waste, which is heated to 900-1000^0C for a sufficient time to ensure complete burning. It helps in reducing the volume up to 90% and it is safer to store the ash. Plasma torch, which generates high temperature, can be used to decompose liquid or solid hazardous waste into ions and atoms that can be converted into molecules, cleaned up and released as gas.

3. **Storage**: Usually, there are some materials, which we can't destroy or change to other forms and have to be stored. The methods used in storage of these substances are as follows:

   a. Dumping the waste in the oceans or burying under the ground. But this is not applicable in those cases where we want to recover the waste. Therefore such wastes are stored.

   b. Permanent retrievable storages. The storage containers can be kept in buildings, salt mines etc. from where they can be retrieved when required for repacking or transfer to other places.

   c. The secure landfill is safer for disposing the hazardous waste. It consists of thick bottom of clay, which is impermeable to ground water and safely contain the waste. A layer of gravel, a polyethylene liner and a layer of absorbent sand follow the clay layer. The gravel layer has perforated pipes to collect any seepage from the stored material. The waste packed in drums are placed in the pit, which is divided into different units. The landfill is then covered with a cover much like the bottom. Vegetation can be grown over the surface to make it obscure. Sump pumps collect any leachate from the landfill, which is purified before being released.

d. The hazardous waste can also be stored in above ground buildings. The advantage is that the leakage is easier to monitor as the bottom is at ground level.

e. In deep well disposal, the liquid waste is pumped under pressure through a pipe into dry porous geological formations far below the aquifer. The liquid can be soaked by the porous rock material and does not mix with the aquifer.

f. Some hazardous waste producing countries ship the waste to the developing countries, which is legally not correct. However, **Basel convention on hazardous waste, 1989** bans all hazardous waste export from developed to developing countries.

Hazardous waste is generally transported to the disposal site by road and rarely by rail and is of great concern because of the risk of accidents. The greatest risk lies in urban areas when the train or truck carrying the waste crashes, causing large-scale damage to human health and environment.

Thus the production, utilization or storage of the hazardous waste needs to be carefully monitored for clean and healthy environment by the people and the environmental protection agencies.

DISASTER MANAGEMENT

A **hazard** is a dangerous condition, may be natural or man made that could cause injury, loss of life or damage to property, livelihood or environment. The hazards can be grouped into different categories based on their source of origin as follows:

1. Natural hazards (exclusively natural) e.g. Earthquake, Volcanic eruptions and Tsunamis.
2. Socio-natural hazards (natural and man made) e.g. landslides, floods, drought, famine and fire.
3. Man made hazards e.g. explosion, leakage of toxic waste, war and civil strife and pollution.

The occurrence of these hazards triggers disasters. The word **"Disaster**" is derived from the French word "Desastre". It is formed from two words i.e. "Des" means evil and "astre" means star, literally meaning evil star. Perhaps the disasters in earlier times may have been thought of due to some unfavourable stars.

According to Turner (1976), disaster is an event concentrated in time and space, which threatens a society or its subdivision with a major unwanted consequence as a result of collapse of the precautions, which had hitherto been culturally accepted as adequate.

The impact of these disasters is multidimensional, affecting domestic, social and economic life of the humans in the affected areas throughout the world. Globally natural disasters account for nearly 80% of all the disaster affected people. According to International Red Cross in 2004, there were in all 360 official natural disasters. It includes 128 major floods, 121 hurricanes and cyclones, 42 earthquakes and Tsunamis, avalanches, forest fires and locust plagues. The number of such disasters reported in 2000, 2001, and 2002 was 431, 395 and 424, respectively.

The year 2005 also witnessed some of the worst disasters. Mujjafrabad in Pakistan suffered an earthquake of 8.4 intensity on the Richter scale, killing more than 1,83,000 people. It killed more than 10,000 people in the bordering Jammu and Kashmir state of India. Indian cities like Bombay, Calcutta, Hyderabad and Chennai experienced heavy rains in 2005 leading to heavy flooding in these cities, causing widespread destruction of life and infrastructure. The loss of life and property was worth crores of rupees. USA also experienced hurricanes like Dennis, Wilma, Rita and Katrina, causing loss of billions of dollars to the exchequer.

More people are killed and affected by disasters now e.g. from 1995-2004, the number of people died is 901,177 whereas in the previous decade it was 643,418 and before this it was only 1.7 billion (H.T. 12.10 2005). Also there is better reporting of disasters these days e.g. The Indian ocean Tsunamis of 26th December 2004 killed 2,24,495 people but in terms of disaster it was smaller than the barely reported famine in North Korea which killed 2,70,000 people from 1995-1999.

Due to geographical position, climate and geological setting approximately 65% of India is earthquake prone, 12% flood prone, 8% cyclone prone and more than 70% of the cultivable land is prone to drought. So, India has to suffer due to one or the other disaster almost every year.

The quantum of loss is the result of vulnerability of a society / region to disaster. The vulnerability reflects the inherent weakness of a community to withstand disasters. Factors like poor living conditions, poverty, inadequate safety procedures, urbanization, population growth, lack of training to prevent, mitigate and prepare for disasters make the population more vulnerable to disasters. The combination of vulnerability and hazard gives us the disaster risk or the possibility of a disaster in a particular area. Besides undermining developmental efforts, the disasters slow down development by destroying initiatives and infrastructures. They shatter the hopes and future of thousands of people. It is imperative therefore that every country should have defined policies and programmes for effective disaster management. Even though specific counter measures will vary with different hazards, it is advisable to have a single set of management arrangements to encompass all hazards.

The **disaster management** is actually a series of activities that run parallel to each other rather than in a sequence of pre or post disaster. The government at central and state level along with the local initiatives and NGOs play an important role in reducing the impact of disasters. Management of disasters can be divided into the following tasks (Fig.3.5):

1. Preparedness.
2. Mitigation of the negative impact of disaster.
3. Immediate rescue and relief.
4. Recovery and Rehabilitation.
5. Documentation and learning for the future.

Activities associated with the above tasks are detailed below:

1. **Preparedness**: It includes measures to ensure that communities and services are capable of coping with the effects of disaster and it can be accomplished by
    - i Community awareness and education to prepare them for disaster mitigation
    - ii Proper warning/forecasting system in respect of the disaster. Though it is not possible in case of calamities like earthquakes but floods and landslides can be predicted to some extent.
    - iii Vulnerable areas can be identified by making hazard zonation maps with technique like G.I.S (Geographic information system).
    - iv A comprehensive preparedness plan for mutual aid is essential for disaster mitigation.

2. **Mitigation of the negative impact of disaster**: It refers to different aspects which reduce the impact of emergency / disaster which can be undertaken prior to its occurrence. The mitigation measures in an area can be:

    i Land use planning
    ii Preventing habitation in risk zones
    iii Construction of disaster resistant buildings
    iv Strengthening the existing house with an additional cost of 20-30% in the sensitive areas.

    The appropriate authorities should see to it that the development of the region is allowed keeping in mind the hazards. The risk of a society to disaster is dependent on its vulnerability and type of the natural hazard.

    Risk = vulnerability x nature and intensity of hazard

    Since the natural hazards are beyond human control, efforts should be made to reduce the vulnerability of the society so that the risk is minimized.

3. **Immediate rescue and relief**: This is the most critical stage and action is needed immediately after the occurrence of the disaster. Therefore the immediate task is to
    i Activate the control room.
    ii Implement disaster management plans like

        a. Evacuation of the people from the affected areas
        b. Set up kitchen, medical camps, shelter and toilet facilities.
        c. Relief for the livestock
        d. Deployment of rescue and search team.
        e. Damage assessment survey.

    The administration should involve the local people to handle such a situation by forming disaster management committees. Various NGOs, voluntary organizations, NCC and NSS should also be involved. During damage assessment surveys, the ground realities should be taken into account for successful reconstruction planning. The assessment process should be transparent to reduce corruption and irregularities.

4. **Recovery and Rehabilitation**: The real test for disaster management starts with the passing of the hazard. Recovery means measures, which support emergency affected communities with reconstruction of physical infrastructure and restoration of economic and emotional well-being. The focus should be on the overall development of the region, considering the local needs of the people, the culture and traditions, strengthening the health and educational system and providing the essential services like roads and communications. People should be financially supported in their respective work areas e.g. it can be agricultural rehabilitation or rehabilitation of the artisans, livestock or employment generation based on the local resources. There should be construction of disaster resistant houses, depending on the socio-cultural traditions and needs of the people. The old houses can be refortified and made disaster resistant.

5. **Documentation and learning for the future**: We always learn from our mistakes. Therefore the management process and its result in the affected areas should be well monitored, documented and analyzed critically to suggest methods for further

improvement in the methods to meet such emergencies. The 15th World conference on disaster management held in July 2005 at Toronto, Canada brought together experts from across the globe to listen and learn, plan and prepare, educate and exchange views on all disciplines of disaster and emergency management. Following the **tsunamis** of December 2004, a **National Disaster Management Centre** was established to facilitate and coordinate the relief work. The ministry of home affairs in the National Government is the nodal ministry for disaster management.

EARTHQUAKE

Earthquakes, tsunamis, volcanoes, floods and landslides are unfortunate byproducts of a process necessary to renew the earth. However, when they affect human populations, their consequences can be the worst and they are the most feared disasters confronting us.

The Earth's crust consists of 12 major plates like the Indo-Australian, African, N. American, S. American, Antarctic and some minor plates like the Cocos and Iranian plate. These plates are slowly but continuously sliding over, under or past each other due to **convection currents** in the molten mass of the mantle lying below the crust. Due to these movements and the resulting deformations, enormous amount of stress gets accumulated in the rocks (crust). When this stress exceeds the capacity of the rocks (crust), they rupture with a sudden violent motion of the earth because of release of energy as shock waves (**seismic wave**), which move outwards from the earthquake focus like ripples in a pool of water. The plane along which the rocks rupture is called **fault plane** and focus of an earthquake is the point of initial movement. The place just above the focus, on the surface of the earth is called **epicentre** (Fig. 3.6). Earthquakes are recorded by instruments called **seismographs**.

The recurring shocks experienced after earthquakes are called **after shocks**. The severity of an earthquake is described by its magnitude and intensity. The magnitude of the earthquake is a measure of the energy released and is measured on the Richter scale, which is a logarithmic scale. Each unit on the Richter scale represents amplitude ten times greater than the next small unit. Thus a magnitude 5.00 earthquake is 10 times greater than magnitude 4.00 and a magnitude 6 is 100 times greater than a magnitude of 4.00 earthquake.

The magnitude of Bhuj earthquake on 26th January 2001 was around 7.7, killing more than 20,000 people and that of Latur on 30.09.1993 was 6.3, killing 7600 people. The earthquake that hit Pakistan in 2005 was about 8.4 on the Richter scale and killed 183000 in Pakistan and 10,000 in Jammu and Kashmir part of India. The earthquake is rated as insignificant (less than 4.00 on the Richter scale), minor (4.0-4.9), damaging (5.0-5.9), destructive (6.0-6.9), major (7.0-7.9) and great (over 8.0).

Due to varying geology at different locations in India, the likelihood and the probable severity of earthquake at different locations is different. Depending on the perceived risk, India is divided into four **seismic zones** (zone II, III, IV, V). Nearly 65% of Indian land comes under moderate (zone III) to severe (zone V) **risk zones** Mumbai, Pune and Ahemdabad fall in zone III, Delhi in zone IV and Bhuj falls in zone V (H.T. 15th October 2005).

Earthquakes often have after shocks that gradually decrease in frequency over a period of up to many months and some have foreshocks from seconds to weeks before the main shock.

The **primary effects** of earthquake include shaking and at times a permanent vertical or horizontal displacement of the ground. These effects prove very destructive for buildings, bridges, dams and pipelines and the people in general.

The **secondary effects** of earthquake include rockslides, urban fires and flooding caused by subsidence of land.

Warning signs of earthquakes (H.T. Report 10th October 2005)

Earthquake prediction is not scientifically possible. Yet people across the world attempt to do so by observing strange animal behavior and studying colour of natural springs. Sometimes these signs play a major role in saving human lives.

Foreshocks: Measuring **foreshock** is a reliable prediction tool. These precede the larger quake. They grow in magnitude and are usually in the same area. There were foreshocks around Bhavnagar before the Bhuj quake.

Strain in rocks: It can be measured across the faults leading to a general prediction about when the fault would rupture.

Ground water levels: Changing water level in deep wells is recognized as a significant precursor to earthquakes. Over 200 research wells more than one thousand meters deep have been drilled for this purpose in China and Japan.

Chemical changes in ground water: At some places rise in chloride and sulphate is noticed before the shock. Wadia Institute of Himalayan Geology observed change in water colour (milky white) two to three days before the earthquake in the Himalayan region.

Radon gas in ground water: Increased levels of radon gas in wells is a major sign of an earthquake. Often radon levels in springs show reaction to seismic events.

Thermal anomaly: Anomalies in ground temperature may be connected with seismic activity. Rise in ground temperature along the fault line points towards a possible quake.

Ground tilting: As stress builds up along a fault, the ground level can change. The ground often tilts or rises in the area that may face an earthquake.

P-Wave velocity: P-waves are constantly being recorded by seismometers across the world. It is noticed that the p-wave velocity decreases by 10% to 15% and then increases to the normal before a major quake.

TSUNAMIS

Tsunami (The giant sea swell) is a Japanese word and it is defined as a wave in the ocean that is generated by a geological event like earthquake, volcanic explosions and massive **sea floor spreading**. Sometimes, they are improperly called tidal waves or **seismic sea waves**. The intensities of the tsunamis vary and generally most of the time they are weak and have heights of few centimeters. However, larger tsunamis may have heights of many feet and as they spread out, their height decrease to a foot or even less. But near the impact areas, where the sea is shallow their height increase again. When these tsunamis or swells approach the shores, they often reach a height of 15m or more and some have been as high as 65m (nearly 200 ft). Tsunami resulting from Chilean earthquake in 1960 caused 7m breakers when it reached Hawaii 15 hours later. The eruption of Indonesian volcano Krakatoa in 1883 created a tsunami 40m high and killed 30,000 people on the nearby island.

On December 26, 2004, an earthquake of magnitude 9.00 on the Richter scale struck at 3.4^0N, 95.7^0E off the coast of Sumatra in the Indonesian Archipelago at 06.29 hrs IST triggering the tsunami. The 2004 Indian Ocean earthquake devastated the shores of Indonesia, Sri-Lanka, India, Thailand and other countries with swells of 15m (50 feet) high. It killed around 79,900 people in Indonesia, 41,000 in Sri-Lanka, 10,000 in India, 4000 in Thailand, 120 in Somalia and 46 in Maldives. The total death toll stood at more than 2,17,000 people.

The quake also produced less damaging Tsunami that struck far flung areas a day later in the Atlantic Ocean and around Antarctica. Researchers at Pacific Marine Environmental Laboratory in Seattle, Washington, using ocean models and tidal gauges demonstrated that the

tsunami generated by the earthquake traveled around the globe several times before their dissipation. The waves directions were guided by the ridges in the middle of the oceans (H.T. 27th August 2005). This is the fourth largest earthquake in the world since 1900 and is the largest since the 1964 Prince William Sound Alaska earthquake.

To mitigate the impact of natural fury on the population inhabiting the coastal areas, dense mangrove forests should be promoted along the coastal areas. Coral reefs are also supposed to act as natural defenses against tsunamis.

Soon after the catastrophe of December 2004, the central government announced to set up **Tsunami Warning Center** (**TWC**) at Hyderabad at a cost of Rs. 125 crores. The center should be operational by September 2007. One of the key mandates of the TWC is the preparation of seawater inundation and vulnerability maps based on inputs and imagery from the areas battered by the last tsunami and this is vital for minimizing future casualties. Hyderabad based **National Remote Sensing Agency** has carried out a survey by taking images of all the affected areas including Andaman's (H.T. 26th December 2005). India would approach the **Pacific tsunami warning center** and countries such as Indonesia, Thailand and Myanmar for required international cooperation in its proposed software programme for the networking of the available data on tsunami and deepwater oceanic changes.

CYCLONES

Cyclones occur in the tropical oceans. A low-pressure area develops over the surface of water when it is heated to 27^0C or more. The low-pressure area remains stationary for a few days. As the pressure falls further the wind speed increases towards the low pressure area causing cloud bursts and heavy rains along with spirally moving storms. These cyclones then move towards the terrestrial areas with low pressure. The cyclonic storm winds move with a speed reaching upto 200 Km/hr.

Cyclones are common in the coastal areas and Andhra Pradesh is the worst affected due to this calamity. The state has a coastline of 760 Km and has experienced 18 devastating storms in the last century. It results in heavy loss of property, wildlife, agricultural property and human lives. A cyclone in 1996 hit the Nellore-Prakasam-Konaseema region of Andhra Pradesh causing heavy loss of lives and destroying paddy fields, coconut grooves and property.

The origin and movement of cyclone can now be predicted with remote sensing satellites due to cooperation between countries sharing information on weather conditions. But damages do occur as the relief operations and agencies involved in it may not function in harmony.

FLOODS

A flood is the discharge of water that exceeds the canal capacity of the river. The floods are most common of the **natural calamities**. Bangla Desh (a very flat country, only a few feet above the sea level) is the most flood prone country in the world and accounts for about two-third of the global loss of life. India accounts for one-fifth of the global deaths due to floods. In India, out of a total geographical area of 329 million hectare, 40 million hectare is prone to floods while 32 million hectare can be reasonably protected. The flood prone states of India are Assam, Bihar, Uttar Pradesh and Andhra Pradesh.

The floods result in heavy loss of life, crop production, damage to property and many people are displaced every year causing a huge loss to the exchequer. The floods result not because of greater **precipitation** but because of **deforestation**, wrong agricultural practices leading to erosion, urbanization and silting of riverbeds making them shallow. The Ganges river basin has risen by 5 to 7 metres in recent years. Collapse of dams, landslides and change in climatic conditions are other factors responsible for floods.

The National programme for flood management was launched in 1954. To mitigate the damages from floods, a nationwide **Flood Forecasting and Warning System** has been established by the **Central Water Commission** on interstate river basins. Flood forecasts are issued through 166 stations for information of central and state governments, district administration, media and the users so that loss of human lives, immovable properties and human miseries can be reduced. It allows the authorities to make optimum utilization of water resources and help to control floods be constructing dams and reservoirs, construction of embankments on rivers, desilting the rivers, diversion of flood waters and preparing natural ponds, tanks and reservoirs.

DROUGHT

It is a prolonged period of unusually dry weather with little rainfall in a region where rains are normally expected. Rajasthan and Gujarat in India have been affected many times by the drought. The droughts usually result due to failure of rainfall. And rainfall is affected by deforestation, mismanagement of land and water resources and unscientific farming methods. Drought leads to:

i. Shortage of drinking water.

ii. Scarcity of water for agricultural purposes.

iii. Drying of water bodies.

iv. Failure of crops and

v. Migration of people.

Drought is blamed for famines. **Famine** is a severe shortage of food accompanied by significant increase in death rates. It indicates that the society is either unable or unwilling to distribute food to all segments of the people. Rajasthan, the largest state in India was in the grip of a severe drought in the year 2000 when more than 75% of the crop was destroyed due to water scarcity. The Sahel region of Africa (Senegal, Mauritania, Mali, Burkina Faso, Niger and Chad) inhabited by about 60 million people has experienced drought in 1968-1974 and 1984-1985. In 1984-1985 the number of deaths were 750,000. Famine leads to migration of people to other areas where they may be kept in refugee camps and could be a cause of unhygienic sanitary conditions. It may also result in spreading of infectious diseases. The civil wars disrupt the normal planting and harvesting and displace millions of peoples. They also create famine like situation because the food distribution by government agencies under such circumstances is not fair.

NATIONAL CENTRE FOR DISASTER MANAGEMENT (NCDM)

NCDM operating from Indian Institute of Public Administration (Delhi) is **nodal agency** for research, training and advocacy in the field of natural disaster management in India. It prepares plan to tackle disaster at different levels and coordinate various research and training programmes in the field of disaster management.

The main objectives of the centre are: -

- Prepare a report on damage caused and resource spent on mitigation practices and relief work.
- To establish link between the nodal ministry for natural disaster and various state training institutes involved in the field of disasters

- To provide technical assistance and services to programmes on natural disaster management and assist SAARC countries in formulating the policies and developing their capabilities in all aspects of disaster management.
- The centre conducts research on various aspects of disaster management like preparedness, mitigation and cost benefit analysis of the preparedness plan.
- It carries out research and surveys about the impact (socioeconomic and environmental) of various natural hazards, community involvement in various phases of disaster management and role of NGOs in disaster management etc.

EARTH COMMISSION (H.T. 27.11.05)

The disasters whether natural or man-made result in heavy casualties, loss of life and slows down the pace of development. The central and state governments suffer huge financial losses every year because of disasters. For example a super cyclone in Orissa on 27.10.1999, killed 8,765 people and the damage was estimated at Rs 5,400 crore. Earthquake in Bhuj and neighbouring areas on January 26th 2001, killed 20,000 people and loss was estimated at 50,000 crores. Tsunami on December 26th 2004 – in India killed around 10,000 people. Apart from these calamities a number of deaths are caused by drought/floods and result in massive loss of property every year.

To decipher the whys and wherefores of Nature's fury and to evolve a scientific method of forecasting these **catastrophes,** the Indian Government decided to set up **Earth Commission** in **2005.**

The Panel's Agenda include:

- To provide the best possible service in forecasting monsoons, cyclones, earthquakes and tsunamis and the impact of global climatic change on the sub-continent.
- Work with other agencies (PMO, Ministry of home, DST, ISRO etc.) to provide alerts on drastic changes in the climate and looming disasters in order to manage them.
- Offer extensive data on water and land and help in scientific management of both these resources as well as to support agriculture and aquaculture. The data on oceans will support fisheries and help in spotting fuel deposits.
- Put together processed data on earth and climatic parameters that are critical for scientific and industrial activity.
- Support research activity on **Earth System Science** (**ESS**) and enhance the human resource base in this field through a special funding mechanism.

NUCLEAR WINTER

It is the rapid cooling of the earth causing its temperature to fall below freezing point in some areas even in mid-summer as a result of a nuclear explosion.

It is believed that when 5,000 megatons (one megatons is equivalent to one million tonne of TNT) nuclear war material is exploded, it would pump 960 million tones of dust in the atmosphere. Approximately 80% of this would reach the stratosphere and remain there for more than one year. The nuclear war would also produce about 225 million tones of smoke for several weeks due to massive fire ignited by the initial explosion. The resulting dust and smoke would then spread to the entire globe. The net result would be an increase in turbidity of the atmosphere, which would reduce the incoming solar radiations by as much as 95%. This would cause immediate cooling of the land by about 10 to 20 ^{0}C. But the change in the temperature of oceans and coastal areas would be in the range of 1-3^{0}C only because of the great heat capacity

of the oceans. This difference in the temperature of the land and ocean would result in horizontal temperature and pressure gradients leading to severe coastal storms. Changes in the vertical temperature of the atmosphere due to absorption of solar energy in the upper atmosphere would also contribute to global modified circulation. These effects of nuclear winter may persist for over a year.

These changes in the atmosphere due to nuclear explosion were based on mathematical simulation models by Turco et. al. (1983) and their hypothesis came to be known as **TTAPS hypothesis** after the first letters of the names of the investigators.

A large-scale nuclear war would result in global disruption of the biosphere as well as biological support systems of the civilization. Smoke in the atmosphere would absorb the incoming solar radiation not permitting them to reach the earth. This will lead to cooling of the earth. Smoke and dust would not allow light to reach the earth; this would cause twilight at noon. There would be freezing of the contaminated water bodies, forests and agricultural crops would die in the absence of photosynthetic activity and city services would be paralyzed. Depletion of ozone layer due to pollutants in the atmosphere would allow UV rays to the earth and they would be lethal to most organisms. Atmosphere would be highly polluted and climatic changes would make life impossible in such an environment.

In 1980s, the nuclear war was considered as an ultimate intervention by many countries and a major threat to the environment. Though many countries like India, Pakistan, Israel and North Korea have nuclear ambitions and capabilities but the chances of nuclear war are bleak. Therefore, nuclear winter is no longer considered a major environmental issue now a days. End of **cold war**, break up of the USSR and signing of the different arms control agreements between nations have almost eliminated the danger of a nuclear conflict.

OIL SPILL

The usual route for the transport of oil across the globe is through the water bodies like oceans, bays and rivers. Though the utmost care is taken so that there is no contamination of these water bodies with oil, still oil is spilled because of one of the following reasons.

i. Negligence on the part of the crew on the ships.

ii. Breakdown of the equipments like pipelines, refineries and storage facilities.

iii. The tankers carrying the oil may collide accidentally with the rocky coasts and result in oil spill

iv. Terrorists may cause oil spill to draw public attention

v. There may be deliberate dumping by the hostile countries

vi. Natural disasters like volcanoes and hurricanes can cause oil spill.

The total quantity of oil released annually into the world's oceans is about 10 million metric tones and bulk of it is due to transport related activities. The 1991Gulf War unleashed about 200 million gallons of oil in the Persian Gulf. More than 700 oil wells were burning in Kuwait for over 10 months and had deleterious effects on the environment.

The largest oil spill in the history is Exxon Valdez oil spill in Prince William Sound in Alaska in March, 1989.The ship collided with a reef due to navigational errors and about 10 million gallons of oil was spilled. It resulted in the death of 2800 sea otters and 250,000 birds. Some of the major recent oil spills are as follows:

1. January 2000, a ruptured pipeline spilled 340,000 gallons of heavy oil into Guanabara Bay. Rio de Janeiro,

2. June 2000, 1400 tones of heavy fuel oil leaked from the bulk carrier Treasure off Cape Town, Africa.
3. January 2001, Ecuadorean-registered ship Jessica spilled 175,000 gallons of diesel and bunker oil into the sea off the Galapagos Islands.
4. November 2002. Prestige carrying 20 million gallons of fuel broke off the Spanish coast.
5. July 2003. Tasman Spirit, Karachi, Pakistan.
6. December 2004. Selendang Ayu, Unalaska Island, Alaska.

In the marine environment, oil spreads by wind currents, waves and tides producing **oil slick**. A thin **sheen** i.e. a rainbow coloured layer of oil is formed on the surface of seawater as it spreads to distant areas. The oil is subjected to various natural processes as evaporation, dissolution, emulsification, oxidation, sedimentation and uptake by the organisms. Since the oil is a complex mixture containing paraffin, cycloparaffins, aromatics and naphthalene aromatics, different methods are employed to make the water bodies free of oil. The volatile compounds however evaporate readily. The different methods employed to clean up the oil on the surface of water are as follows.

i Highly soluble hydrocarbons are broken down by dissolution with certain chemicals sprayed over the oil spill to lessen its impact on beaches and aquatic wild life.

ii Microorganisms are known to readily degrade paraffin. The **bioremediation** involves using mixtures of bacteria and genetically engineered microbial strains to get rid off the problem of oil spills.

iii Clean up by burning of oil on the surface is suitable but the minimum thickness of oil should be 3 mm. However this practice causes air pollution and is rarely used

iv Since oil molecules are hydrophobic and float on the surface of water, skimmers can be used to clean up the oil from the surface.

v **Boom,** a type of coral that floats on the surface of water must be used to contain oil spill. It has the property of absorbing oil from the surface. Special fireproof booms are used for in situ burning of oil spills.

vi Special boats with oil absorbent plastics or vacuums can be used but the problem will be of discarding the oil absorbent after use.

vii Physical steps have to be taken to clean up the beaches as heavy oil residues that are not degraded or deposited on sediments end up as **tar lumps** or tar balls washed to the beaches. The crews can rinse the beaches with pressurized water or use shovels or road equipments to collect the residue on the beaches.

viii The methods used to clean up the oil spills however will vary with the weather conditions, nature and amount of oil spill and the human habitation in the adjacent areas.

Effects of oil spills: Oil spills may have immediate and long lasting effects. It may be directly lethal or disrupt physiological and behavioral activities and bring about changes in the biological habitats.

The organisms also ingest it. The animals may die, become extinct and the ecological balance is disturbed. Some of the effects of oil spills are as follows.

i. Presence of oil on the surface of water inhibits light penetration resulting in inhibition of photosynthetic activity of the phytoplankton and reduced supply of oxygen for the aquatic organisms.

ii. Volatile compounds of oil may cause burning of eyes and skin, irritation or damage to sensitive membranes of eyes, nose and mouth in animals. Benzene and toluene can affect RBCs, suppress immune systems, strain the liver, spleen and kidneys and even interfere with the reproductive system of animals and humans. The other effects include congestion of lungs and gastrointestinal ulceration and hemorrhage due to ingestion of oil during grooming and feeding.

Sea otters trap air within the fur to keep them warm. However oil mats their furs, eliminating the protective blanket of air and cause up to 70% loss of the fur's protective value. The otter' s constant grooming leads to inhalation of hydrocarbon fumes from the oiled fur. The poisoning due to grooming causes shock, convulsions, anaemia, diarrhea, elevated potassium level and **hypoglycemia.**

The whales may die due to inhalation of the oil or skin exposed to oil or the blowhole is plugged with oil and it cannot breathe.

iii. Since oil is persistent, physical impacts are more dangerous in case of wild life, affecting their fur, feather and skin. Oil spills specially affect sea birds that spend time on the sea surface. While cleaning oil from fur and feathers of oil affected birds care should be taken that buoyancy of the animals is restored. The sea birds like Bald eagles and Harlequin ducks covered with oil find it difficult to move around and while cleaning their feathers may consume some oil that may kill them. Oil coated birds suffer from hypothermia, dehydration drowning and starvation and also become easy prey. It changes the insulation properties of feathers and oil-coated birds lose buoyancy, sink and drown. The oil spills have wide ranging affects in marine birds like irritation in the eyes, changes in the liver metabolism, intestinal damage, pneumonia, decreased shell thickness in eggs and reduction in the number of eggs laid down.

iv. Sea turtles are affected by oil spills either through food or absorption through the skin. Nesting sites in the oily sandy beaches may lead to intake of oil with food damaging the digestive tract and irritation of the mucous membranes. Eggs may be contaminated and oiling of eggs may inhibit their development

v. There is no evidence to suggest the harmful affects of oil spill on fish population in the open sea. However, association of the fish with slicks could become a part of the food chain of sea birds like cormorants and darters that are attracted by a school of fish under the slick. There can be risk to fishes like salmon and life history stages of some fishes and crustaceans in waters of estuaries and coral reefs are affected by the oil spills. Mortality of fishes may result due to depletion of dissolved oxygen.

vi. Oil spills have disastrous effect for plankton and benthos forms like clams and oysters. Thus oil spills are capable of disrupting the food chain of the marine ecosystem, threatening the survival and existence of the marine organisms.

vii. Oil and tar coated beaches are anesthetics and are abandoned by people visiting the sea beach

Most of the oil spills are naturally broken down in the environment and their affects are short lived but heavier elements remain longer and damaged mangrove roots. They may be incorporated in to the sediments, which may have long lasting effects on marine life.

In 1990, the US Congress passed the Oil Pollution Act setting safety standards for shipping as well as oil tankers. Another law passed in 1992 called for all tankers to have double hull by the year, 2015. Still prevention is the easiest way to clean oil spills and save the animals affected by them.

URBANIZATION

Man is a social animal. There has been a constant evolution in his way of living. Earlier he used to live in caves and forests as his needs were limited and fulfilled there. With advancement in civilization he started living in small groups, which appeared beneficial for him. There has been a constant improvement in his way of living and his relationship with fellow members coupled with better understanding of the needs of each other. This association slowly evolved into well-defined setups in the form of rural and urban areas.

A **rural area** is defined as an area with a population of around 10,000 people. The rural areas lack in basic infrastructure and facilities. People who live in rural areas are dependent for their livelihood on farming, animal herding, timber harvesting and mining. Modernization and Industrialization led to the development of **urban areas**. The US Bureau of the Census defines an area as being urbanized, if a central city and its closely settled surrounding territory are of a certain size with 50,000 people and density at least 1000 people per square mile (Knox, 1994).

Some countries fix the limit for an urban area between 10,000 to50, 000 people. The basic infrastructure is supposed to be well developed in cities. The first city arose along the Tigris Euphrates river between 4.000 and 3,000 B.C. urbanization is one of the oldest demographic trends. The actual impetus for the development of cities may have been to have centers for storage and distribution of food and for defense purposes. The people who were specialized in their profession move to cities in a quest for better avenues and a comfortable way of life. The urban areas also happened to be the centers of political activity and economic power.

The trend of urbanization initiated by the industrial revolution more than 300 years ago has resulted in an increase in the growth and size of the cities, as people are getting more and more urbanized. Between 1850-2003, the percentage of people living in urban areas increased from 2% to 47% and going by the UN projection about 63% of the world population will be living in urban areas by 2050. Approximately 90% of this growth is projected in developing countries, because the developed countries are already highly urbanized and pace of urbanization is now slow there.

It is observed that when the cities expand they merge with their neighbours to form mega cities or megapolies e.g. in the USA, urban areas between Boston and Washington DC have merged into a nearly continuous mega city and sometimes it is called as Boswash. Delhi, the capital of India has almost lost its boundaries with the NCR towns in a radius of 60 km and the process does not seem to stop in the near future. Because of rapid growth in industrialization, transportation, communication and population same situation is going to happen in almost all the major cities of India.

Urbanization has also led to an increase in the number of cities e.g. only 19 cities had a population of more than one million in 1900 but in 2003, more than 400 cities had population of more than one million people.

In Europe and America, more than 75% of the people live in urban areas and urbanization is expected to reach 84% by 2005. In Africa and South Asia, still 60% of people live in rural areas but now people here are making a beeline to the cities. Ninety percent of the population growth over the next 25 years is expected to be in this less developed part of the world. Cities like Mumbai, Jakarta and Manila of the developing countries are flooded with immigrants every day and by 2025 their population may grow by 50%. With increase in urbanization, poverty also increases in urban areas because usually the poor people migrate to the cities for better opportunities and settle in slums, squatter settlements and shantytowns surrounding the cities. Thus the process of urbanization is rapid in the developing countries. However, it is believed that rural population in these countries may not show much change in the absence of any population control measures..

CAUSES OF URBANIZATION

Population is not static but dynamic due to birth and death rates and movements of individuals into or out of the population. Growth of a population is regulated by natural increase i.e. when the number of births is more than the number of deaths and by immigration. Facilities like improved food supplies, better sanitation, education and better health facilities further push the population growth in urban areas. Immigration to urban areas is influenced by **push factors** that force people out of the rural areas and **pull factors** that draw them to the city. Generally people move to the cities because of the opportunities there. As the population and resources are not uniformly distributed people in some overpopulated areas may be forced to migrate to the cities for better avenues. Sometimes even when the population is below carrying capacity, people leave the area because of economic, political, racial or religious conflicts. Intermigration occurred when Pakistan was carved out of India in 1947 on a religious basis, resulting in loss of life and property and uprooting of many families. The refugees were settled mostly in the cities like Delhi, which further accelerated its population growth.

Change in agricultural practices also pushes people towards the cities. With modern methods of agriculture, there has been a decreased demand of labourers in this sector. The sub-division of agricultural land among several sons reduced the land holdings and income from the agricultural produce. This forced the rural people to look for alternative jobs in the urban areas.

Cities provide jobs, housing, entertainment and freedom from the constraints of rural culture. Once they come to the city, they try to improve their status socially and financially and try to specialize in fields, facilities for which do not exist in rural areas.

Communication system like telephones and televisions in particular lure people to the cities by telecasting images of luxury and opportunity. Cities have always been attractive to those who hoped to improve their economic conditions.

Government policies also promote urbanization, and they are always biased towards rural people e.g. by importing lower priced food items, they may try to please the city residents but the farmers have to suffer as they are not able to get the fair price for their produce. Sometimes the farmers are not able to repay their loans due to crop failure resulting from scarcity of rainfall or fertilizers. Many farmers have committed suicide in Andhra Pradesh and Maharashtra in the last few years for non-payment of their agricultural loans. In the cotton growing Vidarbha region of Maharashtra more than 540 cases of suicide by farmers have been reported in1905-1906. The result is that now-a-days nobody wants to take up farming as a profession and everybody wants to shift to the cities just to get a white collared job. Thus the cities have become the centres for new jobs, housing, education and opportunities. These factors pull people towards cities searching for better life.

ADVANTAGES OF URBANIZATION

1. Urbanization has benefited not only the people living in the cities but the people all over the world as it leads to all round development in the field of industry, commerce, science and technology and jobs for the people. It makes the world a better place to live in.
2. People in cities have an easy access to facilities like medical, family welfare, education and social services.
3. Population density of cities is very high as compared to rural areas and in urban areas more open spaces are left. It helps in preserving biodiversity and reduces stress on agriculture, wildlife and forest etc.
4. The infrastructures in cities are well developed. The collection and recycling of waste material is convenient and economically feasible. The urban areas show a close relationship between the environment and the human population and thus the cities form the ideal place to study human ecology i.e. effects of human beings on the environment and the working of the urban ecosystem

DISADVANTAGES OF URBANIZATION

Urbanization leads to many problems. Some of them are listed below:

1. Usually the cities are not equipped with the infrastructure to meet the demands of increased housing, jobs, food, water and sanitation. The unplanned and uncontrolled growth is at the root cause of these problems. So, in terms of resource use, most of the cities of the world are not self-sustaining.
2. In developed countries, problems of cities include urban decay, sprawl, inefficiency and pollution associated with total dependency on cars and low density suburban development patterns. The urban dwellers occupy only 20% of the land but utilize more than 75% of the available resources.
3. It results in degradation and disturbance of the land area, which decreases and degrades the earth's biodiversity. This may have long-term effects on the vegetation growth, crop yields, and supply of food, water and other resources.
4. It also leads to problem of drinking water. As the city grows in area, demand for water increases causing a shortage of ground water and stressing the aquifer. Even in Delhi, which is situated on the bank of river Yamuna, people almost always complain about the scarcity of drinking water. Even for a bore well, residents have to get themselves registered and seek permission from the local authorities and they are supposed to pay for it..
5. Increase in population of the cities leads to all sorts of problems related to pollution e.g. pollution of air and water and disposal of solid and hazardous wastes. Delhi is amongst the most polluted cities of the world. Urban runoff carry polluted water from cities to rivers and oceans, disturbing the environment even outside the cities.
6. Increasing population of the cities exploits the neighbouring habitats and may disturb the adjoining wildlife habitat, croplands, wetlands and forest area.
7. High population densities in urban areas can be a cause of infectious diseases. Sanitary conditions may not be very perfect.

8. People may suffer due to accidents in the industrial sector as well as due to vehicular movement on the road and are subjected to the risk of noise pollution.
9. Urbanization disturbs soil and sediment, and it leads to soil erosion and increase both the magnitude and frequency of floods.
10. Cities influence the local climate dramatically and temperature is generally warmer in the city than the surrounding areas creating **islands of heat**. Cities tend to be cloudier and rainier than the surrounding areas. They also have more winter fog.

SOLUTION

Urbanization is virtually an irreversible process. Whole habitats are eliminated and permanent resources are depleted. Therefore urban ecological policies should build cities in equilibrium with nature otherwise it may result in more damage to the natural environment. To make urbanization sustainable serious thinking should be given to the following suggestions:

1. The city should be small in size, preferably in the range of 25,000 to 50,000 people.
2. Cities should be provided with green belt to preserve natural habitats to minimize environmental pollution.
3. Arrangement should be made to meet the daily requirements of the people near to the residential areas.
4. People should develop the habit of walking down or use energy efficient vehicle for small distances.

Environmentalists believe that creation of ecocities or green cities will reduce the demand on earth's resources. Such cities will be self sufficient and sustainable. The emphasis will be on the "three Rs" i.e. reuse, recycle or reduce the waste. The utilization of water and energy has to be efficient. Only local trees and plants should be grown to maintain the local climate and efforts have to be made to minimize noise and vehicular pollution.

URBAN DEVELOPMENT SCHEMES INITIATED BY GOVERNMENT OF INDIA

1. **Accelerated Urban Water Supply Programme (AUWSP**): The programme was initiated for towns with population less than 20,000 for solving the water problem. It is funded by the center and state governments in the ratio of 50:50. In the financial year 2003-2004 an amount of Rs. 140 crores was released under the AUWSP.
2. **Integrated Development of Small and Medium Towns (IDSMT):** The scheme came into operation in 1979-1980 and covered towns upto 5 lakhs population. The revised guidelines were issued in August 1995. The central assistance is available in the ratio of 60:40. The plan allocation for the scheme during 2004-2005 was Rs. 200 crores.
3. **Mega City Scheme**: The centrally sponsored scheme of Infrastructure Development in Mega cities was initiated in 1993-1994 in five Mega cities of Mumbai, Chennai, Kolkata, Hyderabad and Bangalore. The sharing of the cost is 25:25 for central and state governments and 50% is mobilized as institutional finance.
4. **Urban Mapping Scheme**: It was taken up as a pilot project during the eighth five-year plan covering 53 towns from different states. In the tenth five-year plan the urban mapping scheme has been replaced by the National Urban Information System (NUIS). In this scheme National Remote Sensing Agency (NRSA), DOS, Hyderabad take aerial photographs and maps and these are used in routine urban planning functions by town planning departments, local bodies, developmental authorities, PWD, tax authorities and

sectoral development agencies as multipurpose maps. The growth and percentage of rural and urban population in India from 1901 to 2001 is given in table 3.1.

Table 3.1 Rural and Urban population of India 1901 to 2001

Census year	Population in Millions		**%age of total Population**	
	Rural	**Urban**	**Rural**	**Urban**
1901	213	26	89.2	10.8
1911	226	26	89.7	10.3
1921	223	28	88.8	11.2
1931	246	33	88.0	12
1941	275	44	86.1	13.9
1951	299	62	82.7	17.3
1961	360	79	82.0	18.4
1971	439	109	80.1	19.9
1981	524	159	76.7	23.3
1991	629	218	74.3	25.7
2001	743	286	72.2	27.78

ENVIRONMENTAL LAWS

The conservation, protection and improvement of the environment is a cause of concern for every human being. Industrialization, urbanization, population growth, exploitation of the resources and disruption of natural ecological balance have polluted the environment leading to its deterioration. The problem of environmental pollution has acquired international dimensions and India is no exception to it. Protection of the environment and natural resources may dent developing nations like India but administrative and legislative strategies of harmonization of environmental values with developmental values is a must and should be formulated depending on the ecological, economic and social / cultural aspects of the country. Usually national policies are established through negotiation and compromise in a democratic society and theoretically it allows all voices to be heard. The resulting policy will serve the interest of the majority. Thus a policy is a rule or decision about how to act or deal with the problem. The environmental policies include rules and regulations concerning the environment that are adopted, implemented and enforced by some governmental agencies whereas the laws are rules set by authority, society or custom

and environmental law includes official rules, decisions and actions concerning environmental quality, natural resources and ecological sustainability.

There have been several legislative measures at the central and state level to prevent and control different components of the environment like the Indian Fisheries Act, 1897; the Indian Ports Act, 1907 and the Motor Vehicle Act, 1938. Stockholm Declaration of 1972 was the first major attempt to conserve and protect the human environment at the international level. Some of the important decisions of Stockholm Declaration were:

- Declaration on the human environment
- An action plan for the human environment.
- A resolution on Institutional and financial arrangements.
- A resolution condemning nuclear weapon test especially those carried out in the atmosphere.
- The decision to refer to the government's recommendation for action at the national level.

It recommended national and international level cooperation in identification and appraisal of environmental damages and problems of global significance. Accordingly, Indian Parliament inserted two articles i.e. 48 A and 51 A (g) in the Constitution of India in 1976. Article 48A directs that the state shall endeavour to protect and improve the environment and safeguard the forest and wildlife of the country. Similarly clause (g) of article 51 A (g) imposes a duty on every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have a compassion for living creatures. The cumulative effects of these articles seem to be that the "state" as well as the "citizen" are under constitutional obligation to conserve, preserve, protect and improve the environment.

Keeping in view the need for environmental protection, the Indian Parliament passed the Water (Protection and Control of Pollution) Act, 1974 which became effective from 23rd March 1974. The Central Board for Prevention and Control of Water Pollution (CBPCWP) was constituted in September 1974. The Air (Prevention and Control of Pollution) Act, 1981 was promulgated on 16th May 1981. The matter related with air pollution was also looked after by (CBPCWP). There had been State Boards already in the different states to advise the respective governments on matters related to water and air pollution. The CBPCWP coordinated the activities of State Pollution Control Boards. While amending the Water (Prevention and Control of Pollution) Act, 1974 in 1988, the CBPCWP were renamed as Central/state Pollution Control Boards (C/SPCB). The CPCB advises the Pollution Control Division of the Ministry of Environment and Forests, New Delhi. The State Pollution Control Boards (SPCB) advise respective state governments.

We have now more than 200 Central and State Legislation, which deal with the environmental issue. However it is important to have meaningful enforcement of these laws than to go by their numbers.

More relevant national enactments for our purpose are as follows:

The Water (Prevention and Control of Pollution) Act, 1974 (amended 1988). The Act provides for the formation of Central Pollution Control Board and the State Pollution Control Board. It provides for the prevention and control of water pollution and maintaining or resorting the wholesome of water. It prohibits any poisonous, noxious or polluting matter from entering into any stream or well. The new industries are required to obtain prior

approval of such Boards before discharging any trade effluents or sewage into water bodies. No person, without the previous consent of the Boards shall bring into use new or altered outlet for the discharge of sewage or trade effluent into a stream or well or sewer or on land. The consent of the Board is also required for continuing an existing discharge of sewage or trade effluent into a stream or well or sewer or land. CPCB monitors the quality of fresh water resources through a network of 784 monitoring stations located on rivers, ground water, canals, creeks and drains.

The Air (Prevention and Control) Act, 1981 (amended 1987). The act has been designed for prevention, control and abatement of air pollution. The act defines an air pollutant as any solid, liquid or gaseous substance including noise present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment. The Act provides that no person shall without the previous consent of the State Boards establish or operate any industrial plant in an air pollution control area. It is expressly provided that persons carrying on industry shall not allow emission of air pollutant in excess of the standards laid down by the board. The CPCB and SPCB constituted under the water act also perform the power and functions under the Air Act. The main function of the Boards under the Air Act is to improve the quality of air and to prevent, control and abate air pollution in the country. CPCB in association with SPCB has set up 295 ambient air quality monitoring stations all over the country.

The Motor Vehicle Act, 1988: The Act has come into force from 1st July 1989. Some salient features of the Act are:

1. New vehicle is to be registered only once the registering authority has inspected the vehicle and is satisfied. The certificate of fitness is to be issued for a new vehicle for a period of two years. Subsequent renewal is every year upto a period of 10 years.
2. Regarding construction, equipment and maintenance of motor vehicle from 1.10.1989, every vehicle shall comply with the emission standards specified under the Act. e.g. Idling emission limit for four-wheeler petrol driven vehicle shall not exceed 3% of the volume, for two wheelers and three wheelers it will not exceed 4.5% by volume. The smoke density for diesel driven vehicle has also been fixed.
3. Transportation of goods of dangerous or hazardous nature to human life has been regulated by this act.
4. Every vehicle is required to meet the safety standards of the components.
5. A prototype of the vehicle to be manufactured will be tested by the ARAI, Pune or CMTTI, Budni or any other authorization.
6. The horn to be used should be in accordance with the approved specifications of Bureau of Indian standards.
7. New items are included for offences and penalties in the Act. Amounts for different types of offences have also been specified.

The Forest Conservation Act, 1980: It was passed with a view to check deforestation. The conservation of forests includes not only preservation and protection of existing forests but also reforestation. The act was amended in 1988. One of the two amendments forbids department to assign any forestlands by way of lease or otherwise to any private person of a non-government body for reforestation. It also forbids clearance of any forestland of naturally grown trees for the purpose of reforestation. The Ministry of Environment and Forest has constituted the **National Forest Commission** on February 7, 2003 to review the

working of forest and wildlife sector. A **National forestry Action programme (NFAP**) has been formulated with an objective of bringing one-third of the area under forest cover and to arrest deforestation in the next 25 years.

Environment Protection Act, 1986: It extends to whole of India. The Act defines various terms like environment, environmental pollutant, environmental pollution and hazardous substances. The act provides general powers to the central government to take all necessary measures for the purpose of

- Protecting and improving the quality of the environment and.
- Preventing, controlling and abating environmental pollution.

The Central government shall have powers for laying down standards for the quality of the environment with various aspects, laying down standards for the discharge or emission of pollutants from various sources, regulate industrial locations, prescribe procedure for managing hazardous substances, establish safeguards for preventing accidents and collect and disseminate information regarding environmental pollution. Any contravention of the provision of the act, rules, orders or directions made there under is punishable with imprisonment for a term, which may extend to five years or with fine upto one lakh rupees, or with both.

The National Environment Tribunal Act, 1995 provides for strict liability for damages arising out of any accidents occurring while handling any hazardous substance. It imposes liability on the owner to pay compensation in case of death or injury to any person, or damage to any property or environment resulting from an accident. The accident must have occurred while handling the hazardous substance.

The Wildlife (Protection) Act, 1972 (amended 1991) was enacted with a view to provide for the protection of wild animals, birds and plants. The act prohibits hunting of animals and birds as specified in the schedules. It prohibits picking, uprooting, damaging or destroying of any specified plant from a forest. The Act provides for State Wildlife Advisory Board to advise the State Governments in policy formation for protection and conservation of wildlife and plants, and selection of areas to be declared as sanctuaries. The act also empowers zoo authorities with control of zoos and captive breeding. It also provides for the control of trade and commerce in wildlife, wildlife products and trophies. The Wildlife (Protection) Act 1972 has been adopted by all states except Jammu and Kashmir, which has its own Act. The first National Wildlife Action Plan (NWAP) of 1983 has been revised and replaced by the new NWAP 2002-2016. **The Indian Board of Wildlife** headed by the Prime Minister is the apex advisory body overseeing and guiding the implementation of various schemes. At present, the protected area network comprises 92 national parks and 500 sanctuaries.

Animal Welfare Board of India (AWBI) is a statutory body under section 4 of the Prevention of Cruelty to Animals Act, 1960 with headquarters at Chennai. It advises the government on welfare issues, gives financial assistance to eligible Animal Welfare Organizations for shelter houses, Model Gaushalas for setting up biogas plants; famine/drought and earthquake relief in various states. So far State Animal Welfare Boards (SAWB) have been set up in 24 states/UTs.

The Batteries (Management and handling) Rules, 2001 regulate the collection, channelization and recycling as well as import of used lead and batteries in the country. These rules inter-alia make it mandatory for the consumers to return used batteries. All concerned parties are required to collect used batteries against new ones sold and these

batteries can be sold/auctioned only to recyclers registered with the ministry/CPCB on the basis of their possessing environmentally sound facilities for recycling/recovery.

The Biological Diversity Act, 2002: The act aims to achieve three things:

1. Conservation of biodiversity.
2. Sustainable use of biological resources and
3. Equitable sharing of benefits arising from such use.

The act has several clauses like it prohibits transfer of Indian genetic material outside the country, provides for levying of appropriate fees and royalties on such transfers, regulates access to such material by the Indian nationals also, provides for measures to conserve and sustainably use biological resources, provides for the development of an appropriate legislation or administrative steps including registration to protect indigenous and community knowledge, empowers governments to declare Biodiversity Heritage Sites as areas for special measures for conservation and sustainable use of biological resources, it stipulates that risk associated with biotechnology will be regulated or controlled through appropriate means and provides for the designation of repositories of biological resources at national and other levels.

The Act also recommends creation of funds at local, state and national level, which will be used to support conservation. The Act also set up National Biodiversity Authority, the State Bio-Board and local Biodiversity Management Committees for matters dealing with the prospects for transfer of genetic resource abroad, use and conservation of resource and knowledge at community and individual level respectively.

The Noise Pollution (Regulation and Control) Rules, 2000 under the Environment (Protection) Act 1986: It provides for prevention and control of noise pollution in the country. The notification seeks to control noise in public places from various sources as industrial, construction activity, generator sets, loud speakers, vehicular horns and other mechanical devices in order to avoid an adverse effect on human health.

INTERNATIONAL ENVIRONMENTAL LAWS

The increasing degradation of the environment has aroused global concern and the international law has expanded to cover environmental issues also, mainly because the pollutants do not recognize boundaries and are carried across the borders. Though there are many international environmental agreements, salient features of only important ones are given below:

Ramsar Convention, 1971: It is adopted for the protection of wetlands and recognizes ecological functions and the economic, cultural, scientific, and recreational values of lands.

World Heritage Convention, 1972: It highlights the universal value of the cultural and natural heritage and support the maintenance of World Heritage Sites. The state has obligation to identify, protect, conserve and transmit to future generations, the unique cultural and natural Heritage of that country. Some of the sites listed in this category in India are Taj Mahal, Ajanta caves, Qutab Minar, Sun Temple Konark and Keoladeo National Park.

London Dumping Convention, 1972: It was amended in 1993 and then in 1996 and requires the state to get prior permission for dumping of radioactive material, biological and chemical warfare agents, persistent plastics, heavy metals and toxic organic wastes in the sea.

Marpol Convention 1973, 1978: The aim of the convention is to prevent or reduce the discharges from ships into sea, particularly the oil spills and ship generated waste. Complete ban exists in special areas like Caribbean Sea and Gulf of Mexico.

CITES, 1973 (Convention on International Trade in Endangered Species): under this convention the parties should identify species that are, or may be threatened by trade. They should also identify species that may be threatened unless the trade is regulated. The former are listed in Appendix I and the latter in Appendix II. Commercial trade is forbidden for species listed in Appendix I e.g. dolphins and whales. The trade is strictly regulated in respect of species listed in Appendix II.

Vienna Convention: (On the protection of the ozone layer) 1985 and Montreal Protocol, 1987. It aims at phasing out the production and consumption of ozone depleting substance. But it has permitted the developing states to delay their compliance of the protocol and has urged the transfer of necessary technology to the developing states from the developed countries.

Basel Convention (on the control of trans boundary movements of hazardous wastes), 1989: The convention seeks to minimize the level of hazardous waste from its source of generation. No export is allowed to countries, which prohibit the hazardous waste, unless they give the consent. State parties should develop and prescribe guidelines for environmental management of hazardous waste.

Climate Change Convention, 1992: It lays down the commitment, to limit Green house gas emission, gather relevant information, develop plan to mitigate and adapt to climate change and co-operate in research and development. In 1997 Kyoto Protocol supplemented the convention, which fixed the target for industrialized states to cut down emissions at least by 5% from the 1990 level, from 2008-2012. More than 150 nations agreed on December 10, 2005 at Montreal, Canada to discuss post 2012 reductions in green house gases but excluding USA, which rejects the emission cutbacks of the current Kyoto Protocol.

Biodiversity Convention, 1992: It outlined three objectives:

(1) Conservation of biodiversity.

(2) Sustainable use of the components of biodiversity and

(3) Fair and equitable sharing of the benefits of using biodiversity.

The states have obligations to develop national programmes for conserving and sustainably using the biodiversity, prepare inventories of bioresources, take ex-situ and in-situ conservation measures and establish a system of protected areas. The Cartagenes Protocol is an attachment to biodiversity convention and according to this adequate measures of protection must be taken in matters of transfer, handling and use of living modified organisms.

UN Convention on Desertification, 1994: The States have to prepare and implement national programme to combat and mitigate the effects of drought. The parties to the convention have to make the prevention of desertification a priority in national policies and must promote awareness of desertification among their citizens.

United Nations Conference On Environment and Development (UNCED) in Rio De Janerio, June 1992, known as Earth Summit: Some major achievements of the Earth Summit are reproduced in the following document:

(i) The Rio Declaration - 27 principles. The series of principles defines the rights and liabilities of the states regarding protection of the environment.

(ii) Agenda – 21 is a massive 800-page document and a blue print for global action to affect the transition to sustainable development. It consists of four sections i.e. social and economic issues, conservation and management of resources for development, strengthening the role of major groups, means of implementation – and forty chapters covering issues like climate change, ozone depletion, transboundary air pollution, drought and desertification etc.

(iii) Statement of Forest Principles – a statement of 17-nonbinding principles for the protection and sustainable development of all forests – tropical, temperate and boreal

(iv) Convention on climate change and

(v) Convention on Biodiversity has been discussed already.

All the above conventions have laudable objectives but seem to represent weak political compromises. The major drawback of international law is that there is no effective enforcement machinery. Therefore, most international obligations relating to environment are consistently violated.

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