

## GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING

### UNIT-4

#### SOCIAL ISSUES AND ENVIRONMENT

#### 4.1 UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT

Until two decades ago the world looked at economic status alone as a measure of human development. Thus countries that were economically well developed and where people were relatively richer were called **Advanced Nations/Developed Nations** while the rest where poverty was widespread and were economically backward were called **Developing Nations**.

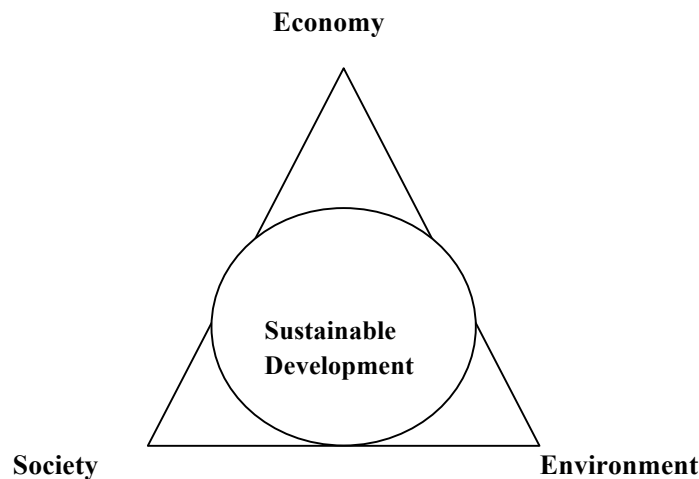
Developed Nations not only exploited their own natural resources rapidly but also used the natural resources of developing countries to grow even larger economies. Later they realized that their lives were being seriously affected by the environmental consequences of development based on economic growth alone. This form of development did not add to the quality of life as the environmental conditions had begun to deteriorate.

The current strategies of economic development are using up resources of the world so rapidly that our future generations, would have serious environmental problems, much worse than those that we are facing at present and considered unsustainable for the world's long-term development. The newer concept of development has come to be known as "**Sustainable Development**".

The nations of the world came to clearly understand these issues in the UN Conference on Environment and Development (UNCED), popularly known as "**The Earth Summit**", held at Rio de Janeiro, **Brazil in 1992**.

##### **Sustainable Development:**

- Norwegian Prime Minister and Director of World Health Organization **G.H. Brundtland** defined it as "**Meeting the needs of the present without compromising the ability of future generations to meet their own needs**".



- It is a multidimensional concept aiming at benefits derived from the interaction between society, economy and environment.

##### **Key aspects for Sustainable Development-**

###### **❖ Inter-generational equity**

- This emphasizes that we should minimize any adverse impacts on resources and environment for future generations.

- This can be possible only if we stop over-exploitation of resources, reduce waste discharge and emissions and maintain ecological balance.
- ❖ **Intra-generational equity**
  - This emphasizes that the development processes should seek to minimize the wealth gaps within and between nations and lead to sustainability. i.e., The technology should address to the problems of the developing countries, producing drought tolerant varieties for uncertain climates, vaccines for infectious diseases, clean fuels for domestic and industrial use.

#### **Important measures for sustainable development-**

- ❖ **Using appropriate technology**
  - It should be locally adaptable, co-friendly, resource-efficient and culturally suitable.
  - The Technology should use less of resources, local labor and should produce Minimum waste.
- ❖ **3-R approach**
  - **Reduce** - This insists on minimization of resource usage.
  - **Reuse** - Using it again and again instead of passing it on to the waste stream.
  - **Recycle** - This reduces pressure on our resources as well as reduces waste generation and pollution.
- ❖ **Prompting environmental education and awareness**
  - Making environmental education the centre of all learning process will greatly help in changing the thinking and attitude of people towards our earth and the environment.
- ❖ **Resource utilization as per carrying capacity**
  - **Renewable resources:** In order to attain sustainability, it is very important to consume the natural resources in such a way that the consumption should not exceed the regeneration capacity.
  - **Non-renewable resources:** For sustainability non-renewable resources should be conserved by recycling and reusing.

Sustainability of a system depends largely upon the carrying capacity of the system. **Carrying capacity** has two basic components:

1. **Supporting capacity** -the capacity to regenerate.
2. **Assimilative capacity** -the capacity to tolerate different stresses.

**“Consumption should not exceed regeneration and changes should not be allowed to occur beyond the tolerance capacity of the system”.**

In order to attain sustainability it is very important to utilize the resources based upon the above two properties of the system.

In case of human beings, the carrying capacity concept becomes all the more complex because unlike other animals, human beings, not only need food to live, but need so many other things to maintain the quality of life.

A True sustainable development should aim at optimum use of natural resources with

- High degree of reusability
- Minimum wastage
- Least generation of toxic by-products
- Maximum productivity.

#### **4.2 URBAN PROBLEMS RELATED TO ENERGY**

- ❖ **Urban sprawl**
  - Earlier a big majority of human population lived in rural areas and their economic activities centered on agriculture, cattle rearing, fishing, hunting or some cottage industry.
  - It was some 200 years ago, with the dawn of Industrial era, the cities showed a rapid development.

- More than 50 percent of the world population lives in urban areas and there is increasing movement of rural people to cities in search of employment.
- The urban growth is so fast that it is becoming difficult to accommodate all the industrial, commercial and residential facilities within a limited municipal boundary. As a result, there is spreading of the cities into the sub-urban or rural areas too. This phenomenon is called urban sprawl.

❖ **Urbanization**

Urbanization is the movement of human population from rural areas to urban areas for the want of better education, communication, health, employment etc.

❖ **Causes of urbanization**

Cities are the main centers of economic growth, trade, transportation, education, medical facilities and employment. Hence rural people move to cities.

In developing countries too urban growth is very fast and in most of the cases it is uncontrollable and unplanned growth. Due to high population density and high energy demanding activities, a higher standard life and their life style the urban problems related to energy are much more magnified as compared to the rural population.

❖ **The energy demanding activities include**

- Residential and commercial lighting.
- Transportation means including automobiles and public transport for moving from residence to workplace.
- Modern life-style using a large number of electrical gadgets in everyday life.
- Industrial plants using a big proportion of energy.
- A large amount of waste generation which has to be disposed off properly using energy based techniques.
- Control and prevention of air and water pollution which need energy dependent technologies.

❖ **Solution for urban energy problem**

- Urban people should be encouraged to use public transport instead of individual transport modes like cars or motor cycles.
- Energy consumption must be minimized.
- Energy production capacity may be increased.
- Use of energy efficient technologies adopted.
- Usage of Solar energy and wind energy should be encouraged.
- Apart from encouraging energy saving methods strict laws and penalties have to be imposed together with energy audit.

#### **4.3 WATER CONSERVATION**

**Water conservation** refers to reducing use of fresh water, through technological or social methods.

❖ **Need for water conservation**

1. Rising population
2. Growing industrialization
3. Expanding agriculture
4. Decrease in rainfall
5. Overexploitation of ground water has raised the demand for water.

Efforts have been made to collect water by building dams and reservoirs and digging wells some countries have also tried to recycle and desalinate (remove salts) water. Conserving water has become a prime environmental concern. The idea of ground water recharging by harvesting rainwater is gaining importance in many cities.

**Strategies that can be adopted to conserve water-**

❖ **Decreasing run-off losses**

Huge water-loss occurs due to runoff on soils, which can be reduced by allowing most of the water to infiltrate into the soil. This can be achieved by using the following techniques.

- a. **Contour cultivation** on small furrows and ridges across the slopes trap rainwater and allow more time for infiltration. Terracing constructed on deep soils has large water-storage capacity. On gentle slopes trapped run off is spread over a large area for better infiltration.
  - b. **Conservation-bench terracing** involves construction of a series of benches for catching the runoff water.
  - c. **Water spreading** is done by channeling or lagoon-leveling.
    - In **channeling**, the water-flow is controlled by a series of diversions with vertical intervals.
    - In **lagoon leveling**, small depressions are dug in the area so that there is temporary storage of water.
  - d. **Chemical wetting agents (Surfactants)** increase the water intake rates when added to normal irrigated soils.
  - e. **Surface crop residues** Tillage, mulch, animal residues etc. help in reducing run-off by allowing more time for water to penetrate into the land.
  - f. **Chemical conditioners** like gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) when applied to sodic soils improve soil permeability and reduce run off. Another useful conditioner is HPAN (hydrolyzed polyacrylonitrile).
  - g. **Water-storage structures** like farm ponds, dug-outs etc. built by individual farmers can be useful measures for conserving water through reduction of runoff.
- ❖ **Reducing evaporation losses**
    - This is more relevant in humid regions.
    - Horizontal barriers of **asphalt** placed below the soil surface increase water availability and increase crop yield by 35-40%. This is more effective on sandy soil but less effective on loamy sand soils.
    - A co-polymer of starch and acrylonitrile called **super**. it has been reported to absorb water upto 1400 times its weight. The chemical has been found to be useful for sandy soils.
  - ❖ **Storing water in soil**
    - Storage of water takes place in the soil root zone in humid regions when the soil is wetted to field capacity.
    - By leaving the soil fallow for one season water can be made available for the crop grown in next season.
  - ❖ **Reducing irrigation losses**
    - Irrigation in early morning or late evening to reduce evaporation losses.
    - Sprinkling irrigation and drip irrigation conserve water by 30-50%.
    - Growing hybrid crop varieties with less water requirements and tolerance to saline water help conserve water.
  - ❖ **Re-use of water**
    - Treated wastewater can be used for ferti-irrigation.
    - Use grey water from washings, bath-tubs etc. for watering gardens, washing cars or paths.
  - ❖ **Preventing wastage of water**
    - This can be done in households, commercial buildings and public places.
    - Closing taps when not in use
    - Repairing any leakage from pipes.
    - Using small capacity flush in toilets.
  - ❖ **Increasing block pricing**
    - The consumer has to pay a proportionately higher bill with higher use of water.
    - This helps in economic use of water by the consumers.

**The goals of water conservation efforts include**

- ❖ **Sustainability** - To ensure availability for future generations, the withdrawal of fresh water from an ecosystem should not exceed its natural replacement rate.

- ❖ **Energy conservation** - Water pumping, delivery, and wastewater treatment facilities consume a significant amount of energy.
- ❖ **Habitat conservation** - Minimizing human water use helps to preserve fresh water habitats for local wildlife and migrating waterfowl, as well as reducing the need to build new dams and other water diversion infrastructure.

#### **Methods of water conservation**

There are so many methods available for water conservation of which the following are important methods

1. Rainwater harvesting
2. Watershed management

### **4.4. RAINWATER HARVESTING**

Rainwater harvesting is a technique of increasing the recharge of groundwater by capturing and storing rainwater. This is done by constructing special water-harvesting structures like dug wells, Percolation pits, lagoons, check dams etc.

#### **❖ Objectives of Rainwater harvesting**

- To reduce run off loss.
- To avoid flooding of roads.
- To meet the increasing demands of water.
- To raise the water table by recharging ground water.
- To reduce groundwater contamination.
- To supplement groundwater supplies during lean season.

#### **❖ Methods**

- By storing in tanks or reservoirs above or below ground.
- By constructing pits, dug-wells, lagoons, trench or check-dams on small rivulets
- By recharging the groundwater.

Before adopting a rain-water harvesting system, the soil characteristics, topography, rainfall pattern and climatic conditions should be understood. Rainwater harvesting helps in recharging the aquifers, improves groundwater quality by dilution, improves soil moisture and reduces soil erosion by minimizing run-off water

#### **❖ Traditional Rain Water Harvesting**

- In **high rainfall** areas rainwater is collected from roof-tops into storage tanks. In foot hills, water flowing from springs is collected by embankment type water storage.
- In **Himalayan foot-hills** people use the hollow bamboos as pipelines to transport the water of natural springs. **Rajasthan** is known for its tankas. (Underground tanks) and khadins (embankments) for harvesting rainwater.
- In our ancient times Talaabs, Baawaris, Johars, Hauz were used to collect rain-water and ensured adequate water supply in dry periods.

#### **❖ Modern Techniques of Rain Water Harvesting**

- In **arid and semi-arid regions** artificial ground water recharging is done by constructing shallow percolation tanks.
- **Check-dams** made of any suitable native material (brush, poles, rocks, plants, loose rocks, wire nets, stones, slabs, sacks etc.) are constructed for harvesting runoff from large catchment areas.
- Rajendra Singh of Rajasthan popularly known as water man has been doing a commendable job for harvesting rainwater by building check dams in Rajasthan and he was honored with the prestigious Magsaysay Award for his work.
- Groundwater flow can be intercepted by building **groundwater dams** for storing water underground. As compared to surface dams, groundwater dams have several advantages like minimum evaporation loss, reduced chances of contamination etc.

- In **roof top rainwater harvesting**, which is a low cost and effective technique for urban houses and buildings, the rain-water from the top of the roofs is diverted to some surface tank or pit through a delivery system which can be later used for several purposes.

**Some of the benefits of rainwater harvesting are as follows-**

- Increases water availability
- Checks the declining water table
- Is environmentally friendly
- Improves the quality of groundwater through the dilution of fluoride, nitrate, and salinity
- Prevents soil erosion and flooding especially in urban areas

## **4.5 WATERSHED MANAGEMENT**

### **Watershed**

It is defined as the land area from which water drains under gravity to a common drainage channel. It is a delineated area with a well-defined topographic boundary and one water outlet.

The watershed can range from a few square kilometers to few thousand square kilometers in size. The watershed comprises complex interactions of soil, landform, vegetation, land use activities and water. A watershed affects us as it is directly involved in sustained food production, water supply for irrigation, power generation, and transportation as well as for influencing sedimentation and erosion, vegetation growth, floods and droughts.

Thus, management of watersheds, treating them as a basic functional unit, is extremely important and the first such Integrated Watershed Management was adopted in 1949 by the Damodar Valley Corporation.

### **Watershed degradation**

The watersheds are very often found to be degraded due to uncontrolled, unplanned and unscientific land use activities. Overgrazing, deforestation, mining, construction activities, industrialization, shifting cultivation, natural and artificial fires, soil erosion and ignorance of local people have been responsible for degradation of various watersheds.

### **Watershed Management**

Rational utilization of land and water resources for optimum production causing minimum damage to the natural resources is known as watershed management.

**The objectives of watershed management are as follows-**

- To rehabilitate the watershed through proper land use adopting conservation strategies for minimizing soil erosion and moisture retention so as to ensure good productivity of the land for the farmers.
- To manage the watershed for beneficial developmental activities like domestic water supply, irrigation, hydropower generation etc.
- To minimize the risks of floods, droughts and landslides.
- To develop rural areas in the region with clear plans for improving the economy of the region.

### **Watershed Management Practices**

In the **Fifth Five Year Plan**, watershed management approach was included with a number of programmes for it and a national policy was developed. The practices of conservation and development of land and water are taken up with respect to their suitability for peoples benefit as well as sustainability.

**Various measures taken up for management include the following-**

- ❖ **Water harvesting**
  - Proper storage of water is done with provision for use in dry seasons in low rainfall areas.
- ❖ **Afforestation and Agroforestry**
  - They help to prevent soil erosion and retention of moisture. In high rainfall areas woody trees are grown in between crops to substantially reduce the runoff and loss of fertile soil.
  - In Dehradun, trees like Eucalyptus and Leucaena and grasses like Chrysopogon are grown along with maize or wheat to achieve the above objectives.
- ❖ **Mechanical measures for reducing soil erosion and runoff losses**

- Several mechanical measures like terracing, bunding, bench terracing, no-till farming, contour cropping, strip cropping etc. are used to minimize runoff and soil erosion particularly on the slopes of watersheds.
- **Bunding** has proved to be a very useful method in reducing runoff, peak discharge and soil loss in Dehradun and Siwaliks.
- ❖ **Scientific mining and quarrying**
  - Due to improper mining, the hills lose stability and get disturbed resulting in landslides, rapid erosion etc.
  - **Contour trenching** at an interval of 1 meter on overburden dump, planting some soil binding plants like Ipomoea and Vitex and draining of water courses in the mined area are recommended for minimizing the destructive effects of mining in watershed areas.
- ❖ **Public participation**
  - People involvement cooperation as well as participation has to be ensured to the success of any watershed management programme.
  - Properly educating the people about the campaign and its benefits or sometimes paying certain incentives to them can help in effective people's participation.

Successful watershed management has been done at Sukhomajri Panchkula, Haryana through active participation of the local people. Watershed management in Himalayan region is of vital importance since most of the watersheds of our country lie here. Several anthropogenic activities accelerate its slope instability which needs to be prevented. On steeper slopes with sliding faces, straw mulching tied with thin wires and ropes helps in establishing the vegetation and stabilizing the slopes. Efforts should be made to protect the watershed by preventing overgrazing, terracing and contour farming to check runoff and erosion etc.

#### 4.6 RESETTLEMENT

Economic development raises the quality and standard of living of the people of a country. Developmental projects are planned to bring benefits to the society. However, in the process of development, very often there is over-exploitation of natural resources and degradation of the environment.

The native people (under privileged tribal people) of the project site are directly affected. Various types of projects result in the displacement of the native people who undergo tremendous economic and psychological distress, as the socio-economic and ecological base of the local community is disturbed.

- ❖ **Displacement problems due to dams:**
  - The big river valley projects is one of the most serious socio-economic impacts due to large scale displacement of local people from their ancestral home and loss of their traditional profession or occupation.
  - India is one of countries in the world leading in big dam construction. The **Hirakund Dam** has displaced more than 20,000 people residing in about 250 villages. The **Bhakra Nangal Dam** was constructed during 1950.s and till now it has not been possible to rehabilitate even half of the displaced persons. **Tehri Dam** on the river Bhagirathi, construction of which was green signalled after three decades of long campaign against the project by the noted activist Sunderlal Bahuguna the propagator of Chipko Movement .
- ❖ **Displacement due to Mining:**
  - Mining causes displacement of the native people. Several thousands of hectares of land area are covered in mining operation and the native people are displaced.
  - Sometimes displacement of local people is due to accidents occurring in mined areas like subsidence of land that often leads to shifting of people.
- **Displacement due to Creation of National Parks:**
  - When some forest area is covered under a National Park, it is a welcome step for conservation of the natural resources. But, it also has a social aspect associated with it which is often neglected.
  - A major portion of the Forest is declared as core-area, where the entry of local dwellers or tribals is prohibited. When these villagers are deprived of their ancestral right or access to the forests, they usually retaliate by starting destructive activities.

#### 4.7 REHABILITATION

The United Nations Universal Declaration on Human Rights [Article 25 (1)] has declared that right to housing is a basic human right. In India, most of the displacements have resulted due to land acquisition by the government for various reasons. For this purpose, the government has the Land Acquisition Act, 1894 which empowers it to serve notice to the people to vacate their lands if there is a need as per government planning.

Provision of cash compensation in lieu of the land vacated exists in section 16 of the Act.

The major issues related to displacement and rehabilitation is as follows-

- Tribals are usually the most affected amongst the displaced who are already poor. Displacement further increases their poverty due to loss of land, home, jobs, food insecurity, loss of access to common property assets, increased morbidity and mortality and social isolation.
- Break up of families is an important social issue arising due to displacement in which the women are the worst affected and they are not even given cash/land compensation.
- The tribals are not familiar with the market policies and trends. Even if they get cash compensation, they get alienated in the modern economic set-up.
- The land acquisition laws ignore the communal ownership of property, which is an inbuilt system amongst the tribals. Thus the tribals lose their communitarian basis of economic and cultural existence. They feel like fish out of water.
- Kinship systems, marriages, social and cultural functions, their folk-songs, dances and activities vanish with their displacement. Even when they are resettled, it is individual-based resettlement, which totally ignores communal settlement.
- Loss of identity and loss of the intimate link between the people and the environment is one of the biggest losses. The age-long indigenous knowledge, which has been inherited and experienced by them about the flora, fauna, their uses etc. gets lost.

#### Rehabilitation Policy

There is a need for a comprehensive National Rehabilitation Policy. Different states are following different practices in this regard. There is a need to raise public awareness on these issues to bring the resettlement and rehabilitation plans on a humane footing and to honour the human rights.

#### Case study

The much debated Sardar Sarovar Project which plans to build 30 big, 135 medium and 3000 minor dams on the Narmada River and its tributaries is estimated to submerge almost as much area as it is meant to irrigate. A total of 573 villages, consisting of about three lakh people are going to be affected due to submergence under water. As a result of the big dams the community rights of the tribals is breached. It is a traumatic experience to get uprooted from one's native place where its generations have lived and move to a new place as a total stranger. Very often the family breaks up. It is a big price that the tribals have to pay for a big dam project which is supposed to bring happiness and prosperity to the country. In return of this big sacrifice, the tribals must be given adequate compensation in the form of land, jobs, cash compensation etc. and care should be taken to improve their quality of life.

#### 4.8 ROLE OF NON-GOVERNMENT ORGANISATIONS (NGO's)

Voluntary organizations can help by advising the government about some local environmental issues and at the same time interacting at the grass-root levels. They can act as an effective and viable link between the two. They can act both as an action group or a pressure group. They can be very effective in organizing public movements for the protection of environment through creation of awareness.

The **Chipko Movement** for conservation of trees by Dasholi Gram Swarajya Mandal in Gopeshwar or the Narmada Bachao Andolan organized by Kalpavriksh, are some of the instances where NGOs have played a landmark role in the society for conservation of environment.

The Bombay Natural History Society (BNHS), the World Wide Fund for Nature - India (WWF, India) Kerala Sahitya Parishad, Centre for Science and Environment (CSE) and many others are playing a significant role in creating environmental awareness through research as well as extension work.

The recent report by CSE on more than permissible limits of pesticides in the cola drinks sensitized the people all over the country.



## 4.9 ENVIRONMENTAL ETHICS

It refers to the issues, principles and guidelines relating to human interactions with their environment. The environmental crisis is an outward manifestation of the crisis of mind and spirit. It all depends on how do we think and act. If we think Man is all powerful and the supreme creature on this earth and man is the master of nature and can harness it at his will it reflects our human-centric thinking.

On the other hand, if we think Nature has provided us with all the resources for leading a beautiful life and she nourishes us like a mother, we should respect her and nurture her is an earth-centric thinking.

The first view urges us to march ahead gloriously to conquer the nature and establish our supremacy over nature through technological innovations, economic growth and development without much botheration to care for the damage done to the planet earth.

The second view urges us to live on this earth as a part of it, like any other creation of Nature and live sustainably. So, we can see that our acts will follow what we think. If we want to check the environmental crisis, we will have to transform our thinking and attitude. That in turn, would transform our deeds, leading to a better environment and better future. These two world-views are discussed here in relation to environmental protection:

### ❖ **Anthropocentric Worldview**

This view is guiding most industrial societies. It puts human beings in the center giving them the highest status. Man is considered to be most capable for managing the planet earth. The guiding principles of this view are-

- Man is the planets most important species and is the in-charge of the rest of nature.
- Earth has an unlimited supply of resources and it all belongs to us.
- Economic growth is very good and more the growth, the better it is, because it raises our quality of life and the potential for economic growth is unlimited.
- A healthy environment depends upon a healthy economy.
- The success of mankind depends upon how good managers we are for deriving benefits for us from nature.

### ❖ **Eco-centric Worldview**

This is based on earth-wisdom. The basic beliefs are as follows-

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

Environmental ethics can provide us the guidelines for putting our beliefs into action and help us decide what to do when faced with crucial situations. Some important ethical guidelines known as Earth ethics or Environmental Ethics are as follows-

- One should love and honour the earth since it has blessed you with life and governs your survival.
- One should keep each day sacred to earth and celebrate the turning of its seasons.
- One should not hold yourself above other living things and have no right to drive them to extinction.
- One should be grateful to the plants and animals which nourish you by giving you food.
- One should limit your offsprings because too many people will overburden the earth.
- One should not waste your resources on destructive weapons.
- One should not run after gains at the cost of nature, rather should strive to restore its damaged majesty.
- One should not conceal from others the effects you have caused by your actions on earth.
- One should not steal from future generations their right to live in a clean and safe planet by impoverishing or polluting it.

- One should consume the material goods in moderate amounts so that all may share the earth's precious treasure of resources.

If we critically go through the above Ten Commandments for earth ethics and reflect upon the same, we will find that various religions teach us the same things in one form or the other. The concept of ahimsa (non-violence) in Buddhism and Jainism ensure the protection and conservation of all forms of life, thereby keeping the ecological balance of the earth intact. Our teachings on having fewer wants ensure to put limits to growth and thus, guide us to have an eco-centric life style.

#### 4.10 TWELVE PRINCIPLES OF GREEN CHEMISTRY:

### 12 PRINCIPLES OF GREEN CHEMISTRY

1. **Prevention**  
It is better to prevent waste than to treat or clean up waste after it has been created.
2. **Atom Economy**  
Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
3. **Less Hazardous Chemical Syntheses**  
Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. **Designing Safer Chemicals**  
Chemical products should be designed to affect their desired function while minimizing their toxicity.
5. **Safer Solvents and Auxiliaries**  
The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.
6. **Design for Energy Efficiency**  
Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.
7. **Use of Renewable Feedstocks**  
A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.
8. **Reduce Derivatives**  
Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

#### 9. Catalysis

Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

#### 10. Design for Degradation

Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

#### 11. Real-time analysis for Pollution Prevention

Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

#### 12. Inherently Safer Chemistry for Accident Prevention

Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

### 4.11 NUCLEAR ACCIDENTS AND HOLOCAUST

Nuclear accidents can occur at any stage of the nuclear fuel cycle. However, the possibility of reactor accidents is viewed more seriously because the effects of reactor accidents are more drastic. Many estimates of hypothetical accidents in a nuclear power station are made taking into consideration various parameters like reactor safety measures which if fail would release large amount of reactor contents, that is, radioactive debris affecting a substantial portion of human population within a particular site in a Particular area.

The modern fusion bombs (nuclear bombs) are of the explosive force of 500 kilotons and 10 megatons. In case of a world war total nuclear exchange of more than 5,000 megatons can be expected. Nuclear bombardment will cause combustion of wood, plastics, petroleum, forests etc. Large quantity of black soot will be carried to the stratosphere. Black soot will absorb solar radiations and won't allow the radiations to reach the earth. Therefore, cooling will result.

The infrared radiations which are re-radiated from the atmosphere to the earth will have very less water vapors and carbon dioxide to absorb them. If they leave the lower atmosphere the green house effect will be disturbed and cooling will occur.

Due to this cooling effect, water evaporation will also reduce. Therefore, infra-red radiations absorbing water vapors will reduce in the atmosphere. This will also cause cooling. In the stratosphere there won't be significant moisture to rainout the thick soot. So, due to nuclear explosions, a phenomenon opposite to global warming will occur. This is called nuclear winter. It may result in lower global temperature.

Even the summer time will experience freezing temperature and drastically affect crop production. Crop productivity will reduce substantially causing famines and human sufferings. The Chernobyl nuclear accident, 1986 has resulted in wide spread contamination by radioactive substances. The devastation caused by nuclear bombs is not only immediate but may be long lasting. Towards, the end of World War II, bombing of Dresden, Germany caused huge firestorms. This caused particle laden updrafts in the atmosphere.

Nuclear holocaust refers to a possible nearly complete annihilation of human civilization by nuclear warfare. Under such a scenario, all or most of the Earth is made uninhabitable by nuclear weapons in future world wars.

Nuclear physicists and others have speculated that nuclear holocaust could result in an end to human life, or at least to modern civilization on Earth due to the immediate effects of nuclear fallout, the temporary loss of much modern technology due to electromagnetic pulses, or nuclear winter and resulting extinctions.

### **Case study**

#### **Atomic bombings of Hiroshima and Nagasaki:**

During the final stages of World War II in 1945, the United States conducted two atomic bombings against the Japanese cities of Hiroshima and Nagasaki, the first on August 6, 1945, and the second on August 9, 1945. These two events are the only use of nuclear weapons in war to date.

For six months before the atomic bombings, the United States intensely fire-bombed 67 Japanese cities. Together with the United Kingdom and the Republic of China, the United States called for the unconditional surrender of Japan in the Potsdam Declaration issued July 26, 1945.

The Japanese government ignored this ultimatum. By executive order of President Harry S. Truman, the U.S. employed the uranium-type nuclear weapon code named "Little Boy" on the city of Hiroshima on Monday, August 6, 1945, followed three days later by the detonation of the plutonium-type weapon code named "Fat Man" over the city of Nagasaki on August 9.

Within the first two to four months after the bombings, acute effects killed 90,000–166,000 people in Hiroshima and 60,000–80,000 in Nagasaki, with roughly half of the deaths in each city occurring in the first 24 hours. The Hiroshima prefectural health department estimates that - of the people who died on the day of the detonation - 60% died from flash or flame burns, 30% from falling or flying debris, and 10% from other causes.

During the following months, large numbers died from the chronic effects of burns, radiation sickness, and other injuries, compounded by illnesses. In a U.S. estimate of the total immediate and short-term causes of death, 15–20% died from radiation sickness, 20–30% from flash burns, and 50–60% from other injuries, compounded by illnesses. In both cities, most of the dead were civilians.

### **4.12 WASTELAND RECLAMATION**

Economically unproductive lands suffering from environmental deterioration are known as wastelands. Eg: salt affected lands, sandy areas, gullied areas, undulating uplands, barren hill-ridge etc. Snow covered areas, glacial areas and areas rendered barren after Jhum cultivation.

More than half of our country's geographical area (about 175 million ha) is estimated to be wasteland, thus indicating the seriousness of the problem for a country like ours which has to support 1/6th of the world's population.

Maximum wasteland areas in our country lie in Rajasthan (36 million ha) followed by M.P. and Andhra Pradesh. Wastelands are formed by natural processes, which include undulating uplands, snow-covered lands, coastal saline areas, sandy areas etc. or by anthropogenic (man-made) activities leading to eroded, saline or waterlogged lands.

The major anthropogenic activities leading to waste land formation are deforestation, overgrazing, mining and erroneous agricultural practices. Although deserts are wastelands formed by natural process, but there are many human activities which accelerate the spreading of desert as we have already discussed. Wasteland reclamation and development in our country falls under the purview of Wasteland Development Board, which works to fulfill the following objectives-

- To improve the physical structure and quality of the marginal soils.
- To improve the availability of good quality water for irrigating these lands.
- To prevent soil erosion, flooding and landslides.
- To conserve the biological resources of the land for sustainable use.

Some important reclamation practices are discussed here-

#### **❖ Land development and leaching**

- For reclamation of the salt affected soil, it is necessary to remove the salts from the root-zone which is usually achieved by leaching i.e. by applying excess amount of water to push down the salts.

- After leveling and ploughing, the field is banded in small plots and leaching is done. In continuous leaching, 0.5 to 1.0 cm water is required to remove 90% of soluble salts from each cm of the soil depending upon texture.
- ❖ **Drainage**
  - This is required for water-logged soil reclamation where excess water is removed by artificial drainage.
  - 1. **Surface drainage:** This is used in areas where water stands on the fields after heavy rains by providing ditches to runoff the excess water. Usually 30-45 cm deep ditches lying parallel to each other at 20-60 m distance are able to remove 5 cm of water within 24 hours.
  - 2. **Sub-surface drainage:** Horizontal sub-surface drainage is provided in the form of perforated corrugated PVC pipes or open-jointed pipes with an envelope of gravel 2-3 m below the land surface. Chances of evaporation of water leading to accumulation of salts almost become nil in this method. The World Bank has funded sub-surface drainage system at Sampla, Rohtak (Haryana) for reducing soil salinity by this method.
- ❖ **Irrigation Practices**
  - Surface irrigation with precise land leveling, smoothening and efficient hydraulic design help to reduce water logging and salinity. High frequency irrigation with controlled amount of water helps to maintain better water availability in the upper root zone.
  - Thin and frequent irrigations have been found to be more useful for better crop yield when the irrigation water is saline as compared to little heavy irrigation.
- ❖ **Selection of tolerant crops and crop rotations**
  - Tolerance of crops to salts is found to range from sensitive, semi-tolerant, tolerant to highly tolerant. Barley, sugar beet and date-palm are highly tolerant crops which do not suffer from any reduction in crop yield even at a high salinity with electrical conductivity (EC) of 10 dS/m.
  - Wheat, sorghum, pearl millet, soyabean, mustard and coconut are salt-tolerant crops. Rice, millets, maize, pulses, sunflower, sugarcane and many vegetables like bottle gourd, brinjal etc. are semi-tolerant. These different crop combinations can be grown on saline soils.
- ❖ **Gypsum amendment**
  - Amendment of sodic soils with gypsum is recommended for reducing soil sodicity as calcium of gypsum replaces sodium from the exchangeable sites.
- ❖ **Green-manures, fertilizers and Biofertilizers**
  - Application of farm yard manure or nitrogen fertilizers have been found to improve saline soils. Green manuring with dhaincha (*Sesbania aculeata*) sunhemp or guar have also been reported to improve salt-affected soils.
  - Blue green algae have been found to be quite promising as biofertilizers for improving salt-affected soils.
- ❖ **Afforestation Programmes**
  - The National Commission on Agriculture (NCA) launched several afforestation schemes in the VI th plan to cope up with the problem of spreading wasteland.
  - The National Wasteland Development Board, in the Ministry of Environment and Forests has set a target of bringing 5 million hectares of wasteland annually under firewood and fodder plantation.
- ❖ **Social Forestry Programmes**
  - These programmes mostly involve strip plantation on road, rail and canal-sides, rehabilitation of degraded forest lands, farm-forestry, waste-land forest development etc.

#### 4.13 CONSUMERISM AND WASTE PRODUCTS

Consumerism refers to the consumption of resources by the people. While early human societies used to consume much less resources, with the dawn of industrial era, consumerism has shown an exponential rise. It has been related both to the increase in the population size as well as increase in our demands due to change in life-style.



Earlier we used to live a much simpler life and used to have fewer wants. In the modern society our needs have multiplied and so consumerism of resources has also multiplied. Our population was less than 1 million for thousands of years ever since we evolved on this earth.

Today we have crossed the six billion mark and are likely to reach 11 billion by 2045 as per World Bank estimates. Let us see how the changing population trends influence consumerism of natural resources and generation of wastes. Two types of conditions of population and consumerism exist.

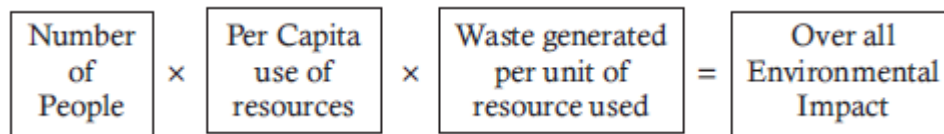
❖ **People over-population**

- It occurs when there are more people than available supplies of food, water and other important resources in the area.
- Excessive population pressure causes degradation of the limited resources, and there is absolute poverty, under-nourishment and premature deaths.
- This occurs in less developed countries (LDCs). Here due to large number of people, adequate resources are not available for all. So there is less per capita consumption although overall consumption is high.

❖ **Consumption over-population**

- This occurs in the more developed countries (MDCs). Here population size is smaller while resources are in abundance and due to luxurious life-style per capita consumption of resources is very high.
- More the consumption of resources more is the waste generation and greater is the degradation of the environment.

This concept can be explained by using the model of Paul Ehrlich and John Holdren (1972)



In LDC.s - No. of people is very high, but per capita use of resources and waste generated are less.

In MDC.s - No. of people is low, but per capita use of resources and wastes generated are very high.

The overall environmental impact of these two types of consumerism may be same or even greater in case of MDCs. Thus, consumerism varies with the country and USA is known for maximum consumerism.

The throw-away attitude and luxurious life-style of the west results in very high resource use as compared to less developed countries. With every unit of energy, mineral or any resource used there is waste generation and pollution in the environment.

A comparison of USA and India can illustrate this point more clearly with every unit of energy, mineral or any resource used there is waste generation and pollution in the environment.

Comparison of consumerism and waste generation Percent global values

Parameter	USA	India
Population	4.7%	16 %
Production of Goods	21%	1 %
Energy use	25%	3 %
Pollutants/wastes	25%	3 %
CFC.s Production	22%	0.7 %

The table shows that although the population of India is 3.4 times more than that of U.S.A. its overall energy use and waste generation are less than 1/8th that of USA. Thus more consumerism leads to more waste production

#### 4.14 THE ENVIRONMENT (PROTECTION) ACT, 1986

The Act came into force on Nov 19, 1986, the birth anniversary of our Late Prime Minister Indira Gandhi, who was a pioneer of environmental protection issues in our country.

1. Environment includes water, air and land and the inter-relationships that exist among and between them and human beings, all other living organisms and property.
2. Environmental pollution means the presence of any solid, liquid or gaseous substance present in such concentration, as may be, or tend to be, injurious to environment.
3. Hazardous Substance means any substance or preparation which by its physico-chemical properties or handling is liable to cause harm to human beings, other living organisms, property or environment. The Act has given powers to the Central Government to take measures to protect and improve environment while the state governments coordinate the actions. The most important functions of Central Govt. under this Act include setting up of-
  - a. The standards of quality of air, water or soil for various areas and purposes.
  - b. The maximum permissible limits of concentration of various environmental pollutants (including noise) for different areas.
  - c. The procedures and safeguards for the handling of hazardous substances.
  - d. The prohibition and restrictions on the handling of hazardous substances in different areas.
  - e. The prohibition and restriction on the location of industries and to carry on process and operations in different areas.

The procedures and safeguards for the prevention of accidents which may cause environmental pollution and providing for remedial measures for such accidents.

For the purpose of protecting and improving the quality of the environment and preventing and abating pollution, standards have been specified under Schedule I- IV of Environment (Protection) Rules, 1986 for emission of gaseous pollutants and discharge of effluents/waste water from industries.

These standards vary from industry to industry and also vary with the medium into which the effluent is discharged or the area of emission. For instance, the maximum permissible limits of B.O.D. (Biochemical Oxygen Demand) of the waste water is 30 ppm if it is discharged into inland waters, 350 ppm if discharged into a public sewer and 100 ppm, if discharged onto land or coastal region.

Likewise, emission standards vary in residential, sensitive and industrial area. Naturally the standards for sensitive areas like hospitals are more stringent. It is the duty of the Pollution Control Board to check whether the industries are following the prescribed norms or not.

Under the Environmental (Protection) Rules, 1986 the State Pollution Control Boards have to follow the guidelines provided under Schedule VI, some of which are as follows-

1. They have to advise the Industries for treating the waste water and gases with the best available technology to achieve the prescribed standards.
2. The industries have to be encouraged for recycling and reusing the wastes.
3. They have to encourage the industries for recovery of biogas, energy and reusable materials.
4. While permitting the discharge of effluents and emissions into the environment, the State Boards have to take into account the assimilative capacity of the receiving water body.
5. The Central and State Boards have to emphasize on the implementation of clean technologies by the industries in order to increase fuel efficiency and reduce the generation of environmental pollutants.

Under the Environment (Protection) Rules, 1986 and amendment was made in 1994 for Environmental Impact Assessment (EIA) of Various Development Projects.

There are 29 types of projects listed under Schedule I of the rule which require clearance from the Central Government before establishing. Others require clearance from the State Pollution Control Board, when the proposed project or expansion activity is going to cause pollution load exceeding the existing levels. The project proponent has to provide EIA report, risk analysis report, NOC from State Pollution Control Board, Commitment regarding availability of water and electricity,

Summary of project report/feasibility report filled in a questionnaire for environmental appraisal of the project and comprehensive rehabilitation plan, if more than 1000 people are likely to be displaced due to the project. Under the Environment (Protection) Act, 1986 the Central Government also made the Hazardous Wastes (Management and Handling) Rules, 1989.

Under these rules, it is the responsibility of the occupier to take all practical steps to ensure that such wastes are properly handled and disposed off without any adverse effects. There are 18 Hazardous Waste

categories recognized under this rule and there are guidelines for their proper handling, storage, treatment, transport and disposal which should be strictly followed by the owner.

The Environment (Protection) Act, 1986 has also made provision for environmental Audit as a means of checking whether or not a company is complying with the environmental laws and regulations. Thus, ample provisions have been made in our country through law for improving the quality of our environment.

#### **4.15 THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981**

Salient features of the act are as follows-

1. The Act provides for prevention, control and abatement of air pollution.
2. In the Act, air pollution has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.
3. Noise pollution has been inserted as pollution in the Act in 1987.
4. Pollution control boards at the central or state level have the regulatory authority to implement the Air Act. Just parallel to the functions related to Water (Prevention and Control of Pollution) Act, the board performs similar functions related to improvement of air quality. The boards have to check whether or not the industry strictly follows the norms or standards laid down by the Board under section 17, regarding the discharge of emission of any air pollutant. Based upon analysis report consent is granted or refused to the industry.
5. Just like the Water Act, the Air Act has provisions for defining the constitution, powers and function of Pollution Control Boards, funds, accounts, audit, penalties and procedures.
6. Section 20 of the Act has provision for ensuring emission standards from automobiles. Based upon it, the state govt. is empowered to issue instructions to the authority incharge of registration of motor vehicles (under Motor Vehicles Act, 1939) that is bound to comply with such instructions.
7. As per Section 19, in consultation with the State Pollution Control Board, the state government may declare an area within the state as air pollution control area. and can prohibit the use of any fuel other than approved fuel in the area causing air pollution. No person shall, without prior consent of State Board operate or establish any industrial unit in the air pollution control area. The Water and Air Acts have also made special provisions for appeals. Under Section 28 of Water Act and Section 31 of Air Act, a provision for appeals has been made. An Appellate Authority consisting of a single person or three persons appointed by the Head of the State, Governor is constituted to hear such appeals as filed by some grieved party (industry) due to some order made by the State Board within 30 days of passing the orders. The Appellate Authority after giving the appellant and the State Board an opportunity of being heard, disposes off the appeal as expeditiously as possible.

#### **4.16 WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974**

It provides for maintaining and restoring the wholesomeness of water by preventing and controlling its pollution.

Pollution is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water, or such discharge as is likely to cause a nuisance or render the water harmful or injurious to public health and safety or harmful for any other use or to aquatic plants and other organisms or animal life.

The salient features and provisions of the Act are summed up as follows-

1. It provides for maintenance and restoration of quality of all types of surface and ground water.
2. It provides for the establishment of Central and State Boards for pollution control.
3. It confers them with powers and functions to control pollution. The Central and State Pollution Control Boards are widely represented and are given comprehensive powers to advise, coordinate and provide technical assistance for prevention and control of pollution of water.



4. The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards.
5. The Act makes provisions for various penalties for the defaulters and procedure for the same.

#### **4.17 WILDLIFE (PROTECTION) ACT, 1972**

Wildlife was transferred from State list to concurrent list in 1976, thus giving power to the Central Govt. to enact the legislation.

The Indian Board of Wildlife (**IBWL**) was created in 1952 in our country, which after the enactment of the Wildlife (Protection) Act actively took up the task of setting up wildlife National Parks and sanctuaries. The major activities and provisions in the act can be summed up as follows

1. It defines the wild-life related terminology.
2. It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.
3. Under the Act, comprehensive listing of endangered wild life species was done for the first time and prohibition of hunting of the endangered species was mentioned.
4. Protection to some endangered plants like Beddome cycad, Blue Vanda, Ladies Slipper Orchid, Pitcher plant etc. is also provided under the Act.
5. The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.
6. The Act provides for the constitution of Central Zoo Authority.
7. There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.
8. The Act imposes a ban on the trade or commerce in scheduled animals.
9. It provides for legal powers to officers and punishment to offenders.
10. It provides for captive breeding programme for endangered species.

Several Conservation Projects for individual endangered species like lion (1972) Tiger (1973), Crocodile (1974) and Brown antlered Deer (1981) were started under this Act.

Some of the major drawbacks of the Act include mild penalty to offenders, illegal wild life trade in J & K, personal ownership certificate for animal articles like tiger and leopard skins, no coverage of foreign endangered wildlife, pitiable condition of wildlife in mobile zoos and little emphasis on protection of plant genetic resources.

#### **4.18 FOREST (CONSERVATION) ACT, 1980**

This act deals with the conservation of forests and related aspects. The Act covers under it all types of forests including reserved forests, protected forests or any forested land irrespective of its ownership.

The salient features of the Act are as follows-

1. The State Govt. has been empowered under this Act to use the forests only for forestry purposes. If at all it wants to use it in any other way, it has to take prior approval of central Government, after which it can pass orders for declaring some part of reserve forest for non-forest purposes (e.g mining) or for clearing some naturally growing trees and replacing them by economically important trees (reforestation).
2. It makes provision for conservation of all types of forests and for this purpose there is an Advisory committee which recommends funding for it to the Central Government.
3. Any illegal non-forest activity within a forest area can be immediately stopped under this Act. Non-forest activities include clearing of forest land for cultivation of any type of plants/crops or any other purpose (except re-afforestation). However, some construction work in the forest for wildlife or forest management is exempted from non-forest activity (e.g. fencing, making water-holes, trench, pipelines, check posts, wireless communication etc.)

#### **1992 Amendment in the Forest Act**

In 1992, some amendment was made in the Act which made provisions for allowing some non-forest activities in forests, without cutting trees or limited cutting with prior approval of Central Government.

These activities are setting of transmission lines, seismic surveys, exploration, drilling and hydroelectric projects. The last activity involves large scale destruction of forest, for which prior approval of the Centre is necessary.

Wildlife sanctuaries, National Parks etc. are totally prohibited for any exploration or survey under this Act without prior approval of Central Govt. even if no tree-felling is involved. Cultivation of tea, coffee, spices, rubber and plants which are cash-crops, are included under non-forestry activity and not allowed in reserve forests.

Even cultivation of fruit-bearing trees, oil-yielding plants or plants of medicinal value in forest area need to be first approved by the Central Government. This is because newly introduced species in the forest area may cause an imbalance in the ecology of the forest. If the species to be planted is a native species, then no prior clearance is required.

Tusser cultivation (a type of silk-yielding insect) in forest areas by tribal as a means of their livelihood is treated as a forestry activity as long as it does not involve some specific host tree like Asan or Arjun. This is done in order to discourage monoculture practices in the forests which are otherwise rich in biodiversity.

Plantation of mulberry for rearing silkworm is considered a non-forest activity. Mining is a non-forestry activity and prior approval of Central Govt. is mandatory. The Supreme Court in a case T.N. Godavarman Thirumulkpad vs. Union of India (1997) directed all on-going mining activity to be ceased immediately in any forest area of India if it had not got prior approval of Central government.

Removal of stones, bajri, boulder etc from river-beds located within the forest area fall under non-forest activity.

Any proposal sent to central govt. for non-forest activity must have a cost-benefit analysis and Environmental Impact statement (EIS) of the proposed activity with reference to its ecological and socio-economic impacts. Thus, the Forests (Conservation) Act has made ample provisions for conservation and protection of forests and prevents deforestation.

#### **4.19 ECOMARK**

It is the certificate issued by Bureau of Indian Standards. Its objective is to increase the environmental awareness among the consumers.

#### **4.20 ENVIRONMENTAL LEGISLATION**

India is the first country in the world to have made provisions for the protection and conservation of environment in its constitution. On 5th June, 1972, environment was first discussed as an item of international agenda in the U.N. Conference on Human Environment in Stockholm and thereafter 5th June is celebrated all over the world as World Environment Day.

#### **Constitutional Provisions**

**Article 48-A** of the constitution provides: .The state shall endeavor to protect and improve the environment and to safeguard forests and wildlife of the country.

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

#### **4.18 ENFORCEMENT OF ENVIRONMENTAL LEGISLATION**

There are a number of important environmental laws in the form of Acts for safeguarding our environmental quality. But inspite of these acts, we find that we are not able to achieve the target of bringing 33% of our land cover under forests. Still we are losing our wild life.

The rivers have been turned into open sewers in many places and the air in our big cities is badly polluted. The status of environment shows that there are drawbacks in environmental legislations and problems in their effective implementation.

Let us examine some important issues related to our acts-

##### **❖ Drawbacks of the Wildlife (Protection) Act, (1972)**

- The Act has been enacted just as fallout of Stockholm Conference held in 1972 and it has not included any locally evolved conservation measures.

- The ownership certificates for animal articles (tiger, leopard skins etc.) are permissible which very often serve as a tool for illegal trading.
- The wildlife traders in Jammu and Kashmir easily get illegal furs and skins from other states which after making caps, belts etc. are sold or smuggled to other countries. This is so happening because J & K has its own Wildlife Act and it does not follow the Central Wild Life Act.
- Moreover, hunting and trading of several endangered species prohibited in other states are allowed in J & K, thereby opening avenues for illegal trading in such animals and articles. The offender of the Act is not subject to very harsh penalties. It is just up to 3 years imprisonment or a fine of Rs. 25,000 or both.

❖ **Drawbacks of the Forest (Conservation) Act, 1980**

- This Act has inherited the exploitative and consumerist elements from the Forest laws of British period. It has just transferred the powers from state to centre, to decide the conversion of reserve forest lands to non-forest areas.
- Thus power has been centralized at the top. At the same time, the local communities have been completely kept out from the decision- making process regarding the nature of use of forest area. Very often, the tribals who lived in the forest and were totally dependent on forests retaliate when stopped from taking any resources from there and start criminal activities including smuggling, killing etc.
- The Act has failed to attract public support because it has infringed upon the human rights of the poor native people. They argue that the law is concerned about protecting the trees, birds and animals, but is treating the poor people as marginal. Very poor community participation in the Act remains
- One of the major drawbacks which affects proper execution of the Act. The forest-dwelling tribal communities have a rich knowledge about the forest resources, their importance and conservation. But, their role and contribution is neither acknowledged nor honored. Efforts are now being made to make up for the gaps in laws by introducing the principles of Public trust or Human rights Protection.

**CPCB (Central and state Pollution Control Board)**

1. It advises the central govt. in matters related to prevention and control of water pollution.
2. Coordinates the activities of State Pollution Control Boards and provides them technical assistance and guidance.
3. Organizes training programs for prevention and control of pollution.
4. Organizes comprehensive programs on pollution related issues through mass media.
5. Collects, compiles and publishes technical and statistical data related to pollution.
6. Prepares manuals for treatment and disposal of sewage and trade effluents. Plans nation-wide programs for prevention, control or abatement of pollution.
7. Establishes and recognizes laboratories for analysis of water, sewage or trade effluent sample.
8. The State Pollution Control Boards also have similar functions to be executed at state level and are governed by the directions of CPCB.
9. The Board advises the state govt. with respect to the location of any industry that might pollute a stream or a well.
10. It lays down standards for effluents and is empowered to take samples from any stream, well or trade effluent or sewage passing through an industry.

The State Board is empowered to take legal samples of trade effluent in accordance with the procedure laid down in the Act. The sample taken in the presence of the occupier or his agent is divided into two parts, sealed, signed by both parties and sent for analysis to some recognized lab.

If the samples do not conform to the prescribed water quality standards (crossing maximum permissible limits), then consent is refused to the unit. Every industry has to obtain consent from the Board (granted for a fixed duration) by applying on a prescribed Proforma providing all technical details, along with a prescribed fee following which analysis of the effluent is carried out.

The Board suggests efficient methods for utilization, treatment and disposal of trade effluents. The Act has made detailed provisions regarding the power of the Boards to obtain information, take trade samples,

restrict new outlets, restrict expansion, enter and inspect the units and sanction or refuse consent to the industry after effluent analysis.

While development is necessary, it is all the more important to prevent pollution, which can jeopardize the lives of the people. Installation and proper functioning of effluent treatment plants (ETP) in all polluting industries is a must for checking pollution of water and land.

Despite certain weaknesses in the Act, the Water Act has ample provisions for preventing and controlling water pollution through legal measures.

## **DRAWBACKS OF POLLUTION RELATED ACTS**

The power and authority has been given to central government with little delegation of power to state government. Excessive centralization very often hinders efficient execution of the provisions of the Acts in the states. Illegal mining is taking place in many forest areas.

In Rajasthan alone, about 14000 cases of illegal mining have been reported. It becomes more difficult to check such activities at the central level. The provision of penalties in the Act is very insignificant as compared to the damage caused by the big industries due to pollution. The penalty is much less than the cost of the treatment pollution control equipments. This always gives a loose rope to the industries.

The Act has not included the right to information for the citizens. This greatly restricts the involvement or participation of the general public. The Environment (Protection) Act, 1986 regarded as an umbrella Act, encompassing the earlier two Acts often seems superfluous due to overlapping areas of jurisdiction. For instance Section 24 (2) of the new Act has made a provision that if the offender is punishable under the other Acts like Water Act or Air Act also, then he may be considered under their provisions.

Interestingly, the penalty under the older two Acts is much lighter than the new Act. So the offender easily gets away with a lighter punishment. Under Section 19, a person cannot directly file a petition in the court on a question of environment and has to give a notice of minimum 60 days to the central government. In case no action is taken by the latter, then alone the person can file a petition which certainly delays the remedial action.

Litigation, particularly related to environment is very expensive, tedious and difficult since it involves expert testimony, technical knowledge of the issues and terminologies, technical understanding of the unit process, lengthy prosecutions etc.

The State Boards very often lack adequate funds and expertise to pursue their objectives. A tendency to seek to exercise gentle pressure on the polluter and out of the court settlements usually hinders the implementation of legal measures. For small units it is very expensive to install Effluent Treatment Plant (ETP) or Air pollution control devices and sometimes they have no other option but to close the unit.

The Act should make some provision for providing subsidies for installing treatment plants or common effluent treatment plants for several small units. The pollution control laws are not backed by sound policy pronouncements or guiding principles. The position of chairman of the boards is usually occupied by political appointee. Hence it is difficult to keep political interference at bay.

The policy statement of the Ministry of Environment and Forests (1992) of involving public in decision-making and facilitating public monitoring of environmental issues has mostly remained on paper. Environmental policies and laws need to be aimed at democratic decentralization of power, community-state partnership, administrative transparency and accountability and more stringent penalties to the offender. There is also a need for environmental law education and capacity building in environmental issues for managers.

## **DISASTER MANAGEMENT:**

### **❖ FLOOD**

A flood occurs due to continuous heavy rainfall in an area, overflowing of rivers and submerging the surrounding areas damaging life and property.

### **Control**

(i) Various preventive measures are proper embankment of water bodies, building check dams on flood-prone streams, prohibiting cultivation in flood plain of rivers and growing forests and perennial trees,

interlinking of river of the country and constructing houses on raised platforms and supported by reinforced stilts.

(ii) Floods can be controlled by collecting data from meteorological department and alerting the people of affecting area.

(iii) Educating the people about the steps to be taken in the event of disaster.

(iv) Hill slopes and catchment areas of rivers must be afforested and reforested.

### ❖ **EARTHQUAKE**

Sudden tremors of the earth's surface are produced due to movement of tectonic plates under the earth. This displacement of earth's crust releases energy stored within the earth's interior which produces vibratory waves.

The intensity of earthquake is measured by Richter, Scale which ranges from 0 to 9. The point from which the earthquake originates is called as epicenter.

#### **Prevention, Control & Mitigation**

(i) Constructing earthquake resistant building in the known earthquake prone zones e.g. wooden houses are preferred in Japan.

(ii) Installation of earthquake study centers studying seismic activities and analysis of seismic zones.

(iii) There must be insurance policies for earthquake victims o rehabilitate them.

(iv) Creation of special task forces, fully trained and equipped, to manage such calamities within shortest possible time.

### ❖ **CYCLONE.**

A cyclone is powerful circular or oval swirling storm of high velocity wind in the coastal regions of Indian Ocean. It is called hurricane in Atlantic Ocean, typhoon in Western Pacific and Willy-willy in sea around Australia.

#### **Control-**

(i) Afforestation of coastal areas is the best measure.

(ii) Construction of dams, embankments, wind breakers etc.

(iii) Conservation of mangrooves in coastal plains.

(iv) Better forecast, warning systems with the help of remote sensing satellites.

(v) Construction of cyclone proof houses and building in coastal areas.

### ❖ **LANDSLIDES**

Landslide is the sudden down slope movement of a mass of rock or soil due to gravitational pull, generally in the rainy season.

#### **Control**

(i) Afforestation and reforestation in the landslide prone areas is the best measure.

(ii) There should be no construction activity in slopy areas.

(iii) Proper drainage of surface and sub surface water.

(iv) Making concrete support at the base of slope along the road.

(v) Construction of curved stone blocks in the risky areas.

#### 4.19 PUBLIC ENVIRONMENTAL AWARENESS

Public awareness about environment is at a stage of infancy. Some awareness has taken place related to environmental degradation, pollution etc. but incomplete knowledge and information and ignorance about many aspects has often led to misconceptions.

Development has paved the path for rise in the levels or standards of living but it has simultaneously led to serious environmental disasters. Issues related to environment have often been branded as antidevelopment.

Some of the main reasons responsible for widespread of environmental ignorance can be summed up as follows

- Our courses in Science, technology, economics etc. have so far failed to integrate the knowledge in environmental aspects as an essential component of the curriculum.
- Our planners, decision-makers, politicians and administrators have not been trained so as to consider the environmental aspects associated with their plans.
- In zeal to go ahead with some ambitious development projects, quite often there is purposeful concealment of information about environmental aspects.
- (iv) There is greater consideration of economic gains and issues related to eliminating poverty by providing employment that overshadows the basic environmental issues.

#### Methods to Propagate Environmental Awareness-

Environmental awareness needs to be created through formal and informal education to all sections of the society. Everyone needs to understand it because environment belongs to all and every individual matters. When it comes to conservation and protection of environment various stages and methods that can be useful for raising environmental awareness in different sections of the society are as follows:

##### ❖ Among students through education

- Environmental education must be imparted to the students right from the childhood stage.
- It is a welcome step that now all over the country we are introducing environmental studies as a subject at all stages including school and college level, following the directives of the Supreme Court.

##### ❖ Through mass-media

- Media can play an important role to educate the masses on environmental issues through articles, environmental rallies, plantation campaigns, street plays, real eco-disaster stories and success stories of conservation efforts.

##### ❖ Among the planners, decision-makers and leaders

- Since this elite section of the society plays the most important role in shaping the future of the society, it is very important to give them the necessary orientation and training through specially organized workshops and training programmers.
- Publication of environment - related resource material in the form of pamphlets or booklets published by Ministry of Environment & Forests can also help in keeping this section abreast of the latest developments in the field.

#### 4.20 CLIMATE CHANGE

Climate is the average weather of an area. It includes general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period- at least 30 years is called climate.

The Intergovernmental Panel on Climate Change (IPCC) in 1990 and 1992 published best available evidence about past climate change, the green house effect and recent changes in global temperature. It is observed that earth's temperature has changed considerably during the geological times. It has experienced several glacial and interglacial periods.

During the past 10,000 years of the current interglacial period the mean average temperature has fluctuated by 0.5- 1°C over 100 to 200 year period. We have relatively stable climate for thousands of years due to which we have practiced agriculture and increased in population. Even small changes in climatic conditions may disturb agriculture that would lead to migration of animals including humans.

Anthropogenic (man-made) activities are upsetting the delicate balance that has established between various components of the environment. Green house gases are increasing in the atmosphere resulting in increase in the average global temperature. This may upset the hydrological cycle, result in floods and droughts in different regions of the world, cause sea level rise, changes in agriculture productivity, famines and death of humans as well as live stock.

The global change in temperature will not be uniform everywhere and will fluctuate in different regions. The places at higher latitudes will be warmed up more during late autumn and winter than the places in tropics.

Poles may experience 2 to 3 times more warming than the global average, while warming in the tropics may be only 50 to 100% on an average. The increased warming at poles will reduce the thermal gradient between the equator and high latitude regions decreasing the energy available to the heat engine that drives the global weather machine.

This will disturb the global pattern of winds and ocean currents as well as the timing and distribution of rainfall. Shifting of ocean currents may change the climate of Iceland and Britain and may result in cooling at a time when rest of the world warms.

By a temperature increase of 1.5 to 4.5°C the global hydrological cycle is expected to intensify by 5 to 10%. Disturbed rainfall will result in some areas becoming wetter and the others drier. Although rainfall may increase, higher temperatures will result in more evapo-transpiration leading to annual water deficit in crop fields.

#### 4.21 GLOBAL WARMING

Troposphere, the lowermost layer of the atmosphere, traps heat by a natural process due to the presence of certain gases. This effect is called **Green House Effect** as it is similar to the warming effect observed in the horticultural green house made of glass.

The amount of heat trapped in the atmosphere depends mostly on the concentrations of heat trapping or green house gases and the length of time they stay in the atmosphere. The major green house gases are carbon dioxide, ozone, methane, nitrous oxide, chlorofluorocarbons (CFCs) and water vapors.

The average global temperature is 15°C. In the absence of green house gases this temperature would have been 18°C. Therefore, Green House Effect contributes a temperature rise to the tune of 33°C. Heat trapped by green house gases in the atmosphere keeps the planet warm enough to allow us and other species to exist.

The two predominant green house gases are water vapors, which are controlled by hydrological cycle, and carbon dioxide, which is controlled mostly by the global carbon cycle. While the levels of water vapor in the troposphere have relatively remained constant, the levels of carbon dioxide have increased.

Other gases whose levels have increased due to human activities are methane, nitrous oxide and chlorofluorocarbons. Deforestation has further resulted in elevated levels of carbon dioxide due to non-removal of carbon dioxide by plants through photosynthesis.

Warming or cooling by more than 2°C over the past few decades may prove to be disastrous for various ecosystems on the earth including humans, as it would alter the conditions faster than some species could adapt or migrate. Some areas will become inhabitable because of drought or floods following a rise in average sea level.

#### ❖ Greenhouse Gases

Due to anthropogenic activities there is an increase in the concentration of the greenhouse gases in the air that absorb infra-red light containing heat and results in the re-radiation of even more of the outgoing thermal infra-red energy, thereby increasing the average surface temperature beyond 15°C. The phenomenon is referred to as the **enhanced green house effect** to distinguish its effect from the one that has been operating naturally for millennia. The greenhouse gases present in the troposphere and resulting in an increase in the temperature of air and the earth are discussed here-

##### 1. Carbon dioxide

- It contributes about 55% to global warming from green house gases produced by human activity. Industrial countries account for about 76% of annual emissions.

- The main sources are fossil fuel burning (67%) and deforestation, other forms of land clearing and burning (33%).
- CO<sub>2</sub> stays in the atmosphere for about 500 years. CO<sub>2</sub> concentration in the atmosphere was 355 ppm in 1990 that is increasing at a rate of 1.5 ppm every year
- 2. **Chlorofluorocarbons (CFCs)**
  - This is responsible for 24% of the human contribution to greenhouse gases.
  - They also deplete ozone in the stratosphere. The main sources of CFCs include leaking air conditioners and refrigerators, evaporation of industrial solvents, production of plastic foams, aerosols, propellants etc.
  - CFCs take 10-15 years to reach the stratosphere and generally trap 1500 to 7000 times more heat per molecule than CO<sub>2</sub> while they are in the troposphere. This heating effect in the troposphere may be partially offset by the cooling caused when CFCs deplete ozone during their 65 to 110 years stay in the stratosphere.
  - Atmospheric concentration of CFC is 0.00225 ppm that is increasing at a rate of 0.5% annually.
- 3. **Methane (CH<sub>4</sub>)**
  - It accounts for 18% of the increased greenhouse gases.
  - Methane is produced when bacteria break down dead organic matter in moist places that lack oxygen such as swamps, natural wetlands, paddy fields, landfills and digestive tracts of cattle, sheep and termites. Production and use of oil and natural gas and incomplete burning of organic material are also significant sources of methane.
  - Methane stays in the atmosphere for 7-10 years. Each methane molecule traps about 25 times as much heat as a CO<sub>2</sub> molecule.
  - Atmospheric concentration of methane is 1.675 ppm and it is increasing at a rate of 1% annually.
- 4. **Nitrous Oxide (N<sub>2</sub>O)**
  - It is responsible for 6% of the human input of green house gases. Besides trapping heat in the troposphere it also depletes ozone in the stratosphere.
  - It is released from nylon products, from burning of biomass and nitrogen rich fuels (especially coal) and from the breakdown of nitrogen fertilizers in soil, livestock wastes and nitrate contaminated ground water.
  - Its life span in the troposphere is 140-190 years and it traps about 230 times as much heat per molecule as CO<sub>2</sub>. The atmospheric concentration of N<sub>2</sub>O is 0.3 ppm and is increasing at a rate of 0.2% annually.

### **Impacts of Enhanced Greenhouse Effect**

The enhanced greenhouse effect will not only cause global warming but will also affect various other climatic and natural processes.

#### ❖ **Global temperature increase**

- It is estimated that the earth's mean temperature will rise between 1.5 to 5.5°C by 2050 if input of greenhouse gases continues to rise at the present rate.
- Even at the lower value, earth would be warmer than it has been for 10,000 years.

#### ❖ **Rise in Sea Level**

- With the increase in global temperature sea water will expand. Heating will melt the polar ice sheets and glaciers resulting in further rise in sea level.
- Current models indicate that an increase in the average atmospheric temperature of 3°C would raise the average global sea level by 0.2-1.5 meters over the next 50-100 years.

One meter rise in sea level will inundate low lying areas of cities like Shanghai, Cairo, Bangkok, Sydney, Hamburg and Venice as well as agricultural lowlands and deltas in Egypt, Bangladesh, India, China and will affect rice productivity. This will also disturb many commercially important spawning grounds, and would probably increase the frequency of storm damage to lagoons, estuaries and coral reefs.

In India, the Lakshadweep Islands with a maximum height of 4 meters above the level may be vulnerable. Some of the most beautiful cities like Mumbai may be saved by heavy investment on embankment to prevent inundation.

Life of millions of people will be affected, by the sea level rise who have built homes in the deltas of the Ganges, the Nile, the Mekong, the Yangtze and the Mississippi rivers.



❖ **Effects on Human Health**

- The global warming will lead to changes in the rainfall pattern in many areas, thereby affecting the distribution of vector-borne diseases like malaria, filariasis, elephantiasis etc.
- Areas which are presently free from diseases like malaria, schistosomiasis etc. may become the breeding grounds for the vectors of such diseases. The areas likely to be affected in this manner are Ethiopia, Kenya and Indonesia.
- Warmer temperature and more waste stagnation would favour the breeding of mosquitoes, snails and some insects, which are the vectors of such diseases. Higher temperature and humidity will increase/aggravate respiratory and skin diseases.

❖ **Effects on Agriculture**

- The effect of global warming on agriculture may show positive or negative effects on various types of crops in different regions of the world.
- Tropical and subtropical regions will be more affected since the average temperature in these regions is already on the higher side. Even a rise of 2°C may be quite harmful to crops.
- Soil moisture will decrease and evapo-transpiration will increase, which may drastically affect wheat and maize production. Increase in temperature and humidity will increase pest growth like the growth of vectors for various diseases.
- Pests will adapt to such changes better than the crops. To cope up with the changing situation drought resistant, heat resistant and pest resistant varieties of crops have to be developed.

**Measures to Check Global Warming**

To slow down enhanced global warming the following steps will be important-

- Cut down the current rate of use of CFCs and fossil fuel.
- Use energy more efficiently.
- Shift to renewable energy resources.
- Increase Nuclear Power Plants for electricity production.
- Shift from coal to natural gas.
- Trap and use methane as a fuel.
- Reduce beef production.
- Adopt sustainable agriculture.
- Stabilize population growth.
- Efficiently remove CO<sub>2</sub> from smoke stacks.
- Plant more trees.
- Remove atmospheric CO<sub>2</sub> by utilizing photosynthetic algae.

**4.22 ACID RAIN**

Oxides of sulfur and nitrogen originating from industrial operations and fossil fuel combustion are the major sources of acid forming gases. Acid forming gases are oxidized over several days by which time they travel several thousand kilometers.

In the atmosphere these gases are ultimately converted into sulfuric and nitric acids. Hydrogen chloride emission forms hydrochloric acid. These acids cause acidic rain. Acid rain is only one component of acidic deposition. Acidic deposition is the total of wet acidic deposition (acid rain) and dry deposition. Rain water is turned acidic when its pH falls below 5.6.

The clean or natural rain water has a pH of 5.6 at 20°C because of formation of carbonic acid due to dissolution of CO<sub>2</sub> in water. The Adirondack Lakes located in the state of New York are known to receive acid rains. The strong acids like sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) and nitric acid (HNO<sub>3</sub>) dissolved or formed in rainwater dissociate or release hydrogen ions thereby increasing the acidity in rain drops.

Generally sulfuric acid forms a major fraction of acid rain, followed by nitric acid and a very small fraction of other acids. However, in urban areas calcium (Ca<sup>2+</sup>), Magnesium (Mg<sup>2+</sup>) and ammonium (NH<sub>4</sub><sup>+</sup>) ions help to neutralize the rain drops shifting the overall H<sup>+</sup> towards basic scale.

The overall pH of any raindrop is due to the net effect of carbonic acid, sulfuric acid, nitric acid and other acidic constituents or any neutralizers such as ammonia. In the absence of rain, dry deposition of acid may occur.

Acid forming gases like oxides of sulphur and nitrogen and acid aerosols get deposited on the surface of water bodies, vegetation, soil and other materials. On moist surfaces or in liquids these acid forming gases can dissolve and form acids similar to that formed in acid rain. If the oxidizers are present on the liquid surfaces then these gases undergo oxidation to form acids.

Fine particles or acid droplets can act as nuclei for water to condense to form rain droplets. By such process sulfuric acid is incorporated into the droplets. In the clouds additional SO<sub>2</sub> and NO<sub>2</sub> contact the droplets and get absorbed which can be oxidized by the dissolved hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) or other oxidizers. In the droplets falling from the clouds additional acidic gases and aerosol particles get incorporated, further decreasing their pH.

A unit decrease in pH value causes 10 times increase in acidity. Average pH in rainfall over eastern United States from April 1979 to March 1980 was less than 5.0. In India acid rain is recorded from certain places:

Name of place	pH of rainwater
Kodaikanal	5.18
Minicoy	5.52
Mohanbari	5.50

### Effects of acid rain

Acid rain causes a number of harmful effects below pH 5.1. The effects are visible in the aquatic system even at pH less than 5.5. It causes deterioration of buildings especially made of marble e.g. monuments like Taj Mahal. Crystals of calcium and magnesium sulphate are formed as a result of corrosion caused by acid rain.

It damages stone statues. Priceless stone statues in Greece and Italy have been partially dissolved by acid rain. It damages metals and car finishes. Aquatic life especially fish are badly affected by lake acidification. Aquatic animals suffer from toxicity of metals such as aluminium, mercury, manganese, zinc and lead which leak from the surrounding rocks due to acid rain. It results in reproductive failure, and killing of fish.

Many lakes of Sweden, Norway, Canada have become fishless due to acid rain. It damages foliage and weakens trees. It makes trees more susceptible to stresses like cold temperature, drought, etc. Many insects and fungi are more tolerant to acidic conditions and hence they can attack the susceptible trees and cause diseases.

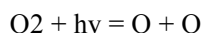
### Control of Acid Rain

Emission of SO<sub>2</sub> and NO<sub>2</sub> from industries and power plants should be reduced by using pollution control equipments. Liming of lakes and soils should be done to correct the adverse effects of acid rain. A coating of protective layer of inert polymer should be given in the interior of water pipes for drinking water.

## 4.23 OZONE LAYER DEPLETION

For the last 450 million years the earth has had a natural sunscreen in the stratosphere called the ozone layer. This layer filters out harmful ultraviolet radiations from the sunlight and thus protects various life forms on the earth. Ozone is a form of oxygen.

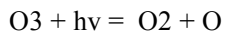
The molecule of oxygen contains two atoms whereas that of ozone contains three (O<sub>3</sub>). In the stratosphere ozone is continuously being created by the absorption of short wave-length ultraviolet (UV) radiations. Ultraviolet radiations less than 242 nanometers decompose molecular oxygen into atomic oxygen (O) by photolytic decomposition.



The atomic oxygen rapidly reacts with molecular oxygen to form ozone.



(M is a third body necessary to carry away the energy released in the reaction). Ozone thus formed distributes itself in the stratosphere and absorbs harmful ultraviolet radiations (200 to 320 nm) and is continuously being converted back to molecular oxygen.



Absorption of UV radiations results in heating of the stratosphere. The net result of the above reactions is an equilibrium concentration of ozone.

Ozone concentration in about 24 km of the stratosphere i.e. from 16 km to 40 Km away from earth is about 10 ppm (as compared to 0.05 ppm concentration of harmful troposphere ozone). This equilibrium is disturbed by reactive atoms of chlorine, bromine etc. which destroy ozone molecules and result is thinning of ozone layer generally called ozone hole.

The amount of atmospheric ozone is measured by **Dobson Spectrometer** and is expressed in **Dobson units (DU)**. One DU is equivalent to a 0.01 mm thickness of pure ozone at the density it would possess if it were brought to ground level (1atm) pressure.

Normally over temperate latitude concentration is about 350 DU, over tropics it is 250 DU whereas at sub polar regions (except when ozone thinning occurs) it is on an average 450 DU. It is because of the stratospheric winds which transport ozone from tropical towards polar regions.

### **Thinning of Ozone Layer**

The Antarctic ozone hole was discovered by Dr Joe C. Farman and his colleagues in the British Antarctic Survey who had been recording ozone levels over this region since 1957. During spring season of south pole i.e. September to November each year ozone depletion is observed. Steep decline has been observed since mid 1970s with a record low concentration of 90 DU in early October of 1993.

Chlorofluorocarbons (CFC) are mainly responsible for ozone depletion in the stratosphere. CFCs are a group of synthetic chemicals first discovered by Thomas Midgley Jr. in 1930. CFC-11 and CFC-12 are the CFCs most commonly used. CFCs are used as coolants in refrigerators and air conditioners, as propellants, cleaning solvents, sterilant and in styrofoam etc. CFCs released in the troposphere reach the stratosphere and remain there for 65-110 years destroying O<sub>3</sub> molecules.

In 1974, Rowland and Molina warned that CFC are lowering the concentration of ozone in the stratosphere and predicted severe consequences. It was in 1985 that scientists discovered that 50% (98% in some areas) of upper stratospheric ozone over Antarctica was destroyed during the Antarctic spring and early summer (September-December). At Antarctic region the temperature during winter drops to 90°C. The winds blowing in a circular pattern over earth's poles create polar vortices.

Water droplets in clouds when enter these vortices form ice crystals. CFCs get collected on the surfaces of these ice crystals and destroy ozone much faster. Similar destruction of ozone over North Pole occurs during Arctic spring and early summer (February-June). The depletion is 10-25% and it is less than that observed at South Pole. Nitrous oxide emitted by supersonic aircrafts, during combustion of fossil fuel and use of nitrogen fertilizers breaks ozone molecules.

Chlorine liberated from chlorofluorocarbons also break ozone molecules. The chain reaction started in Antarctic spring i.e. August/ September continues till nitrogen dioxide is liberated from nitric acid formed in the stratosphere by photolysis (breakdown by sunlight). Nitrogen dioxide combines with chlorine and stops further destruction of ozone.

### **Effects of Ozone Depletion**

Ozone depletion in the stratosphere will result in more UV radiation reaching the earth especially UV-B (290-320 nm). The UV-B radiations affect DNA and the photosynthetic chemicals. Any change in DNA can result in mutation and cancer. Cases of skin cancer (basal and squamous cell carcinoma) which do not cause death but cause disfigurement will increase.

Easy absorption of UV rays by the lens and cornea of eye will result in increase in incidents of cataract. Melanin producing cells of the epidermis (important for human immune system) will be destroyed by UV-rays resulting in immuno-suppression.

Fair people (can't produce enough melanin) will be at a greater risk of UV exposure. Phytoplanktons are sensitive to UV exposure. Ozone depletion will result in decrease in their population thereby affecting the population of zooplankton, fish, marine animals, in fact the whole aquatic food chain.

Yield of vital crops like corn, rice, soybean, cotton, bean, pea, sorghum and wheat will decrease. Degradation of paints, plastics and other polymer material will result in economic loss due to effects of UV radiation resulting from ozone depletion.

