UNIT 6: SOCIAL ISSUES AND THE ENVIRONMENT

FROM UN-SUSTAINABLE TO SUSTAINABLE DEVELOPMENT

Meaning of Sustainable Development

Sustainable development is a term that was first brought into common use by the World Commission on Environment and Development, a group appointed by the United Nations. The Commission made sustainable development the theme of its final report, Our Common future, published in 1987. They defined the term as a form of development or progress that "meets the needs of the present without compromising the ability of future generations to meet their own needs".

Of course, in the traditional sense, we still use the word development to refer to the clearing of natural areas to make room for more shopping malls, housing tracts, or agricultural land, a process that is conspicuously non sustainable in the long term. Therefore, the idea of sustainable development strikes many people as an oxymoron a self contradictory concept.

We need to think of development in a broader sense, of moving toward protecting and enhancing those aspects of the environment and social justice which are necessary conditions for the sustainability of continuing gains in knowledge and understanding. For example, can we think of development in terms of protecting farm soil from erosion? In terms of saving natural areas and the wildlife they support, for their aesthetic, recreational, and scientific value? In terms of stabilizing world population? Can we define development in terms of improving our physical, mental, and emotional health? In terms of reducing the underlying factors that lead to crime and corruption? In terms of improving relations among different peoples and nations? In terms of increasing people's access to educational and career opportunities? In terms of discovering and implementing new technologies for recycling, reducing pollution, and harnessing solar energy?

In short, can we thank of development as learning to be stewards of Earth, not just to protect wild species, but to enhance the general well being and security of human life for generations to come?

Importantly, this concept of sustainable development should not be confused with the idea of returning to the status of a primitive culture "living in harmony with nature. First, the idea of primitive cultures living happily and peacefully in harmony with nature is largely imaginary. Their lives actually included much suffering, discomfort, and pain, high infant mortality and early death. They also had wars with neighboring tribes. In reality, humans have always been territorial and covetous of their neighbor's resources. Living in balance with nature was just a result of lacking the understanding and technology to manipulate nature more to their advantage and a result of a belief system that tended to prevent innovation. Also, we must point out again that the world is replete with the ruins of civilizations that did not sustain themselves and became extinct.

The good news is that, critics not with standing, growing numbers of people in all walks of life scientists, sociologies, workers and executives, economists, government leaders, an clergy, as well as traditional environmentalists are recognizing that "business as usual" is not sustainable. These caring people are beginning to play an important role in changing society's treatment of Earth. For example, adding their voices to the literally hundreds of traditional environmental and professional organizations devoted to controlling pollution and protecting wildlife, people in business have formed the Business Council for Sustainable Development, economists have formed the International Society for Ecological Economies, religious leaders have formed the National Religious Partnership for the Environment, and philosophers are speaking out for a new ethic of "caring for creation". And for the first time in 1994, the US Department of Commerce began to consider the consumption of environmental assets in their calculation of the gross domestic product (GDP).

Sustainable development was the primary focus of a 1992 world summit meeting of leaders and representatives from 180 nations the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil. The outcome of this conference, a "blueprint" intended to guide development in sustainable directions into and through the next century, is now published in book form as Agenda 21.

Thus, we are seeing a melding of environmentalists with many other individuals and groups that appreciate the problems jeopardizing sustainability. Together, they are working to bring out corrective measures. With this breadth of participation, it is difficult today to define an environmentalist, except perhaps as "anyone who cares for creation, is interested in human sustainability, and is making efforts to achieve it".

In the later half of nineteen seventies the phase "Sustainable Society" appeared in academic circles and scientific writings. Turning points come, civilization adjust, believes and values change, adversities come and go but it is important that life processes continue. We are probably approaching a turning point. We can no longer follow the pattern of development which we have no far been following. We shall have to change our ways, modify our believes and values so that our society should at least be able to sustain itself on long term basis. No one can argue against the desirability of sustainability. But how it would be achieved and what would be the structure of this sustainable society? There is considerable disagreement among scientific circles regarding these aspects.

In 1983, United Nation's General Assembly established a "World Commission on Environment and Development". In its report entitled "Our Future" submitted in 1987, the Commission emphasized Sustainable Development as a key to the problems of environment. Sustainable development was defined as the development which provides for the needs of the present generation without compromising the ability of the future generation to meet their own needs. The concept of Sustainable Development can mobilize broader political consensus within and among nations. It is a broad concept of social and economic progress. It requires political reforms, access to knowledge and resources and a more just and equitable distribution of wealth both within and between the nations.

Today gross inequalities and injustices exist in the distribution of wealth and resources. The life of comfort, convenience and abundance is enjoyed only by a minority consisting of about one third of the total world population. Two third of world population is classed as under developed consisting of poor and deprived masses. There is severe environmental depreciation associated with this absence of development. Disparate and hungry people will till any soil regardless of long term consequences. They will be tempted to cut any tree for fuel if they have no other option but cold. Many of them shall poach any animal if it fetches them something to satisfy their hunger. Only economic development can eliminate poverty and create the capacity to solve environmental problems. This makes economic development a must for the protection of the environment. However, to bring the world's under developed two third to a reasonable standard of life to fulfill their legitimate necessities enormous efforts and resources shall be needed if we follow the pattern of development which humanity has followed so far and which may cause drastic damage to the environment and wild life. Telling the world's two third majority that we have suddenly reached a point where it is necessary to put restriction on economic growth would be unreasonable, unfair and unjust.

URBAN PROBLEMS RELATED TO ENERGY

Try to imagine what life would be like without all the energy we use. There would be no transportation beyond walking, horseback, or boats powered by paddles or wind. There would be no home appliances, air conditioners, or lighting or communications equipment. There would be little manufacturing beyond what could be done by hand, on looms or on potters, wheels. Farming would depend on hand labor and on draft animals such as horses and oxen. In short, anything beyond a primitive existence is irrevocably tied to harnessing energy sources. Let's look at this matter in a little more details.

Harnessing Energy Sources: An Overview

Throughout human history, the advance of technological civilization has been tied to the development of energy sources. In early times (and even today in less developed regions), the major energy source was muscle power. Some people lived in relative luxury by exploiting the labor of others slaves, indentured servants, and minimally paid workers. Human labor was supplemented to some extent by the work of domestic animals for agriculture and transportation, by water power and wind power for milling grain, and by the sun. However, these power sources are, of course, limited by geography and climate.

By the early 1700s, inventors had already designed many kinds of machinery. The limiting factor was a continual power source to run them. The break through that launched the Industrial Revolution was the development of the steam engine in the late 1700s. In a steam engine, water is boiled in a closed vessel to produce high pressure steam, which pushes a piston back and forth in a cylinder. Through its connection to a crankshaft, the piston turns the drivewheel of the machinery. Steam engines rapidly became the power source for steamships, steam shovels, steam tractors, steam locomotives, and stationary engines to run sawmills, textile mills, and virtually all other industrial plants.

At first, the major fuel for steam engines was firewood. Then, as demands for energy increased and firewood around industrial enters became scarce, coal was substituted. By the end of the 1800s, coal had become the dominant fuel and remained so into the 1940s. In addition to being used as fuel for steam engines, coal was widely used for heating, cooking, and industrial processes. In the 1920s, coal provided 80% of all energy used in the United States, with similar percentages in other industrializing countries.

Though coal and steam engines powered the Industrial Revolution that greatly improved life for most people, they had many drawbacks. The smoke and people, they had many drawbacks. The smoke and fumes from the numerous coal fires made air pollution in cities far worse than anything seen today. Writers have recorded that often they could not see as far as a city block away because of the smoke. Coal is also notoriously hazardous to mine and dirty to handle, and burning coal results in large quantities of ashes that must be removed. As for steam engines, because of the size and bulk of the boiler, the engines were heavy and awkward to operate. Often the fire had to be started several hours before the engine was put into operation in order to heat the boiler sufficiently.

In the late 1800s, simultaneous development of three technologies the internal combustion engine, oil well drilling, and the refinement of crude oil into gasoline and other liquid fuels combined to provide an alternative to steam power. The replacement of coal fired steam engines and furnaces with petroleum fueled engines and oil furnaces was an immense step forward for convenience. Also, air quality was greatly improved because cities were gradually rid of the smoke and soot from burning coal (It was only in the 1960s, with the tremendous proliferation of cars, that pollution from gasoline engines became a problem). Further, the gasoline internal combustion engine provides a valuable power to weight advantage that allowed rapid advances in technology. A 100-horsepower gasoline engine weighs but a tiny fraction of what a 100-horse power steam engine and its boiler weigh, and jet engines have an even greater power to weight ratio. Automobiles and other forms of transportation would be cumbersome, to say the least, without this power to weight advantage, and airplanes would be impossible.

Replacement of one energy technology with another is a very gradual process, however, because it is most cost effective to use existing machinery until it wears out before replacing it. It was not until the late 1940s that crude oil surpassed coal to become the dominant energy source for the United States. Since then, however, its use has continued to grow. Crude oil currently provides about 40% of the total U.S. Energy demand. The story is similar throughout the rest of the world, although the timing of events differs. We have noted that many poor regions of the world remain dependent on firewood. Coal is still the dominant fuel used in the countries of Eastern Europe and in China.

Development throughout the world, so far as it has occurred since the 1940s, has been largely predicated on technologies that consume gasoline and other fuels refined from crude oil. Thus, oil is the mainstay for most of the country in the world. Coal has not passed from the picture, however, it has become a major source of energy for generating electrical power, as we discuss shortly.

Natural gas, the third primary fossil fuel (the other two being oil and coal), is found in association with oil or is found during the search for oil. As it is largely methane, which produces only carbon dioxide and water as it burns, natural gas burns more cleanly than oil; thus, in terms of pollution, it is a more desirable fuel. Despite the obvious fuel potential of natural gas, at first there was no practical way to transport it from wells to consumers. Any gas released from oil fields was (and in many parts of the world still is) flared i.e. vented and burned in the atmosphere, a tremendous waste of valuable fuel. Gradually the United States constructed a network of pipelines connecting wells and consumers. With the completion of these pipelines, the use of natural gas for heating, cooking, and industrial processes escalated rapidly because of its cleanliness, convenience (no storage bins or tanks are required on the premises), and relatively low cost.

Thus, three fossil fuels crude oil, coal and natural gas provide maximum portion of energy fuel input. The remaining portion is provided mostly by nuclear power, water power, and renewable, which, along with coal, are used for the generation of electrical power. This changing pattern of energy sources in the picture is similar for developed countries of the world but problem is more severe with developing countries, although the percentages differ somewhat depending on the energy resources of any given country.

WATER CONSERVATION RAIN, WATER HARVESTING, WATER SHED MANAGEMENT

Conservation of Fresh Water Resources

Water is the basic need of a living organism. No one can live without water. The demand for freshwater is likely to exceed its supply by the first or second decade of the next century. An acute crisis is expected to follow in some regions of the world. The shortage of water shall make many localities barren, devoid of life. Fertile land will become deserts. Conservation of fresh water is, therefore, an absolute necessity of today. Otherwise the tomorrow will be grim, drier and barren to live through. It is somewhat consoling that though the actual quantity of water drawn has already reached the level of total water availability, the irrecoverable consumption of water is well below this level. Needless to say this is due to a number of steps undertaken to minimize wastage of fresh water resources and to make more efficient use of the available water. Some of these may be summarized as follows:

1. **Water Economy, Re-use and Recycling** : For almost all spheres of human activity till date, more water is drawn than the amount actually needed. Much of the surplus water is returned to surface flow in an impure state. A little care can reduce the over consumption. We waste water because of its easy availability. If a water meter is installed and money charged for every bucket of water we use, water consumption in domestic establishments livestock management and industries shall drastically decline. The resultant surplus may be diverted to regions of water scarcity. This shall also reduce production of waste waters which pollute our aquatic systems.

Power generation is another sphere of human activity wherein a large amount of water is needed. Most of it, however, is used as coolant (about 90-95%). Irrecoverable consumption is only 5-10%. The heated waters from thermal power plants may be utilized elsewhere after proper cooling. The same is true for many industries. Water used once may be used again for another purpose. All processes do not require good quality water. Agricultural runoffs from fields can likewise be used to irrigate cropland down the stream while an efficient use of water with conditions of proper drainage can significantly reduce the agricultural runoffs.

2. **Development of an Efficient Distribution System** : Water resources are not distributed evenly. Some localities have plenty of water. Others have little of it. Therefore, transport of water from one place to another becomes an essential part of water conservation efforts. Many river basins have plenty of water which flows down unused to the sea. This surplus can be diverted to drier regions through a system of canals and pipes. Water drawn out from underground sources can also be transported to zones where underground water can not be tapped. The surplus of one basin can be used to make up the deficit at another.

3. **Reduction of Pollution and Recycling of Water**: Pollution spoils huge quantities of our surface water. All possible efforts should be undertaken to divert waste waters to some treatment plant instead of releasing them into our surface waters. While treated water can be safely discharged in our aquatic systems, it may also be recycled where there is more pressing need. Ordinarily the biodegradable impurities of waste waters make them most undesirable. These can be conveniently decomposed by some biological treatment followed by treatment with a suitable disinfectant. This makes the water concerned almost as good as it was earlier. If not for direct consumption these waters can be used satisfactorily for other purposes such as washing and cleaning, as coolant in industries, for irrigation etc.

4. **Enhancement of Surface Storage Capacity**: About 27,000 cubic kms of fresh water which rush down to the oceans through streams and rivers of the world as flood flow are of no use to the mankind. We can store this water in tanks and reservoirs for use during drier seasons. This can be done by erecting embankments and dams which check the flood flows and detain water for longer duration on land surface. Through a system of pipes and canals the water can be supplied wherever

needed. The potential energy, the energy of water flow as it moves from a higher place to lower may be used in hydroelectric power generation, while the reservoirs which develop behind the dam may be used for fisheries and other recreational activities.

However, surface storage of water, in huge quantities, is a risky and costly venture. Water losses through evaporation and seepage are enormous both from the reservoir and the distribution system. Much of the water infiltrates the soil and moves to the ground water table. Large areas of fertile land are submerged which may include human settlements as well. Natural ecosystems are destroyed. The pressure of standing water table enhances seismic activity which may precipitate an earthquake. A crack in the dam, sabotage or bombardment during wars is catastrophic to the people living down streams. Entire localities may be washed away by rapidly gushing waters. The multimillion rupees projects are gradually made defunct by silt and debris carried by the river water if little is done to reduce soil erosion upstreams in the catchment area of the river.

5. **Improvement of Underground Storage Capacity**: An enormous amount of fresh water is stored in underground deposits. It represents accumulations over a long period of time. Every year, about 10-15% of total precipitation enters the ground water table. These deposits regularly feed streams and rivers during drier periods. Ground water deposits are cheap and easily obtainable source of freshwater except for the cost involved in its withdrawal. We can improve the ground water storage capacity of earth's crust by providing an effective plant cover over the soil surface. Plants obtain most of their water from soil moisture and keep the surroundings cool and humid, thereby, preventing excessive loss of water through evaporation. They check the flow of water and impede air currents. As a result of which more water percolates down the soil surface to add to the ground deposits. On bare and denuded surface, much of water, deposited by precipitation, flows down quickly as flood flows. Little of it permeates the soil surface to recharge the ground water table. In dry seasons there is an equally rapid loss of water from the soil in absence of plant cover.

6. **Augmentation of Existing Supplies of Fresh Water**: As mentioned earlier, annual precipitation has been considered to be the upper limit upto which we can draw water from its deposits on land surface or beneath. An overdraft is detrimental to the ecology and environment of the locality. Many regions of the world with scanty rainfall have no other choice but to augment their water supplies by other means. This can be done by:

(a) *Desalination of sea water*: A huge store of water exists in our oceans. Only if the salt content of sea water is removed we can use the water for consumptive purposes. This can be done by desalinization plants, which are essentially huge distillation sets operated on solar energy. Desalinization plants are already under operation in a number of Middle East countries. However, these plants are very expensive.

(b) *Artificial rain making*: In general only 20-30% of the moisture content of atmosphere over a locality precipitates as snow or rains. It has been observed that clouds with temperatures ranging between 5°-20°C nearly always lack condensation nuclei over which moisture condenses to form droplets of water. Small particles of substances like silver iodide, sodium chloride, dry ice (solid CO_2) etc. are injected into a thick layer of clouds (cumulus clouds), around which moisture condenses and droplets of water from which sink down as rains. In a number of countries active experiments are being carried out in this direction. However, the process of artificial rain making is still in an experimental stage.

In scientific terms, water harvesting refers to collection and storage of rainwater and also other activities aimed at harvesting source and groundwater, prevention of losses through evaporation and seepage and all other hydrological studies and engineering interventions, aimed at conservation and efficient utilization of the limited water endowment of physiographic unit such as a watershed.

In general, water harvesting is the activity of direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the groundwater.

Rain is the first form of water that we know in the hydrological cycle, hence is a primary source of water for us.

Rivers, lakes and groundwater are all secondary sources of water. In present times, we depend entirely on such secondary sources of water. In the process, it is forgotten that rain is the ultimate source that feeds all these secondary sources and remain ignorant of its value. Water harvesting means to understand the value of rain, and to make optimum use of rainwater at the place where it falls.

Need for Water Harvesting

We get a lot of rain, yet we do not have water, Why? Because we have not reflected enough on the value of the raindrop. The annual rainfall over India is computed to be 1,170 mm 946 inches. This is higher compared to the global average of 800 mm (32 inches)[6]. However, this rainfall occurs during short spells of high intensity. Because of such intensities and short duration of heavy rain, most of the rain falling on the surface tends to flow away rapidly, leaving very little for the recharge of groundwater. This makes most parts of India experience lack of water even for domestic uses.

Ironically, even Cheerapunji which receives about 11,000 mm of rainfall annually suffers from acute shortage of drinking water. This is because the rainwater is not conserved and allowed to drain away. Thus it does not matter how much rain we get, if we do not capture or harvest it.

This highlights the need to implement measures to ensure that the rain falling over a region is taped as fully as possible through water harvesting, either by recharging it into the groundwater aquifers or storing it for direct use.

How Much Water Can be Harvested?

The total amount of water that is received in the form of rainfall over an area is called the rainwater endowment of that area. Out of this, the amount that can be effectively harvested is called the water harvesting potential.

Water harvesting potential = Rainfall (mm) x Collection efficiency

The collection efficiency accounts for the fact that all the rainwater falling over an area cannot be effectively harvested, because of evaporation, spillage etc. Factors like runoff coefficient and the first flush wastage are taken into account when estimating the collection efficiency.

The following is an illustrative theoretical calculation that highlights the enormous potential for rainwater harvesting. The same procedure can be applied to get the potential for any plot of land or rooftop area, using rainfall data for that area.

Consider a building with a flat terrace area of 100 sq. m. The average annual rainfall in Delhi is approximately 600 mm (24 inches). In simple terms, this means that if the terrace floor is assumed to be impermeable, and all the rain that falls on it is retained without evaporation, then, in one year, there will be rainwater on the terrace floor to a height of 600 mm.

Area of plot	= 100 sq. m. (120 sq. yd.)
Height of rainfall	= 0.6 m (600 mm or 24 inches)
Volume of rainfall	= Area of plot X Height of rainfall
	= 100 sq. m x 0.6 m
	= 60 cu. M. (60,000 litres)

Assuming that only 60% of the total rainfall is effectively harvested.

Volume of water harvested

= 36,000 litres (60,000 litres x 0.6)

This volume is about twice the annual drinking water requirement of 5-member family. The average daily drinking water requirement per person is 10 litres[7].

Watershed Management

Availability of water in a given soil is a critical factor and is related to erosion, siltation, loss of cover and productivity. In India floods bring much havoc causing loss of life and property each year. Due to floods, the plains have become silted with mud and sand, thus affecting the cultivable land areas. Extinction of civilization in some coastal areas is mainly due to such natural calamites as flood. The National Commission on floods has calculated that the land area prone to floods has doubled from 20 million hectares in 1971 to 40 million hectares in 1980. Flood damage cost the country Rs. 21 crore in 1951 which increased to Rs. 1,130 crore in 1977. It was Rs. 128 crore per year during the decade 1960-70, increasing to Rs. 739 crore per year during 1970-80. The worst suffering States are Assam, Bihar, Orissa, UP and West Bengal. These aspects are to be given serious thought to save further destruction of mankind. Through modern technology and scientific knowledge, there is need of a proper understanding of the ecosystem so that changes could be forecast well in time. Thus management of rainfall and resultant runoff is very important. Such management can be best based on a natural unit called watershed. A watershed is an area bounded by the divide line a water flow. Thus it may be drainage basin or stream. The Himalayas are one of the most critical watersheds in the world. Our water regimes in the mountain ranges are threatenend resulting in the depletion of water resources. The damage to reservoirs and irrigation systems and misuse to Himalayan slopes are mounting as are the costs for control measures during the “flood season” every year. The vast hydroelectric power potential can be harnessed from Himalayan watersheds only when proper control measures are taken. These include soil and land use survey, soil conservation in catchments of River Valley Projects and flood prone rivers, afforestation/social forestry programmes, Drought Prone Area Development Programmes and Desert Development and Control of Shifting Cultivation.

ENVIRONMENTAL ETHICS

Environmental ethics have been made an important issue with the popularization of the concept of deep ecology. There are following six ethical principles:

- To protect and augment the important components of the life support systems, such as providing conservation to non renewable resources, sustainable use of renewable resources etc.
- To ensure fair sharing of resources
- To bring awareness regarding concealed social, economic and environmental costs of consumerism
- To adopt willingly, the frugality and fraternity as a sustainable way of life
- To meet genuine social needs through the blending of economic and environmental imperatives
- To stop and reverse the arms build up throughout the globe

The ethics basically relate to morality or duty. To stay in a natural forest before departing from social bindings has been a long practice in the vedic civilization. ‘Banaprastha’ a stage of life between garhastha (family life) and sannyas (saint hood) has been dedicated by the vedic people for staying in a forest, to forget all contradictions and bindings of family life. The morality of recognizing the right of every living creature to survive in this world is the basic environmental ethics for all human being. Human being is itself a part of nature, it is the supreme natural creation on the earth, through the process of organic evolution. Separation of human life from nature is like separating baby from mother. Man must live in harmony with all forms of diversity of life and resources on the earth.

IUCN (1980) has provided some ethical principles for preserving biodiversity. These are compiled and illustrated as follows:

- This world is an interdependent whole composed by human being and natural communities. The well being and health of any one portion is depending on the well being and health of the other portion.

- Human being is a part of nature and are covered under the same immutable ecological laws, as are all other species on the earth. Destiny of man is intoned with the destiny of other life forms on earth.

- All life forms on earth depend on the uninterrupted functioning of natural systems that ensure the energy flow and supply of nutrients. This calls for necessity of ecological responsibilities among all people in order to ensure the survival, security, equity and dignity of the world's communities.

- The ecological limits within which we are bound to work should never be considered as limits to human endeavour; instead the space within the limits guides us to develop a sustainable method of human activity that ensures environmental stability and continued existence of diversity.

- Human cultures throughout the globe should have immutable respect for nature and should recognize only those human developmental activities that are in harmony with nature. All human cultural adaptations in favour of local environment should be allowed to prosper.
- Human being must recognize the right of other life forms/species to permanently and freely exist in nature. This calls for providing conservation to diversified components

of nature including species, habitats, air, water, landscape etc. All ecological processes that maintain biospheric integrity must be maintained through protection.

- Man should consider sustainability as the basic principle for any social and economic development.

- Utilization of different moral values that are personal, social, cultural in nature, regarding day to day life including food, health, hygiene, recreation, trade and commerce, industry, science and technology shall ensure ethical conservation to natural resources. Recognition and dispersion of such utilitarian values, generation after generation will ensure sustainable and equitable distribution of resources.

- Human rights (within the dimension of moral ethics) must be ensured to all men and women. All human should be empowered with responsibility for their own lives as well as for the life of the earth (biosphere). This calls for full access to educational, social and political opportunities for all persons.

- Ensuring well being through providing a clean environment with all its natural resources for the future generations is a social responsibility of the existing generation. This calls for sustainable use of renewable resources and limiting/halting consumption of non renewable resources (as the situation demands).

- Diversity in ethical and cultural outlooks towards nature and human life should be encouraged through the promotion of relationships that enhance and respect the diversity of life, irrespective of the political, religious and / or economic ideology of the existing society.

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

The phenomenon of acid rains is a consequence of accumulation of huge amounts of oxides of sulphur, nitrogen and fine particulate materials or aerosols. However, unlike the reducing type of pollution which involves fog or smog, these gases and aerosols accumulate high up in the atmosphere. Water vapours condense on aerosol surface and form a fine film providing suitable loci as well as catalysts for the oxides of sulphur and nitrogen to dissolve in water and react to form to corresponding acids. These acids form salts, such as sulphates and nitrates, when they come in contact with aerosols of basic nature. The secondary aerosols are thus formed which bear acids and salts of these acids. Large and heavier aerosols are developed when smaller ones coalesce together and these tend to drift downwards. As water vapours continue to condense on these aerosols large droplets of water are produced which rain down as acid rains. Hydrochloric acid derived from the oxidation of organochlorine compounds and polyvinyl chloride in plastics may also be present in these droplets. Rain also traps much of wind blown particles dust and other gaseous constituents which may also be acidic in nature as its falls down

$$SO_2 + H_2O \dashrightarrow H_2SO_3 + O \dashrightarrow H_2SO_4$$
$$2NO + O_2 \dashrightarrow 2NO_2 + H_2O + O \dashrightarrow 2HNO_3$$
$$NH_3 + H_2O \dashrightarrow NH_4OH$$
$$NH_4OH + H_2SO_4 \dashrightarrow (NH4)_2\,SO_4 + H_2O$$
$$NH_4OH + HNO_3 \dashrightarrow NH_4NO_3 + H_2O$$

Thus all chemical reactions which result in the formation of fog or smog and reducing type of pollution occur higher up in the atmosphere and give rise to rains of acidic nature which may have a pH in the range of 2.5 – 4.8. Sulphuric acid, nitric acid, various sulphates and nitrates are the main chemical constituents of these rains, though small amount of other acids like hydrochloric acid and their salts may also be present. The damages caused by acid precipitation are of a very diverse nature and can be summed up as follows:

1. The corrosive action of the acid content in these rains damages buildings, wood, steel and cement concrete structures. It also damages fabric and other fibrous materials. Many of our monuments which are built up of steel, stone of cement concrete are threatened by the corrosive action of acid rains (like the Tajmahal at Agara).
2. Low pH causes release of many toxic metals and trace elements in excessive amounts as the rate of decay and decomposition of parent rocks is enhanced. Though in traces these elements are bio-accumulated by living organisms and are bio-magnified to concentration many thousand times higher than their concentration in the surrounding medium as they move up along the food chain. So even small rise in concentration of many of these elements in the environment could be dangerous to the living beings.

3. Acid precipitation affects aquatic system drastically as due to low mineral content, the capacity of natural waters to assimilate the introduced acid is limited. There is a reduction in the alkalinity. Solubilities of various chemicals and gases are affected with decline pH and the entire chemical picture of the water concerned undergoes a change. Soft waters are the worst sufferers because of their low salt content. Changes in pH also affect microbial community which are responsible for decomposition of organic matter, maintenance of plant nutrients and properly balanced mineral cycles.

The Green House Effect

The gaseous mantle around our globe allows a considerable portion of solar radiations to enter right upto the surface of earth which absorbs it and radiates back infra red and heat waves. This heat is transferred to layers above, as warm layer rises and is in turn passed on the higher and higher layers. Finally much of the solar radiations are radiated back to space as infra red and heat waves.

The system consisting of our globe and its atmosphere is in a state of dynamic equilibrium with the rate of absorption of solar radiations and its emission back to space as infra red and heat waves, nearly balancing each other. Those gases and vapours which allow free passage to radiations of relatively shorter wavelengths (290 nm – 700 nm) while absorbing effectively infra red and heat waves (700 nm onwards) play a very important role in maintaining surface temperatures within a range in which life can exist. They form a blanket around the globe which checks the passage of infra red and heat waves from earth's crust back to space and keep it warm and hospitable. The phenomenon is similar to that of green house in which the glass enclosed atmosphere gets heated up due to its insulation from the rest of the environment. Hence, global warming is also known as Green House Effect and the gases responsible for it are called green house gases.

Causes of Global Warming

Very slow, almost imperceptible rise of about 4 - 5°C in the global temperatures has occurred in the past 20,000 years. However, a rise of about 0.3 - 0.7°C was recorded during the last century alone, which is remarkably faster as compared to change that occurred in the past.

This acceleration in the pace of global warming coincides with a rise in the concentration of green house gases in the atmosphere. The insulation of earth's surface from the outer space caused by green house gases tends to become more and more effective as the concentration of these gases rises. More than and infra red radiations are trapped by the gaseous mantle around the globe which accelerates the pace of global warming.

Gases Responsible for Global Warming

There are a number of gases present in the atmosphere which are capable of absorbing effectively heat waves and infra red rays while being transparent to radiations of lower wavelengths. Carbon dioxide, methane, oxides of nitrogen, sulphur dioxide, ozone, chorofluorocarbons and water vapours are some of the gaseous constituents of troposphere which come in this category. From the point of global warming, however, only those gases are important which maintain an effective concentration in the troposphere, i.e., the region of atmosphere immediately covering earth's surface. There are five such gases rising concentration of which has been implicated in causing noticeable rise in the mean global temperatures. These gases are: carbon dioxide, methane, chlorofluorocarbons, nitrogen oxide and water vapours. Other gases like sulphur dioxide, ozone are not able to contribute much as they are quickly cleared from the atmosphere.

Carbon Dioxide

It is one of the most important green house gases of which about 18 billion tons are being introduced into the atmosphere annually. A rise of about 26% has already been recorded in a period of 200 years only. Between the years 1980-90, carbon dioxide has been estimated to be responsible for at least about 55% of global rise in temperatures. The concentration of this gas is still rising at a rate of about 0.5% per year.

Methane

Methane is another green house gas which is produced when organic matter decays under anaerobic conditions. In 1950 its concentration was about 1.1ppm while in the year 1985 it was estimated to be 1.78 ppm. The concentration of this gas is rising at a rate of about 1% per year. Between the years 1980-90 about 15% of the total warming has been attributed to this gas alone. In the atmosphere methane undergoes oxidation to carbon dioxide and water both of which tend to accentuate the green house effect.

Nitrous Oxide

Nitrous oxide is another troublesome gas. Other oxides of nitrogen are reacted upon or cleared rapidly while nitrous oxide undergoes decomposition very slowly and hence it tends to accumulate in the atmosphere. In 1950 its concentration was about 280 ppb while in 1985 it had reached 380 ppb. Between the years 1980-90, nitrous oxide accounted for at least 6% of the total global warming. The concentration of this gas is still rising at a rate of about 0.3% per year.

Water Vapours

About 70% of earth's surface is covered with water wherefrom an enormous quantity of water evaporates. Likewise the process of transpiration introduces a substantially large amount of water vapours into the atmosphere. Precipitation brings down about 496.1 x 10^3 cubic kms of water to earth's surface whereas vapours equivalent to 14,000 cubic kms of water stay back permanently in the atmosphere. Water vapour like any other green house gases contributes significantly to the global warming. With an overall rise in temperatures the rate of global transpiration and evaporation shall also go up which shall introduce more water vapours into the atmosphere and could in turn influence the pattern of global warming.

Chlorofluorocarbons

Chlorofluorocarbons represent a group of man made, colourless, odourless, easily liquefiable chemicals which have more potential for global warming than any other green house molecules. They are very stable compounds which may persist in the atmosphere for periods as long as 80-100 years. Though first introduced only in fifties, chlorofluorocarbons have rapidly attained such levels that between the years 1980-90, they were responsible for 24% of global warming. Till 1985, about 15 million tons of these compounds had been released in the atmosphere. The spite of much international efforts to check the use of these chemicals CFCs are still rising at a rate of about 5% per year.

Apart from contributing substantially to global warming the persistent nature of chlorofluorocarbons enables them to accumulate and rise random to reach the stratosphere. Strong ultra violet radiations present in the stratosphere decompose these compounds to yield chlorine atoms which catalytically destroy the vital ozone shield.

It is human activity which is mainly responsible for the accumulation of green house gases in the atmosphere. Energy production and its use, intensive agriculture, maintenance of huge livestock population, use of chlorofluorocarbons, land use modification and industrial production are some of the aspects of human activity which are responsible for this accumulation. These practices, apart from introducing gaseous pollutants in the atmosphere have also modified natural ecosystems and vegetation which act as an efficient sink for many of these pollutants. So while the input of green house gases into the atmosphere continues at a greater pace their removal or output from the atmosphere has definitely been reduced. The acceleration in the pace of these activities is tremendous and is intimately linked with growth, development and prosperity.

Power generation, refrigeration facilities, transportation activities, extensive deforestation for human habitations, his industries, agriculture etc. are necessities of today. Putting restriction on these activities involves drastic lowering of living standards and amenities and an equally serious reduction in growth, development and technological advancement. To cap up all these come international rivalries and conflicting interests which blame the developed world for all the environmental deterioration caused so far demanding the advanced nations to take up responsibilities for the clean up. Though much environmental awareness has been created in the recent past the key issues are lost in the conflict and confusion and little effective efforts have so far been done to redress the situation.

Consequences of Global Warming

Global records of earth's surface temperatures indicate that a warming of about 0.5° (0.3 - 0.7°C) has occurred during the last century alone. Results from recent climatic models suggest that mean global temperatures shall rise by 2 - 6°C during the next century of we assume that carbon dioxide concentration in the troposphere increases to 600 ppm.

The projected change in mean surface temperatures may appear insignificant because variations of this magnitude are experienced in course of seasonal or even daily weather. In fact this is not so. During the last great Ice Age, about 12,000 years ago, when much of Northern America and Europe was covered with a sheet of ice, the mean surface temperatures were only about 5°C lower than today. The world climate was very much different from what it is now. The transition from the great Ice Age to present day climate during which average surface temperature rose by 5°C took almost twelve thousand years. But the variations of almost similar magnitude shall be experienced within a course of single century if green house gases continue to rise at the present rate.

Though there are considerable uncertainties regarding the precise consequences of global warming one of the obvious results of the general heating up of earth's surface shall be a rather rapid rise in mean sea level. During the last fifteen thousand years mean sea level has slowly been rising. Evidences suggest that about 12,000 years back it was nearly 100 m lower than the present day level. It is expected that global rise in temperatures shall further enhance the rate of already rising sea levels in two ways. Firstly, large deposits of ice present on earth's surface shall melt which will add more water to the oceans. Secondly, rise in temperatures shall also cause thermal expansion of the upper layers of water. An increase of 4 - 5°C could cause enough expansion of this enormous mass of water so as the raise the mean sea level 5-6 cms. If all ice present on earth's curst was to melt, sea level could rise by about 60 m. Large stretches of low lying areas shall be submerged. As much of the world population live near shore, this could be a total catastrophe. About sixty odd island countries shall face deep encroachments by sea water and some like Maldives may disappear altogether.

The rise in global temperatures shall not be uniform all over the surface area of the world. Most of the workers agree that polar regions of the world would undergo larger increase in temperature, about ten to twelve times as much as the tropics. This shall bring unprecedented changes in wind and precipitation patterns within a span of a single century. During the last Ice Age, with a colder Arctic region, North Africa, the deserts of Arabia and the Thar Desert of India were fertile regions. But with its warming the precipitation belt has shifted northward today. More warming shall move it further north. So North Africa, Europe, parts of Russia and the fertile corn belt of the United

States could become drier, while much of peninsular India, parts of Australia and some of the Central Africa shall become more humid. In India the deserts of Rajasthan could expand right upto Punjab, Delhi and western part of Uttar Pradesh while eastern part of India shall experience little change. Higher temperatures shall cause a rise in evapo-transpiration and ground water table may be affected as the rate of recharge of sub surface water table shall change. Salt waters encroaching upon the low lying areas may results in wastage of many of our fresh water reservoirs and could spoil much of our under ground water resources also. These are all speculations only based on scientific observations and logic. What is, however, certain, is that changes of enormous magnitude shall occur within a short span of time during the next century.

As the climatic belts shift away from equator towards poles, vegetation shall have to shift in the same direction to stay in favourable climatic conditions. Those species which are unable to do so, shall die. There will be losses of genetic resources on large scale. Hardy and resistant forms shall come up and survive. An altogether changed biotic spectrum shall replace the earlier ones and almost all important biomes shall be affected. As temperature changes will affect wind and precipitation patterns also water could play an important part in altering the biotic communities. It has been suggested that some rise in precipitation, however, shall be balanced by an enhanced evapo-transpiration and this could lead to water deficit and moisture stress in many regions of the world. Insects and pests may increase as warmer conditions could be more favourable to their growth and coupled with higher humidity pathogenic diseases shall multiply. Cycling of mineral nutrients may be affected and with it leaching and desertification may follow in many areas. The effect of global warming on agriculture will be of a varied type in different parts of the world. Wheat and maize crops may suffer from moisture stress. More fertilizers shall have to be used to sustain productivity. In places where temperature conditions are already near the upper tolerance levels, even a rise of 1-2°C may be quite harmful. Alterations in cropping pattern shall occur and pest resistant varieties more suitable to warmer conditions shall have to be developed. In short green house warming shall bring with it an entirely new environment in which life though not impossible yet its existence shall be tougher to maintain.

The Problem of Ozone Depletion

Sun emits radiations at all wavelengths. Of these, radiations important to our planet are: ultraviolet radiations, light rays, and infrared rays or heat waves. Radiations of visible spectrum and infrared rays carry little energy which does not harm living beings. The energy content of ultraviolet radiations is, however, larger than the limits of tolerance of a living cell and hence is harmful or even lethal to a living system. Though these high energy radiations triggered the biochemical process on, which led to the emergence of life on this planet, their continued presence was injurious to the living system. Life as a consequence, had to await the development of an effective shield of atmospheric gases (O_2, N_2, O_3) which could check the biocidal radiations high up in the atmosphere before it could come out on land.

Ultraviolet Radiations and Ozone

Ultraviolet radiations are usually grouped, rather arbitrarily, into the following three categories:

1. Ultraviolet – A (UV-A): With a wavelength range between 315 – 400 nm which do not cause much harm to a living system. Only a part of these radiations reaches earth's surface, which are tolerated by the living beings.

2. Ultraviolet – B (UV-B): With a wavelength from 280 nm to 315 nm which are more damaging than UV-A.

3. Ultraviolet – C (UV-C): With a wavelength range from 200 nm to 280 nm which carry larger amount of energy. These are the most damaging radiations for the biosphere. However, they are almost completely absorbed by atmospheric gases.

Much of the harmful high energy solar radiations at various heights by the gaseous mantle which surrounds our planet. Though oxygen, nitrogen and a number of other constituents of the atmosphere absorb short wavelength ultraviolet radiations, none of these gases can absorb effectively wavelengths greater than 220 nm. This leaves a gap which is filled by ozone alone. It absorbs all radiations between 220 to 290 nm. Radiations above 290 nm are not completely absorbed by this gas, which however are considerably diluted by the ozone layer. A depletion of ozone content of the atmosphere shall result in increased penetration of 290 – 315 nm radiations (UV-B), which are very injurious to the biosphere. In extreme cases radiations with wavelengths lower than 280 nm may also reach earth's surface.

Laboratory studies have shown that absorption of ultraviolet radiations within the range of UV-B by a living cell is largely due to the absorption of energy by nucleic acids, the DNA and RNA molecules. The energy thus absorbed breaks up these macromolecules and affects adversely such vital processes as protein synthesis, growth and reproduction. Alterations in DNA molecules could cause long rang genetic effects which could change the very shape of life on this planet.

The Ozone Layer

High up in the stratosphere, about 15-40 kms above earth's surface, short wavelength ultraviolet radiations in the range of 180 to 220 nm are absorbed by molecular oxygen which splits up into its constituent atoms. These atoms combine with molecular oxygen to produce ozone:

$$O_2 \longrightarrow O + O$$
$$O_2 \longrightarrow O \longrightarrow O_3$$

Therefore, ozone is a result of photochemical reactions in which the starting molecule is oxygen. Along with this reaction another photochemical reaction which causes breakdown of ozone molecules due to absorption of 200 – 290 nm radiations also occur.

$$O_3 \longrightarrow O_2 + O$$
$$O_3 \longrightarrow O \longrightarrow 2O_2$$

The two reactions, i.e., the formation and destruction of ozone molecule normally balance each other and ultimately result in effective absorption of short wavelength ultraviolet radiations in the stratospheric region. Life underneath is thus protected from the biocidal solar, radiations.

Ozone occurs in the atmosphere because the atmosphere contains oxygen. Without oxygen there would have been no ozone umbrella to protect the living systems on earth's surface. Evolution of atmospheric oxygen and subsequently the ozone layer has, therefore, been intimately connected with the evolution of life on this planet.

Primitive atmosphere contained very little oxygen. The only process which could have contributed some oxygen is photo dissociation of water molecules by 195 – 200 nm ultraviolet radiations which are soon cut off as some oxygen accumulates and this stops the photo dissociation reaction. Large concentrations of oxygen could not be attained by this process alone. It was only after the evolution of photosynthesis that a gradual accumulation of oxygen occurred. With the accumulation of this vital gas more and more ozone was produced which provided means to check 220 – 290 nm ultraviolet radiations effectively. With the built up oxygen concentration little 180 – 220 nm could reach upto earth's crust. Ozone formation and the zone of its maximum concentration, therefore, gradually shifted upwards where the ultraviolet light of suitable wavelength was available, i.e. the stratosphere.

Most of the ozone present in the atmosphere, almost 90% is concentrated in the stratosphere at an altitude of about 15 - 40 kms. If the entire ozone present in the stratosphere is condensed into a single sheet covering the globe, it will form only 2.4 – 2.6 mm thick layer at equator and 3.1 and 4.5 mm thick layer at latitudes about 70°N and S. At ground level ozone occurs in traces only. Though maximum amount of ozone production occurs over equator, its concentration is lowest here as most of the ozone formed is displaced towards the poles with massive movement of atmospheric air.

Consequences of Stratospheric Ozone Depletion

Ozone layer shields us from biocidal ultraviolet radiations. Depletion of stratospheric ozone concentration shall results in an increased penetration of Ultraviolet-B radiations. A higher loss of stratospheric ozone could cause entry of not only UV-B radiations but also Ultraviolet-C radiations. This could turn the geological clock back to the era when the ozone umbrella was very thin. Terrestrial life shall be drastically affected so also will be aquatic life which occurs in shallower waters. In brief consequences of ozone depletion may be summed up as follows:

1. DNA and RNA molecules absorb UV radiations in the range of 280 – 315 nm and break down. Increased UV-B penetration shall cause a rapid rise in ailments and damages associated with DNA and RNA disruption. Cancers of the parts exposed to solar radiations shall become more frequent. Crude estimates suggest that there could be 100% rise in incidence of skin cancers for a 25% reduction in stratospheric ozone content.

2. A direct correlation has been observed between cataract formation in eyes and ultraviolet radiations. Our skin and eye-lens contains chromatophores which absorb ultraviolet radiations and generate highly reactive oxygen, hydroxyl radicals and hydrogen peroxide which damage cell's structural and functional components.

3. Higher animals possess thick skin, hairs etc. as protective devices. However, plants and lower animals which are often at a lower level in the trophic structure shall be the worst suffers as they have nothing but a simple cell wall for their protection against high energy radiations. With the primary trophic levels drastically impaired the entire ecosystems could collapse. This is more likely in marine environment where the tiny phytoplanktons are the sole producers.

4. With rise in high energy ultraviolet radiations a number of complex photochemical reactions are likely to occur which shall produce a variety of toxic highly irritating chemicals the photochemical among from seemingly harmless constituents. These chemicals could be highly injurious to living systems. In plants adverse effects on the process of photosynthesis could drastically affect primary production which in turn could disturb the entire ecosystem.

Nuclear Accident and Holocaust Case Study

The potential for accidents

Prior to 1986 the scenario for a worst case nuclear power plant disaster was a matter of speculation. Then, at 1:24 a.m. local time on April 26, 1986, events at a nuclear power plant in Ukraine made such speculation irrelevant. Since that day, Charnobyl has served as a horrible example of nuclear energy gone awry.

While conducting a test of stand by diesel generators, engineers disabled the safety systems withdrew the control rods, shut off the flow of steam to the generators, and decreased the flow of coolant water in the reactor. They did not allow for the radioactive heat energy generated by the fuel core and, lacking coolant, the reactor began to heat up. The extra steam produced could not escape and had the effect of rapidly boosting the energy production of the reaction. In an attempt to quell the reactor the engineers quickly inserted the carbon tipped control rods. The carbon tips acted as moderators, slowing down the neutrons to a speed where they triggered more fission reactions, and the result was a split second power surge to 100 times the maximum level. Steam explosions then blew the 2000 ton top off the reactor; the reactor melted down, and a fire was ignited in graphite, which burned for days. At least 90 million curies of radioactivity in the form of fission products were released in a plume that rained radioactive particles over thousands of square miles.

As radioactive fallout settled, 135000 people were evacuated and relocated. The reactor was eventually sealed in a sarcophagus of concrete and steel. A barbed wire fence now surrounds a 100 square mile exclusion zone around the reactor site. The soil remains contaminated with radioactive compounds, yet 2000 Ukrainian workers are bused in daily to work at the two remaining reactors in the Chornobyl complex; the Ukrainian government does not want to lose the power still being generated.

Only two engineers were killed by the explosion, itself, but 31 of the personnel brought in to contain the reactor in the aftermath of the explosion died of radiation in a few months. Over a broad area down wind to the disaster, buildings and roadways were washed down to flush away radioactive dust. Even with these precautions, however, many people in or near the evacuation zone were exposed to dangerous levels of radiation, especially the short lived radioisotope iodine 131. Because iodine collects in the thyroid gland, the radioactive iodine has been responsible for great increases in the incidence of thyroid cancer in Ukraine and neighboring Belarus (over 700 cases in children have occurred since 1986). The long term effects are estimated to range from 140000 to 475000 cancer deaths worldwide from the accident.

However, LWRs are not immune to accidents, the most serious being a complete core meltdown as a result of total loss of coolant. This has never happened, but there was a close call at Three Mile Island.

Three Mile Island. On March 28, 1979, the Three Mile Island nuclear power plant near Harrisburg, Pennsylvania, suffered a partial meltdown as a result of a series of human and equipment failures and a flawed design. The steam generator shut down automatically because of a lack of power in its feed water pumps, and eventually a pressure value on top of the generator opened in response to the ensuing buildup of pressure. Unfortunately, the valve remained stuck in the open position and drained coolant water from the reactor vessel. There were no sensors to indicate that this pressure operated relief valve was open. Operators responded poorly to the emergency, shutting down the emergency cooling system at one point and shutting down the pumps in the reactor vessel. One instrument error compounded the problem: Gauges told operators that the reactor was full of water when, actually, it needed water badly. The core was uncovered for a time and suffered a partial meltdown, and a small amount of radioactive gas was released to the atmosphere.

The drama held the whole nation particularly the 300000 residents of metropolitan Harrisburg poised for evacuation in suspense for several days. The situation was eventually brought under control and no injuries occurred, but it could have been much worse if meltdown had been complete. The reactor was so badly damaged, and so much radioactive contamination occurred inside the containment building, that the continuing cleanup is proving to be as costly as building a new power plant. There are no plans to restart the reactor.

Real costs of the accidents at Three Mile Island and Chornobyl must also be reckoned in terms of public trust. Public confidence in nuclear energy already was declining, but plummeted after the two accidents. The accidents pointed to human error as a highly significant factor in nuclear safety, and human error is something the public understands well. Nuclear proponents suffered a serious loss of credibility with Three Mile Island, but Chornobyl was their worst nightmare come true a full catastrophe, just as the antinuclear movement had predicted might someday occur.

Recently, there was an accident in India too in Kalapakkam Nuclear Reactor near Chennai due to leakage in nuclear reactor.

WASTE LAND RECLAMATION

Waste land are those which for one or the other reason have poor the life sustaining property. Out of 100 per cent potentially active lands only 44 per cent are available for cultivation and 56 per cent of land are non-available for cultivation.

The wasteland can be made useful by increasing productivity of land by using some useful methods as afforestation or by using biofertilizers.

Soil degradation is a complex phenomenon derived by interaction between natural and socio economic factors. The degradation or deterioration of soil may be caused by the following factors:

1. Physical factors, e.g. loss of fertile top soil due to water or wind erosion.
2. Chemical factors e.g. depletion of nutrients or toxicity due to acidity or alkalinity (salinization) or water logging.
3. Biological factors which affect the microflora and reduce the microbial activity of the soil. These factors reduce the yield.

Some other factors as deforestation, extensive cultivation on marginal land, improper cultivation practices like monocropping, poor manuring, misuse of fertilizers or excess use of fertilizers, excessive irrigation, overgrazing, fragility of soil, adverse weather and mining may accelerate the process of soil degradation.

During last decade nutrients deficiency has been considered as the main cause of poor productivity and crop failure. A study of the current trends in agronomic practices has suggested that the nutrients deficiency is further aggravated by continued use of high yielding crop varieties, intensive cropping pattern and relatively poor fertilizers.

Among the major causes of degradation, water erosion is considered to be the most severe one which covers almost 87% of the affected area. The main cause of water erosion is removal of vegetation, over exploitation of vegetation, over grazing and improper agricultural practices. The latest data revealed that erosion has rendered 200 million hectares or 36% of the total area of the country barren.

Soil degradation is a global phenomenon. Of the world's total land area of 13.5 billion hectares, only 3.03 billion hectares (22 per cent) is actually cultivable and about 2 billion hectares is degraded. The annual loss of land is expected to go up to 10 million hectares by 2000 A.D. In India alone, about 188 million hectares, or almost 57% of total land area, is degraded.

Causes of Soil Degradation

The main reasons for unproductiveness or degradation of soils are as follows:

1. Nutrient disorder
2. Water logging
3. Salinity
4. Erosion
5. Biological degradation
6. Other causes

National Wasteland Development Board

For wasteland and its management a separate board was established in 1985 which deals with the land degradation, reclamation of ravines, usar lands and arid tracts and deforestation which is called National Wasteland Development Board (NWDB).

The main objectives of National Development Board is to check land degradation, to convert wastelands which is for sustainable use, to increase biomass and to restore ecological balance. At present in 146 districts of India wastelands have been identified. The NWDB has converted 2.7 million hectares of wasteland for afforestation in 1989-90 costs Rs. 700 crores. Now this department has been merged under Ministry of Rural Development. There are several regional centres of NWDB. These centres assist the central and state governments in evaluation and formulation of projects to provide training and reorientation programmes.

THE ENVIRONMENT PROTECTION ACT 1986

This important Act received the assent of the President of India on May 23, 1986 and was published in the official Gazette of India Extraordinary, Pt. II, Sec. 1, dated May 26, 1986, pp. 1-11. this is “An Act to provide for the protection and improvement of environment and for matters connected therewith”. In fact, this has been enacted under Article 253 of the Constitution after the Bhopal disaster. Section 3(1) of this Act empowers the Government of India “to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution.” In this Act, the Centre has been authorized to set new national standards for maintaining environmental quality (ambient standard) and also the standards for controlling emissions and effluent discharges; to prescribe procedures for hazardous wastes and chemicals management; to regulate the location of industries; to establish safeguards to prevent accidents; to collect and disseminate information on environmental pollution. This Act is the first Act to empower the Central Government authority to issue direct written orders, to close, prohibit, or regulate any industry, operation or process or to stop or regulate the water and electric supply or any other service. Later these powers have also been included in the Air Act, 1981 and the Water Act, 1974 through amendments (mentioned earlier).

The Central Government authority also enjoys the power to take samples of air, water, soil or any other substance from any place for analysis. The Act also says that persons discharging pollutants in excess of prescribed standards must be responsible for prevention or mitigation of the pollution and is bound to report the discharge to governmental authorities. The Act has provision for severe penalties to offenders, such as imprisonment upto five years or a fine upto Rs. 1.0 lakh or both. There is additional fine of upto Rs. 5,000 for every day of continuing violation. [Section 15(1)]. However, Section 24 of this Act is controversial. This section provides that in case any offence is punishable under either the Environment (Protection) Act of 1986 or any other Law, the offender is liable to be punished under the 'other law' and not under the Environment (Protection) Act. Prior to amendment of the Air Act in 1987, and the Water Act in 1988, both these laws had "less stringent penalties than did the Environment (Protection) Act", which enticed the offender to divert the case under Environment (Protection) Act, for trial under such 'other' acts mentioned in Section 24 of the Act.

Section 19 of this Act empowers any person, in addition to govt. authorized officials, to file a complaint 'citizens suit' with a court alleging an offence under this Act. This provision enables people to enforce power for the protection of the environment. A minimum of 60 days notice is given to an offender, prior to filing a complaint.

The Environment (Protection) Rules 1986 have been published in Gazette of India. Extraordinary, Pt. II, Sec. 3(i) dated 9th November, 1986. These rules have been made by the Central Government, "in exercise of powers conferred by section 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986). Likewise the Hazardous wastes (Management and Handling) Rules, 1989 (Gazette of India, Extraordinary, Pt. II, Sec. 3 (ii), 28th July, 1989; and Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganism/Genetically Engineered Organisms or Cells [Gazette of India, Extraordinary, Pt. II, Sec. 3 (ii), 5th December, 1989] have also been enforced. Readers are advised to read the book, namely '*Environment Law and Policy in India, Cases, Materials and Statutes*' by Armin Rosencranz, Shyam Divan and Martha L. Noble, originally published by A.S. Pandya for N.M. Tripathi Private Limited, Mumbai; to get detail regarding this topic of discussion.

THE AIR (PREVENTION & CONTROL OF POLLUTION) ACT, 1981

This is an Act to provide for the prevention, control and abatement of air pollution in the country so as the preserve the quality of air. Central and State Boards constituted under section 3 and 4 of Water Prevention and State Boards for Prevention and Control of Air Pollution. The salient features of the Act are:

1. The Act is applicable to whole India.
2. U/S 19 of the Act the State Govt. in consultation with SPCB is vested with power to declare Air Pollution Control Area in which provisions of the Act shall be applicable.
3. As per provisions in Sec. 21 (1) & (2), no person can establish or operate any industrial plant without the previous consent of State Pollution Control Board. Every application for consent shall be made in Form-1 and shall be accompanied by prescribed fee.
4. With a period of four months after the receipt of application, the Board shall complete the formalities to either grant, or refuse consent. During the course of processing consent application, Board may seek any information about the industry after giving notice in Form II.
5. U/S 22, 22(A) operating any industrial plant so as the cause emission of air pollution in excess of standard laid down by state Board is liable for litigation by the board.

Powers of State Board

Besides providing consultation to State Government for declaring or restricting an areas as Air Pollution Control Area, State Board is vested with following powers:

1. *Power of entry and inspection*: Any person empowered by State Board shall have right to enter the industry premises for determining the status of pollution control equipment or otherwise necessary for compliance of the Act, and the person concerned of the industry shall be bound to render assistance as deemed necessary for ensuring measures, and carrying out functions laid down in the Act. [U/S 24].

2. *Power to take samples*: State Board or any person empowered by it shall have power to take samples or air or emission from any chimney, flue or any duct of any other outlet in such manner as may be prescribed. [U/S 26].

3. *Power to give direction*: State Board may issue any direction to any person, authority including closure, prohibition or regulation of any industry and can also issue directives for the stoppage or regulation of supply of electricity, water or any other services. The direction should, however, be preceded by proposed directive in writing giving opportunity of being heard unless grave injury to the environment is likely, in which proposed directive may be avoided [U/S 31 A].

THE WATER (PREVENTION & CONTROL OF POLLUTION) ACT, 1974

This Act was enacted for prevention and control of water pollution and maintaining or restoring of wholesomeness of water. The Central and State Pollution Control Boards were constituted under section 3 and 4 of the Act respectively. The Act was amended in 1978 and 1988 to clarify certain ambiguities and to vest more powers in Pollution Control Board. Salient items and obligations on the part of industries are:

1. To obtain consent to establish or new discharge U/S 25 of the Act. This is mandatory for every industry/local body discharging any domestic sewage or trade effluent into water, stream, well sewer or on land. For this purpose consent application has to be filed with State Pollution Control Board (SPCB) in form XIII complete in all respects along with prescribed consent fee. It is obligatory to provide additional information sought by State Board. On receipt of application, State Board may grant the consent with specific conditions and date of validity or refuse the consent for reasons to be recorded in writing.

2. Once after obtaining the consent to establish and installing all facilities as communicated by the industry, it shall apply for consent to operate for which same form XIII has to be used.

3. Similar provisions of application and grant of consent exists for industries discharging the trade effluent waste prior to enactment of Act [U/S 26 of the Act].

4. On expiry of period of 4 months of filing an application completed in all respects consent shall be deemed to be given unconditionally unless consent is granted or refuse. This will not hold, however, if application is not complete or State Board raises any quarry which remain unanswered, in which case the period extends from the date of submission of additional information.

Power of State Board

1. To obtain information: On construction, installation or disposal system if it has any relevance to prevention or control of pollution [U/S 20].

2. Carry out any related work: if any industry fails to take up the same despite giving specific time bound notice by state board, for execution of such work any expenses incurred along with interest may be recovered from such person or industry as arrears of land revenue [U/S 30].

3. Collect and analyze samples of streams/wells or trade effluent: in case of trade effluent, in order to have legal validity, person taking sample should give notice in prescribed from, divide the sample in to two parts and seal. One part of sample is sent to lab recognized by State Pollution Control Board U/S 17 (2) and second part on request and at cost of occupier to the State Board Lab notified U/S 52 of the Act.

4. To give direction: To any person/officer or authority, who will be bound to comply with the directions. The direction may include direction for closure/prohibition or regulation of any industry operation or process or stoppage/regulation of services like electricity, water etc. The direction should be in writing and proposed direction (except under cases of grave injury to environment) followed by opportunity of being heard should precede direction. [U/S 33A).

5. Enter and inspect any place for performing any of the functions of board or to assess compliance or to examine any plants, records, documents etc. and seize, if necessary. [U/S 23).

THE WILDLIFE (PROTECTION) ACT, 1972

This Act, enables all State Wildlife Advisory Boards, to regulate hunting of wild life, regulation of wild life trade, regulation of trade of animal and bird products, establishment of sanctuaries and national parks. The Boards can impose penalty on offenders showing non-compliance with the law. This Act has listed species according to their conservation status in five schedules. Schedule-I lists endangered species that cannot be harmed in any way; Schedule – II includes species that need special protection; Schedule – III includes big game species; Schedule – IV includes small game species; Schedule – V includes species that can be hunted without permission. Hunting of species under Schedule – II, III and IV is regulated through licensing. The Act was amended in 1982 to introduce provisions for capture and transport of wild life to a different location for scientific management and ex situ conservation.

THE FOREST (CONSERVATION) ACT, 1981

After its introduction in 1980, and implementation in 1981 the Act has been amended in 1988. The special feature of this Act compels a State Government to take 'prior approval' of the Government of India, if it 'dereserves' a reserved forest, wants to use forest designated land for non-forest purposes, wants to assign any forest designated land to a private person or corporation, wants to clear a forest land for reforestation. Approvals are granted or refused only after the advise of an advisory committee constituted to look after these requests from the states. When diversion is allowed, compensatory afforestation of a non forest land of same area is directed along with other preconditions. In case, non-forest lands are not available, compensatory afforestation should be conducted on degraded forest land and the area should be twice the are a being diverted.

PUBLIC AWARENESS

The Environmental scenario of India is very wise. Ours is a country highly diverse climatically, geologically, geographically, edaphically, floristically, faunistically, ethnically, lingually, socially and economically. Therefore, EE has to be essentially location specific. At the first level, special attention must be paid to school going children and women (about 50% of the population). They are to be made aware of health, family planning, nutrition, rural development, slum improvement, sanitation, hygiene, water and food contamination, fodder, fuel wood etc. Non-Government organizations have to play a significant role. In the Directory of the Dept. of Environment, there are more than 200 non-governmental organizations of which nearly 150 work in the area of environmental education and awareness. Moreover, children are to be told the real meaning of wildlife. Most children think only tiger, lion or elephant as wildlife. They are to be educated for plants, smaller animals, microbes etc. i.e., holistic approach to wildlife.

Role of Non-Governmental Organizations (NGOs) in Environmental Awareness

Non-Governmental organizations are mostly registered under Societies Registration Act, or Indian Trust Act. Some are registered under Companies Act. NGOs perform following essential functions in the natural and human environment, and keep direct contact with the grass root people.

- Awareness development in environmental, social, medical aspects
- Work towards better health and hygiene, family planning etc.
- Work for sustainable agriculture
- Tribal welfare and development
- Conservation of biodiversity through activism
- Research in the field of ecology including man forest interaction etc.
- Activism against pollution
- Providing legal actions to public against pollution causing industries, organizations, systems
- Training of educated people for resource person development
- Act as a nodal agency for providing feed back to governments, regarding public response to government policy and other issues
- Active policy research
- Conducting conservation movements
- Preventing cruelty to animals
- Protection of biodiversity
- Counseling people to solve local social problems
- Help in creation of microplanning by the local people
- Publish popular magazines, scientific journals, to spread environmental and social awareness and knowledge
- Conduct seminar, symposiums, conferences for dispersion of knowledge and sharing experience with a variety of related people

Some Important Non-Governmental Organizations of India Working in the Sector of Environment:

- Bangiya Gigyan Parishad, Kolkata

- Bombay Natural History Society, Mumbai
- Breakthrough Science Society, Kolkata
- Centre for Environment Education, Ahmedabad
- Centre for Human Settlements International (Habitat), Kolkata
- Centre for Science and Environment (CSE), New Delhi
- Centre for Study of Man and Environment, Kolkata
- Development Alternatives, New Delhi
- Gene Campaign, New Delhi
- Indian Institute of Biosocial Research and Development, Kolkata
- Indian Institute of Ecology and Environment, New Delhi
- Liberal Association for Movement of People (LAMP), Kolkata
- M.S. Swaminathan Research Foundation, Chennai
- Nagarik Mancha, Kolkata
- Narmada Bachao Andolan (NBA), Baroda
- National Environmental Conservation Association (NECA), Varanasi, UP
- Nature Environment and Wildlife Society, (NEWS), Kolkata
- North Eastern Society for Preservation of Nature, Siliguri
- Paschim Banga Bigyan Mancha, Kolkata
- Paugmark, Kolkata
- People for Animal, New Delhi
- People United for Better Living in Calcutta (Public), Kolkata
- Ramkrishna Mission Seva Pratisthan, Kolkata
- Research Foundation for Science, Technology, and Ecology, New Delhi
- Society for Direct Initiative for Social & Health Action (DISHA), Kolkata
- Society for Participatory Action and Reflection, (SPAR), Kolkata
- Society for Promotion of Wasteland Development, New Delhi
- Tata Energy Research Institute (TERI), New Delhi
- Toxics Link, New Delhi
- World Environment Foundation, New Delhi
- World Wide Fund for Nature (WWF), India, New Delhi

Important Dates Dedicated to Environment Related Conservation Efforts:

Celebration of these dates helps us to remember the importance of specific environmental issues and also helps in awareness development in favour of environmental conservation.

14-30 January	Animal welfare fortnight
2 February	World wetland day
22 March	World water day
23 March	World meteorological day
5 April	National maritime day
22 April	Earth day water resource day
28 April	World heritage day
5 June	World environment day
17 June	World day to combat desertification and drought
1 July	Vanamahotsav day
6 August	Hirosima day
16-18 September	Clean up the world campaign
1-7 October	Wildlife week
2 October	International natural disaster day
4 October	World animal welfare day
5 October	World habitat day
24 November	World biodiversity conservation day
19 November to 18 December	National environment month
3 December	World conservation day
29 December	International day for biological diversity