ENVIRONMENTAL STUDIES
LECTURE NOTES

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UNIT-I

ENVIRONMENTAL SCIENCE INTRODUCTION AND NATURAL RESOURCES

1.1 INTRODUCTION

The word Environment is derived from the French word "Environ" which means "surrounding". Our surrounding includes biotic factors like human beings, Plants, animals, microbes, etc and abiotic factors such as light, air, water, soil, etc. Environment is a complex of many variables, which surrounds man as well as the living organisms.

Environment includes water, air and land and the interrelation ships which exist among and between water, air and land and human beings and other living creatures such as plants, animals and micro organisms. She suggested that environment consists of an inseparable whole system constituted by physical, chemical, biological, social and cultural elements, which are interlinked individually and collectively in myriad ways. The natural environment consist of four interlinking systems namely, the atmosphere, the hydrosphere, the lithosphere and the biosphere. These four systems are in constant change and such changes are affected by human activities and vice versa.

Components of Environment

Environment has been classified into four major components:

1. Hydrosphere,
2. Lithosphere,
3. Atmosphere,
4. Biosphere.

Hydrosphere includes all water bodies such as lakes, ponds, rivers, streams and ocean etc. Hydrosphere functions in a cyclic nature, which is termed as hydrological cycle or water cycle. Lithosphere means the mantle of rocks constituting the earth's crust. The earth is a cold spherical solid planet of the solar system, which spins in its axis and revolves around the sun at a certain constant distance.

Lithosphere mainly, contains soil, earth rocks, mountain etc. Lithosphere is divided into three layers-crusts, mantle and core (outer and inner). Atmosphere The cover of the air, that envelope the earth is known as the atmosphere.

Atmosphere is a thin layer which contains gases like oxygen, carbon dioxide etc. and which protects the solid earth and human beings from the harmful radiations of the sun. There are five concentric layers within the atmosphere, which can be differentiated on the basis of temperature and each layer has its own characteristics. These include the troposphere, the stratosphere, the mesosphere, the thermosphere and the exosphere.

Biosphere it is otherwise known as the life layer, it refers to all organisms on the earth's surface and their interaction with water and air. It consists of plants, animals and micro-organisms, ranging from the tiniest microscopic organism to the largest whales in the sea. Biology is

concerned with how millions of species of animals, plants and other organisms grow, feed, move, reproduce and evolve over long periods of time in different environments. Its subject matter is useful to other sciences and professions that deal with life, such as agriculture, forestry and medicine. The richness of biosphere depends upon a number of factors like rainfall, temperature, geographical reference etc. Apart from the physical environmental factors, the man made environment includes human groups, the material infrastructures built by man, the production relationships and institutional systems that he has devised. The social environment shows the way in which human societies have organized themselves and how they function in order to satisfy their needs.

UNIT-II

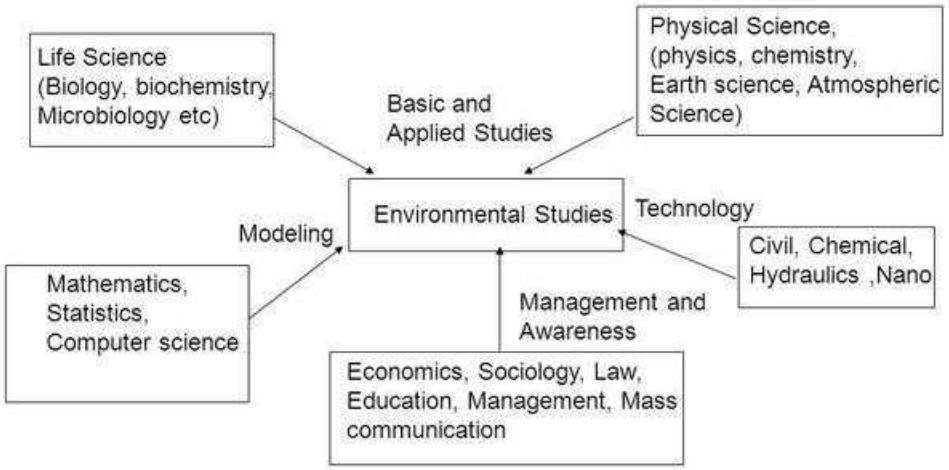
1.1.1 MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

Environmental science is an interdisciplinary academic field that integrates physical and biological sciences, (including but not limited to Ecology, Physics, Chemistry, Biology, Soil Science, Geology, Atmospheric Science and Geography) to the study of the environment, and the solution of environmental problems. Environmental science provides an integrated, quantitative, and interdisciplinary approach to the study of environmental systems.

Related areas of study include environmental studies and environmental engineering. Environmental studies incorporate more of the social sciences for understanding human relationships, perceptions and policies towards the environment. Environmental engineering focuses on design and technology for improving environmental quality.

Environmental scientists work on subjects like the understanding of earth processes, evaluating alternative energy systems, pollution control and mitigation, natural resource management, and the effects of global climate change. Environmental issues almost always include an interaction of physical, chemical, and biological processes.

The multidisciplinary nature of environmental science is illustrated in following diagram



1.1.2 SCOPE OF ENVIRONMENTAL SCIENCE

Because of environmental studies has been seen to be multidisciplinary in nature so it is considered to be a subject with great scope. Environment is not limited to issues of sanitation and health but it is now concerned with pollution control, biodiversity conservation, waste management and conservation of natural resources. This requires expert eyes and hence is creating new job opportunities. The opportunities in this field are immense not only for scientists but also for engineers, biologists. There is a good chance of opportunity to find a job in this field as environmental journalists. Environmental science can be applied in the following spheres:

Ecosystem Structure and Function

The study of ecosystems mainly consists of the study of the processes that link the leaving organism or in other words biotic component to the non-living organism or a biotic component. So for the study of environment we should aware with biotic and a biotic components.

Natural Resource Conservation

For managing and maintenance of forests which are natural resources and for the maintenance of wildlife forms task under natural resource conservation. It is also a scope of environmental studies

Environmental Pollution Control

With the knowledge of environmental science everybody can control the pollution. He/she can handle the waste management and also look for ways to control pollution on the aspect of pollution control.

Environmental management

There are several independent environmental consultants who are working with Central and State pollution control Board. They offer advice to solve the problems of environment the optimum solution for the upcoming problems. They give direction for controlling pollution due to industrial development. There are several current consultants who are working with government pollution control boobs, involved in policy making, pollution control and maintenance of ecological balance.

The scope of environmental studies in industry

Environmental scientist's work towards maintenance of ecological balance, they also work towards conservation of biodiversity and regulation of natural resources as well as on preservation of natural resources. Most of the industries have a separate environmental research and development section. These sections govern the impact that their industry has on the environment. Our environment is being degraded by the rapid industrialization. To combat this

menace there is a growing trend towards manufacture of "green" goods and products. So we can say that there is a good scope in the field of industry from environmental studies.

Research and development

Research and development have tremendous scope due to increment in public awareness regarding the environment. Various universities and governmental organizations offer a scope for such research. These universities conduct research studies in order to develop the methods toward monitoring and controlling the source of environmental pollution. Due to an increasing threat from global warming, many steps are being undertaken for the reduction of greenhouse gases and the adoption of renewable energy resources. They generate awareness now regarding the use of solar energy for variety of purposes. This provides scope of environmental history in the field of research and development.

Social Development

NGO (Nongovernmental organizations) help in creating awareness regarding the protection of the environment and making the masses aware of various environmental issues . They also generate a public opinion in this field. They work towards disseminating information and in bringing about changes in political policies that are personally effect the environment. The social dimension of this profession includes controlling population explosion through organizing advisory awareness camps.

1.1.3 IMPORTANCE OF ENVIRONMENT SCIENCE

The environment studies enlighten us, about the importance of protection and conservation of our indiscriminate release of pollution into the environment.

Environment science has become significant for the following reasons:

1. Environment Issues Being of International Importance

It has been well recognized that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.

2. Problems Cropped in the Wake of Development

Development, in its wake gave birth to Urbanization, Industrial Growth, and Transportation Systems, Agriculture and Housing etc. However, it has become phased out in the developed World. The North, to cleanse their own environment has fact fully, managed to move ‘dirty’ Factories of South. When the West developed, it did so perhaps in ignorance of the Environmental impact of its activities. Evidently such a path is neither practicable nor desirable, even if developing world follows that.

3. Explosively Increase in Pollution

World census reflects that one in every seven persons in this planted lives in India. Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soils health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

4. Need to Save Humanity from Extinction

It is incumbent upon us to save the humanity from extinction. Consequent to our activities Constricting the environment and depleting the biosphere, in the name of development.

5. Need for Wise Planning of Development

Our survival and sustenance depend. Resources withdraw, processing and use of the product have all to by synchronized with the ecological cycles in any plan of development our actions should be planned ecologically for the sustenance of the environment and development.

1.1.4 NEED FOR PUBLIC AWARENESS

It is essential to make the public aware of the formidable consequences of the Environmental Degradation, if not retorted and reformative measures undertaken would result in the extinction of life. We are facing various environmental challenges. It is essential to get the country acquainted with these challenges so that their acts may be eco-friendly.

Some of these challenges are as under:

1. Growing Population

A population of over thousands of millions is growing at 2.11 per cent every year. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does automatically lead to development, yet the development leads to a decrease in population growth rates. For this development of the women is essential.

2. Poverty

India has often been described a rich land with poor people. The poverty and environmental degradation have a nexus between them. The vast majority of our people are directly dependent on the nature resources of the country for their basic needs of food, fuel shelter and fodder. About 40% of our people are still below the poverty line. Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge environment degradation are two facets of the same challenge. The population growth is essentially a function of poverty. Because, to the very poor, every child is an earner and helper and global concerns have little relevance for him.

3. Agricultural Growth

The people must be acquainted with the methods to sustain and increase agricultural growth with damaging the environment. High yielding varieties have caused soil salinity and damage to physical structure of soil.

4. Need to Ground water

It is essential of rationalizing the use of groundwater. Factors like community wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies as lakes are an important challenge. It so finding our suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean which are difficult challenges is essential.

5. Development and Forests

Forests serve catchments for the rivers. With increasing demand of water, plan to harness the mighty river through large irrigation projects were made. Certainly, these would submerge forests; displace local people, damage flora and fauna. As such, the dams on the river Narmada, Bhagirathi and elsewhere have become areas of political and scientific Debate.

1.2 NATURAL RESOURCES

The word resource means a source of supply. The natural resources include water, air, soil, minerals, coal, forests, crops and wildlife are examples. All the resources are classified based on quantity, quality, re-usability, men's activity and availability.

Natural resources are naturally occurring substances that are considered valuable in their relatively unmodified (natural) form. A natural resource's value rests in the amount of the material available and the demand for it. The term was introduced to a broad audience by E.F. Schumacher in his 1970s book Small is Beautiful.

a) Renewable resource or inexhaustible resources

The renewable resources can maintain themselves or can be replaced if managed wisely. These resources are constantly renewed in nature. The renewable resources are therefore not likely to be lost due to excessive and unwise use.

b) Non-renewable resources or exhaustible resources

These resources once used are lost forever, as they are not restored. They include metallic minerals and fossil fuels. At current rates of usage, all the industrial metals may lose for less than a century and those of petroleum and natural gas may exhaust in 15-20 years.

Natural Resources and Associated Problems

Human population is growing day-by-day. Continuous increase in population caused an increasing demand for natural resources. Due to urban expansion, electricity need and industrialization, man started utilizing natural resources at a much larger scale. Non-renewable resources are limited. They cannot be replaced easily. After some time, these resources may come to an end. It is a matter of much concern and ensures a balance between population growth and utilization of resources. This overutilization creates many problems. In some regions there

are problems of water logging due to over irrigation. In some areas, there is no sufficient water for industry and agriculture. Thus, there is need for conservation of natural resources.

There are many problems associated with natural resources:

Forest resources and associated problems

1. Use and over-exploitation.
2. Deforestation.
3. Timber extraction.
4. Mining and its effects on forest.
5. Dams and their effects on forests and tribal people.

Water resources and associated problems

1. Use and overutilization of water.
2. Floods, droughts etc.
3. Conflicts over water.
4. Dams and problems.

Mineral resource and associated problems

1. Use and exploitation.
2. Environmental effects of extracting and using minerals.

Food resources and associated problems

1. World food problems.
2. Changes caused by agriculture and over grazing.
3. Effects of modern agriculture.
4. Fertilizer-pesticide problems.
5. Water logging and salinity.

Energy resources and associated problems

1. Growing energy needs.

Land resources and associated problems

1. Land degradation.
2. Man-induced landslides.
3. Soil erosion and desertification.

1.3 FOREST RESOURCES

Forests are one of the most important natural resources and a part of biosphere since these are natural assets on this earth. Forests predominantly composed of trees, shrubs, woody vegetation etc… Approximately 1/3rd of the earth's total land area is covered by forests. Forests are important ecologically and economically. Ecologically forests are to be considered as earth's lungs because they consume CO_2 and release O_2which is required for sustaining the life on this earth. The poisonous gas CO_2 is absorbed by the trees of forests and reduces the global warming and helps to continue hydrological cycle, reduce soil erosion. Forest ecosystems are extremely good & hold a good quantity of water.

Economically forests provide timber, fodder to grazing animals, firewood(conventional fuel), bamboos, rubbers, medicines, gums, resins, food items etc.

USES OF FOREST

1. Watershed protection:

• Reduce the rate of surface run-off of water.

• Prevent flash floods and soil erosion.

• Produces prolonged gradual run-off and thus prevent effects of drought.

2. Atmospheric regulation:

• Absorption of solar heat during evapo-transpiration.

• Maintaining carbon dioxide levels for plant growth.

• Maintaining the local climatic conditions.

3. Erosion control:

• Holding soil (by preventing rain from directly washing soil away).

4. Land bank:

• Maintenance of soil nutrients and structure.

5. Local use - Consumption of forest produce by local people who collect it for subsistence – (Consumptive use)

• Food - gathering plants, fishing, hunting from the forest. (In the past when wildlife was Plentiful, people could hunt and kill animals for food. Now those populations of most Wildlife species have diminished; continued hunting would lead to extinction.)

• Fodder - for cattle.

• Fuel wood and charcoal for cooking, heating.

• Poles - building homes especially in rural and wilderness areas.

• Timber – household articles and construction.

• Fiber - weaving of baskets, ropes, nets, string, etc.

• Sericulture – for silk.

• Apiculture - bees for honey, forest bees also pollinate crops.

• Medicinal plants - traditionally used medicines, investigating them as potential Source for new modern drugs.

6. Market use - (Productive use)

• Most of the above products used for consumptive purposes are also sold as source of income for supporting the livelihoods of forest dwelling people.

• Minor forest produce - (non-wood products): Fuel wood, fruit, gum, fiber, etc.which are Collected and sold in local markets as a source of income for forest dwellers.

• Major timber extraction - construction, industrial uses, paper pulp, etc. Timber extraction is done in India by the Forest Department, but illegal logging continues in many of the forests of India and the world.

OVER EXPLOITATION OF FORESTS

Forest has been known to possess huge potential for human use and they have been exploited since early times for their vast potential. Exploitation of forest has taken place to meet human demands in the following ways:

- Due to wood cutting and large scale logging for raw materials like timber, pulp wood, fuel wood etc
- Deforestation due to road construction
- Clearing of forest to create more agricultural lands to meet the food needs of growing population
- Encroachment of forests leading to destruction of about 19.57 lakh hectares (2013)of forest in the country
- About 78% of forest area is under heavy grazing
- Mining activities leads to clearing of forests
- Big hydro electric projects result in large scale destruction of forest

In India, **Joint forest management** has come up as innovative approach involving community participation so that the rural economy is strengthened as well as forest resources are conserved through public involvement

DEFORESTATION

Deforestation is the permanent destruction of indigenous forests and woodlands. The term does not include the removal of industrial forests such as plantations of gums or pines. Deforestation has resulted in the reduction of indigenous forests to four-fifths of their pre-agricultural area. Indigenous forests now cover 21% of the earth's land surface. Deforestation refers to the loss of forest cover (or) the aimless destruction of trees. The clearing of forests across the earth has been occurring on a large scale basis for many centuries. This process involves the cutting down, burning and damaging of forests. Currently 12 million hectares of forests are cleared annually and the current rate of deforestation continues, the world's forests will vanish within the next 100 years about 80% of the original forests on the earth have already been cleared.

Major causes of Deforestation:

a. **Shifting cultivation** : There are an estimated 300 million people living as shifting cultivators who practice slash and burn agriculture and are supported so clear more than 5 lakh ha of forests for shifting cultivation annually. In India, we have this practice of North-East and to some extent in Andhra Pradesh, Bihar and M.P. which contribute to nearly half of the forest clearing annually.

b. **Fuel requirements**: Increasing demands for fuel wood by the growing population in India alone has shooted up to 300-500 million tons in 2001 as compared to just 65 million tons during independence, thereby increasing the pressure on forests.

c. **Raw materials for industrial use**: Wood for making boxes, furniture, railway-sleepers, plywood, match boxes, pulp for paper industry etc. have exerted tremendous pressure on forests. Plywood

is in great demand for packing tea for Tea industry of Assam while fir tree wood is exploited greatly for packing apples in J & K.

d. **Development projects**: Massive destruction of forests occurs for various development projects like hydroelectric projects, big dams, road construction, mining etc.

e. **Growing food needs**: In developing countries this is the main reason for deforestation. To meet the demands of rapidly growing population, agricultural lands and settlements are created permanently by clearing forests.

f. **Overgrazing:** The poor in the tropics mainly rely on wood as a source of fuel leading to loss of tree cover and the cleared lands are turned into the grazing lands. Overgrazing by the cattle leads to further degradation of these lands.

g. Conversion of forests and woodlands to agricultural land to feed growing numbers of people

Major activities and threats to Forests resources:

1. Timber Extraction: Logging for valuable timber, such as teak and Mahogany not only involves a few large trees per hectare but about a dozen more trees since they are strongly interlocked with each other a by vines etc. Also road construction for making approach to the trees causes further damage to the forests. The steps in timber extraction are:

a) Clear felling
b) Mechanized logging
c) Manual logging
d) Selective logging

2. Mining: Mining operations for extracting minerals and fossil fuels like coal often involves vast forest areas. Mining from shallow deposits is done by surface mining while that from deep deposits is done by sub-surface mining. More than80000 ha of land of the country is presently under the stress of mining activities. Mining and its associated activities require removal of vegetation along with underlying soil mantle and overlying rock masses. This results in defacing the topography and destruction of the landscape in the area. Large scale deforestation has been reported in Mussorie and Dehradun valley due to indiscriminating mining of various minerals over a length of about 40 Km.

DAMS AND OTHER EFFECTS ON FOREST AND TRIBAL PEOPLE

Forest are directly are indirectly effected by the forest. Hydro-electric dams are main cause for deforestation. About 40,000 large dams are currently obstructing Workloads Rivers. Destruction of forest occurs for constructing big dams, which alters ecological balance. In these way landslides, droughts and floods conditions may rise in area. Socio-economic problems related to tribal and native people results from big dam construction

Dam construction produces a number of health hazards. Thousands of workers who build the dams attacked by the diseases like AIDS, measles, tuberculosis, syphilis etc. Dam building has resulted in wide range human rights violations. Rehabilitation policy of the government is

important and typical when most of the displaced persons are tribal people. Tribal life and culture are mostly associated with forest

CASE STUDIES:

Chipko movement related to mining or quarrying opposed by SundarlalBahuguna in North India. The first Chipko action took place spontaneously in April 1973 and over the next five years spread to many districts of the Himalaya in Uttar Pradesh. The name of the movement comes from a word meaning 'embrace': the villagers hug the trees, saving them by interposing their bodies between them and the contractors' axes. The Chipko protests in Uttar Pradesh achieved a major victory in 1980 with a 15-year ban on green felling in the Himalayan forests of that state by order of India's then Prime Minister, Indira Gandhi. Since then the movement has spread to Himachal Pradesh in the North, Kamataka in the South, and Rajasthan in the West, Bihar in the East and to the Vindhyas in Central India. In addition to the 15-year ban in Uttar Pradesh, the movement has stopped clear felling in the Western Ghats and the Vindhyas and generated pressure for a natural resource policy which is more sensitive to people's needs and ecological requirements.
Sardar Sarovar – Narmada project is a multipurpose project in Gujarat

1.4 WATER RESOURCES

Water resources are sources of water that are useful or potentially useful. Uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually all of these human uses require fresh water.

Distribution of water on earth:

- 97% of the water on the Earth is salt water. Only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice. The remaining unfrozen freshwater is found mainly as groundwater, with only a small fraction present above ground or in the air

Fresh water occurs mainly in two forms
1. Ground water and 2. Surface water

1. Groundwater: About 9.86% of the total fresh water resources is in the form of groundwater and it is about 35-50 times that of surface water supplied

USES OF WATER:

1. DOMESTIC USE: Water used in the houses for the purposes of drinking, bathing, washing Clothes, cooking, sanitary & other needs. The recommended value according to Indian standard specification for domestic use is 135 liters/day
2. INDUSTRIAL USE: Water is required for various industries such as cement, mining, textile, leather industries.
3. PUBLIC USE: This includes water used for public utility purpose such as watering parks, Flushing streets, jails etc.
4. FIRE USE: Water is used in case of accidents and to prevent the fire issues.

5. IRRIGATION: To grow crops which is the main sources for food?
6. OTHER USES: Hydro electric power generation requires water.

OVER UTILIZATION OF GROUND WATER AND SURFACE WATER

Over use of groundwater has following effects.

1. **Lowering of water table:** Excessive use of ground water for drinking, irrigation and Domestic purposes has resulted in rapid depletion of ground water in various regions leading to lowering of water table & drying of wells.

The reasons for shortage of water are:

a. Increase in population,
b. Increasing demand of water for various purposes.
c. Unequal distribution of fresh water.
d. Increasing pollution of water sources cause over exploitation.

2. **Ground subsidence:** When ground water withdrawal is greater than its recharge rate, the sediments in the aquifer become compacted. This is called ground subsidence which may cause damage of buildings, destroy water supply systems etc.

3. **Drought. A drought** is an extended period of months or years when a region notes a deficiency in its water supply whether surface or underground water. Generally, this occurs when a region receives consistently below average precipitation.

We can define drought in four main ways:

a) Meteorological drought: related to rainfall amounts
b) Hydrological drought: determined by water levels in reservoirs
c) Agricultural drought: related to the availability of water for crops
d) Socioeconomic Drought: related to demand and supply of economic goods

a) Meteorological Drought: Meteorological drought is generally defined by comparing the rainfall in a particular place and at a particular time with the average rainfall for that Place. The definition is, therefore, specific to a particular location. Meteorological drought leads to a depletion of soil moisture and this almost always has an impact on crop production.

b) Hydrological Drought: Hydrological drought is associated with the effect of low rainfall on water levels in rivers, reservoirs, lakes and aquifers. Hydrological droughts usually are noticed some time after meteorological droughts. First precipitation decreases and, Sometime after that, water levels in rivers and lakes drop.

C) Agricultural Drought: Agricultural drought mainly effects food production and farming. Agricultural drought and precipitation shortages bring soil water deficits, reduced ground water or reservoir levels, and so on. Deficient topsoil moisture at planting may stop germination, leading to low plant populations.

d) Socioeconomic Drought: Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply. The supply of many economic goods, such as water, forage, food grains, fish, and hydroelectric power, depends on weather. Due to variability of climate, water supply is sufficient in some years but not satisfactory to meet human and environmental needs in other year

FLOODS

A **flood** is an overflow of water that submerges land which is normally dry. The European Union (EU) Floods Directive defines a flood as a covering by water of land not normally covered by water. Flooding may occur as an overflow of water from water bodies, such as a river or lake, in which the water overtops or breaks, resulting in some of that water escaping its usual boundaries, or it may occur due to an accumulation of rainwater on saturated ground in an area flood. Floods can also occur in rivers when the flow rate exceeds the capacity of the river channel, particularly at bends in the waterway. Floods often cause damage to homes and businesses if they are in the natural flood plains of rivers.

CONFLICTS OVER WATER

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

A wide range of water conflicts appear throughout history, though rarely are traditional wars waged over water alone. Instead, water has historically been a source of tension and a factor in conflicts that start for other reasons. However, water conflicts arise for several reasons, including territorial disputes, a fight for resources, and strategic advantage.

These conflicts occur over both freshwater and saltwater, and between international boundaries. However, conflicts occur mostly over freshwater; because freshwater resources are necessary, yet limited, they are the center of water disputes arising out of need for potable water. As freshwater is a vital, yet unevenly distributed natural resource, its availability often impacts the living and economic conditions of a country or region. The lack of cost-effective water desalination techniques in areas like the Middle East, among other elements of water crises can put severe pressures on all water users

According to the 1992 International Conference on Water and the Environment, Water is a vital element for human life, and any human activity relates somehow to water. Unfortunately, it is not a renewable resource and in the future it "might get worse with climate change

Water conflicts occur because the demand for water resources and potable water extend far beyond the amount of water actually available. Elements of a water crisis may put pressures on affected parties to obtain more of a shared water resource, causing diplomatic tension or outright conflict.

The Cauvery water dispute: Out of Indias 18 major rivers, 17 are shared between different states. In all these cases, there are intense conflicts over these resources which badly seem to resolve. The Cauvery river water is a born of contention between tamilnadu and Karnataka and the problem is almost hundred years old. Tamilnadu occupying the downstream region of the river wants water-use regulated in the upstream state Karnataka refuses to do so and claims its privacy over the river as upstream user. The river water is almost fully utilized and both the

states having increasing demands for agriculture and industry. The consumption is more in Tamilnadu than Karnataka where the catchment area is rockier. On June 2, 1990, the Cavery Water dispute tribunal was set up which through an interim award directed Karnataka to ensure that 205 TMCF of water was made available in Tamilnadus mettur dam every year, till a settlement was reached. In 1991-92 due to good monsoon, there was no disputr as there was good stock of water in Mettur , but in 1995, the situation turned into a crisis due to delayed rains and an expert committee was set up to look into the matter which found there was a complex cropping pattern in Cauvery basin. Sambra paddy in winter, Kurvai paddy in summer and some cash crops demanded intensive water, thus aggravating the water crisis. Proper selection of crop varieties, optimum use of water, better rationing and rational sharing patterns, and pricing of water are suggested as some measures to solve the problem.

DAMS-BENEFITS AND PROBLEMS

Today there are more than 45,000 large dams around the world, which play an important role in communities and economies that harness these water resources for their economic development. Current estimates suggest some 30-40% of irrigated land worldwide relies on dams. Hydropower, another contender for the use of stored water, currently supplies 19% of the world's total electric power supply and is used in over 150 countries. The world's two most populous countries – China and India – have built around 57% of the world's large dams.

BENEFITS:

River valley projects with big dams have usually been considered to play a key role in the development process due to their multiple uses. India has the distinction of having the largest number of river valley projects. The tribal's living in the area pin big hopes on these projects as they aim at providing employment and raising the standard and quality of life. The dams have tremendous potential for economic upliftment and growth. They can help in checking floods and famines, generate electricity and reduce water and power shortage, provide irrigation water to lower areas, provide drinking water in remote areas and promote navigation, fishery etc

PROBLEMS:

- Fragmentation and physical transformation of rivers.
- Serious impacts on riverine ecosystems.
- Social consequences of large dams due to displacement of people.
- Water logging and Stalinization of surrounding lands.
- Dislodging animal populations, damaging their habitat and cutting off their migration routes.
- Fishing and travel by boat disrupted.

Large dams have had serious impacts on the lives, livelihoods, cultures and spiritual existence of indigenous and tribal peoples. They have suffered disproportionately from the negative Impacts of dams and often been excluded from sharing the benefits. In India, of the 16 to 18 million people displaced by dams, 40 to 50% were tribal people, who account for only 8% of our nation's one billion people.

1.5 MINERAL RESOURCES

A mineral is a naturally occurring substance of definite chemical composition and identifiable physical properties. An ore is a mineral or combination of minerals from which a useful substance, such as a metal, can be extracted and used to manufacture a useful product.

The geological processes are caused for the formation of the minerals over millions of years ago in the earth's crust. Minerals are generally localized in occurrence and the deposits are very sporadic in distribution. Mineral resources are non renewable and the mineral /ore is extracted by the process of mining.

Iron, aluminum, zinc, manganese and copper are important raw materials for industrial use. Important non-metal resources include coal, salt, clay, cement and silica. Stone used for building material, such as granite, marble, limestone, constitute another category of minerals. Minerals with special properties that humans value for their aesthetic and ornamental value are gems such as diamonds, emeralds and rubies. The luster of gold, silver and platinum is used for ornaments. Minerals in the form of oil, gas and coal were formed when ancient plants and animals were converted into underground fossil fuels.

Uses of minerals:

Minerals are used in a large number of ways for domestic, industrial, commercial
Sectors etc…

1. Generation of energy by using coal (lignite / anthracite); uranium, gold, silver, platinum, diamond are used in jewellery. Copper, aluminum etc are used as cables for transmission of power.
2. Some of the minerals are used in ayurvedam as medicine.

Gold is reputed to strengthen the heart muscle and increase energy and stamina.

Mining and its Process:

Minerals and their ores need to be extracted from the earth's interior so that they can be used. This process is known as mining. **Mining** is the extraction of valuable minerals or other geological materials from the earth, from an ore body, lode, vein, (coal) seam or reef, which forms the mineralized horizon and package of economic interest to the miner.

Mining operations generally progress through four stages:

(1) Prospecting: Searching for minerals.
(2) Exploration: Assessing the size, shape, location,
(3) Development: Work of preparing access to the deposit so that the minerals can be extracted from it.
(4) Exploitation : Extracting the minerals from the mines.

Types of mining:

The method of mining has to be determined depending on whether the ore or mineral deposit is nearer the surface or deep within the earth. The topography of the region and the Physical nature of the ore deposit is studied. Mines are of two types

a) Surface (open cut or strip mines)
b) Deep or shaft mines.

a) Surface Mining: Surface mining is used to obtain mineral ores that are close to Earth's Surface. The soil and rocks over the ore are removed by blasting. Typically, the remaining ore is drilled or blasted so that large machines can fill trucks with the broken rocks. The trucks take the rocks to factories where the ore will be separated from the rest of the rock. Surface mining includes open-pit mining, quarrying, and strip mining.

1) Open-pit mining creates a big pit from which the ore is mined. The size of the pit grows until it is no longer profitable to mine the remaining ore.

2) Strip mines are similar to pit mines, but the ore is removed in large strips.

3) A quarry is a type of open-pit mine that produces rocks and minerals that are used to make buildings.

b) Underground Mining: Underground mining is used for ores that are deep in Earth's surface. For deep ore deposits, it can be too expensive to remove all of the rocks above the ore. Underground mines can be very deep. The deepest gold mine in South Africa is more than 3,700 meters deep (that is more than 2 miles)! There are various methods of underground mining. These methods are more expensive than surface mining because tunnels are made in the rock so that miners and equipment can get to the ore. Underground mining is dangerous work. Fresh air and lights must also be brought in to the tunnels for the miners. Miners breathe in lots of particles and dust while they are underground. The ore is drilled, blasted, or cut away from the surrounding rock and taken out of the tunnel

Environmental effects:

Mineral extraction and processing in mines involves a negative impact on environment. Much risk is involved in mining process because of high temperature, pressure Variations, fire hazards and lack of ventilation in mines.

- Mining process involves removal of over burden of soil, ore extraction & transportation, crushing & grinding of ore, water treatment of ore, storage of waste material. As a result of these activities cause air pollution, noise pollution, water pollution, loss of habitat of wildlife, concentration of toxic substances in tailing ponds and spreading of dust.
- People working in mines often suffer from serious respiratory system and skin diseases.
- Mining often causes ground subsidence which results in tilting of buildings, cracks in houses, buckling of roads, bending of rail tracks etc.
- Exploration process before a mining involves, geochemical, geophysical surveys Drilling activities which causes for air pollution, noise pollution etc...
- In addition, disturbance of all vegetation (flora) and fauna (animals) from that a region.
- **Acid mine drainage** (AMD), or **acid rock drainage** (ARD): The outflow of acidic water from (usually abandoned) metal mines or coal mines. However, other areas where the earth has been disturbed (e.g. construction sites, subdivisions, transportation corridors, etc.) may also contribute acid rock drainage to the environment

1.6 FOOD RESOURCES

The main sources of human food are plants and animals. Human beings consume almost all parts of plants in the form of **cereals** (wheat, barley, millet, rye, oats, maize, corn, rice etc.); **pulses** (peas, red grams, green grams); **vegetables** (carrot, cauliflower, beans); **fruits** (banana, orange, grapes, pineapple) and **spices** (pepper, cloves). Also a number of products such as milk, butter, egg and meat supplement the requirements.

WORLD FOOD PROBLEMS

Since world's population is growing every year and the demand of food is also increasing continuously. Although world's food production has increased almost three times during the last 50 years, but at the same time rapid population growth outstripped the food production. So, the world food problem is a complex one depending on food production, population increase, the prevalence of poverty and environmental impacts.

Famines are due to lack of access to food but not lack of food. Modern agriculture is largely based upon technological factors like the use of improved seeds, chemical fertilizers, synthetic pesticides etc…

The **green revolution** however changed traditional agricultural practices with a rapid increase in food production in developing countries. An American agricultural scientist, **Norman Borlaug** developed a high yielding variety of wheat through new concepts in plant breeding. By the mid 1960's, the green revolution was fully adopted in India.

CHANGES CAUSED BY AGRICULTURE AND OVER GRAZING

CHANGES CAUSED BY AGRICULTURE

There are two types of agricultural systems:
(1) Traditional system and (2) Modern and Industrialized system

(1) Traditional system:
The traditional system is again subdivided into two types namely:
(a) **Traditional Subsistence Agriculture** (TSA): In this system, only enough crops or livestock Are produced for the use of family and a little surplus to sell to meet the needs.
(b) **Traditional Intensive Agriculture**(TIA):Farmers increase their inputs of human labor, Water fertilizers to get higher yields for the use of their families and to sell small quantities for getting income.

(2) **Modern and industrialized system:** In the system of **modern and industrialized agriculture**, a large extent of land will be brought under agriculture and huge quantities of fuel, energy,
water, chemical fertilizers, pesticides used to produce large quantities of single crops purely for sale. This system is spreading in India in the name of Green revolution. But this modern agricultural system has its own adverse effects on environment.

a. Excessive use of chemical fertilizers to boost up the crop yield, contaminate groundwater with nitrate. The presence of excess of nitrate in drinking water is dangerous for human Health. Excess Nitrate reacts with hemoglobin and causes for "Blue **Baby Syndrome**" which kill the infants.

b. The excessive N P K fertilizers in agriculture fields are often washed off with water and leads to **algal blooming** and **Eutrophication. Phosphates** have been accumulating in soils, lake sediments for decades change the ecology. Increased levels of phosphates in water bodies cause Eutrophication (growth of unwanted plants).

c. The excessive use of pesticides enters the food chain and become hazardous to human life.

d. A large area of fertile land has become saline in recent years due to excessive irrigation.

e. Consumption of fuel energy is more when shifting of human and animal labour to agriculture machinery. Use of fuel leads to air pollution.

f. Continuing to increase input of fertilizers, water and pesticides eventually produces no Additional increase in crop yield but slows down the productivity of the crop.

g. Due to increased irrigation, the underground **aquifers are slowly and constantly become dry**. The rate at which they are being depleted is much faster than its recharge.

h. Excessive application of chemical fertilizers can increase soil **salt content**. The percolation of domestic and industrial sewage also increase the salinity of soil.

i. The stagnation of water in the soil in the upper layers causes for **water logging** which Causes for less oxygen availability for respiration of plants.

Modern, intensive agriculture causes many problems, including the following:

- Artificial fertilizers and herbicides are easily washed from the soil and pollute rivers, lakes and Water courses.
- The prolonged use of artificial fertilizers results in soils with a low organic matter content Which is easily eroded by wind and rain?
- Dependency on fertilizers. Greater amounts are needed every year to produce the same Yields of crops.
- Artificial pesticides can stay in the soil for a long time and enter the food chain where they build up in the bodies of animals and humans, causing health problems.
- Artificial chemicals destroy soil micro-organisms resulting in poor soil structure and aeration and decreasing nutrient availability.
- Pests and diseases become more difficult to control as they become resistant to artificial Pesticides. The numbers of natural enemies decrease because of pesticide use and habitat loss.

WATER LOGGING

Water logging refers to the saturation of soil with water. Soil may be regarded as waterlogged when the water table of the groundwater is too high to conveniently permit an anticipated activity, like agriculture. In agriculture, various crops need air (specifically, oxygen) to a greater or lesser depth in the soil. Water logging of the soil stops air getting in. How near the water table must be to the surface for the ground to be classed as waterlogged varies with the purpose in view. A crop's demand for freedom from water logging may vary between seasons of the year, as with the growing of rice (Oryza sativa).

In irrigated agricultural land, water logging is often accompanied by soil salinity as waterlogged soils prevent leaching of the salts imported by the irrigation water

SALINITY

Soil salinity is the salt content in the soil; the process of increasing the salt content is known as salinization. Salt is a natural element of soils and water. Salinization can be caused by natural processes such as mineral weathering or the gradual withdrawal of an ocean. It can also be caused by artificial processes such as irrigation

Salinization is a process that results from:

- High levels of salt in the water.

- Landscape features that allow salts to become mobile(movement of water table).
- Climatic trends that favors accumulation.
- Human activities such as land clearing, aquaculture activities and the salting of icy roads.

CHANGES CAUSED BY OVER GRAZING

Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. It can be caused by either livestock in poorly managed agricultural applications, or by overpopulations of native or native wild. Overgrazing reduces the usefulness, productivity, and biodiversity of the land and is one cause of desertification and erosion. Overgrazing is also seen as a cause of the spread of invasive species of non-native plants and of weeds. Overgrazing typically increases soil erosion. Reduction in soil depth, soil organic matter and soil fertility impair the land's future natural and agricultural productivity. Soil fertility can sometimes be mitigated by applying the appropriate lime and organic fertilizers. However, the loss of soil depth and organic matter takes centuries to correct. Their loss is critical in determining the soil's water-holding capacity and how well pasture plants do during dry weather.

1.7 ENERGY RESOURCES

Energy is defined by physicists as the capacity to do work. Energy is found on ourplanet in a variety of forms, some of which are immediately useful to do work, while others require a process of transformation. Energy can neither be created nor destroyed but transformed from one form to other. Energy is closely related to force. When a force causes an object to move, energy is being transferred from the force to kinetic energy. Energy is present in a number of forms such as mechanical, thermal, chemical, biological energy etc.. Energy production and utilization have become essential to carry out many activities in modern life. Energy is one of the important requirements that a country needs for its economic growth. At the same time, energy production has its impact on environment due to pollution and finally affects the quality of life of people.

GROWING ENERGY NEEDS

Energy plays a key role in the process of economic growth of a nation. The industrial development of any country is dependent on the organized development of its power resources'.

Energy is also indispensable for agriculture, transport, business and domestic requirements. In fact, electricity has such a wide range of applications in modern economic development that its per capita consumption is, to a great extent, an index of the material advancement of the country.

Energy is the capacity for doing useful work. It is an essential input for economic growth. This energy is used in the form of electrical energy, thermal energy, light, mechanical energy and chemical energy etc.

Energy is measured in joules in Si units. The annual per capita energy consumption in developed countries ranges from 5 to 11 kW whereas in the developing countries it is between 1 to 1.5 KW Only

Uses of Energy

1. Energy is a primary input in any industrial operation.

2. It is also a major input in sectors such as commerce, transport, tele-communications etc.

3. The wide range of services required in the household and industrial sectors.

4. Owing to the far-reaching changes in the forms of energy and their respective roles in supporting human activities, research and training on various aspects of energy and environment have assumed great significance.

Types of energy: There are three main types of energy;
A. **Non-renewable B. Renewable C.Nuclear energy**

A. Non – renewable energy resources

Fossil fuels: Fossil means the remains of an animal or a plant which have become hard and turned into rock. All these found in earth's crusts which have been formed in the past by the geological processes. Fossil fuels are solid coal (lignite), liquid (crude oil / petroleum) and gases (natural gas).

a) Coal***:*** Huge quantity of plant materials buried under earths crust and altered by geological process and converted into carbon rich fuel. It is a non – renewable source because it takes a very long period (million of years) for its formation.

Coal is extracted by the process of mining and involves accidents due to mine collapse, ground water pollution, accumulation of poisonous material, explosive gases etc cause diseases. CO2 pollution leads to green house effect (global warming).

b) Crude oil***:*** It is obtained in the form of liquid . The crude oil is heated up to 600^{o}C in the oil refinery and condense the vapours of hydro – carbons. Petrol another petroleum products are refined fuels from crude oil. Petroleum products are used in large quantities in the manufacture of detergents, plastics, fertilizers, pharmaceuticals, synthetic rubber etc.. The transport sector consumes about 40% of diesel; 25% industries and 19%household and rest 16% agriculture and other sectors. .

c) Natural Gas: Gas deposits are trapped from the sedimentary formations by means drilling holes into the rock formations. While burning of natural gas, the emission of CO2 is less and thus reduces green house effect and global warming. A total of 734 billion cubic mts of gas is estimated as proven reserves.

B. Renewable energy resources: Renewable energy systems use resources that are constantly replaced and are usually less polluting.

Examples include hydropower, solar, wind, and geothermal (energy from the heat inside the earth).

1. Solar energy: The energy which is derived from the sun is known as solar energy. It can be used for direct heating or sun's heat is converted into electricity. Photo voltaic cells convert direct solar energy into electricity.

A number of solar equipments have been developed to utilize sun rays to heat water, to cook food, to pump water and to run certain machines and used for street lighting, railway signals etc. But the major problem with solar energy is that during cloudy weather it is available in less quantity than on sunny days.

How Solar Power Works

The sun's energy can be captured to generate electricity or heat through a system of panels or mirrors.

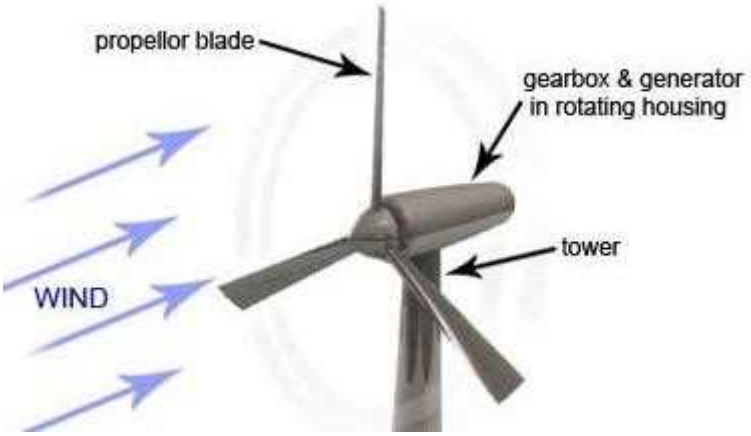
- Solar, or photovoltaic, cells convert sunlight directly into electricity. Most photovoltaic cells are made primarily of silicon, the material used in computer semiconductor chips, and arranged on rectangular panels. When sunlight hits a cell, the energy knocks electrons free of their atoms, allowing them to flow through the material. The resulting DC (direct current) electricity is then sent to a power inverter for conversion to AC (alternating current).
- Solar thermal collectors use heat-absorbing panels and a series of attached circulation tubes to heat water or buildings.
- Solar concentration systems use mirrors -- usually arranged in a series of long, parabolic troughs, a large round dish, or a circle surrounding a "power tower" -- to focus the sun's reflected rays on a heat-collecting element. The concentrated sunlight heats water or a heat-transferring fluid such as molten salt to generate steam, which is then used conventionally to spin turbines and generate electricity.
- Passive solar design is the creative use of windows, skylights and sunrooms, building site and orientation, and thermal construction materials to heat and light buildings, or to heat water, the natural way.

2. Hydro-Power energy: Electrical power is generated by hydro-electric projects in which dams are constructed across the river. The kinetic energy of water is converted into mechanical energy by means of turbines and in turn, the mechanical energy is transferred into electrical energy by generators. Hydro power projects lead to several environmental problems like destruction of animal habitats, deforestation, migration of people etc..

3. Geothermal energy: Geothermal energy found within rock formations. Inside the earth the temperature rises with depth .The temperature in earth's crust is around 4000o C. Geysers (a natural spring that emits hot water) and hot springs are examples for geothermal energy where the steam and hot water come to the surface, in areas where the steam is tapped by drilling. The obtained steam is then used to generate power. Air pollution results in case of geothermal energy where the gases like H_2S, NH_3, CO_2 present in the steam coming out of the geothermal sources. The overall efficiency for power production is low (15%) as compared to fossil fuels (40%).

4. Wind energy: Wind energy is the kinetic energy associated with the movement of atmospheric air. Wind mills convert the wind energy into electrical energy. On an average wind mills can convert 30 – 40 % of available wind energy into electrical energy at a steady wind speed of 8.5mts / sec. The efficiency of wind mill is increased with the speed of wind and length of rotor blade.

The total wind energy potential in India's estimate is 25,000 MW of this about6000 MW is located in Tamil Nadu; 5000 MW in Gujarat and contribute thestates of Andhra Pradesh, Maharashtra, Uttar Pradesh and Rajasthan forbalance quantity.



Merits & demerits of wind energy:

1. It is a non – polluting and environment friendly source of energy.
2. It is a renewable energy available at free of cost
3. Power generation is cheaper with nil recurring expenses.
4. Wind mills are suitable to erect at on shore, remote and rural areaswhere wind blows with required intensity.
5. Favorable in geographic locations which are away from cities.
6. Wind turbine design, manufacturing, installation is complex due tovarying atmospheric conditions.
7. Wind power doesn't suitable for large scale generation.

5. Ocean energy: Seas and oceans are large water bodies . Seas absorb solar radiation and large amounts of solar energy are stored in the tides and waves of the ocean. Ocean energy is non – polluting in nature and suitable at a few places only. Energy from seas or oceans is obtained from the following:

(1) **Ocean Thermal Energy Conversion**: The oceans collect and store huge quantities of solar on the surface of the water while the temperature of deepwater is very low. Using this temperature difference it is possible to convert heat into electricity.
(2) **Tidal energy:** Tidal waves of the sea can be used to turn turbine and generate electricity. Asia's first tidal power plant of 800 - 1000 MW capacity is proposed to be set up at Kandla in Gulf of Kutch.

6. Bio mass energy: Bio-mass is an organic material from living beings or its residues. It is a renewable source of energy derived from the waste of various human and natural activities. The bio-mass energy sources include Wood, animal manure, sugarcane waste, agriculture crops, house hold waste, roots of plants, garbage etc. The simplest way of using bio-mass energy sources is to allow them to dry out in the sun and burn them.

7. Bio-gas: Bio-gas is a sustainable source of energy by virtue of its production from available natural organic wastes of cattle dung, human excreta, poultry waste, plant leaves, paddy husk etc…. Bio-gas is amixture of methane (68%), CO_2 (31%) and N_2 (1%). Methane gas (CH_4) is produced by bio-gas plants and this gas is utilized as cooking gas whose calorific value varies from 4400 – 6200 Kilo Calories / cum. Heat value of biogas can be improved by reducing its

CO_2 content.Bio-gas production is carried out in an enclosed bio-gas plant made of bricks or steel. Aslurry of waste organic matter is fed into the plant through an inlet and gas formed is tapped by an inverted drum. As gas is produced the drum rises and the gas may be drawn through an outlet.Bio-gas is commonly produced from cattle dung in a bio gas plant known as Gobar Gas plant. Bio-gas is a clean, cheap fuel that can be used for lighting purpose, lifting water through small pumps.

C. Nuclear Energy or Atomic power: It is the energy which is trapped inside the atom. It is non–renewable source of energy which is released during fission or fusion of certain radioactive elements. The most important advantage of atomic power is the production of an enormous amount of energy from a small quantity of radioactive element. For eg: 1 kg of Uranium liberates energy equivalent to 30000 kgs of coal.
Energy released during nuclear reaction (mass – energy equation as per Albert Einstein's formula E = mc2).
Nuclear Energy is produced by two processes namely (1) Nuclear Fission and (2) Nuclear Fusion.
Nuclear Fission: The nucleus in atoms is split by fast moving neutrons and in turn a tremendous amount of energy in the form of heat, light etc is released by a chain of reactions. Uranium is used as fuel. The energy released slowly in this process is utilized to generate electricity or else released suddenly all at once, results a tremendous explosion as in the case of Atom bomb.
Nuclear Fusion*:* Nuclear energy can be generated by fusion process which involves two hydrogen atoms combine to produce one helium atom.
Eg: hydrogen bomb. The disposal of nuclear wastes during mining, fuel production and reactor operation for a long time period resulting in adverse effects on environment. Disposable of nuclear waste is a national and global problem.

USE OF ALTERNATIVE ENERGY SOURCES

Alternative energy is any energy source that is an alternative to fossil fuel. These alternatives are intended to address concerns about such fossil fuels.

The nature of what constitutes an alternative energy source has changed considerably over time, as have controversies regarding energy use. Today, because of the variety of energy choices and differing goals of their advocates, defining some energy types as "alternative" is highly controversial.

In a general sense, alternative energy as it is currently conceived, is that which is produced or recovered without the undesirable consequences inherent in fossil fuel use, particularly high carbon dioxide emissions, an important factor in global warming. Sometimes, this less comprehensive meaning of "alternative energy" excludes nuclear energy

- Solar energy is the generation of electricity from the sun. It is split up into two types, thermal and electric energy. These two subgroups mean that they heat up homes and generate electricity respectively.
- Wind energy is the generation of electricity from the wind.
- Geothermal energy is using hot water or steam from the Earth's interior for heating buildings or electricity generation.

- Biofuel and Ethanol are plant-derived substitutes of gasoline for powering vehicles.
- Nuclear binding energy uses nuclear fission to create energy.
- Hydrogen is used as clean fuel for spaceships, and some cars

CASE STUDIES

• In 1981, a plane called 'The Solar Challenger 'flew from Paris to England in 5hours, 20minutes. It had 16,000 solar cells glued to the wings and tail of the plane and they produced enough power to drive a small electric motor and propeller. Since 1987, every three years there is a World Solar challenge for solar operated vehicles in Australia where the vehicles cover 3000 kms.

• The world's first solar-powered hospitals in Mali in Africa. Being situated at the edge of the Sahara desert, Mali receives a large amount of sunlight. Panel's of solar cells supply the power needed to run vital equipment and keep medical supplies cool in refrigerators.

• In recent years, the popularity of building integrated photovoltaic's (BIPV's) has grown considerably. In this application, PV devices are designed as part of building materials (i.e. roofs and siding) both to produce electricity and reduce costs by replacing the costs of normal construction materials. There are more than 3, 000 BIPV systems in Germany and Japan has a program that will build 70,000BIPV buildings.

1.8 LAND RESOURCES

Land as a resource: Landforms such as hills, valleys, plains, river basins and wetlands include different resource generating areas that the people living in them depend on. Many traditional farming societies had ways of preserving areas from which they used resources. If land is utilized carefully it can be considered a renewable resource. The roots of trees and grasses bind the soil. If forests are depleted, or grasslands overgrazed, the land becomes unproductive and wasteland is formed. Intensive irrigation leads to water logging and salinization, on which crops cannot grow. Land is also converted into a non-renewable resource when highly toxic industrial and nuclear wastes are dumped on it. Land on earth is as finite as any of our other natural resources. While mankind has learnt to adapt his lifestyle to various ecosystems world over, he cannot live comfortably for instance on polar ice caps, on under the sea, or in space in the foreseeable future.

LAND DEGRADATION AND CONTROL OF LAND DEGRADATION

Land degradation can be defined as any change in the land that alter its conditions or reduces its quality. Land degradation occurs due to both natural disasters like volcanic eruptions, earthquakes, heavy rains, fire etc or human induced activities. The other causes of land degradation consist of wind blow, salinity of water, water logging, soil acidity, loss of flora and fauna.

Desertification is land degradation occurring in the arid, semi-arid regions of the world. These dry lands cover about 40% of the earth's surface and puts at risk more than 1 billion people who are dependent on these lands for survival.

Land clearing and deforestation; Mining activity in forest areas; urban conversion; bringing more land under cultivation; soil pollution ; loss of organic matter in the soils; alkalinization of soils; salinity of water etc leads to land degradation. Severe land degradation affects in decreasing the mineral wealth and economic development of nations.

The methods that are followed for the prevention of land degradation are called soil conservation methods. Some of the popular methods are;

(a) **Contour farming**: The land is prepared with alternate furrows (a long narrow cut in the Ground) and ridges at the same level. The water is caught and held in furrows and stores which reduces run off and erosion.

(b) **Mulching**: Stems of maize, cotton, tobacco etc are used as a mulch (decay of leaves) to reduce soil moisture, evaporation.

(c) **Crop rotation**: Growing same crop year after year depletes the nutrients and land becomes Unproductive. This is overcome by changing the crops and cultivating legumes (plants like peas, beans) after a regular crop.

(d) **Strip cropping**: It consists of planting crops in rows or strips along contours to check flow of water.

LANDSLIDES AND MAN INDUCED LAND SLIDES

Landslides always exist on this planet and the term land slide is used to describe a wide variety of process that result a downward movement of rocks under gravitational forces. In other words, mass movement of rocks, debris and soil down a slope of land.

Landslides are primarily associated with steep slopes. Surface run-off and changes in drainage also cause for landslides. Landslides can also be initiated by rainfall; earthquakes; volcanic activity, changes in groundwater movement or any combination these factors.

Debris-flows can travel down a hillside of speeds up to 200 miles per hour (more commonly, 30 – 50 miles per hour) depending on the slope angle, water content, and type of earth and debris in the flow.

While landslides are a naturally occurring environmental hazard they have recently increased in frequency in certain areas due to human activities.

Building excavations collapses in mining (e.g.: coal mine) causes landslides. However, landslides can be triggered by the human beings by induced changes in the environment.

Simply landslides can be explained in three ways:

(a) Inherent of rocks (weakness in the structure of a rock)

(b) Due to heavy seismic or volcanic activity and

(c) Due to various environmental conditions.

SOIL EROSION AND CAUSES FOR SOIL EROSION

The top layer of the earth is called as soil. Soil erosion occurs due to deforestation, overgrazing, industrialization; desertification etc.

a. Deforestation: Mining, industrial, urban development etc causes deforestation and leads to exposure of the land to wind and rains causing soil erosion. Cutting trees leads to deforestation which in turn loss of organic matter in the soils.

b. Overgrazing: When sufficient amount of grass is available for the organisms usually the entire land /area may be subjected to exhaust and the land is exposed without grass and ultimately the land expose to wind/rain causing soil erosion. .

c. Industrialization: Different processes carried out by industries and mining operations cause soil pollution which leads to degradation of land

DESERTIFICATION:

Desertification is the process which turns productive into non- productive desert as a result of poor land-management. Desertification occurs mainly in semi-arid areas (average annual rainfall less than 600 mm) bordering on deserts. In the Sahel, (the semi-arid area south of the Sahara Desert), for example, the desert moved 100 km southwards between 1950 and 1975.

CAUSES OF DESERTIFICATION

* Overgrazing is the major cause of desertification worldwide. Plants of semi-arid areas are adapted to being eaten by sparsely scattered, large, grazing mammals which move in response to the patchy rainfall common to these regions. Early human pastoralists living in semi-arid areas copied this natural system. They moved their small groups of domestic animals in response to food and water availability. Such regular stock movement prevented overgrazing of the fragile plant cover.

* Cultivation of marginal lands, i.e lands on which there is a high risk of crop failure and a very low economic return, for example, some parts of South Africa where maize is grown.

* Destruction of vegetation in arid regions, often for fuelwood.

* Poor grazing management after accidental burning of semi-arid vegetation.

* Incorrect irrigation practices in arid areas can cause salinization, (the buildup of salts in the soil) which can prevent plant growth.

When the practices described above coincide with drought, the rate of desertification increases dramatically.

Increasing human population and poverty contribute to desertification as poor people may be forced to overuse their environment in the short term, without the ability to plan for the long term effects of their actions. Where livestock has a social importance beyond food, people might be reluctant to reduce their stock numbers.

EFFECTS OF DESERTIFICATION

Desertification reduces the ability of land to support life, affecting wild species, domestic animals, agricultural crops and people. The reduction in plant cover that accompanies desertification leads to accelerated soil erosion by wind and water. South Africa losing approximately 300-400 million tonnes of topsoil every year. As vegetation cover and soil layer are reduced, rain drop impact and run-off increases.

Water is lost off the land instead of soaking into the soil to provide moisture for plants. Even long-lived plants that would normally survive droughts die. A reduction in plant cover also results in a reduction in the quantity of humus and plant nutrients in the soil, and plant production drops further. As protective plant cover disappears, floods become more frequent and more severe. Desertification is self-reinforcing, i.e. once the process has started, and conditions are set for continual deterioration.

1.8.1 ROLE OF AN INDIVIDUAL CONSERVATION OF NATURAL RESOURCES

Different natural resources like forests, water, soil, food, mineral and energy resources play a vital role in the development of a nation. With our small individual efforts we can together help in conserving our natural resources to a large extent. Following are the ways:

a) Conserve Water:

1. Don't keep water taps running while brushing, shaving, washing or bathing.
2. In washing machines fill the machine only to the level required for your clothes.
3. Install water saving toilets that use not more than 6 liters per flush.
4. Check for water leaks in pipes and toilets and repair them promptly.
5. Reuse the soapy water of washing from clothes for gardening, driveways etc.
6. Water the plants and the lawns in the evening when evaporation losses are minimum. Never water the plants in mid-day.
7. Install a system to capture rain water.

b) Conserve energy:

1. Turn off lights fans and other appliances when not in use.
2. Obtain as much heat as possible from natural sources. Dry the clothes in sun instead of direr if possible.
3. Use solar cooker for cooking which will be more nutritious and will save your LPG Expenses.
4. Build your house with provision for sunspace which will keep your house warmer and will provide more light.
5. Drive less, make fewer trips and use public transportations whenever possible.Share a car-pool if possible.
6. Control the use of A.C.
7. Recycle and reuse glass, metals and papers.
8. Use bicycle or just walk down small distances instead of using vehicle.

Protect the Soil:

1. Grow different types of ornamental plants, herbs and trees in your garden. Grow grass in the open areas which will bind the soil and prevent its erosion.
2. Make compost from your kitchen waste and use it for your kitchen-garden.
3. Do not irrigate the plants using a strong flow of water as it would wash off the soil.
4. Better use sprinkling irrigation.

Promote Sustainable Agriculture:

1. Do not waste food; Take as much as you can eat.
2. Reduce the use of pesticides.
3. Fertilize your crop with organic fertilizers.
4. Use drip irrigation.
5. Eat local and seasonal vegetables.
6. Control pest

UNIT-III

ECOSYSTEM

2.1 ECOSYSTEM

An **ecosystem** is a community of organisms that interact with each other and non living components for sustainable development and adaptation to changing conditions. There are different type of ecosystems around us which involves living organisms and non living organisms. If we combine all the ecosystems present on earth, it is called **Biosphere**. The term ecosystem was first proposed by A.G.Tansley (1935) who defined ecosystem as follows: "Ecosystem is defined as a self-sustained community of plants and animals existing in its own environment."Odum (1971) defined ecosystem as any unit that includes all the organisms in a given area interacting with the physical environment, so that a flow of energy give rise to a clearly defined tropic structure, biotic diversity and material cycles within the system "Michael Allaby (1983) defined ecosystem as a community of interdependent organisms together with the environment

CONCEPT OF ECOSYSTEM:

In an ecosystem, the interaction of life with its environment takes place at many levels. A single bacteria in the soil interacts with water, air around it within a small space while a fish in a river interacts with water and other animals, rivals in a large space. .

Considering the operational point of view; the biotic and abiotic components of an ecosystem are so interlinked such that their separation from each other is practically difficult. So, in an ecosystem both organisms (biotic communities) and abiotic environment (rainfall, temperature, humidity) each influence the properties with other for maintenance of life.

STRUCTURE OF ECOSYSTEM

A structure of Ecosystem comprise of

•The Composition of biological community including, species number, biomass, life history, and distribution in space.

•The quantity and distribution of non-living material, such as nutrient water, etc.

•The rage of condition of existence such as temperature, light.

FUNCTION OF ECOSYSTEM:

•The rate of biological energy flow i.e. production & respiration rates of the community.

•The rate of material or nutrient cycles

•Biological or ecological regulation including both regulation of organism by environment and regulation of environment by the organisms.

2.1.1 COMPONENTS OF AN ECOSYSTEM:

There are two components of an ecosystem; Living components and non living components.

Non Living Components: (**Abiotic**) Non living components are the physical and chemical factors that directly or indirectly affect the living components e.g. air, water, land, rock etc. Non living components are also called **Abiotic** components.
Physical factors include sunlight, water, fire, soil, air, temperature etc.
Chemical factors include moisture, salinity of water, soil nutrients, oxygen dissolved in water etc.
Living Components: Living components in an ecosystem are either producers or consumers. They are also called **biotic** components. Producers can produce organic components e.g. plants can produce starch, carbohydrates, cellulose from a process called photosynthesis. Consumers are the components that are dependent on producers for their food e.g. human beings and animals•

Biotic Components are further classified into 3 main groups

•Producers •Consumers •Decomposers or Reducers

1. **Producer (Autotrophs):** The green plants have chlorophyll with the help of which they trap solar energy and change it into chemical energy of carbohydrates using simple inorganic compound namely, water and carbon dioxide. This process is known as photosynthesis. The chemical energy stored by the producers is utilized partly by the producers for their own growth and survival and the remaining is stored in the plants for their future use. They are classified into two categories based on their source of food.
   a)Photoautotrophs: An organism capable of synthesizing its own food from inorganic substances using light as an energy source. Green plants and photosynthetic bacteria are photoautotrophs.
   b)Chemotrophs: Organisms that obtain energy by the oxidation of electron donors in their environments. These molecules can be organic (chemoorganotrophs) or inorganic (chemolithotrophs).
2. **Consumers (Heterotrophs):** The animals lack chlorophyll and are unable to synthesis their own food therefore they depend on the producers for their food. •They are known as heterotrophs (i.e. heteros= others, trophs= feeder).The Consumers are of 4 types:
   (a) Primary Consumer: (Herbivores) i.e. Animal feeding on plants, e.g. Rabbit, deer, goat etc.
   (b) Secondary Consumers: The animal feeding on Herbivores are called as secondary Consumer or primary carnivores. e.g. Cats, foxes, snakes.
   (c) Tertiary Consumers: These are large carnivores which feed on secondary consumers. e.g. Wolves
   (d) Quaternary Consumers: They are also called omnivores these are largest carnivores Which feed on tertiary consumers and are not eaten up by any other animals. e.g. lion and Tiger.

3. **Decomposers or Detrivores:**Bacteria & fungi belong to this category. They break down the dead organic matter of producers & consumers for their food and release to the environment the simple inorganic and organic substance. These simple substances are reused by the producers resulting in a cyclic exchange of material between biotic & abiotic environment.
   Eg: Bacteria, Earth worms, Beetles etc

2.1.2 ENERGY FLOW IN AN ECOSYSTEM

•Biological activities require energy which ultimately comes from the sun. Solar energy is transformed into chemical energy by a process of photosynthesis this energy is stored in plant tissue and then transformed into heat energy during metabolic activities.

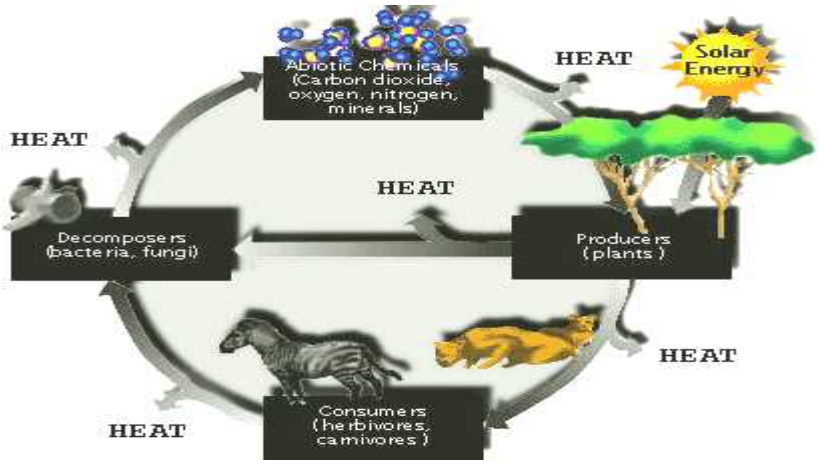
•Thus in biological world the energy flows from the sun to plants and then to all heterotrophic organisms. The flow of energy is unidirectional and non-cyclic.

This one way flow of energy is governed by laws of thermodynamics which states that:

(a) Energy can neither be created nor be destroyed but may be transformed from one form to another

(b) During the energy transfer there is degradation of energy from a concentrated form (mechanical, chemical, or electrical etc.) to a dispersed form (heat).

No energy transformation is 100 % efficient; it is always accompanied by some dispersion or loss of energy in the form heat. Therefore, biological systems including ecosystems must be supplied with energy on a continuous Basis.



MODELS OF ENERGY FLOW IN ECOSYSTEM

1. Single Channel Energy Flow Model: The flow of energy takes place in a unidirectional manner through a single channel of producers to herbivores and carnivores. The energy captured by autotrophs does not revert back to solar input but passes to herbivores; and that which passes to herbivores does not go back to autotrophs but passes to consumers. Due to one way flow of energy, the entire system would collapse if primary source of energy were cut off. At each tropic level there occurs progressive decrease in energy which is mainly due to loss of energy as heat in metabolic reactions and also some of the energy is utilized at each tropic level

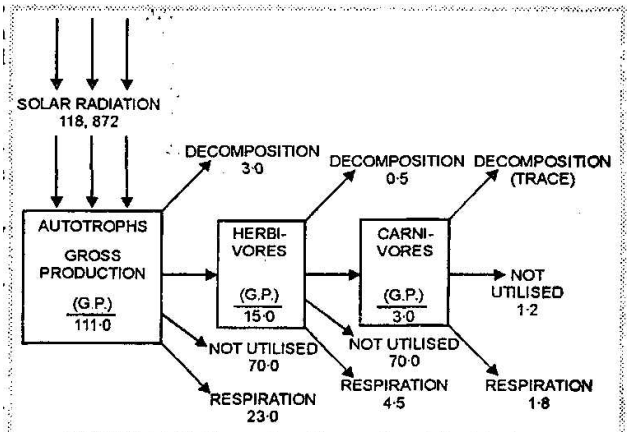


FIGURE 14.14. Energy flow diagram for a lake (Freshwater ecosystem) in g cal/cm^2/yr (modified from Lindeman, 1942).

2. Y- shaped model: shows a common boundary, light and heat flow as well as import, export and storage of organic matter . Decomposers are placed in separate box to partially separate the grazing and detritus food chains. In terms of energy levels decomposers are in fact a mixed group. •Y- shaped energy flow is more realistic and practical than the single channel energy flow model because: •It conforms to the basic stratified structure of ecosystems •It separates the two chains i.e. grazing & detritus food chain in both time and space. •Micro consumers (bacteria & fungi) and the macro consumers (animals) differ greatly in size- metabolism relations in two models.

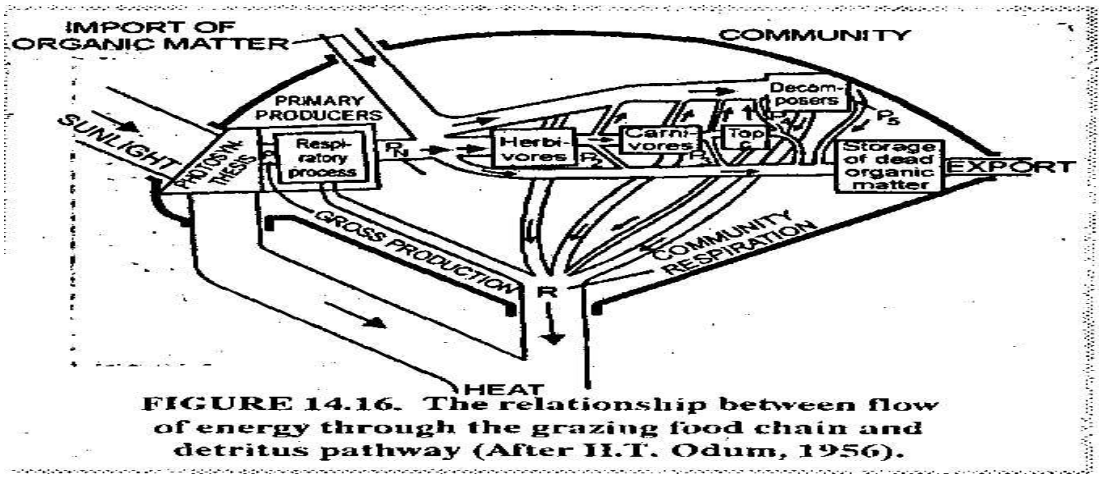


FIGURE 14.16. The relationship between flow of energy through the grazing food chain and detritus pathway (After H.T. Odum, 1956).

3.Universal energy flow model :As the flow of energy takes place, there is gradual loss of energy at each level there by resulting in less energy available at the next tropic level as indicated by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy is mainly the energy which is not utilized (U). This is the energy loss in locomotion, excretion etc. or it the energy lost in respiration (CR) which is for maintenance. The remaining energy is used for production (P).

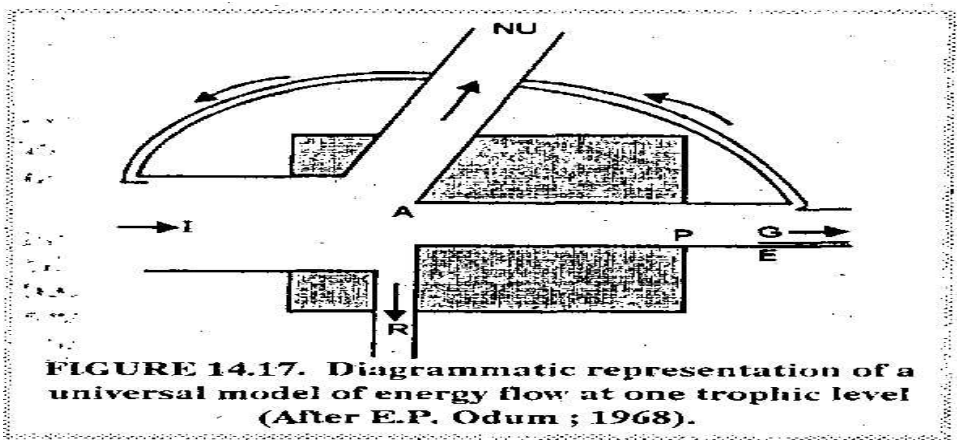


FIGURE 14.17. Diagrammatic representation of a universal model of energy flow at one trophic level (After E.P. Odum ; 1968).

2.1.3 ECOLOGICAL SUCCESSION

Ecological Succession is the phenomenon or process by which a community progressively transforms itself until a stable community is formed. It is a fundamental concept in ecology, refers to more or less predictable and orderly changes in the composition or structure of an ecological community. Succession may be initiated either by formation of new, unoccupied habitat (e.g., a lava flow or a severe landslide) or by some form of disturbance (e.g. fire, severe wind throw , logging) of an existing community. Succession that begins in areas where no soil is initially present is called primary succession, whereas succession that begins in areas where soil is already present is called secondary succession.

Clement's theory of succession/Mechanisms of succession

F.E. Clement (1916) developed a descriptive theory of succession and advanced it as a general ecological concept. His theory of succession had a powerful influence on ecological thought. Clement's concept is usually termed classical ecological theory. According to Clement, succession is a process involving several phases:

1. **Nudation**: Succession begins with the development of a bare site, called Nudation (disturbance).
2. **Migration**: It refers to arrival of propagules.
3. **Ecesis**: It involves establishment and initial growth of vegetation.
4. **Competition**: As vegetation became well established, grew, and spread, various species began to compete for space, light and nutrients. This phase is called competition.
5. **Reaction**: During this phase autogenic changes affect the habitat resulting in replacement of one plant community by another.
6. **Stabilization:** Reaction phase leads to development of a climax community.

Seral communities:

A seral community is an intermediate stage found in an ecosystem advancing towards its climax community. In many cases more than one seral stage evolves until climax conditions are attained. A prisere is a collection of seres making up the development of an area from non-vegetated surfaces to a climax community. Depending on the substratum and climate, a seral community can be one of the following:

Hydrosere : Community in freshwater
Lithosere **:** Community on rock
Psammosere **:** Community on sand
Xerosere **:** Community in dry area
Halosere **:** Community in saline body (e.g. a marsh)

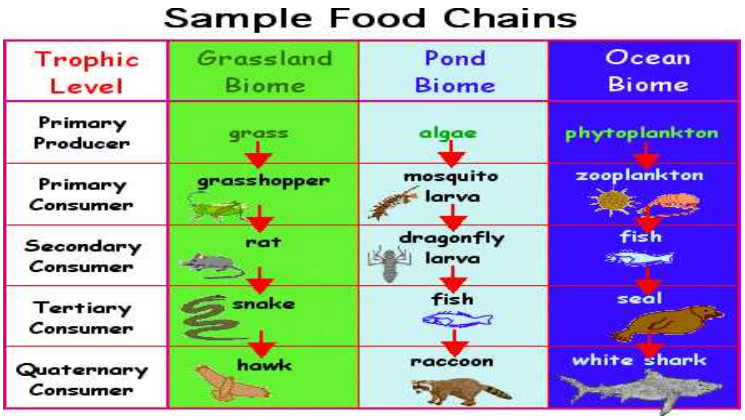
Climax community

The final or stable community in a sere is the climax community or climatic vegetation. It is self-perpetuating and in equilibrium with the physical habitat. There is no net annual accumulation of organic matter in a climax community mostly. The annual production and use of energy is balanced in such a community.

2.1.4 FOOD CHAIN, FOOD WEB & ECOLOGICAL PYRAMIDS:

FOOD CHAIN:

In food chain each organism eats the smaller organisms and is eaten by the larger one. All those organisms which are interlinked with each other through food to gather constitute the ecosystem. •The different levels in a food chain are called tropic levels, Each food chain has three main tropic levels:- Producer level, Consumer level, and decomposer level. If any of the intermediate stage of the food chain is removed, the succeeding links of the food chain will be affected.



Types of Food Chains*:*

a) **Grazing Food Chain:** This type of food chain starts from living green plants goes to grazing herbivores and onto carnivores. Ecosystem with such type of food chain directly

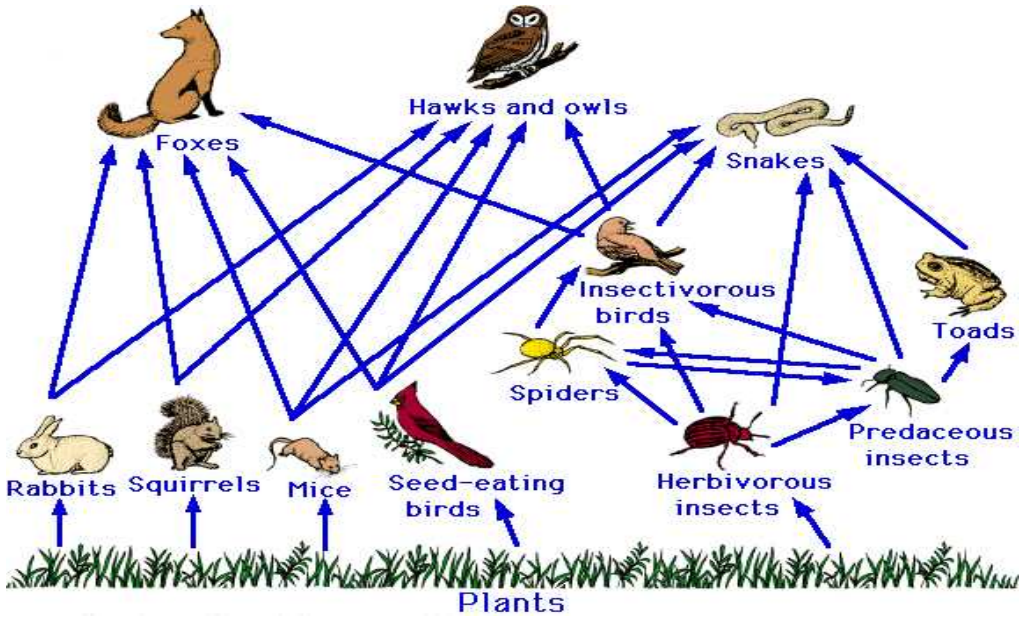
depends upon the solar energy for their food requirements. Most of the ecosystem in nature follows this type of food chain.

b) **Detritus food Chain:** This type of food chain goes from dead organic matter onto microorganisms and then to the organisms feeding on detritus and their predators. Such ecosystems are less dependent on direct solar energy.

c) **Parasitic Food Chain:** This type of food chain starts from big hosts and ends with parasitic organisms

FOOD WEB*:*

The interconnected, interlocking pattern of food chain is known as food web. •Under natural condition of the linear arrangement of food chain hardly occurs and they remain interconnected with each other through different types of organisms at different levels Such a interconnected and interlocking pattern of food chain is known as food web..



ECOLOGICAL PYRAMIDS

The different species in a food chain are called tropic levels. Each food chain has 3 main trophic level, producer, consumer, and decomposers. •Thus Graphical representation of these trophic levels is called as Ecological Pyramids. It was devised by an ecologist "**Charles Elton**" therefore this pyramid are also called Ecological pyramid or **Eltonian pyramids**.

Types of Ecological Pyramids:

Ecological pyramids are of three types: I

I) Pyramid of Number II)Pyramid of biomass
III)Pyramid of Energy

I) **Pyramid of Number**:

•They show the relationship between producers, herbivores, and carnivores at successive tropic levels in terms of their number.

•In case of pond ecosystem the producers are mainly phytoplankton and are always maximum in number this number then shows a decrease towards apex as primary consumers are zooplanktons are lesser in number than phytoplankton, the secondary consumers are large fish are even lesser in number than the phytoplankton. Thus the shape of pyramid is upright. But in case of forest ecosystem the pyramids is always inverted because the producers are mainly large trees, are lesser in numbers, the herbivores fruit eating birds are more in number than the producers, then there is gradual decrease in number of secondary consumers thus making pyramid upright again. Thus the pyramid of number does not give a true picture of the food chain and are not very functional.

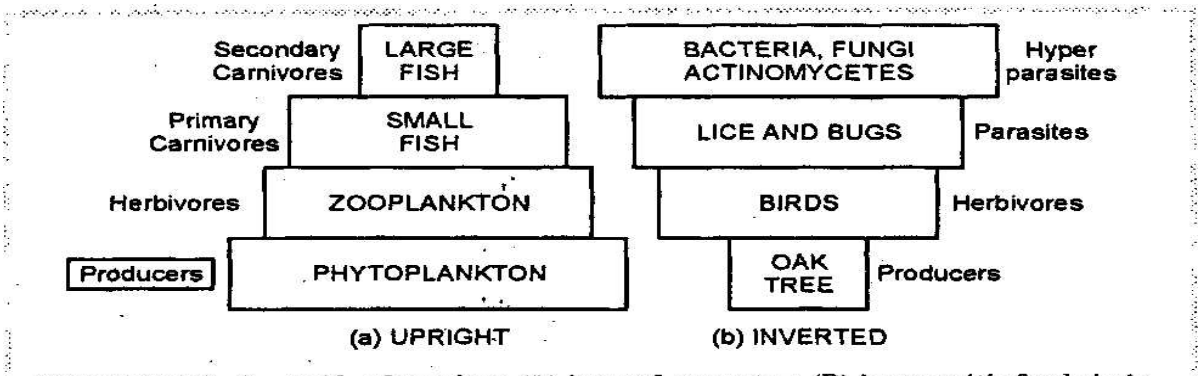
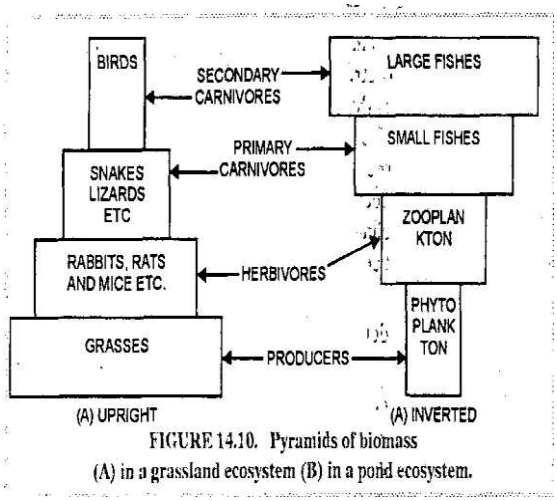


FIGURE 14.9. Pyramids of numbers (A) in pond ecosystem (B) in parasitic food chain.

II) **Pyramid of Biomass**:

•The pyramid of biomass represents the relationship between different tropic levels in terms of biomass. •There is generally gradual decrease in biomass of organisms at successive levels from the producers to the top carnivores. Thus pyramid of biomass is upright for grassland ecosystem.
•However in case of a pond as the producers are algae, are least in number and this value gradually shows an increase towards the apex of pyramid thus making the pyramid inverted in shape.



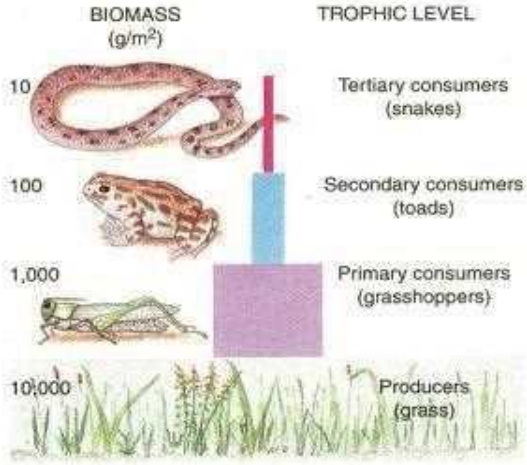
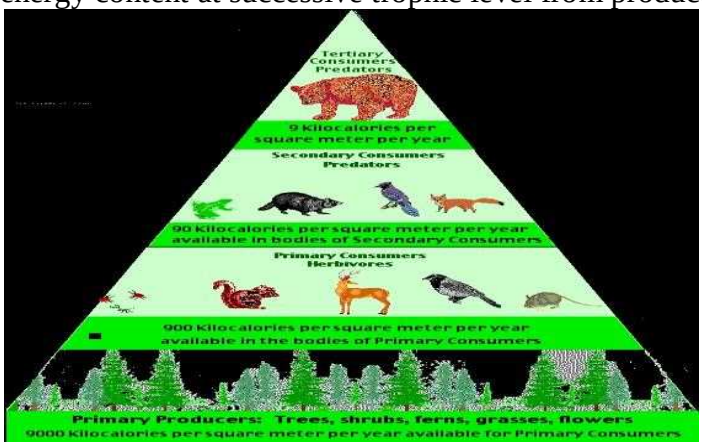


FIGURE 14.10. Pyramids of biomass
(A) in a grassland ecosystem (B) in a pond ecosystem.

III) **Pyramid of energy**:

•Of the 3 types of ecological pyramid the energy pyramid gives the best picture of overall nature of the ecosystem. In this type of pyramid the tropic level is decided depending upon the rate at which food is being produced.

•In shape it is always upright as in most of the cases there is always gradual decrease in the energy content at successive trophic level from producers to various consumers.



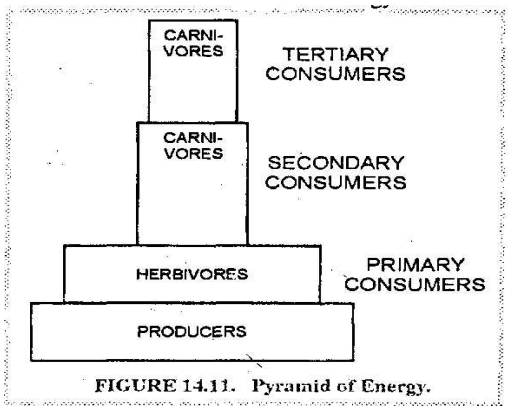


FIGURE 14.11. Pyramid of Energy.

2.1.4 CLASSIFICATION OF ECOSYSTEMS

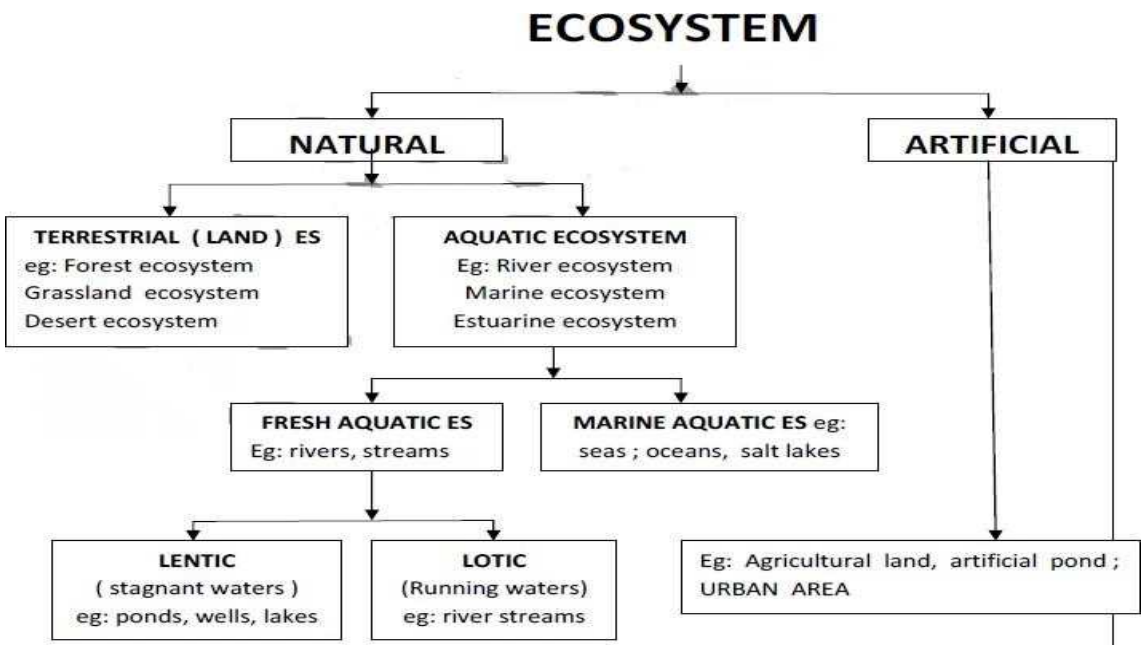
Due to the abiotic factors, different ecosystems develop in different ways. These factors and their interaction between each other and with biotic components have resulted in formation of different types of ecosystems as explained below.

Ecosystem may be natural or artificial.

Artificial Ecosystem: These are maintained or created artificially by man. The man tries to control biotic community as well as physico-chemical environment.

Eg: Artificial pond, urban area development.

Natural Ecosystem: It consists of Terrestrial and Aquatic Ecosystems which are maintained naturally.



Different types of ecosystem of biosphere artificially categorized as follows:

I) Natural Ecosystems: These ecosystems operate by themselves under natural conditions without any major interference by man. Based upon the particular kind of habitat, these are further divided as: •Terrestrial as forest, grassland, desert etc.

•Aquatic which may be further distinguished as

•Freshwater which may be lotic (running water as springs, stream, river) or lentic (standing water as

lake, pond, pools, ditch, swamps, etc.)

•Marine Ecosystems: as an ocean or shallow ones like sea or estuary etc.

II) Artificial Ecosystems: These are maintained by man where, by addition of energy & planned manipulations natural balance is disturbed regularly.

For eg : croplands like maize, wheat, rice-fields etc., where man tries to control the biotic community as well as physico-chemical environment are artificial ecosystems

Pond Ecosystem: A Pond as a whole serves a good example of freshwater ecosystem

•**Abiotic Components**: The chief components are heat, light, pH of water, CO_2, oxygen, calcium, nitrogen, phosphates, etc.

•**Biotic Components**: The various organization that constitute the biotic component are as follows,

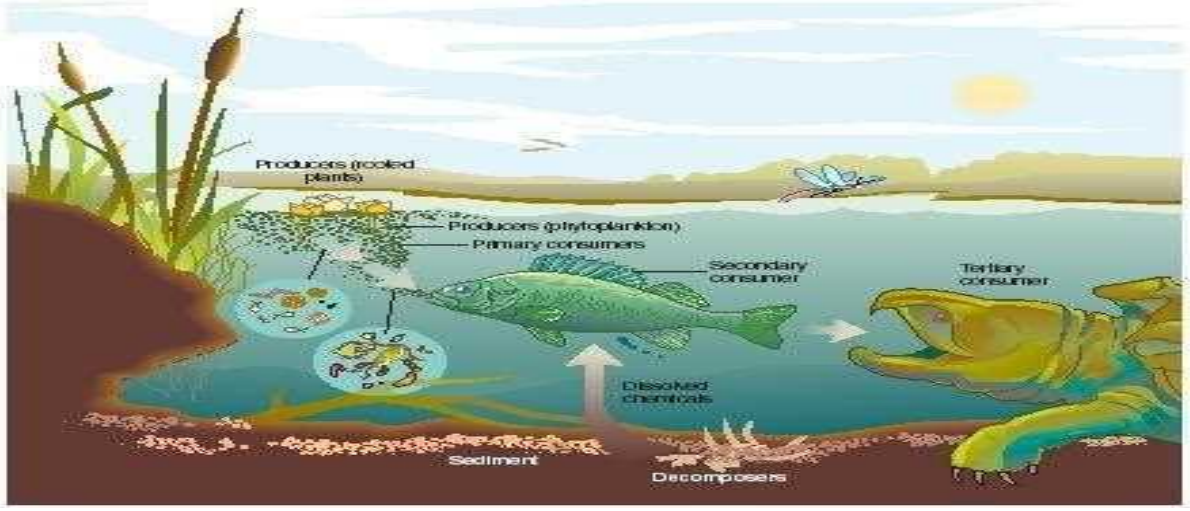
•**Producers:** These are green plants, and some photosynthetic bacteria. The producer fix radiant energy and convert it into organic substances as carbohydrates, protein etc

•**Macrophytes:** these are large rooted plants, which include partly or completely submerged hydrophytes, eg Hydrilla, Trapha, Typha.

•**Phytoplankton:** These are minute floating or submerged lower plants eg algae.

•**Consumers:** They are heterotrophs which depend for their nutrition on the organic food manufactured by producers. •**Primary Consumers**: – **Benthos**: These are animals associated with living plants ,detrivores and some other microorganisms –**Zooplanktons:**

These are chiefly rotifers, protozoans, they feed on phytoplankton •**Secondary Consumers:** They are the Carnivores which feed on herbivores, these are chiefly insect and fish, most insects & water beetles, they feed on zooplanktons. •**Tertiary Consumers:** These are some large fish as game fish, turtles, which feed on small fish and thus become tertiary consumers. •**Decomposers:** They are also known as micro-consumers. They decompose dead organic matter of both producers and animal to simple form. Thus they play an important role in the return of minerals again to the pond ecosystem, they are chiefly bacteria, & fungi.



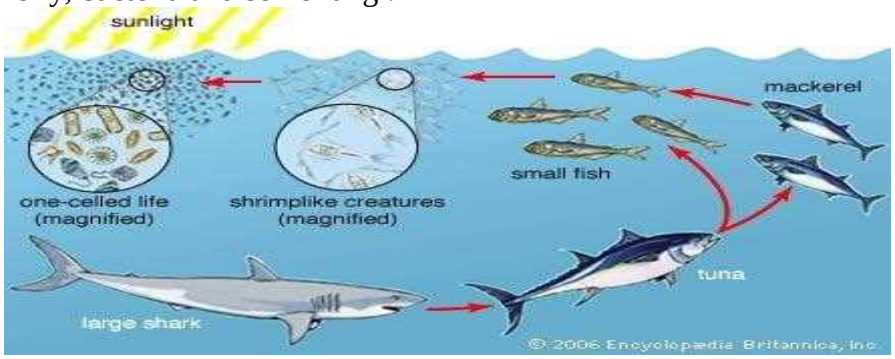
Ocean Ecosystem

are more stable than pond ecosystem, they occupy 70 % of the earth surface.

•**Abiotic Components:** Dissolved oxygen, light, temperature, minerals. •Biotic Components:

•**Producers:** These are autotrophs and are also known Primary producers. They are mainly, some microscopic algae (phyto-planlanktons) besides them there are mainly, seaweeds, as brown and red algae also contribute to primary production. •**Consumers:** They are all heterotrophic macro consumers •**Primary Consumer:** The herbivores, that feed on producers are shrimps, Molluscs, fish, etc. •**Secondary Consumers:** These are carnivores fish as Herring, Shad, Mackerel, feeding on herbivores. •**Tertiary Consumers:** These includes, other carnivores fishes like, COD, Halibut, Sea Turtle, Sharks etc.

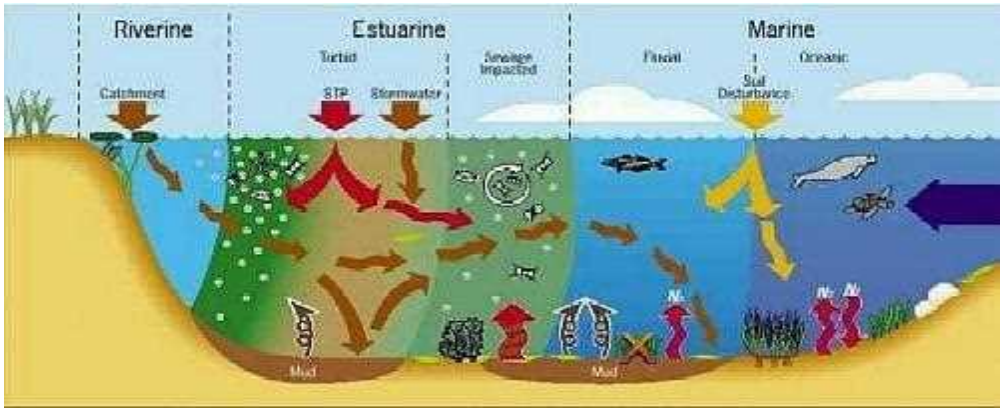
•**Decomposers:** The microbes active in the decay of dead organic matter of producers, and animals are chiefly, bacteria and some fungi.



Estuarine Ecosystem

•An estuary is a partially enclosed body of water along the coast where fresh water from river and streams meet and mix with salt water from oceans. These Ecosystems are considered as most

fertile ecosystem. •**Abiotic Components**: Nutrients such as phosphorus and nitrogen, temperature, light, salinity, pH. •This ecosystem experience wide daily and seasonal fluctuations in temperature and Salinity level because of variation in freshwater in flow. •**Biotic Components:** •**Producers: Phyplanktons**- these micro-organisms manufacture food by photosynthesis and absorb nutrients such as phosphorous and nitrogen, besides them, mangroves, sea grass, weeds, and salt marshes. •**Consumers: Primary consumers**, Zooplanktons that feed on Phytoplankton, besides them some small microorganisms that feed on producers. •**Secondary Consumer:** Include worms, shellfish, small fish, feeding on Zooplanktons •**Tertiary Consumer:** Fishes, turtles, crabs, starfishes feeding on secondary consumers. •**Decomposers:** Fungi & Bacteria are the chief microbes active in decay of dead organic matter.



River Ecosystem

•As Compared with lentic freshwater (Ponds & lakes), lotic waters such as streams, and river have been less studied. However, the various components of an riverine and stream ecosystem can be arranged as follows. •**Producers:** The chief producers that remain permanently attached to a firm substratum are green algae as Cladophora, and aquatic mosses. •**Consumers:** The consumers show certain features as permanent attachment to firm substrata, presence of hooks & suckers, sticky undersurface, streamline bodies, flattened bodies.. Thus a variety of animal are found, which are fresh spongy and caddis-fly larvae, snails, flat worms etc. •**Decomposers:** Various bacteria and fungi like actinomycetes are present which acts as decompose

UNIT-IV

2.2 BIODIVERSITY

The word biodiversity is a combination of two words: "biological and diversity" and refers to the variety of life on the Earth. **Biodiversity** is the degree of variation of life forms within a given species, ecosystem, biome, or an entire planet. Biodiversity is a measure of the health of ecosystems.
The term biological diversity was used first by wildlife scientist and conservationist Raymond F. Dasmann in the 1968.
The term's contracted form biodiversity may have been coined by W.G. Rosen in 1985

Biodiversity is usually considered at three different levels:
The following are different types of biodiversity

1. Genetic diversity: variety in the genetic makeup among individuals within a species
2. Species diversity: variety among the species or distinct types of living organisms found in different habitats of the planet
3. Ecosystem or ecological diversity: variety of forests, deserts, grasslands, streams, lakes, oceans, coral reefs, wetlands and other biological communities
4. Functional diversity: biological and chemical processes of functions such as energy flow an matter cycling needed for the survival of species and biological communities

1. Genetic Diversity: Genetic diversity is the "raw material" that permits species to adjust to a changing world whether these changes are due to natural factors or are caused by human factors. It refers to the variation at the level of individual genes and provides a mechanism for populations to adapt to their ever-changing environment.
Eg: Human beings

2. Species Diversity: Species diversity refers to the different types of living organisms on Earth. This includes the many types of birds, insects, plants, bacteria, fungi, mammals, and more. Many differing species often live together in communities depending on each other to provide their needs.
A species can be defined as a group or population of similar organisms that reproduce by interbreeding within the group. Members of a species do not normally reproduce with members of any other species. Members of a specific species possess common characteristics that distinguish them from other species and this remains constant regardless of geographic location.

3. Ecosystem Diversity: Ecological diversity or ecosystem diversity is the variety of biological communities, such as forests, deserts, grasslands and streams that interact with one another and with their physical and chemical (nonliving) environments. It relates to the different forms of life which are present in any one particular area or site, in more precise terms, it concerns the different species of a particular genus which are present in an ecological community.

2.2.1 VALUES OF BIODIVERSITY

The value of biodiversity (in terms of its commercial utility, ecological services, social and aesthetic values) is enormous. There are several ways that biodiversity and its various forms are Valuable to humans. The biodiversity value may be classified as follows:

1. CONSUMPTIVE VALUE: Biodiversity is an essential requirement for the maintenance of global food supply. The main sources of human food include animals, fish and plant produces.
A large number of plants are consumed by human beings as food. A few animal species are consumed by people which come from cattle, pigs, sheep, goats, buffaloes, chickens, ducks, geese and turkey species.
Fish: Many fresh water fish can be grown in ponds. Israel and China already get about half of their fish from aqua culture.
Drugs & medicines: About 75% of the world's population depends upon plants or plant extracts for medicines. The drug Penicillin used as an antibiotic is derived from a fungus called **Penicillium.** Likewise, Tetracycline from bacteria which is used to cure malaria is obtained from the bark of cinchona tree. .
Fuel: The fossil fuels like coal, petroleum products and natural gas are the products of biodiversity.

2. PRODUCTIVE VALUE: Some of the organisms are commercially usable where the product is marketed and sold. The animal products like tusks of elephants; musk from deer; silk from silkworm; wool from sheep or goats; fur of many animals etc all of which are traded in the market.

Eg: Calabar bean was tradionally used as a poison in West Africa.

Daisy plants were first used as a lice remedy in the Middle East and this led to the Discovery of Pyrethrum. Mosquito coils made from Pyrethrum are sold in the market.

The bacterium Bacillus thuringiensis produces toxic proteins that kill certain insects.

3. SOCIAL VALUE: These are the values associated with the social life, religion and spiritual aspects of the people. Many of the plants are considered to be sacred in our country like Tulasi, Mango leaves, Banana leaves . The leaves, fruits, flowers of some of the plants are used in worship. Many animals like cow, snake, bull, peacock also have significant place in spiritual and thus hold special importance. Thus, biodiversity has distinct social value, attached with different societies.

4. ETHICAL VALUE: The ethical value means that human beings may or may not use a certain species but knowing the very fact that this species exists in nature gives pleasure.

For eg: A peculiar species of Pigeon, grey / white bird with short legs is no more on this earth. Similarly, Dodo species is also no more. Human beings are not deriving anything direct from Kangaroo, giraffe but strongly feel that these species should exist in nature.

5. AESTHETIC VALUE: Every one of us would like to visit vast stretches of lands to enjoy the visible life. People from farther areas, spend a lot of time and money to visit wild life areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco tourism.

Eco-tourism is estimated to generate 12 billion dollars of revenue annually that roughly gives the aesthetic value of biodiversity.

A study of the impact of environment on the psyche was undertaken by Kaplan and Kaplan (1989) in which they found that being near nature relieved working stresses while people who worked in closed environment or human made structures experienced much more job stresses and illnesses.

2.2.2 BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVEL

The enormous diversity of life forms in the biosphere has evolved essentially through the process of trial and error during course of organic evolution. The changes in character of living organism which confer some advantage to the species are retained.

The changes in climatic conditions are reflected in the distribution of living organism and the pattern of biodiversity on our planet. The number of species present per unit area decreases as we move from mild tropics to the tundra's.

The Indian region (8° to 30° N and 60° to 97.5°) with total area of 329 million hectares is very rich in biodiversity. It is estimated that about 4500 species of plants occur in this country. The position of Indian sub-continent at the confluence of there biogeography reels is also an important contributing factor and explain the preserve of African, European, Sind, Japanese and Indo-Malayan elements in the flora and fauna in India. It is the sum total of such remarkable

diversity that has made India a "gene bank" for a number of food crops, forest trees, medical and aromatic plants and domesticated animal.

Forests are important bioreserves; most of the 1700 million hectares of tropical forests are located in poor countries. The forests surrounding Reo de Aneroid are part of vegetation which is rich in species of plants and animals that are endemic. There are about 53.5% of trees species found only in these forests and studies of birds, reptiles, primates and butter flies have revealed equally high or higher endemics.

2.2.3 INDIA AS A MEGA DIVERSITY NATION

India contains a great wealth of biodiversity in the forests, wet lands and marine areas. Hence biodiversity can be observed at all levels ie locally, nationally and globally . India, as a subcontinent representing a major part of South Asia is rich in flora and fauna and hence it is one of the world's "MEGADIVERSITY NATIONS" .
It is estimated that over 75000 species of animals and over 45000 species of plants are found in India.

Biogeographic regions of India: According to **wild life Institute of India**, the country has 10 distinct biogeographic zones or regions. They are:
1. Trans – Himalayan Zone
2. Himalayan Zone
3. Desert Zone
4. Semi – arid Zone
5. Western Ghats
6. Deccan Zone
7. Gangetic plain Zone
8. NE Indian Zone
9. Coastal Zone
10. Islands around the country

2.2.4HOT SPOTS OF BIODIVERSITY

Areas which exhibit high species richness as well as high species endemism are termed as hot spots of biodiversity. Species which are restricted only to particular areas are known as endemic. India shows a good number of endemic species. About 62% of amphibians and 50% of lizards are endemic to India. Western Ghats are the site of maximum endemism. The term "Hot spots" was introduced by **Myers** (1988). There are 25 such hot spots of biodiversity on a global level out of which two are present in India, namely the Eastern Himalayas and Western Ghats. These hotspots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity. According to Myers an area is designated as a hotspot when it contains at least 0.5% of the plant species as endemics.

a) Eastern Himalayas: They display an ultra-varies topography that fosters species diversity and endemism. Recent studies have shown that North East India along with its contiguous regions of Burma and Chinese provinces of Yunnan and Schezwan is an active center of organic evolution and is considered to be the cradle of flowering plants. Out of the world's recorded flora 30% are endemic to India of which 35000 are in the Himalayas.

b) Western Ghats: It extends along a 17000 km² strip of forests in Maharashtra, Karnataka, Tamilnadu and Kerala and has 40% of the total endemic plant species. The major centers of diversity are Agastyamalai Hills and Silent valley- the new Amambalam Reserve Basin .It is reported that only 6.8% of the original forests are existing today while the rest has been deforested or degraded, which raises a serious cause of alarm, because it means we have already lost a huge proportion of the biodiversity.

2.2.5 THREATS TO BIODIVERSITY

Extinction or elimination of a species is a natural process of evolution. In the geologic period the earth has experienced mass extinctions. During evolution, species have died out and have been replaced by others. However, the rate of loss of species in geologic past has been a slow process, keeping in view the vast span of time going back to 444 million years. The process of extinction has become particularly fast in the recent years of civilization. Edward O. Wilson prefers the acronym HIPPO, standing for habitat destruction, invasive species, pollution, human overpopulation, and over-harvesting
Following are the major causes and issues related to threats to biodiversity:

1. Habitat destruction: Habitat destruction has played a key role in extinctions, especially related to tropical forest destruction. Factors contributing to habitat loss are: overpopulation, deforestation, pollution (air pollution, water pollution, soil contamination) and global warming or climate change.
Habitat size and numbers of species are systematically related. Physically larger species and those living at lower latitudes or in forests or oceans are more sensitive to reduction in habitat area. Conversion to "trivial" standardized ecosystems (e.g., monoculture following deforestation) effectively destroys habitat for the more diverse species that preceded the conversion. In some countries lack of property rights or lax law/regulatory enforcement necessarily leads to biodiversity loss (degradation costs having to be supported by the community)

2. Poaching: Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars per year continues, the developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth of wildlife. The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hong Kong are the major importers of the wildlife products or wildlife itself. The trading of such wild life products is highly profit making for the poachers who just hunt these prohibited wild lives and smuggle it to other countries mediated through mafia. The worst part is that for every live animal that actually gets into the market about 50 additional animals are caught and killed

If you are fond of rare plants, fish or birds, please make sure that you are not going to the endangered species or wild-caught species. Doing so will help in checking further decline of these species. Also do not purchase fur coat, purse or bag, or items made of crocodile skin or python skin. You will certainly help in preserving biodiversity by doing so.

3. Man-Wildlife Conflicts: We have discussed about the need to preserve and protect wildlife. However, sometimes we come across conflicting situations when wildlife starts causing immense damage and danger to man and under such conditions it becomes very difficult for the forest department to pacify the affected villages and gain local support for wildlife conservation. Instances of man animal conflicts keep on coming to lime light from several states in our country.

In Sambalpur, Orissa 195 humans were killed in the last 5years by elephants. In retaliation the villagers killed 95 elephants in the border region of Kote-Chamarajanagar belt in Mysore have been reported recently. The man-elephant conflict in this region has arisen because of massive damage done by the elephants to the farmer's cotton and sugarcane crops. The agonized villagers electrocute the elephants and sometimes hide explosives in the sugarcane fields, which explode as the elephants intrude into their fields. In fact, more killings are done by locals than by poachers.

Causes of Man-animal conflicts:

Dwindling habitats of tigers, elephants, rhinos and bears due to shrinking forests cover are compelled to move outside the forests and attack the field or sometimes even humans. Human encroachment into the forest areas has rendered all forest living animals to trespass the borders of human civilizations. This is because the conflicts between man and the wildlife have increased since it is an issue of survival of both

3.1 Invasive Non-Native Species: Species that are non-native to a particular area can sometimes spread very quickly, for example the zebra mussel and Japanese knotweed have spread rapidly in Ireland in the past two decades. As a result, these species can destabilize an ecosystem by altering habitats affecting food webs.

3.2 Pollution/Litter: As you will remember from the Litter and Waste theme, pollution is always caused by humans. Pollution can have a huge impact, altering the balance within ecosystems, and is the cause of death for millions of animals and plants around the world every year.

3.3 Land Use Change/Increased Infrastructure Development: This is the alteration of natural areas by humans, for example, the clearing of huge areas of rainforest in South America for farming. In Ireland, upland open habitats, such as rough grassland, scrub and heath, have been changed by agriculture and afforestation.

3.4 Intensive Farming Practices: Extensive use and concentrations of chemical and/or biological pesticides and the removal of hedgerows are typical practices in modern-day intensive farming. Often large areas of land are planted with a single crop (monocultures) which greatly reduces the level of biodiversity in that area.

3.5 Climate Change: It is now widely accepted that the current global rate of change in climate is as a result of human activity. As global air or sea temperature changes, even by just 1 or 2 degrees, the habitats in which species live will also change and may even become uninhabitable to some species.

2.2.6 ENDANGERED AND ENDEMIC SPECIES

Endangered species A species whose numbers are reduced to the point. That means endangered species are in immediate danger of extinction.
The International Union Conservation of Nature (IUCN) classified the species of plants and animals as:
(a) Endangered species
(b) Threatened species: Species (including animals, plants, fungi, etc.) which are vulnerable to endangerment in the near future)
(c) Rare species : Among the important endangered animal species, Indian wild ass; the Kashmir stag, the Golden Langur etc .. are considered highly endangered. There are also
endangered bird species like Siberian crane; the great Indian Bustard; the florican etc..
The IUCN published the data on endangered species of both plants and animals of India. The data symbolizes the working signal for those species which are endangered and if not protected are likely to become extinct in near future
A species is said to be **extinct** when it is not seen in the wild for 50 years at a stretch e.g. Dodo, Passenger Pigeon.
A species is said to be **endangered** when its number has been reduced to a critical level or whose habitat, have been drastically reduced and if such species is not protected and conserved, it is in immediate danger of extinction.

Endangered species of India

The International Union for Conservation of Nature and Natural Resources(IUCN) publishes the **Red Data Book** which include the list of endangered species of plants and animals. The red data symbolizes the warning signal for those species which are endangered and if not protected are likely to become extinct in near future

The animals that are listed under the critically endangered category are as under:

1)MalabarLargeSpottedCivet
2)NamdaphaFlyingSquirrel
3)SalimAli'sFruitBat
4)SumatranRhinoceros

EndangeredSpeciesareasunder:
1)AsiaticLion
2)AsiaticBlackBear
3)DesertCat
4)GreatIndianRhinoceros
5)IndianElephant(or)AsianElephant

ThreatenedSpeciesareasunder:
1)IndianWildAss
2)Leopard

Endemic species of India

India has two biodiversity hot-spots and thus possesses a large number of endemic species.

The endemic species are those taxa whose distribution is confined to a restricted area due to their specific ecological niches and edaphic gradients. Therefore, the habitats of endemic species are far more vulnerable than other species. Endemic species once lost, it is a loss of biodiversity of these species forever.

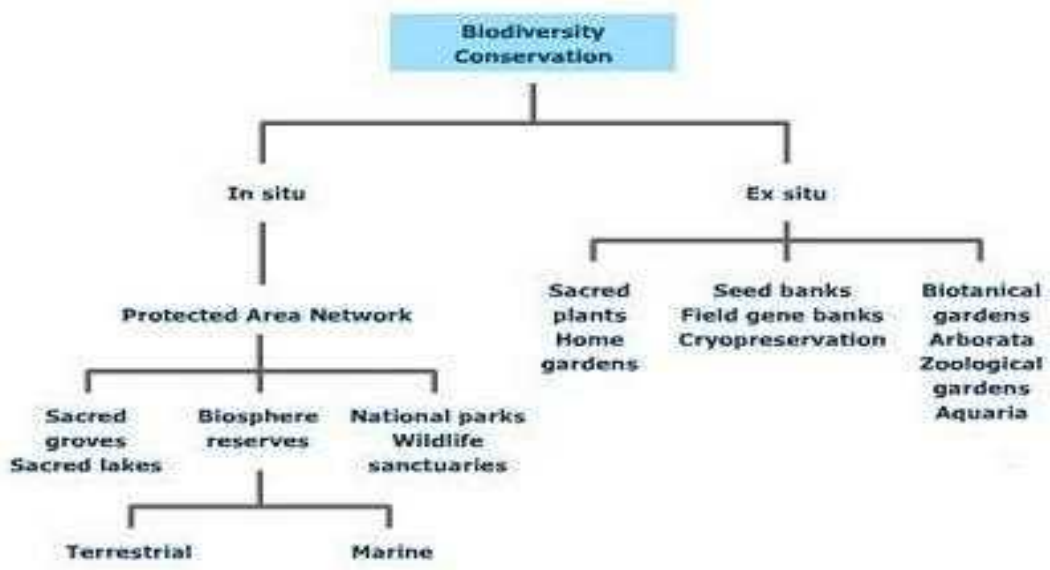
In India there are about 5725 endemic taxa of angiosperms (33.5% of Indian flora) which are located in 25 hot spots. The major hotspots in India which contain largest number of endemic plant species are the Southern Western Ghats and Eastern Himalayas with 1286 and 1808 endemic species respectively. There are about 1272 species of endemic angiosperms out of 3800 species occurring in Kerala (33.5% of Kerala flora) which represent 22.6% of Indian endemics. Seventy percent of the 1272 species of endemics have the major areas of distribution in Kerala with spill over in adjacent regions. On the basis of the study of the distributional range, about 102 endemic species occur exclusively in Kerala.

A large number out of a total of 81,000 of animals in our country is endemic. The Western Ghats are particularly rich in amphibians (frogs, toads etc) and reptiles (lizards, crocodiles etc) about 62% amphibians and 50% lizards are endemic to Western Ghats

.2.2.7 CONSERVATION OF BIODIVERSITY

In order to maintain and conserve biodiversity, the Ministry of Environment and Forests, government of India has already taken several steps to manage wildlife, the objectives of which are:

1. Maintenance of a number of species in protected areas such as National Parks, Sanctuaries..
2. To improve the biosphere reserves
3. Implement strict restrictions of export of rare plants and animals
4. Educate the public on these through the government agencies and NGO's.



A) In-situ conservation: The preservation of species **in its natural ecosystem** is called in-situ conservation. As a consequence, protected areas are being identified and maintained for natural conservation of species by individual countries. For the conservation and management of endangered species several projects have been established.
These are:

Tiger Projects: Corbett National Park which is 300 km from New Delhi is the oldest National Park of India having 1318.54 sq km. It was one of the nine Tiger Reserves created at the launch of the Project Tiger in 1973.

Gir Lion Projects: The Gir Forest of Gujarat where lions are found. This has an area of 1412 sq kms and declared as a National Park.

Elephant Projects: The objective was to ensure long-term survival of population of elephants (not come into operations). Project Elephant (PE), a centrally sponsored scheme, was launched in February 1992 to provide financial and technical support to major elephant bearing States in the country for protection of elephants and their habitats. The Project is being implemented in 13 States/UTs, viz..Andhra Pradesh, Arunachal Pradesh, Assam, Jharkhand, Karnataka, Kerala, Meghalaya, Nagaland, Orissa, Tamil Nadu, Uttaranchal, Uttar Pradesh and West Bengal.
There are about 7000 protected areas in the world which include a variety of National parks, Sanctuaries etc which vary in size (between 100 to 500 sq km), purpose (protection of one or more species and their habitats).. In India, there are 39 National Parks and 492 wildlife sanctuaries.

National Parks: These are protected areas exclusively for wild life. Human activities like hunting, Firewood collection, timber harvesting etc… are restricted in these areas to that wild plants and animals could grow in a protected environment

The following measures should be adopted for the conservation of biodiversity:
1. Over grazing in the forest and areas of vegetation should be controlled because it may Destroy the useful rare plants.
2. The habitat of plants and animals should be conserved.
3. The natural condition of ecosystem should be studied and researched in time and again, then Specific programs for conservation should be conducted.
4. Human activities should be done without destroying natural environment.
5. Illegal hunting and smuggling of animals and plants should be strictly avoided.
6. Effective laws and rules should be adopted for the conservation of rare animals and plants.
7. Industries are established from the raw materials. During the process of collecting raw materials, care should be taken not to destroy useful plants and habitats of animals.
8. Public awareness should be created about the importance of rare animals and plants, causes of rareness and measures for their preservation.

B) Ex-situ conservation: The conservation of elements of biodiversity out of the context of their natural habitats is referred to as ex-situ conservation. Zoos, botanical gardens and seed banks are all example of ex-situ conservation. In India we have the following important gene and seed bank facilities.

i) National Bureau of Plant Genetic Resources (NBPGR) is located in New Delhi. Here agricultural and horticultural crops are stored by **cryopreservation** of seeds, pollens etc. by using liquid nitrogen at a low temperature as low as -196^0_C.

ii) National Bureau of Animal Genetic Resources (NBAGR) located at karnal, Haryana. It preserves the semen of domesticated bovine animals.

UNIT-V

ENVIRONMENTAL POLLUTIONS

3.1 ENVIRONMENTAL POLLUTION

INTRODUCTION:

According to **ODUM (1971)**, Pollution is **"an undesirable change in the characteristics of air, water and land that harmfully affect the life and also create health hazards for all living organisms on the globe"**.
According to **SOUTHWICK (1976),** Pollution can be defined as **"the unfavorable (or) alteration of environment caused by human activities and causing harm to human beings".**

TYPES OF POLLUTION:

Basically the Pollution is of two types viz.,

(1) Natural Pollution: This type of pollution is limited in its occurrence generally from natural hazards like volcanic eruptions, emissions of natural gas, soil erosion, ultraviolet rays, cosmic rays etc and
(2) Manmade Pollution: Most of the pollution is man made only. However, Pollution is usually categorized as Air Pollution; Water Pollution; Thermal Pollution; Noise Pollution; Land & soil Pollution; Radio Active Pollution and Marine Pollution

3.1.1 AIR POLLUTION

Air pollution may be described as "**the imbalance in quality of air so as to cause adverse effects on the living organisms existing on earth**". Pollution is due to the presence of undesirable substance of sufficient quantity which exists in environment.
The substance or energy which causes pollution is called pollutant.

Types of air pollutants:
Pollutants may be classified according to origin and state of matter.

a) According to Origin: Air pollutants are divided into two categories as primary & secondary.
1) Primary air pollutants are those which are emitted directly into the atmosphere.
Eg: C; CO; CO_2; SOx ; N; S; H; NOx; CFC's etc .
2) Secondary air pollutants are those which are produced in the air by the interaction Among the primary air pollutants or by reaction with atmospheric constituents.
Eg: **Ozone (O_3)**; **Smog; Para Acetyl Nitrate (PAN)**; **Acid Rain**; **Aerosols.**

b) According to State of Matter: Air pollutants include fine solids; liquids and gases. Dust, Smoke, Fumes etc are examples for solid particles whereas fog is an example for liquid particles.

PRIMARY POLLUTANTS

1. Carbon Monoxide: It is a colorless, odorless, poisonous gas that is produced by the incomplete burning of carbon based fuels (coal, petrol, diesel and wood) which comes from the automobile industries, exhaust devices, About 70% of CO emissions are from the transport sector.

When the air is polluted with CO, human blood is likely to be deprived of oxygen and leads to coma and death. In mild dosages, it leads to headache.

2. Oxides of Sulphur: SO_2 is a gas produced from burning of coal, mainly in thermal power plants. Some industries such as paper mills produce SO_2. It is injurious not only to men and plants, but it also attacks rapidly a few rocks such as limestone, marbles, electric contacts etc. It can even dissolve nylon.

Paper absorbs SO_2 causing the paper to become brittle and fragile. SO_2 polluted air leads to corrosion of metals such as Fe, Zn, Cu, steel etc… SO_2 is a major contributor to Smog and acid rain.

Sulphur trioxideis more irritant than SO_2 because it combines immediately with water to form sulphuric acid.

3. Oxides of Nitrogen: Combustion of coal, oil, natural gas and gasoline which produces upto 50 ppm of Nitrogen. NOx are also produced when fossil fuels are burned especially in power plants and motor vehicles. NO_2poisoning results SILOFILTER disease. High levels of NO_2 exposure causes cough and make the human beings feel short of breath. People who are exposed to NO_2 for a long time have a higher chance of getting respiratory infections.

NOx compounds contribute for the formation of Ozone. Similarly, when nitrogen oxide when combine with SOx to form acid rain.

4. Chloro Fluoro Carbons: CFC's (also known as Freon) are non- toxic. They contain Carbon, Fluorine and Chlorine atoms.The five main CFCs are the following:

- CFC – 11 (Trichloro Fluoro Methane $CFCl_3$)
- CFC – 12 (Dichloro Fluoro Methane CF_2Cl_2)

The major uses of CFCs are as coolants in refrigerators and in air conditioners; as solvents in cleaners particularly for electronic circuit boards etc.. CFCs are the main cause of ozone depletion. CFCs have a lifetime in the atmosphere of about 20 to 100 years, and as a result one free chlorine atom from a CFC molecule can do a lot of damage.

SECONDARY POLLUTANTS:

1) Ozone (O_3) / Ozone layer Depletion: Ozone consists of oxygen molecules which contain three oxygen atoms. It is not emitted directly into the air but produced in the atmosphere when oxygen combines with oxygen radical (**$O^{\cdot}$**) in the presence of sunlight. Ozone protects us from ultra violet radiation and other harmful rays.

It is observed that over the last few years, many manmade processes release gases into atmosphere causing drastic depletion of ozone layer. The chlorine atoms cause depletion of ozone slowly and holes are formed in the ozone layer.

Ozone reacts with tissues and cause for breathing and decrease the working ability of the lungs, chest pains and coughing. It lowers the human body resistance power and leads to cold; pneumonia also.

Antarctic Ozone depletion: According to NIMBUS-7 satellite picture which was taken on 5th October, 1987 the protective ozone layer showed a hole over 50% of the area of the Antarctica continent covering 7 million sq km.
On Jan 1st 1989, the country Montreal (Canada) proposed redesigning refrigeration, air conditioning technology replacing the use of CFCs by ozone friendly substitutes.

2) Smog: Smog is a combination of smoke and fog or various gases when react in the presence of sunlight. The effects of smog on human health cause for respiratory, irritation to the eyes, diseases related to nose, throat, bronchitis, pneumonia, headache, nerves, liver, and kidneys.
The first smog related deaths were recorded in London in 1873, when it killed 500 people. In 1892, December, London had worst experiences causing 1000 deaths. In 1940's severe smog began covering the cities of Los Angeles in USA.

3) Acid rain: Acid rain has become one of the most important global environmental problems and poses significant adverse impact on soils, rivers, lakes, forests and monuments. The phenomenon occurs when SOx and NOx from the burning of fossil fuels such as Petrol, Diesel, Coat etc combine with water vapour in atmosphere and fall as rain or snow or fog.
Natural sources like volcanoes, forest fires, etc also contribute SOx and NOx. Increased urban and industrial activities cause air pollution resulting in the rise of concentration of SO_2 and NOx. Sulphur dioxide and NO_2 combines with water vapour in the atmosphere produce sulphuric acid and Nitric acid respectively and results acid rain. Some of the examples are:
Europe and parts of W Asia have experienced rain with water pH range of 4.5 to 5.0 (acidic) in 1958.

AIR POLLUTION EFFECTS, PREVENTION AND CONTROL MEASURES:
Human beings breathe 22000 times a day on the average, inhaling 16 kg of air. Atmosphere constitutes a protective cover of gases surrounding the earth which
sustains life and saves it from unfriendly environment.
The atmosphere consists of several layers viz. Troposphere, Stratosphere; Mesosphere; Thermosphere & Exosphere.
The lower atmosphere i.e., the troposphere contains 70% of gaseous components of major, minor and traces. Ultra violet radiation from the sun is absorbed by ozone in the stratosphere which is so called ozone layer located between 17 - 26 kms above sea level.

Effects of Air pollution: The effects of pollution may be direct and affect certain organisms. The effects of pollution may possess a hazard or nuisance. Long continued pollution even affects the evolution of a species and eliminates organisms that cannot tolerate certain pollutants and favor others who can eat.
Air pollution causes deaths, Impair health, reduce visibility and brings vast economic losses. It can also cause intangible losses to historic monuments such as Taj Mahal.
Finally, Air pollution can affect the environment on a global scale.

Prevention and control of Air Pollution:

- Inputs that do not contain the pollutants.
- Operating process to minimize generation of the pollutants.
- Replacing the process with one does not generate the pollutant.
- Removing the pollutants from the process.
- Substitution of raw materials.

Eg: The substitution of high sulphur coal with low sulphur coal in power plants.
Eg: Changing a fossil fuel with nuclear energy can eliminate sulphur emission.

- By involving the Process Modification:
  Eg: Chemical and petroleum industries have changed by implementing Automated operations, computerized process control by reducing the Oxidation of SO_2 to SO_3 by reducing excess air.
- By involving the control technologies: Control equipment viz., Wet Collector (scrubber), Gravity Settling chamber; Cyclone Collectors, Dry Scrubbers, filters, electrostatic precipitators etc. are to be used to minimize the air pollution.

3.1.2 WATER POLLUTION

Hydrosphere in the universe contains water in the form of oceans, rivers, lakes, tanks and many other water sources.
Water sources in the world are of two types.
They are (1) Marine water bodies and (2) Fresh Water bodies.
Water is a good solvent for many substances. Because of this property water cannot exist in its pure form at many parts of the world. Water pollution is mainly because of sewage, industrial disposals i.e., effluents.

PARAMETERS OF WATER POLLUTION:
Chemical examination of water (tests): pH; Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), etc are some of the chemical tests to find the stage of pollution of water.

1. pH: The value of pH gives the degree of acidity or alkalinity of polluted water. Determination of pH is important in calculating the coagulant (thick or thin) dose.

2. Biological Oxygen Demand (BOD): It is defined as the quantity of oxygen utilized by micro organisms at a temperature of 20^oC, generally measured for 5 days. When water is polluted by unwanted materials, naturally the O_2 content gets reduced and that water become not fit for consumption either by human beings or animals or plants.
Living organisms require water with some quantity of sustainable oxygen in it. That oxygen is necessary for living organisms is generally called BOD. If there is reduction in oxygen content of water, it becomes unfit for biological consumption because there is change in BOD.

COMMON TYPES OF WATER POLLUTANTS:
A) Based on sources **B) Based on natures**

A) Based on sources:
a) Disease causing agents: Bacteria, viruses, protozoan that enter water from domestic sewage and animal wastes.
b) Water soluble inorganic chemicals: Acids, salts and compounds of toxic metals such as Lead, Mercury can make water unfit to drink, harm fishes and other aquatic life. Also Nitrate, Phosphate compounds dissolve in water that can cause excessive growth of algae, which then die and decay, depleting dissolved O_2 in water and killing fish.

c) Water Soluble Organic chemicals: Oil, gasoline (a type of oil is obtained from petroleum), pesticides, detergents and many other water soluble chemicals that threaten human health and harm fish.

d) Heat: Large quantity of water is heated when it is used in the cooling towers of thermal power plants. When this hot water is discharged into the nearby water bodies, it causes an increase in its temperature.

e) Sewage: sewage is waste water from municipal area where there is human habitation. Sewage which comes from homes is called **domestic sewage**

B) Based on natures:

In nature water pollution is classified into three types by **Kimball** (1975). They are:

1. Domestic water pollution: Sewage is a part of domestic water pollution. Domestic sewage not only contains unwanted waste materials, but it is also infested with harmful bacteria, virus etc. These are responsible for causing diseases in animals and human beings, if they drink this polluted water and even plants may die if polluted water is provided. Domestic water pollution leads to Diarrhea, Cholera and Typhoid in human beings.

2. Agricultural Water Pollution: Water require for plants for its growth. Major irrigation, minor irrigation, sprinkler irrigation, drip irrigation, lift irrigation carry waste substances and causing water pollution in addition to the utilization of fertilizer and pesticides. Agricultural water pollution leads to Eutrophication & Water Bloom.

Ecological effects: The important troubling ecological impacts are:

1. Excessive nutrients in water bodies promote plant growth which leads to a drop in water quality;
2. Disruption of the natural ecosystem E.g. lack of oxygen for shelf marine life (causing a drop in their population).
3. Decrease in the recreational and aesthetic value of water bodies
4. Health problems when it occurs in drinking water reserves
5. Coral reef decline
6. Decreased biodiversity,
7. Changes in species composition and dominance, and
8. Toxicity effects.
9. Toxic phytoplankton species
10. Decreases in water transparency (increased turbidity)
11. Color, smell, and water treatment problems
12. Dissolved oxygen depletion
13. Increased incidences of fish kills
14. Loss of desirable fish species

3. Industrial water pollution: Many industries discharge waste materials containing harmful chemicals. Such Industrial wastes are called **effluents**. The river Godavari is polluted because of effluents released by the paper industry. It affects the entire water ecosystem causing enormous damage to fishes, prawns and fresh water animals.

Eg: Minamata disease & Fluorosis.

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

of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms.
Minamata disease was first discovered in Minamata city in Japan in 1956. It was caused by the release of methyl mercury from, the Chisso Corporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bio- accumulated in shellfish and fish in Minamata
Bay which when eaten by the local people resulted in mercury poisoning. While cat, dog, pig, and human deaths continued over more than 30 years, the government and company did little to prevent the pollution.
Fluorosis: People suffer from a disease called fluorosis after consuming water containing fluorine for sufficiently a long time. Quantity of fluoride in water is only 1 ppm. Diseases caused by fluorosis are:

- Back pain and cannot easily bend.
- Joints get stiffened as so movement of joints is impaired.
- Teeth are the worst effected and a brown coating appears on the enamel of teeth giving bad appearance.
- Persons with fluorosis cannot erect freely.

CONTROL MEASURES OF WATER POLLUTION:

1. Drinking water should be boiled, cooled and then used.
2. Disinfection of drinking water should be done by using chemicals like bleaching powder.
3. Pesticides and insecticides should be prevented from nearby use of water lakes,ponds and pools.
4. Drainage water should not be allowed to mix with drinking water.
5. Drainage system should be maintained properly.
6. Chlorination process is to be adopted for drinking water. For 1 litre of water 30 - 40 mg of chlorine is to be added to get perfect disinfection. It kills bacteria, fungi, fungal spores and other microbes also.

3.1.3 SOIL POLLUTION

Definition:
Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, Radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health. Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost topsoil. The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food.

There are many different ways that soil can become polluted, such as:

- Seepage from a landfill
- Discharge of industrial waste into the soil
- Percolation of contaminated water into the soil
- Rupture of underground storage tanks
- Excess application of pesticides, herbicides or fertilizer
- Solid waste seepage

The most common chemicals involved in causing soil pollution are:

- Petroleum hydrocarbons
- Heavy metals
- Pesticides
- Solvents

Types of Soil Pollution

- Agricultural Soil Pollution and pollution due to urban activities
  - i) Pollution of surface soil
  - ii) Pollution of underground soil
- Soil pollution by industrial effluents and solid wastes
  - i) Pollution of surface soil
  - ii) Disturbances in soil profile

CAUSES OF SOIL POLLUTION:

Soil pollution is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage links, application of pesticides, and percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage.

A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the Soil or which disturbs the biological balance of the organisms in the soil. Pollution in soil has adverse effect on plant growth.

Pollution in soil is associated with

- Indiscriminate use of fertilizers
- Indiscriminate use of pesticides, insecticides and herbicides
- Dumping of large quantities of solid waste
- Deforestation and soil erosion

1. Indiscriminate use of fertilizers:

Soil nutrients are important for plant growth and development. Plants obtain carbon, hydrogen and oxygen from air and water. But other necessary nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and more must be obtained from the soil. Farmers generally use fertilizers to correct soil deficiencies. Fertilizers contaminate the soil with impurities, which come from the raw materials used for their manufacture. Mixed fertilizers often contain ammonium nitrate (NH_4NO_3), phosphorus as P_2O_5, and potassium as K_2O. For instance, arsenic, lead and cadmium present in traces in rock phosphate mineral get transferred to super phosphate fertilizer. Since the metals are not degradable, their accumulation in the soil above their toxic levels due to excessive use of phosphate fertilizers becomes an indestructible poison for crops.

The over use of NPK fertilizers reduce quantity of vegetables and crops grown on soil over the years. It also reduces the protein content of wheat, maize, grams, etc., grown on that soil. The carbohydrate quality of such crops also gets degraded. Excess potassium content in soil decreases Vitamin C and carotene content in vegetables and fruits. The vegetables and fruits grown on over fertilized soil are more prone to attacks by insects and disease.

2. Indiscriminate use of pesticides, insecticides and herbicides:

The first widespread insecticide use began at the end of World War II and included DDT **(dichlorodiphenyltrichloroethane) and gammaxene**. Insects soon became resistant to DDT and as the chemical did not decompose readily, it persisted in the environment. Since it was soluble in fat rather than water, it biomagnified up the food chain and disrupted calcium metabolism in birds, causing egg shells to be thin and fragile. As a result, large birds of prey such as the brown pelican, ospreys, falcons and eagles became endangered. DDT has been now been banned in most western countries. Ironically many of them including USA still produce DDT for export to other developing nations whose needs outweigh the problems caused by it.

The most important pesticides are DDT, BHC, chlorinated hydrocarbons, organophosphates,

aldrin, malathion, dieldrin, furodan, etc. The remnants of such pesticides used on pests may get adsorbed by the soil particles, which then contaminate root crops grown in that soil. The consumption of such crops causes the pesticides remnants to enter human biological systems, affecting them adversely.

An infamous herbicide used as a defoliant in the Vietnam War called Agent Orange (dioxin), exposure to Agent Orange.

Pesticides not only bring toxic effect on human and animals but also decrease the fertility of the soil. Some of the pesticides are quite stable and their bio- degradation may take weeks and even months.

Pesticide problems such as resistance, resurgence, and health effects have caused scientists to seek alternatives. Pheromones and hormones to attract or repel insects and using natural enemies or sterilization by radiation have been suggested

3. Dumping of large quantities of solid waste:

In general, solid waste includes garbage, domestic refuse and discarded solid materials such as Those from commercial, industrial and agricultural operations. They contain increasing amounts of paper, cardboards, plastics, glass, old construction material, packaging material and toxic or otherwise hazardous substances. Since a significant amount of urban solid waste tends to be paper and food waste, the majority is recyclable or biodegradable in landfills. Similarly, most agricultural waste is recycled and mining waste is left on site.

The portion of solid waste that is hazardous such as oils, battery metals, heavy metals from smelting industries and organic solvents are the ones we have to pay particular attention to. These can in the long run, get deposited to the soils of the surrounding area and pollute them by altering their chemical and biological properties. They also contaminate drinking water aquifer sources. More than 90% of hazardous waste is produced by chemical, petroleum and metal-related industries and small businesses such as dry cleaners and gas stations contribute as well.

4. Deforestation and soil erosion:

Soil Erosion occurs when the weathered soil particles are dislodged and carried away by wind or water. Deforestation, agricultural development, temperature extremes, precipitation including acid rain, and human activities contribute to this erosion. Humans speed up this process by construction, mining, cutting of timber, over cropping and overgrazing. It results in floods and cause soil erosion.

EFFECTS OF SOIL POLLUTION

1. Agricultural
   - Reduced soil fertility
   - Reduced nitrogen fixation
   - Increased erosion
   - Larger loss of soil and nutrients
   - Deposition of silt in tanks and reservoirs
   - Reduced crop yield
   - Imbalance in soil fauna and flora
2. **Industrial**
   - Dangerous chemicals entering underground water
   - Ecological imbalance
   - Release of pollutant gases
   - Release of radioactive rays causing health problems
   - Increased salinity
   - Reduced vegetation
3. **Urban**

   Clogging of drains
   - Inundation of areas
   - Public health problems
   - Pollution of drinking water sources
   - Foul smell and release of gases
   - Waste management problems

CONTROL MEASURES OF SOIL POLLUTION

The following steps have been suggested to control soil pollution. To help prevent soil erosion, we can limit construction in sensitive area. In general we would need less fertilizer and fewer pesticides if we could all adopt the three R's: Reduce, Reuse, and Recycle. This would give us less solid waste.

1. Reducing chemical fertilizer and pesticide use Applying bio-fertilizers and manures can reduce chemical fertilizer and pesticide use. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution.

2. Reusing of materials

Materials such as glass containers, plastic bags, paper, cloth etc. can be reused at domestic levels rather than being disposed, reducing solid waste pollution.

3. Recycling and recovery of materials

This is a reasonable solution for reducing soil pollution. Materials such as paper, some kinds of plastics and glass can and are being recycled. This decreases the volume of refuse and helps in the conservation of natural resources. For example, recovery of one tonne of paper can save 17 trees.

4. Reforesting

Control of land loss and soil erosion can be attempted through restoring forest and grass cover to check wastelands, soil erosion and floods. Crop rotation or mixed cropping can improve the fertility of the land.

5. Solid waste treatment

Proper methods should be adopted for management of solid waste disposal. Industrial wastes

can be treated physically, chemically and biologically until they are less hazardous. Acidic and alkaline wastes should be first neutralized; the insoluble material if biodegradable should be allowed to degrade under controlled conditions before being disposed.

3.1.4 MARINE POLLUTION

Pollution of oceans is damaging the marine environment and is becoming a major problem. Marine environment is interesting for various reasons such as Sea food; Navigation; Adventure; Tourism etc,, Marine Pollution is harmful and its danger can be identified in a variety of ways.

Sources & causes of marine pollution:
Marine pollution originates from one of two sources --- the land or the sea which are explained below:
Marine Oil Pollution: Oil is basically an important pollutant which destroys marine environment. The various sources of oil pollution are:
Run-off oil from streets; disposal of lubricants from machines; Off shore oil and gas exploitation from off-shore drilling; blowouts at off-shore drilling rigs; oil escaping under high pressure from a bore hole in the ocean floor. **Waste chemicals, mud and accumulation of toxic substances in the ocean in theform of mercury, dioxin, PCBs, PAHs (Poly Aromatic Hydrocarbons) Radioactivity. benzene; xylene (colorless, flammable liquids) and heavy metals such as lead; copper; nickel, mercury also cause for marine pollution during the off shore drilling activities. Both dumping and exploitation of ocean resources cause ocean pollution also.**
PAHs: It is a chemical compound and organic pollutant. These occur in oil, coal and tar deposits and are produced as byproducts of fuel burning.
PAHs are lipophilic meaning they mix more easily in oil than water.
Eg for PAHs are: Acenaphthene; Anthracene; Benzopyrene; Chrysene; Coronene; Fluorene; Pyrene.

Other sources from land: The major sources of marine pollution originating from the land vary from country to country. Effluents are discharged either directly into the sea or enters the coastal waters through rivers. Thousands of barrels of oil burn when oil wells were set on fire. Tanker accidents on land carry oil to the nearby streams / canals and cause for marine Pollution. Due to burning of oil, smoke, SO2, NO2, CO is added towards atmospheric contamination.

The effects of oil pollution depend mainly on the following factors:
Type of oil and its viscosity, amount / quantity released, distance covered, time, average water temp etc..
Effects of Marine Pollution:

S No	Source	Effect
1	Sewage & run- off from forestry;	Depletes oxygen in water causes killing of fishes.
2	Sediments from mining	Sediments clog in the gills of fishes
3	Sewage from municipalities, towns; cities etc…	Contaminate sea food
4	Industrial discharge; pesticides from farms	Cause disease in coastal marine life
5	Oil from off shore drilling; industries/ automobiles	Low level contamination kill larvae whereas high level contamination causes death for sea fishes

6	Litter (rubbish), waste, plastics	Marine life disturbs
7	Hot water from power plants	Kills corals.

Marine Pollution Abatement / Prevention & control measures of Marine pollution:

The following are the some of the control measures for marine pollution:

1. Improving existing sewage disposal facilities
2. Ensuring individual houses have sewage disposal systems (such as septic tanks).
3. Large resorts should use and manage their own packaged treatment plants.
4. Marine planning and management should be considered as processes such as land – sea interaction; inter disciplinary co-operation; participation of public & private sector organizations; balance between protection and development public participation
5. Oil tankers are double hulled (two layered bottom) to reduce the chance of oil leakage
6. Recycling facilities for used oil.

3.1.5 NOISE POLLUTION

INTRODUCTION:

Everyone knows that sound is a form of energy that is capable of causing disturbances in human beings. Ears are the hearing organs in human beings.

A thin membrane is called Tympanum (or) ear drum receives the vibrations produced by sound to a limited extent. Human ear is capable of perceiving about 85 decibels of sound. Beyond the limit, the ear drum cannot bear sound.

In nature, we hear different types of sounds. Sound is a kind of vibration which travel through air, water, and are sensed by the ear. This is from music, speech, etc from radio / television / computers etc., one thing in this matter is that we can increase the volume of sound or decrease as per our taste whereas, a noise is a sound which cannot be heard clearly and only mixed sounds will be heard.

For eg: in an office one is talking on mobile, phone ringing another side, ring tones in some person's hands, loud conversations with one and another etc., this is called noise. One cannot increase or decrease the volume of noise. In general, a sound is a vibration from a particular machine, place or material which can be heard clearly whereas a noise a mixed vibrations that will come to us from all directions. A sound can be clear and can be able to hear, whereas a noise will not be clear and cannot be heard.

SOURCES OF NOISE:

Noise is an unwanted sound and noise pollution occurs through different sources:

1. Vehicles produce noise that leads to noise pollution.
2. Automobile industry is another source of noise pollution.
3. Noise pollution is very common in industrial areas where machines are working for factories making more noise.

The sources of noise are more in urban and industrial areas, than in rural areas. The sources of noise may be stationary or mobile. The stationary sources include industries, loud speakers, mining operations, use of machineries, TV, Radio and Grinders etc. The mobile sources include Road Traffic, Highway Noise, Railway Traffic and Air Traffic.

(1) Stationary sources:

a) Industrial noise: The main categories of industrial activity that are particularly relevant to the study of noise are the following:

Product fabrication, Product assembly, Power generation by means of generators, Combusting process in furnaces (burning of gases)

b) Noise from construction works: Construction noise, a major source of noise pollution is emitted by construction equipment. The sources of noise are dozers excavators, front end loaders, soil compactors, cranes, air compressors, concrete vibrators, riveting steel structure during the casting, dismantling of construction materials etc...

c) Noise from other sources: These include sources such as sirens, barking dogs, ambulances, Police vehicles, Fire engines etc.

(2) Mobile sources:

Road traffic: Of all sources of noise pollution, road traffic is the most prevalent and perhaps the most source of noise pollution. More people are exposed to noise from motor vehicles and the noise depends on various factors such as Road location, Road design, Vehicle standards, Driver behaviors, Horns, Traffic density. ,

Noise of common road vehicles

Vehicle type	**Noise (db)**
Medium road traffic (Main roads)	70- 80
Heavy road traffic (High ways)	80- 90
Buses & Trucks upto 3.5 tons	85- 95
Trucks upto 3.5-12 tons	90-100
Motor cycles	90-105

It can be observed that motor cycles with their exposed engines and inadequate silencing arrangements are notorious noise producers, which produce more than 30 times sound than a small passenger car.

a) Railway traffic: Noise from railway traffic is not serious nuisance as compared to the road traffic noise. The level of noise associated with rail traffic is related to the type of engine, the speed of the train, track type and condition. The majority of noise emitted by trains is produced by the engine (or) by the interaction of wheels with the tracks, horns, warning signals at crossings etc..,

b) Air traffic: The noise of air craft is different from that of road traffic in the sense it is intermittent. Noise is maximum during takeoff and landing. Noise made by jet planes is more disturbance than that of propeller driven air craft. Supersonic air craft produce noise at high levels due to its intensity.

EFFECTS OF NOISE:

At 120 decibels the ear registers pain but hearing damage begins about 85 decibels. Apart from hearing loss, noise can cause lack of sleep, irritation, indigestion, ulcers, High B.P., Heart diseases , Stress etc.,.

1. Annoyance (Feeling slightly angry): One of the most important effects of noise on human is

annoyance. Due to this breathing rate affects.

2.Noise- induced hearing loss: Exposure to noise for a long enough duration results in damage to the inner ear and thus decreases one's ability to hear. The louder the noise the less time it takes to cause hearing loss.

3.Effects on sleep: Noise disturbs sleep. It has been found that the cases related to various levels of noise are associated with sleep disturbances. Sleep disturbance by noise depends on the characteristics of the noise such as frequency, loudness and whether the noise is continuous or intermittent.

Other effects: There are many other effects of noises such involve aggression (ready to attack). People may turn mad and nerves may not function normally, People may be deformed in many ways including increased stress and strain, nonfunctioning of hands, legs etc due to noise pollution if exposed continuously.

CONTROL MEASURES:

Noise pollution could be controlled by either reducing the noise at the source or by preventing its transmission.

The first step in the prevention of noise pollution is to control the noise at source itself.

For eg: Lubrication of machines reduces the noise produced, Tightening the loose nuts, Reducing the vibrations produced by machines etc…

Failing to control the noise at its source, the second step is to prevent its transmission for eg: keeping the noise machine covered in an enclosure so that the sound does not escape and reach the receivers, construction of noise barriers on road sides, sound proof the buildings by using heavy curtains on the windows, acoustical tiles on the ceiling and walls, by sealing the cracks in the walls to reduce the noise coming from outside.

If the noise levels are not able to bring down to the desired levels in some cases, the only alternative is to follow:

- Avoiding horns except in emergency situations.
- Sound proof or eco-generators and Turning down the volume of stereos.
- Conducting the awareness programs

3.1.6 THERMAL POLLUTION

Thermal pollution is also known as heat pollution and occurs when heat is released into water or air that produces undesirable effects. Sudden heat release usually due to forest fire or volcanoes or human induced activities. Thermal pollution is also the addition of excess undesirable heat to water that makes it harmful to human, animal or aquatic life.

Sources of Thermal Pollution:

Various sources of thermal pollution include

Thermal Power Plants ; Nuclear Power Plants ; Petroleum Refineries; Steel Plants; Metallurgical industries; Paper Mills; Chemical Plants. Coal fired power plants constitute major sources of thermal pollution. Nuclear plants discharge much heat and also traces of toxic radioactive substances. Many industries use water for cooling purpose and thus the heat effluents are finally discharged into water.

Temperature and its effects: Temperature plays an important role in determining the conditions in which living things can survive.
Birds and mammals require a narrow range of body temp for survival whereas aquatic species can exist at a certain range of temperatures.
Thermal pollution increases water temperature causing a change (lowering) of dissolved oxygen levels. This disrupts and causes decay of plant and animal species.
For eg: The warmer water increases the metabolic rate of fish and other animals in the sea; this decreases the life expectancy of aquatic animals.

Management of Thermal Pollution:
Thermal Pollution is controlled by the following methods:
1. Cooling Towers are designed to control the temperature of water which transfers some of the heat from the water to the surrounding atmosphere by evaporation. There are two types of cooling towers namely wet cooling towers and dry cooling towers.
2. Cooling ponds are employed for thermal discharges. Heated effluents on the surface of water in cooling ponds maximize dissipation of heat to the atmosphere.
3. Artificial lakes are manmade bodies of water which offer possible alternative. The heating effluents are discharged into lake at one end and the water for cooling purpose may be withdrawn from the other end

3.1.7 NUCLEAR HAZARDS

Radioactivity is the phenomenon of emission of energy from radioactive isotopes (i.e., unstable isotopes), such as Carbon-14, Uranium-235, Uranium-238, Uranium-239, Radium-226, etc. The emission of energy from radioactive substances in the environment is often called as 'Radioactive Pollution'.

Sources/causes of nuclear hazards
The sources of radioactivity are both natural and man-made. The natural sources include:
a) Natural sources:
1) Emissions from radioactive materials from the Earth's crust.
People have been exposed to low levels of radiation from these natural sources for several millennia. But it is the man-made sources which are posing a threat to mankind.

b) **Man-Made Sources:** The man-made sources of radioactivity are nuclear wastes (i.e., waste material that contains radioactive nuclei) produced during the:
1) Mining and processing of radioactive ores;
2) Use of radioactive material in nuclear power plants;
3) Use of radioactive isotopes in medical, industrial and research applications; and
4) Use of radioactive materials in nuclear weapons.
The greatest exposure to human beings comes from the diagnostic use of X-rays, radioactive isotopes used as tracers and treatment of cancer and other ailments.

Effects of nuclear hazards:
The effects of radioactive pollutants depend upon half-life, energy releasing capacity, rate of diffusion and rate of deposition of the contaminant. Various atmospheric conditions and climatic

conditions such as wind, temperature and rainfall also determine their effects.
The effects may be somatic (individual exposed is affected) or genetic (future generations) damage. The effects are cancer, shortening of life span and genetic effects or mutations.

Some of the possible effects are listed as under:

1) Radiations may break chemical bonds, such as DNA in cells. This affects the genetic make-up and control mechanisms. The effects can be instantaneous, prolonged or delayed types. Even it could be carried to future generations.

2) Exposure at low doses of radiations (100-250 rads), men do not die but begin to suffer from fatigue, nausea, vomiting and loss of hair. But recovery is possible.

3) Exposure at higher doses (400-500 rads), the bone marrow is affected, blood cells are reduced, natural resistance and fighting capacity against germs is reduced, blood fails to clot, and the irradiated person soon dies of infection and bleeding.

4) Higher irradiation doses (10,000 rads) kill the organisms by damaging the tissues of heart, brain, etc.

5) Workers handling radioactive wastes get slow but continuous irradiation and in course of time develop cancer of different types.6) Through food chain also, radioactivity effects are experienced by man.

But the most significant effect of radioactivity is that it causes long range effects, affecting the future of man and hence the future of our civilization.

Control measures:

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

1) Leakages from nuclear reactors, careless handling, transport and use of radioactive fuels, fission products and radioactive isotopes have to be totally stopped;
2) Safety measures should be enforced strictly;
3) Waste disposal must be careful, efficient and effective;
4) There should be regular monitoring and quantitative analysis through frequent sampling in the risk areas;
5) Preventive measures should be followed so that background radiation levels do not exceed the permissible limits;

6) Appropriate steps should be taken against occupational exposure; and
7) Safety measures should be strengthened against nuclear accidents

3.2 SOLID WASTE MANAGEMENT

Solid wastes are the material that arises from various human and economic activities. It is being produced since the beginning of civilization. Ever increasing population growth, urbanization and industrialization are contributing to the generation of solid waste in huge quantities.

Waste is enviable; waste is by product of human activity which has lack of use. The term waste refers to the useless material generated from different sources such as household, public places, hospital, commercial centre construction sites and production of waste from industries.

Waste can be classified through various methods on the basis of physical state (solid, liquid and gaseous) and then within solid waste (according to its original use packaging waste, food waste etc.) material (glass, paper etc.) physical properties, domestic, commercial, biodegradable, non-biodegradable etc. Solid wastes have prevailing characteristics which sets them apart from the liquid and gaseous wastes.

The characteristics are that the waste remains highly visible in the environment. Liquid wastes are quickly relegated to sewer and are out of sight and gaseous wastes disperse in to the atmosphere. Accumulation of large quantities of solid wastes is having an adverse impact on the environment.

There are many waste types defined by modern systems of waste management, notably including:

- municipal solid waste (MSW)
- construction waste and demolition waste (C&D)
- institutional waste, commercial waste, and industrial waste (IC&I)
- medical waste (also known as clinical waste)
- hazardous waste, radioactive waste, and electronic waste
- biodegradable waste

Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each.

Effects

a) Health Hazard

If solid wastes are not collected and allowed to accumulate, they may create unsanitary conditions. This may lead to epidemic outbreaks. Many diseases like cholera, diarrhea, dysentery, plague, jaundice, or gastro-intestinal diseases may spread and cause loss of human

lives. In addition, improper handling of the solid wastes is a health hazard for the workers who come in direct contact with the waste.

b)Environmental Impact

If the solid wastes are not treated properly, decomposition and putrefaction may take place, causing land and water pollution when the waste products percolate down into the underground water resources. The organic solid waste during decomposition may generate obnoxious odors. Stray dogs and birds may sometimes invade garbage heaps and may spread it over the neighborhood causing unhygienic and unhealthy surroundings.

Control measures

An integrated waste management strategy includes three main components

1. Source reduction

2. Recycling

3. Disposal

Source reduction is one of the fundamental ways to reduce waste. This can be done by using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity. On an individual level we can reduce the use of unnecessary items while shopping, buy items with minimal packaging, avoid buying disposable items and also avoid asking for plastic carry bags.

Recycling is reusing some components of the waste that may have some economic value. Recycling has readily visible benefits such as conservation of resources reduction in energy used during manufacture and reducing pollution levels. Some materials such as aluminum and steel can be recycled many times. Metal, paper, glass and plastics are recyclable. Mining of new aluminum is expensive and hence recycled aluminum has a strong market and plays a significant role in the aluminum industry. Paper recycling can also help preserve forests as it takes about 17 trees to make one ton of paper. Crushed glass (cullet) reduces the energy required to manufacture new glass by 50 percent. Cullet lowers the temperature requirement of the glassmaking process thus conserving energy and reducing air pollution.

However even if recycling is a viable alternative, it presents several problems. The problems associated with recycling are either technical or economical. Plastics are difficult to recycle because of the different types of polymer resins used in their production. Since each type has its own chemical makeup different plastics cannot be recycled together. Thus separation of different plastics before recycling is necessary. Similarly in recycled paper the fibers are weakened and it is difficult to control the colour of the recycled product. Recycled paper is banned for use in food containers to prevent the possibility of contamination. It very often costs less to transport raw paper pulp than scrap paper. Collection, sorting and transport account for about 90 percent of the cost of paper recycling.

The processes of pulping, deinking and screening wastepaper are generally more expensive than making paper from virgin wood or cellulose fibers. Very often thus recycled paper is more expensive than virgin paper. However as technology improves the cost will come down.

Disposal of solid waste is done most commonly through a sanitary landfill or through incineration. A modern sanitary landfill is a depression in an impermeable soil layer that is lined with an impermeable membrane. The three key characteristics of a municipal sanitary landfill that distinguish it from an open dump are:

• Solid waste is placed in a suitably selected and prepared landfill site in a carefully prescribed manner.

• The waste material is spread out and compacted with appropriate heavy machinery.

• The waste is covered each day with a layer of compacted soil. The problems with older landfills are associated with groundwater pollution. Pollutants seeping out from the bottom of a sanitary landfill (leachates) very often percolate down to the groundwater aquifer no matter how thick the underlying soil layer. Today it is essential to have suitable bottom liners and leachate collection systems along with the installation of monitoring systems to detect groundwater pollution.

The organic material in the buried solid waste will decompose due to the action of microorganisms. At first the waste decomposes aerobically until the oxygen that was present in the freshly placed fill is used up by the aerobic microorganisms. The anerobes take over producing methane which is poisonous and highly explosive when mixed with air in concentrations between 5 and 15 percent. The movement of gas can be controlled by providing impermeable barriers in the landfill. A venting system to collect the blocked gas and vent it to the surface where it can be safely diluted and dispersed into the atmosphere is thus a necessary component of the design of sanitary landfills.

Even though land filling is an economic alternative for solid waste disposal, it has become increasingly difficult to find suitable land filling sites that are within economic hauling distance and very often citizens do not want landfills in their vicinity. Another reason is that no matter how well engineered the design and operation may be, there is always the danger of some environmental damage in the form of leakage of leachates. Incineration is the process of burning municipal solid waste in a properly designed furnace under suitable temperature and operating conditions. Incineration is a chemical process in which the combustible portion of the waste is combined with oxygen forming carbon dioxide and water, which are released into the atmosphere.

This chemical reaction called oxidation results in the release of heat. For complete oxidation the waste must be mixed with appropriate volumes of air at a temperature of about 815o C for about one hour.

Incineration can reduce the municipal solid waste by about 90 percent in volume and 75 percent in weight. The risks of incineration however involve airquality problems and toxicity and disposal of the fly and bottom ash produced during the incineration process. Fly ash consists of finely divided particulate matter, including cinders, mineral dust and soot. Most of the incinerator ash is bottom ash while the remainder is fly ash. The possible presence of heavy metals in incinerator ash can be harmful. Thus toxic products and materials containing heavy metals (for example batteries and plastics) should be segregated.

Thus extensive air pollution control equipment and high-level technical supervision and skilled employees for proper operation and maintenance is required. Thus while sanitary landfills and incinerators have their own advantages and disadvantages, the most effective method of solid waste management is source reduction and recycling.

Vermi – Composting

Nature has perfect solutions for managing the waste it creates, if left undisturbed. The biogeochemical cycles are designed to clear the waste material produced by animals and plants. We can mimic the same methods that are present in nature. All dead and dry leaves and twigs decompose and are broken down by organisms such as worms and insects, and is finally broken down by bacteria and fungi, to form a dark rich soil-like material called compost.

These organisms in the soil use the organic material as food, which provides them with nutrients for their growth and activities. These nutrients are returned to the soil to be used again by trees and other plants. This process recycles nutrients in nature. This soil can be used as a manure for farms and gardens.

3.2.1 ROLE OF INDIVIDUALS IN PREVENTION OF POLLUTION

The role of an individual in maintaining a pollution free, pure and congenial environment and in preserving its resources is actually the need of the hour. Individuals can, however, play an important role in abatement of air, water, soil or noise pollution in the following simple manners:

1) Use low-phosphate, phosphate-free or biodegradable dishwashing liquid, laundry detergent, and shampoo.
2) Don't use water fresheners in toilets.
3) Use manure or compost instead of commercial inorganic fertilizers to fertilize gardens and yard plant.
4) Use biological methods or integrated pest management to control garden, yard, and household pests.
5) Don't pour pesticides, paints, solvents, oils, or other products containing harmful chemicals down drain or on the ground. Contact the authorities responsible for their disposal.
6) Recycle old motor oil and antifreeze at an auto service center that has an oil recycling program

7) If you get water from a private well or suspect that municipal water is contaminated, have tested by an EPA certified laboratory for lead, nitrates, trihalomethanes, radon, volatile, organic compounds and pesticides.

8) Run water from taps for several minutes every morning before using the water for drinking or cooking. Save it and use it to water plants.

If you have a septic tank, monitor it yearly and have it cleaned out every three to five years by a reputable contractor so that it won't contribute to groundwater pollution. Do not use Septic tank cleaner, which contain toxic chemicals that can kill bacteria important to sewage Decomposition and that can contaminate groundwater if systems malfunction.

9) Support ecological land-use planning in your community.

10) Get to know your local water bodies and form watchdog groups to help monitor, protect, and restore them.

3.3 DISASTER MANAGEMENT

Disaster means a terrible event that causes a great damage / loss to the human beings. It is a situation arising from natural forces where large scale disruption of infrastructure, services etc. occurs. It causes a serious impact on human life, economy and environment. Natural disasters are always severe and sudden.

Some disasters are:

(A) Geological: in nature like the earthquakes;

(B) Landslides (rocks slides down from the side of a hill); Volcanic eruptions etc..

(C) Climatic disasters / Natural calamities: These are of different types affect nations all over the world. Because of the large geographical size of the country, India often faces natural calamities like floods, cyclones and drought occurring frequently in different parts of the country.

Natural calamities are of two types:

1. Major calamities: eg: earthquakes; droughts; floods, tsunamis; cyclones etc
2. Minor calamities: eg: hailstorms; avalanches; fire accidents

(D) Man induced disasters include wars, battles, riots, rail/road accidents, nuclear explosions.

The disaster Management: The natural disaster management involves the following steps:
Relief measures: it include rescue tools; communication equipments; heavy machines to remove debris; water pumps; technicians; drugs, doctors, ambulances..

Disaster predictions: The predictions of natural hazards may be made on the basis of past history of the area with regular monitoring of the environmental changes caused by human activities to assess the genesis of natural disasters.

Education: Disaster education plays a significant role in disaster education. It create awareness and improve the standards to prevent from the disasters.

Geographic Information Systems: (GIS): GIS is a system that captures, stores, analyzes , manages and presents data with reference to geographic location of the area. In simple terms, GIS is the merging of cartography, statistical analysis and database technology. GIS may be used in Archaeology, Geography, Remote Sensing, Land surveying; Natural Resource Management;

Urban Planning etc. GIS programs help by means of maps available data of the problem areas, to predict the severity of the disaster.

Floods

Floods are high stream flow that overflows the natural banks of the rivers and most of the times become calamitous. India is the most flood affected nation after Bangladesh. Out of total deaths by Floods in the world, (1/5) are from India. The main causes of floods are excessive rains in river catchments, poor natural drainage, Change of river course, Landslide restricting river flow, cyclone and very intense rainfall. Over that past few years the rise in population is forcing large settlements along the river banks, making the country highly vulnerable to Floods. The most vulnerable states of India are Uttar Pradesh, Bihar, Assam, West Bengal, Gujarat, Orissa, Andhra Pradesh, Madhya Pradesh, Maharashtra, and PunjabandJammu&Kashmir. In 1994, a major flood killed 147 people in Kerala, 138 in Gujarat and marooned 10000 in Madhya Pradesh. In 1995, the states of Uttar Pradesh, Haryana and Arunachal Pradesh were severely hit by flood causing huge casualties. In the year 1996, a fierce flood literally paralyzed India, Thousands of people died, got homeless, were marooned in the states of Rajasthan, Andhra Pradesh, Jammu & Kashmir also affecting many other parts of the country. In short, nearly every year one or the other part of the country is severely hit by Floods and creating a shameful history for India. It is high time that the policies and measures for various preventions and disaster management activities are properly implemented. Development of flood risk maps, flash flood run off modeling, water logging problems, systems for monitoring and management of flood using remote sensing and GIS.

Earth-quakes Earthquakes occur due to the sudden movements in the earth crust. The earth's crust has several tectonic plates of solid rocks which slowly move along their boundaries. When friction prevents these plates from slipping, stress builds up and results in the sudden fractures which occur along their boundaries of the plates or fault lines (planes of weakness) within the plates. This causes earthquakes, the violent, short term vibrations in the earth. The point on a fault at which the first movement occurs during an earth quake is called the epicenter. The severity of an earthquake is generally measured by its magnitude on RichterScale.

Richter scale	**Severity of earthquake**
Less than 4	Insignificant
4-4.9	Minor
5-5.9	Damaging
6-6.9	Destructive
7-7.9	Major
8-8.9	Great

Damage to property and life can be prevented by monitoring of buildings and structures under Strong Earth Motion, experimental and analytical investigations on structures to predict their behavior under earthquake conditions, strengthening through retrofits, development of

earthquake resistant design methodologies, better materials, risk assessment, preparation of seismic codes, seismic zonation and development of risk specific designs

Landslides

Landslides are mass movement of rocks and debris that usually follow a cyclone, volcano or earthquake. In the hilly areas of India, the sliding of huge masses of land has been a common natural disaster causing havoc to life and property. One of the worst and most disastrous landslides has been recorded in the year 1998 in the state of Uttarakhand, when nearly 380 people were killed. As a measure of concern many committees and other measures have been taken to protect from this natural havoc in India. In India, the regions of Himalayas and the Western ghats are the most vulnerable to these land-slides. The main causes of landslides are weak, weathered materials, physical property variation, Ground Uplift, erosion, Earthquake, Volcanic eruptions etc. The general and simple mitigation that are adopted or should be adopted are drainage correction, proper land-utilization, reforestation and spreading of awareness.

Cyclones

Cyclone refers to a whirl in the atmosphere with very strong winds circulating around it in anti-clockwise direction in the Northern Hemisphere and clockwise in the Southern Hemisphere. Cyclones are intense low pressure areas with pressure increasing outwards. Cyclones can be hazardous as Cyclones are normally associated with strong winds. A storm surge is an abnormal rise of sea level near the coast caused by a severe tropical cyclone; as a result, sea water inundates low lying areas of coastal regions drowning human beings and lives- stock, eroding beaches and embankments, destroying vegetation and reducing soil fertility. Apart from strong winds, cyclones can result in heavy rains causing floods. However, the most destructive factor associated with the cyclones is the storm surge. The worst and the oldest cyclone in India were in 1737, in Calcutta that took 300000 lives respectively. For cyclone forecast and advance warning, the Government has strengthened the Meteorological Department, by providing Cyclone Surveillance Radars at Calcutta, Paradeep, Visakhapatnam, Machilipatnam, Madras and Karaikal in the east coast and at Cochin, Goa, Bombay and Bhuj in the west coast. As India has a vast coastline it is extremely vulnerable to cyclone.

3.3.1 E-WASTE

Front panel of CRTs	Barium (Ba)	Short term exposure causes: • Muscle weakness; • Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	• Carcinogenic (lung cancer) • Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis. • Skin diseases such as warts.

MANAGEMENT OF E-WASTES

It is estimated that 75% of electronic items are stored due to uncertainty of how to manage it. These electronic junks lie unattended in houses, offices, warehouses etc. and normally mixed with household wastes, which are finally disposed off at landfills. This necessitates implementable management measures.

In industries management of e-waste should begin at the point of generation. This can be done by waste minimization techniques and by sustainable product design. Waste minimization in industries involves adopting:

- inventory management,
- production-process modification,
- volume reduction,
- Recovery and reuse.

Inventory management

Proper control over the materials used in the manufacturing process is an important way to reduce waste generation (Freeman, 1989). By reducing both the quantity of hazardous

Materials used in the process and the amount of excess raw materials in stock, the quantity of waste generated can be reduced. This can be done in two ways i.e. establishing material-purchase review and control procedures and inventory tracking system.

Another inventory management procedure for waste reduction is to ensure that only the needed quantity of a material is ordered. This will require the establishment of a strict inventory tracking system. Purchase procedures must be implemented which ensure that materials are ordered only on an as-needed basis and that only the amount needed for a specific period of time is ordered.

Production-process modification

Changes can be made in the production process, which will reduce waste generation. This reduction can be accomplished by changing the materials used to make the product or by the more efficient use of input materials in the production process or both. Potential waste minimization techniques can be broken down into three categories:

i) Improved operating and maintenance procedures,
ii) Material change and
iii) Process-equipment modification.

Volume reduction

Volume reduction includes those techniques that remove the hazardous portion of a waste from a non-hazardous portion. These techniques are usually to reduce the volume, and thus the cost of disposing of a waste material. The techniques that can be used to reduce waste-stream volume can be divided into 2 general categories: source segregation and waste concentration. Segregation of wastes is in many cases a simple and economical technique for waste reduction. Wastes containing different types of metals can be treated separately so that the metal value in the sludge can be recovered. Concentration of a waste stream may increase the likelihood that the material can be recycled or reused. Methods include gravity and vacuum filtration, ultra filtration, reverse osmosis, freeze vaporization etc.

For example, an electronic component manufacturer can use compaction equipments to reduce volume of waste cathode ray-tube.

Recovery and reuse

This technique could eliminate waste disposal costs, reduce raw material costs and provide income from a salable waste. Waste can be recovered on-site, or at an off-site recovery facility, or through inter industry exchange. A number of physical and chemical techniques are available to reclaim a waste material such as reverse osmosis, electrolysis, condensation, electrolytic recovery, filtration, centrifugation etc. For example, a printed-circuit board manufacturer can use electrolytic recovery to reclaim metals from copper and tin-lead plating bath.

However recycling of hazardous products has little environmental benefit if it simply moves the hazards into secondary products that eventually have to be disposed of. Unless the goal is to redesign the product to use nonhazardous materials, such recycling is a false solution.

Sustainable product design

Minimization of hazardous wastes should be at product design stage itself keeping in mind the following factors*

- **Rethink the product design:** Efforts should be made to design a product with fewer amounts of hazardous materials. For example, the efforts to reduce material use are reflected in some new computer designs that are flatter, lighter and more integrated. Other companies propose centralized networks similar to the telephone system.
- **Use of renewable materials and energy:** Bio-based plastics are plastics made with plant-based chemicals or plant-produced polymers rather than from petrochemicals. Bio-based toners, glues and inks are used more frequently. Solar computers also exist but they are currently very expensive.
- **Use of non-renewable materials that are safer:** Because many of the materials used are non-renewable, designers could ensure the product is built for re-use, repair and/or upgradeability. Some computer manufacturers such as Dell and Gateway lease out their products thereby ensuring they get them back to further upgrade and lease out again.

3.3.2 PLASTICS WASTE MANAGEMENT

Environmental Issues and Challenges

The quantum of solid waste is ever increasing due to increase in population, developmental activities, changes in life style, and socio-economic conditions, Plastics waste is a significant portion of the total municipal solid waste (MSW).
It is estimated that approximately 10 thousand tons per day (TPD) of plastics waste is generated i.e. 9% of 1.20 lacs TPD of MSW in the country.

The plastics waste constitutes two major categories of plastics;

(i) Thermoplastics: Thermoplastics, constitutes 80% and thermoset constitutes approximately 20% of total post-consumer plastics waste generated in India. The Thermoplastics are recyclable plastics.
Eg: Polyethylene Terephthalate (PET), Low Density Poly Ethylene (LDPE), Poly Vinyal Chloride (PVC), High Density Poly Ethylene (HDPE), Polypropylene (PP), Polystyrene (PS) etc.

(ii) Thermoset plastics: Thermoset plastics contains alkyd, epoxy, ester, melamine formaldehyde, phenolic formaldehyde, silicon, urea formaldehyde, polyurethane, metalised and multilayer plastics etc.

The environmental hazards due to mismanagement of plastics waste include the following aspects:

- Littered plastics spoil beauty of the city and choke drains and make important public Places filthy;
- Garbage containing plastics, when burnt may cause air pollution by emitting polluting Gases;
- Garbage mixed with plastics interferes in waste processing facility and may also cause Problems in landfill operations;
- Recycling industries operating in non-conforming areas are posing unhygienic Problems to the environment.

Main Features of the Plastics Manufacture and Usage(Amendment) Rules, 2003

Regulation of plastics waste, particularly manufacture and use of recycled plastics carry bags and containers is being regulated in the country as per "Recycled Plastics Manufacture and Usage Rules, 1999 and as amended in 2003. According to these Rules:

1. No person shall manufacture, stock, distribute or sell carry bags made of virgin or recycled plastic bags which are less than 8 x 12 inches in size and having thickness less than 20 microns.

2. No vendor shall use carry bags/containers made of recycled plastics for storing, carrying, dispensing or packaging of food stuffs

3. Carry bags and containers made of recycled plastic and used for purposes other than storing and packaging food stuffs shall be manufactured using pigments and colorants as per IS 9833:1981 entitled "List of pigments and colorants for use in plastics in contact with food stuffs, pharmaceuticals and drinking water"

4. Recycling of plastics shall be undertaken strictly in accordance with the Bureau of Indian Standard specification: IS 14534:1998 entitled "The Guidelines for Recycling of Plastics"

5. Manufacturers of recycled plastic carry bags having printing facilities shall code/mark carry Bags and containers as per Bureau of Indian Standard specification: IS 14534:1998 (The Guidelines for Recycling of Plastics).

6. No person shall manufacture carry bags or containers irrespective of its size or weight unless the occupier of the unit has registered the unit with respective SPCB/PCC prior to the commencement of production.

7. The prescribed authority for enforcement of the provisions of these rules related to manufacturing and recycling is SPCB in respect of States and the PCC in Union Territories and for relating to use, collection, segregation, transportation and disposal shall be the District Collector/ Deputy Commissioner of the concerned district

Options for Plastic Waste Management

Recycling of plastics through environmentally sound manner:

Recycling of plastics should be carried in such a manner to minimize the pollution during the process and as a result to enhance the efficiency of the process and conserve the energy. Plastics recycling technologies have been historically divided into four general types -primary, secondary, tertiary and quaternary.

- **Primary** recycling involves processing of a waste/scrap into a product with characteristics similar to those of original product.
- **Secondary** recycling involves processing of waste/scrap plastics into materials that have characteristics different from those of original plastics product.
- **Tertiary** recycling involves the production of basic chemicals and fuels from plastics waste/scrap as part of the municipal waste stream or as a segregated waste.
- **Quaternary** recycling retrieves the energy content of waste/scrap plastics by burning / incineration. This process is not in use in India.

Steps Involved in the Recycling Process

1.Selection: The recyclers / reprocessors have to select the waste / scrap which are suitable for recycling /reprocessing.
2.Segregation: The plastics waste shall be segregated as per the Codes 1-7 mentioned
3.Processing: After selection and segregation of the pre-consumer waste (factory waste) shall be directly recycled. The post consumer waste (used plastic waste) shall be washed, shredded, agglomerated, extruded and granulated

Polymer Coated Bitumen Road
The CPCB has undertaken a project in collaboration with Thiagarajar College of Engineering Madurai to evaluate the performance of polymer coated built roads laid during 2002-2006 in different cities.
The observations are as below:

- The coating of plastics over aggregate improves Impact, Los Angels Abrasion and Crushing Value with the increase in the percentage of plastics.
- The extracted bitumen showed almost near value for Marshall stability.
- The entire road was having good skid resistance and texture values.
- All the stretches in the roads have been found reasonably strong.
- The unevenness index values of these roads are nearly 3000 mm/km, which indicate a good surface evenness.
- The plastic tar roads have not developed any potholes, rutting, raveling or edge flaw, even though these roads are more than four years of age.
- Polymer coated aggregate bitumen mix performs well compared to polymer modified bitumen mix.
- Higher percentage of polymer coating improves the binding strength of the mix.
- Foam plastics have better binding values.

3.4WATER CONSERVATION

Water being one of the most precious and indispensable resources needs to be conserved. The following strategies can be adopted for conservation of water.

1. **Decreasing run-off losses:** Huge water-loss occurs due to run-off on most of the soils, which can be reduced by allowing most of the water to infiltrate into the soil.
This can be achieved by using contour cultivation, terrace framing, water spreading, chemical treatment or improved water-storage system.

a) Contour cultivation: on small furrows and ridges across the slopes trap rainwater and allow more time for infiltration. Terracing constructed on deep soils have large water-storage capacity. On gentle slopes trapped run off is spread over a large area for better infiltration

b) Conservation-bench terracing: It 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 water

d) Chemical wetting agents (Surfactants): These seem to increase the water intake rates when added to normal irrigated soil.

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 ($CaSO_4.2H_2O$) 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. build by individual farmers can be useful measures for conserving water through reduction of runoff.

2. **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 slumper' has been reported to absorb water up to 1400 times its weight. The chemical has been found to be useful for sandy soils.

3. Storing water in soil: Storage of water takes place in the soil root zone in humed 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.

4. Reducing irrigation losses:

a) Use of lined or covered canals to reduce seepage

b) Irrigation in early morning or late evening to reduce evaporation losses

c) Sprinkling irrigation and drip irrigation to conserve water by 30-50%

d) Growing hybrid crop varieties with less water requirements and tolerance to saline Water help conserve water.

5. Reuse of water:

a) Treated wastewater can be used for ferti-irrigation

b) Using grey water from washings, bath-tubs etc. for watering gardens, washing cars or paths help in saving fresh water.

6. **Preventing wastage of water:** This can be done in households, commercial buildings and public places.

a) Closing taps when not in use
b) Repairing any leakage from pipes
c) Using small capacity flush in toilets.

7. **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 consumer

3.4.1 RAIN WATER HARVESTING

Introduction:

The term rainwater harvesting is being frequently used these days, however, the concept of water harvesting is not new for India. Water harvesting techniques had been evolved and developed centuries ago.

Ground water resource gets naturally recharged through percolation. But due to indiscriminate development and rapid urbanization, exposed surface for soil has been reduced drastically with resultant reduction in percolation of rainwater, thereby depleting ground water resource. Rainwater harvesting is the process of augmenting the natural filtration of rainwater in to the underground formation by some artificial methods. "Conscious collection and storage of rainwater to cater to demands of water, for drinking, domestic purpose & irrigation is termed as Rainwater Harvesting.

Why to harvest rain water?

- To arrest ground water decline and augment ground water table
- To beneficiate water quality in aquifers
- To conserve surface water runoff during monsoon
- To reduce soil erosion
- To inculcate a culture of water conservation

Rainwater harvesting can be harvested from the following surfaces:

Rooftops: If buildings with impervious roofs are already in place, the catchment area is effectively available free of charge and they provide a supply at the point of consumption.

Paved and unpaved areas i.e., landscapes, open fields, parks, storm water drains, roads and pavements and other open areas can be effectively used to harvest the runoff. The main advantage in using ground as collecting surface is that water can be collected from a larger area. This is particularly advantageous in areas of low rainfall.

Water bodies: The potential of lakes, tanks and ponds to store rainwater is immense. The harvested rainwater can not only be used to meet water requirements of the city, it also recharges groundwater aquifers.

Storm water drains: Most of the residential colonies have proper network of storm water drains. If maintained neatly, these offer a simple and cost effective means for harvesting rainwater.

Types of Harvesting System

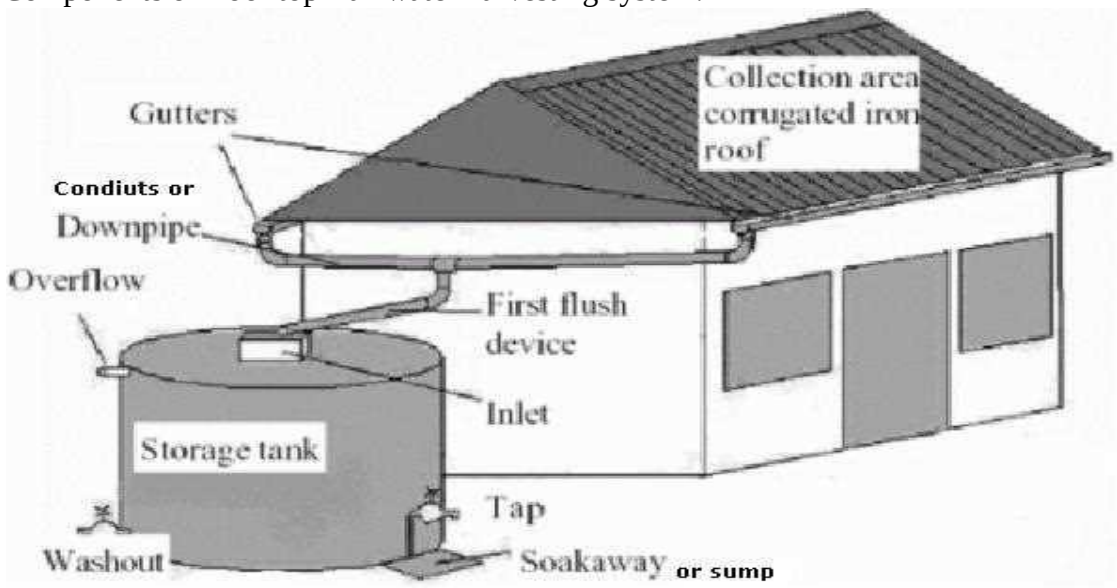
Broadly rainwater can be harvested for two purposes

A. Roof top rain water harvesting (RTRWH)
B. Charged into the soil for withdrawal later (groundwater recharging)

A. Roof top rain water harvesting (RTRWH)

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system. This method is less expensive and very effective and if implemented properly helps in augmenting the ground water level of the area.

Components of Roof top Rainwater harvesting system:



Roof top rain water harvesting system

The system mainly constitutes of following sub components**:**

- Catchment, Coarse mesh, Gutters, Conduits or Conveyance
- Transportation
- First flush
- Filter
- Storage
- Supply unit

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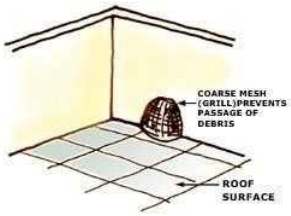
1. **Catchments:** The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanized iron or corrugated sheets can also be used for water harvesting.

2. Coarse mesh: Present at the corners of the roof to prevent the passage of debris



Source: A water harvesting manual for urban areas

3.Gutters:

Channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and could be made using:

- Locally available material such as plain galvanized iron sheet (20 to 22 gauge), folded to required shapes.
- Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
- Bamboo or betel trunks cut vertically in half.

The size of the gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 per cent oversize.

Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed depends on the construction of the house; it is possible to fix iron or timber brackets into the walls, but for houses having wider eaves, some method of attachment to the rafters is necessary.

4 **Conduits or Conveyance:**

Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI), materials that are commonly available.

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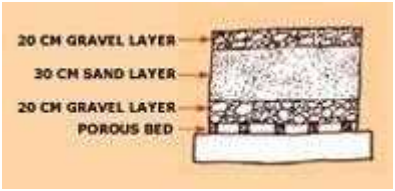
5. First-flushing

A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This needs to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.

6. Filtration or Purification:

The filter is used to remove suspended pollutants from rainwater collected over roof. A filter unit is a chamber filled with filtering media such as fiber, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank or recharges structure. Charcoal can be added for additional filtration.

(i) Charcoal water filter: A simple charcoal filter can be made in a drum or an earthen pot. The filter is made of gravel, sand and charcoal, all of which are easily available.



(ii) Sand filters

Sand filters have commonly available sand as filter media. Sand filters are easy and inexpensive to construct. These filters can be employed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and

microorganisms.
In a simple sand filter that can be constructed domestically, the top layer comprises coarse sand followed by a 5-10 mm layer of gravel followed by another 5-25 cm layer of gravel and boulders.

7. **Storage or Sump:** A storage provision to collect filtered water from the tank through the filter channel for storage and collection.
There are various options available for the construction of these tanks with respect to the shape, size and the material of construction.
Shape: Cylindrical, rectangular and square.
Material of construction: Reinforced cement concrete, (RCC), ferrocement, masonry, plastic (polyethylene) or metal (galvanized iron) sheets are commonly used.
Position of tank: Depending on space availability these tanks could be constructed above ground, partly underground or fully underground. Some maintenance measures like cleaning and disinfection are required to ensure the quality of water stored in the container.

B. Charged into the soil for withdrawal later (groundwater recharging)

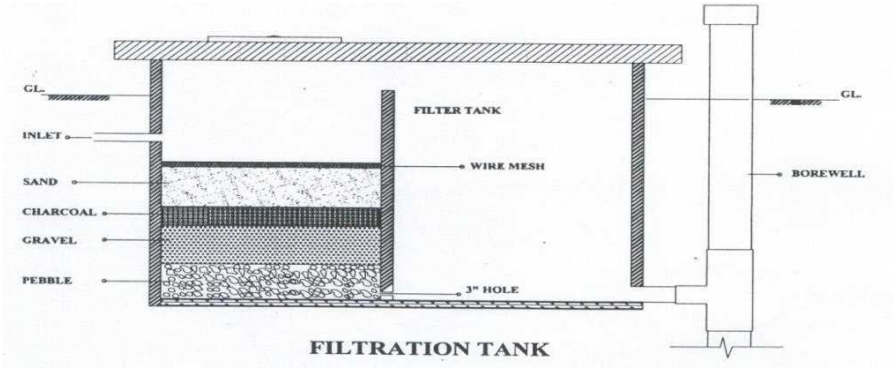
Ground water aquifers can be recharged by various kinds of structures to ensure percolation of rainwater in the ground instead of draining away from the surface. Commonly used recharging methods are:

a) Recharging of bore wells
b) Recharging of dug wells.
c) Recharge pits
d) Recharge Trenches
e) Soak ways or Recharge Shafts
f) Percolation Tanks

a) Recharging of bore wells

Rainwater collected from rooftop of the building is diverted through drainpipes to settlement or filtration tank. After settlement filtered water is diverted to bore wells to recharge deep aquifers. Abandoned bore wells can also be used for recharge.

Optimum capacity of settlement tank/filtration tank can be designed on the basis of area of catchments, intensity of rainfall and recharge rate as discussed in design parameters. While recharging, entry of floating matter and silt should be restricted because it may clog the recharge structure. "first one or two shower should be flushed out through rain separator to avoid contamination. This is very important, and all care should be taken to ensure that this has been done."

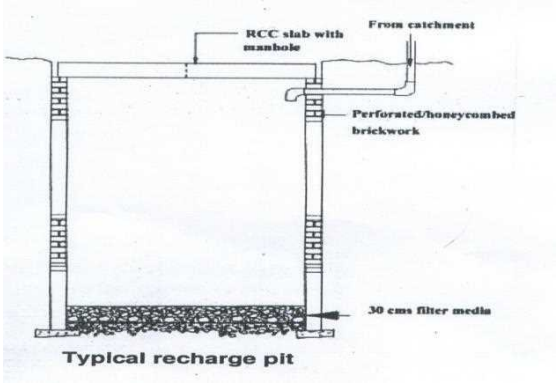


FILTRATION TANK

b) Recharge pits

Recharge pits are small pits of any shape rectangular, square or circular, contracted with brick or stone masonry wall with weep hole at regular intervals, top of the pit can be covered with perforated covers. Bottom of pit should be filled with filter media

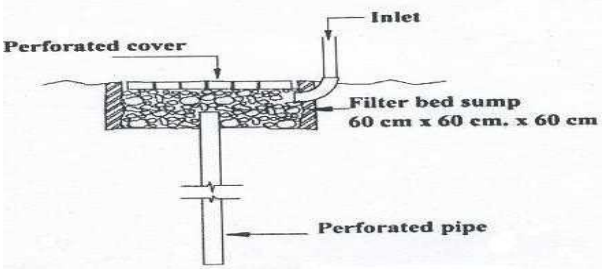
The capacity of the pit can be designed on the basis of catchment area, rainfall intensity and recharge rate of soil. Usually the dimensions of the pit may be of 1 to 2 m width and 2 to 3 m deep depending on the depth of pervious strata. These pits are suitable for recharging of shallow aquifers, and small houses.



Typical recharge pit

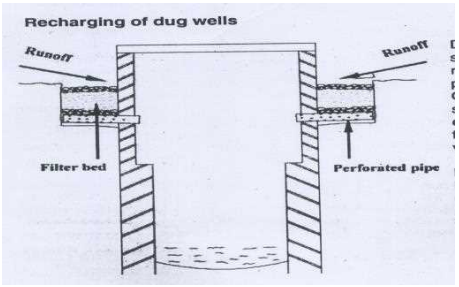
c)soak away or recharge shaft

Soak away or recharge shafts are provided where upper layer of soil is alluvial or less pervious. These are bored hole of 30 cm dia. up to 10 to 15 m deep, depending on depth of pervious layer. Bore should be lined with slotted/perforated PVC/MS pipe to prevent collapse of the vertical sides. At the top of soak away required size sump is constructed to retain runoff before the filters through soak away. Sump should be filled with filter media.



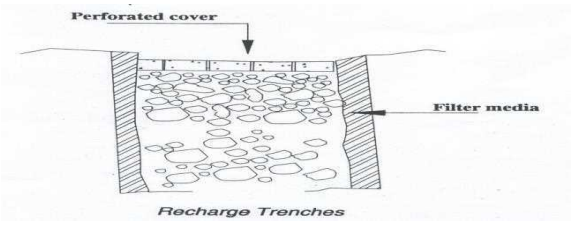
d) Recharging of dug well

Dug well can be used as recharge structure. Rainwater from the rooftop is diverted to dug wells after passing it through filtration bed. Cleaning and desalting of dug well should be done regularly to enhance the recharge rate. The filtration method suggested for bore well recharging could be used



e) Recharge trenches

Recharge trench in provided where upper impervious layer of soil is shallow. It is a trench excavated on the ground and refilled with porous media like pebbles, boulder or brickbats. It is usually made for harvesting the surface runoff. Bore wells can also be provided inside the trench as recharge shafts to enhance percolation. The length of the trench is decided as per the amount of runoff expected. This method is suitable for small houses, playgrounds, parks and roadside drains. The recharge trench can be of size 0.50 to1.0mwideand1.0to1.5mdeep.



f) Percolation tanks

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the ground water. These can be built in big campuses where land is available and topography is suitable. Surface run-off and roof top water can be diverted to this tank. Water

accumulating in the tank percolates in the solid to augment the ground water. The stored water can be used directly for gardening and raw use. Percolation tanks should be built in gardens, open spaces and roadside green belts of urban area.

3.4.2 WATERSHED MANAGEMENT

Introduction:

The land area drained by a river is known as the river basin. The watershed is defined as the land area from which water drains under gravity to a common drainage channel. Thus watershed is a delineated area with a well defined topographic boundary and one water outlet. The watershed can range from a few square kilometers to few thousand square kilometers in size.

In the watershed the hydrological conditions are such that water becomes concentrated within a particular location like a river or a reservoir, by which the watershed is drained. The watershed comprises complex interactions of soil, landform, vegetation, land use activities and water. People and animals are an integral part of a watershed having mutual impacts on each other. We may live anywhere we would be living in some watershed. A watershed affects 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. Organizing, 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.

Objectives of Watershed Management:

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

The objectives of watershed management are as follows:

1. 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.
2. To manage the watershed for beneficial developmental activities like domestic water supply, irrigation, hydropower generation etc.
3. To minimize the risks of floods, droughts and landslides.
4. To develop rural areas in the region with clear plans for improving the economy of the regions.

Watershed management practices:

In the fifth year plan, watershed management approach was included with a number of programs for it and a national policy was developed. In watershed management the aspects of development are considered with regard to availability of the resources.

The practices of conservation and development of land and water are taken up with respect to their suitability for people's benefit as well as sustainability.

Various measures taken up for management include the following:

1. **Water harvesting:** Proper storage of water is done with provision for use in dry seasons in low rainfall areas. It also helps in moderation of floods.

2. **Afforestation and agro-forestry:** In watershed development, afforestation and crop plantation play a very important role. 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, Leucaena and grasses like chrysopogon are grown along with maize or wheat to achieve the objectives. Woody trees grown successfully in such agro-forestry programs include Sheesham, Teak and Keekar which have been used in watershed areas of river Yamuna.

3. **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 andSiwaliks

4. **Scientific mining and quarrying:** Due to improper mining, the hills lose stability and get disturbed resulting in landslides, rapid erosion etc. Contour trenching a tan interval of one meter on overburdened dump, planting some soil binding plants land draining of water courses in the mined area are recommended for minimizing the destructive effects of mining in watershed areas.

5. **Public participation:** People's involvement including the farmers and tribals is the key to the success of any watershed management program, particularly the soil and water conservation. People's cooperation as well as participation has to be ensured for the same.

3.4.3RESETTLEMENT AND REHABILITATION OF PEOPLE

Problems and concerns: 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. Besides this, quite often, the native people of the project site are directly affected. These native people are generally the poorest of the poor, underprivileged tribal people. Various types of projects result in the displacement of the native people who undergo tremendous economic and psychological distress, as the socioeconomic and ecological base of the local community is disturbed.

a) Displacement problems due to dams:

The big river valley projects have 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 the countries in the world leading in big dam construction and in the last 50 years more than 20 million people are estimated o have directly or indirectly affected by these dams e.g. Hirakum Dam, Bhakra Nangal Dam, Tehri Dam are the examples where many people and their villages in the vicinity got affected. It also resulted in movement lead by Sunderlal Bahuguna- movement called Chipko Movement- One more stir is currently on is Sardar Sarovar Project- three states people and many villages get affected.

b) Displacement due to mining:

Mining is another developmental activity, which causes displacement of the native people. Several thousands of hectares of land area is 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 people e.g. various mines are predominant in Jharkhand, these mines had displaced many people.

c) Displacement due to creation of National park :

When some forests are covered under a National Park, it is a welcome step for conservation of the natural resources. However, 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 forests, they usually retaliate by starting destructive activities. There is a need to look into their problems and provide them some employment

REHABILITATION ISSUES:

The United Nations Universal Declaration on Human Rights 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 the Act.

The major issues related to displacement and rehabilitation are as follows:

a) 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.

b) Break up of families in 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.

c) 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.

d) 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.

e) 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.

f) Loss of identity and loss of the intimate link between the people and the environment is one of the biggest loss. 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.

CASE STUDY:

In case of **sardar sarovar project** Gujarat Government is formulating its policy through various government resolutions. It has decided that each landed outstee shall be entitled to allotment of irrigable land in the state which he chooses for his resettlement. The area of the land would be equal to that owned by his earlier and the minimum land given to an outstee would be 2 hectares. However, there are problems of landless outstees and those natives who were cultivating forest land. The cut-off date for identifying an adult son in a family has been fixed. It is important since the adult son is to be treated as a separate family. The people of 20 submerged villages in Gujrat hane been resettled at different locations leading to disintegration of joint families.

3.4.4CLIMATE CHANGE

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in 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 1992published 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.
However, during the past10000 years of the current interglacial period, the mean average temperature has fluctuated by 0.51˚ 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 population.
Even small changes in climatic conditions may disturb agriculture that would lead to migration of animals including humans.
Anthropogenic activities are upsetting the delicate balance that has been established between various components of the environment.
Green house gases are increasing in 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 agricultural productivity, famines and death of humans as well as livestock

3.4.5 GLOBAL WARMING

Introduction:

Before the Industrial Revolution, human activities released very few gases into the atmosphere and all climate changes happened naturally. After the Industrial Revolution, through fossil fuel combustion, changing agricultural practices and deforestation, the natural composition of gases in the atmosphere is getting affected and climate and environment began to alter significantly.
Over the last 100 years, it was found out that the earth is getting warmer and warmer, unlike previous 8000 years when temperatures have been relatively constant. The present temperature is 0.3 - 0.6 ^{o}C warmer than it was 100 years ago.

The **greenhouse effect** is a naturally occurring process that aids in heating the Earth's surface and atmosphere. It results from the fact that certain atmospheric gases, such as **carbon dioxide**, **water vapor**, and **methane**, are able to change the energy balance of the planet by absorbing **long wave radiation** emitted from the Earth's surface. Without the greenhouse effect life on this planet would probably not exist as the average temperature of the Earth would be a chilly -18° Celsius, rather than the present 15° Celsius.

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone (refer Figure 9.4). Certain human activities, however, add to the levels of most of these naturally occurring gases.

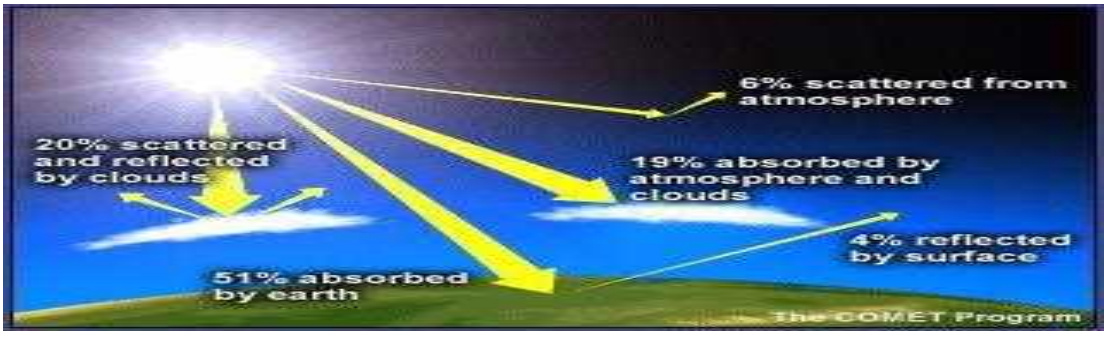
Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Very powerful greenhouse gases that are not naturally occurring include hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulfur hexafluoride (SF_6), which are generated in a variety of industrial processes.

Often, estimates of greenhouse gas emissions are presented in units of millions of metric tons of carbon equivalents (MMTCE), which weights each gas by its Global Warming Potential or GWP value.

As energy from the Sun passes through the atmosphere a number of things take place. A portion of the energy (26% globally) is **reflected** or **scattered** back to space by clouds and other atmospheric particles. About 19% of the energy available is absorbed by clouds, gases (like **ozone**), and particles in the atmosphere. Of the remaining 55% of the solar energy passing through the Earth's atmosphere, 4% is reflected from the surface back to space. On average, about 51% of the Sun's radiation reaches the surface. This energy is then used in a number of processes, including the heating of the ground surface; the melting of ice and snow and the evaporation of water; and plant photosynthesis.



The heating of the ground by sunlight causes the Earth's surface to become a radiator of energy in the long wave band (sometimes called **infrared radiation**). This emission of energy is generally directed to space . However, only a small portion of this energy actually makes it back to space. The majority of the outgoing infrared radiation is absorbed by the **greenhouse gases**

Absorption of long wave radiation by the atmosphere causes additional heat energy to be added to the Earth's atmospheric system. The now warmer atmospheric greenhouse gas molecules begin radiating long wave energy in all directions. Over 90% of this emission of long wave energy is directed back to the Earth's surface where it once again is absorbed by the surface. The heating of the ground by the long wave radiation causes the ground surface to once again radiate, repeating the cycle described above, again and again, until no more long wave is available for absorption.

A number of gases are involved in the human caused enhancement of the greenhouse effect .These gases include: **carbon dioxide** (CO_2); **methane** (CH_4); **nitrous oxide** (N_2O); **chlorofluorocarbons** (CFxClx); and **tropospheric ozone** (O_3). Of these gases, the single most important gas is **carbon dioxide** which accounts for about 55% of the change in the intensity of the Earth's greenhouse effect. The contributions of the other gases are 25% for **chlorofluorocarbons**, 15% for **methane**, and 5% for **nitrous oxide**. **Ozone's** contribution to the enhancement of green house effect is still yet to be quantified.Average concentrations of atmospheric **carbon dioxide** in the year 2005 were about 380 parts per million .Prior to 1700, levels of carbon dioxide were about 280 parts per million. This increase in carbon dioxide in the atmosphere is primarily due to the activities of humans. Beginning in 1700, societal changes brought about by the **Industrial Revolution** increased the amount of carbon dioxide entering the atmosphere. The major sources of this gas include fossil fuel combustion for industry, transportation, space heating, electricity generation and cooking; and vegetation changes in natural prairie, woodland, and forested ecosystems. Emissions from fossil fuel combustion account for about 65% of the extra carbon dioxide now found in our atmosphere. The remaining 35% is derived from deforestation and the conversion of prairie, woodland, and forested ecosystems primarily into agricultural systems.

Natural ecosystems can hold 20 to 100 times more carbon dioxide per unit area than agricultural systems. Artificially created **chlorofluorocarbons** are the strongest greenhouse gas per molecule. However, low concentrations in the atmosphere reduce their overall importance in the enhancement of the greenhouse effect.

Current measurements in the atmosphere indicate that the concentration of these chemicals may soon begin declining because of reduced emissions. Reports of the development of ozone holes over the North and South Poles and a general decline in global stratospheric ozone levels over the last two decades has caused many nations to cut back on their production and use of these chemicals.

Since 1750, **methane** concentrations in the atmosphere have increased by more than 150%. The primary sources for the additional methane added to the atmosphere (in order of importance) are rice cultivation, domestic grazing animals, termites, landfills, coal mining, and oil and gas extraction. Anaerobic conditions associated with rice paddy flooding results in the formation of methane gas. However, an accurate estimate of how much methane is being produced from rice paddies has been difficult to obtain. More than 60% of all rice paddies are found in India and

China where scientific data concerning emission rates are unavailable. Nevertheless, scientists believe that the contribution of rice paddies is large because this form of crop production has more than doubled since 1950. Grazing animals release methane to the environment as a result of herbaceous digestion. Some researchers believe the addition of methane from this source has more than quadrupled over the last century. Termites also release methane through similar processes. Land-use change in the tropics, due to deforestation, ranching, and farming, may be causing termite numbers to expand. If this assumption is correct, the contribution from these insects may be important. Methane is also released from landfills, coal mines, and gas and oil drilling. Landfills produce methane as organic wastes decompose over time. Coal, oil, and natural gas deposits release methane to the atmosphere when these deposits are excavated or drilled.

The average concentration of **nitrous oxide** in the atmosphere is now increasing at a rate of 0.2 to 0.3% per year. Sources for this increase include land-use conversion; fossil fuel combustion; biomass burning; and soil fertilization. Most of the nitrous oxide added to the atmosphere each year comes from deforestation and the conversion of forest, savanna and grassland ecosystems into agricultural fields and rangeland. Both of these processes reduce the amount of nitrogen stored in living vegetation and soil through the decomposition of organic matter. Nitrous oxide is also released into the atmosphere when fossil fuels and biomass are burned. However, the combined contribution of these sources to the increase of this gas in the atmosphere is thought to be minor. The use of nitrate and ammonium fertilizers to enhance plant growth is another source of nitrous oxide. Accurate measurements of how much nitrous oxide is being released from fertilization have been difficult to obtain. Estimates suggest that the contribution from this source may represent from 50% to 0.2% of nitrous oxide added to the atmosphere annually.

Ozone's role in the enhancement of the greenhouse effect has been difficult to determine scientifically. Accurate measurements of past long-term (more than 25 years in the past) levels of this gas in the atmosphere are currently unavailable. Concentrations of ozone gas are found in two different regions of the Earth's atmosphere. The majority of the ozone (about 97%) found in the atmosphere is localized in the **stratosphere** at an altitude of 15 to 55 kilometers above the Earth's surface. In recent years, the concentration of the **stratospheric ozone** has been decreasing because of the buildup of **chlorofluorocarbons** in the atmosphere. Since the late 1970s, scientists have discovered that **total column ozone** amounts over Antarctica in the springtime have decreased by as much as 70%. Satellite measurements have indicated that the zone from 65° North to 65° South latitude has had a 3% decrease in stratospheric ozone since 1978. Ozone is also highly concentrated at the Earth's surface. Most of this ozone is created as an artificial by product of **photochemical smog**.

Global Warming (Climate Change) Implications

Rise in global temperature

Observations show that global temperatures have risen by about 0.6 °C over the 20th century. There is strong evidence now that most of the observed warming over the last 50 years is caused by human activities. Climate models predict that the global temperature will rise by about 6 °C by the year 2100.

Rise in sea level

In general, the faster the climate change, the greater will be the risk of damage. The mean sea level is expected to rise 9 - 88 cm by the year 2100, causing flooding of low lying areas and other damages.

Food shortages and hunger

Water resources will be affected as precipitation and evaporation patterns change around the world. This will affect agricultural output. Food security is likely to be threatened and some regions are likely to experience food shortages and hunger.

3.4.6 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 decomposition is the total wet acidic deposition (acid rain) and dry deposition. Rain water is turned acidic when its pH falls below 5.6. In fact clean or natural rain water has a pH of 5.6 at 20˚ c because of formation of carbonic acid due to dissolution of CO2 in water. In 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 an form acids similar to that formed in acid rain.

Effects of acid rain:

Acid rain causes a number of harmful effects below pH 5.1. The effects are visible in the aquatic

even at pH less than 5.5.

1. 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.
2. It damages stone statues. Priceless stone statues in Greece and Italy have been partially dissolved by acid rain.
3. It damages metals and car finishes.
4. Aquatic life especially fish are badly affected by lake acidification
5. 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.
6. It results in reproductive failure, and killing of fish.
7. Many lakes of Sweden, Norway, and Canada have become fishless due to acid rain.
8. It damages foliage and weakens trees
9. 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 measures:

1. Emission of SO_2 and NO_2 from industries and power plants should be reduced by using pollution control equipments.
2. Liming of lakes and soils should be done to correct the adverse effects of acid rain.
3. A coating of protective layer of inert polymer should be given in the interior of water pipes for drinking water

3.4.7 OZONE LAYER DEPLETION

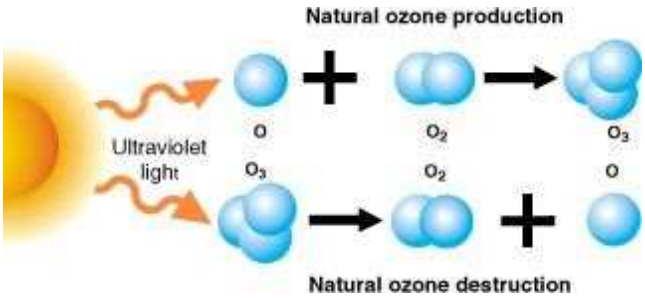
As early as 1896, the Swedish scientist Svante Arrhenius had predicted that human activities would interfere with the way the sun interacts with the earth, resulting in global warming and climate change. His prediction has become true and climate change is now disrupting global environmental stability. The last few decades have seen many treaties, conventions, and protocols for the cause of global environmental protection.
Few examples of environmental issues of global significance are:

- Ozone layer depletion
- Global warming

One of the most important characteristics of this environmental degradation is that it affects all mankind on a global scale without regard to any particular country, region, or race. The whole world is a stakeholder and this raises issues on who should do what to combat environmental degradation.

Earth's atmosphere is divided into three regions, namely troposphere, stratosphere and mesosphere. The stratosphere extends from 10 to 50 kms from the Earth's surface. This region is concentrated with slightly pungent smelling, light bluish ozone gas. The ozone gas is made up of molecules each containing three atoms of oxygen; its chemical formula is O_3.

The ozone layer, in the stratosphere acts as an efficient filter for harmful solar Ultraviolet B (UV-B) rays Ozone is produced and destroyed naturally in the atmosphere and until recently, this resulted in a well-balanced equilibrium .



Ozone is formed when oxygen molecules absorb ultraviolet radiation with wavelengths less than 240 nanometres and is destroyed when it absorbs ultraviolet radiation with wavelengths greater than 290 nanometres. In recent years, scientists have measured a seasonal thinning of the ozone layer primarily at the South Pole. This phenomenon is being called the ozone hole.

Ozone Depletion Process

Ozone is highly reactive and easily broken down by man-made chlorine and bromine compounds. These compounds are found to be most responsible for most of ozone layer depletion.

The ozone depletion process begins when CFCs (used in refrigerator and air conditioners) and other ozone-depleting substances (ODS) are emitted into the atmosphere. Winds efficiently mix and evenly distribute the ODS in the troposphere. These ODS compounds do not dissolve in rain, are extremely stable, and have a long life span. After several years, they reach the stratosphere by diffusion.

Strong UV light breaks apart the ODS molecules. CFCs, HCFCs, carbon tetrachloride, methyl chloroform release chlorine atoms, and halons and methyl bromide release bromine atoms. It is the chlorine and bromine atom that actually destroys ozone, not the intact ODS molecule. It is estimated that one chlorine atom can destroy from 10,000 to 100,000 ozone molecules before it is finally removed from the stratosphere.

Chemistry of Ozone Depletion

When ultraviolet light waves (UV) strike CFC* ($CFCl_3$) molecules in the upper atmosphere, a carbon-chlorine bond breaks, producing a chlorine (Cl) atom. The chlorine atom then reacts with an ozone (O_3) molecule breaking it apart and so destroying the ozone. This forms an ordinary oxygen molecule (O_2) and a chlorine monoxide (ClO) molecule. Then a free oxygen** atom breaks up the chlorine monoxide. The chlorine is free to repeat the process of destroying more ozone molecules. A single CFC molecule can destroy 100,000 ozone molecules.
* CFC - chlorofluorocarbon: it contains chlorine, fluorine and carbon atoms. ** UV radiation breaks oxygen molecules (O_2) into single oxygen atoms.

Effects of Ozone Layer Depletion

1) Effects on Human and Animal Health: Increased penetration of solar UV-B radiation is likely to have high impact on human health with potential risks of eye diseases, skin cancer and infectious diseases.

2) Effects on Terrestrial Plants: In forests and grasslands, increased radiation is likely to change species composition thus altering the bio-diversity in different ecosystems. It could also may affect the plant community.

3) Effects on Aquatic Ecosystems: High levels of radiation exposure in tropics and subtropics may affect the distribution of Phytoplankton's, which form the foundation of aquatic food webs. It can also cause damage to early development stages of fish, shrimp, crab, amphibians and other animals, the most severe effects being decreased reproductive capacity and impaired larval development.

4)Effects on Bio-geo-chemical Cycles: Increased solar UV radiation could affect terrestrial and aquatic bio-geo-chemical cycles thus altering both sources and sinks of greenhouse and important trace gases, e.g. carbon dioxide (CO_2), carbon monoxide (CO), carbonyl sulfide (COS), etc. These changes would contribute to biosphere-atmosphere feedbacks responsible for the atmosphere build-up of these greenhouse gases.

5) Effects on Air Quality: Reduction of stratospheric ozone and increased penetration of UV-B radiation result in higher photo dissociation rates of key trace gases that control the chemical reactivity of the troposphere. This can increase both production and destruction of ozone and related oxidants such as hydrogen peroxide, which are known to have adverse effects on human health, terrestrial plants and outdoor materials.

The ozone layer, therefore, is highly beneficial to plant and animal life on earth filtering out the dangerous part of sun's radiation and allowing only the beneficial part to reach earth. Any disturbance or depletion of this layer would result in an increase of harmful radiation reaching the earth's surface leading to dangerous consequences.

3.4.8NUCLEAR HOLOCOST AND NUCLEAR ACCIDENTS

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 loss of much modern technology due to electromagnetic pulses, or nuclear winter and resulting extinctions. Since 1947, the Doomsday Clock of the Bulletin of the Atomic Scientists visualizes how far the world is from a nuclear holocaust.

The threat of a nuclear holocaust plays an important role in the popular perception of nuclear weapons. It features in the security concept of mutually assured destruction (MAD) and is a common scenario in survivalism. Nuclear holocaust is a common feature in literature, especially in speculative genres such as science fiction, dystopian and post-apocalyptic fiction.

The English word "holocaust", derived from the Greek term "holokaustos" meaning "completely burnt", is commonly defined as "a great destruction resulting in the extensive loss of life, especially by fire."

Case study: Chernobyl reactor

A mishandled reactor safety test led to an uncontrolled power excursion, causing a severe steam explosion, meltdown and release of radioactive material at the Chernobyl nuclear power plant located approximately 100 kilometers north-northwest of Kiev. Approximately fifty fatalities resulted from the accident and the immediate aftermath most of these being cleanup personnel. An additional nine fatal cases of thyroid cancer in children in the Chernobyl area have been attributed to the accident. The explosion and combustion of the graphite reactor core spread

radioactive material over much of Europe. 100,000 people were evacuated from the areas immediately surrounding Chernobyl in addition to 300,000 from the areas of heavy fallout in Ukraine, Belarus and Russia. An "Exclusion Zone" was created surrounding the site encompassing approximately 1,000 mi^2 (3,000 km^2) and deemed off-limits for human habitation for an indefinite period. Several studies by governments, UN agencies and environmental groups have estimated the consequences and eventual number of casualties. Their findings are subject to controversy.

Nuclear weapons causes holocaust:

If all the nuclear weapons in the world were used, then all of humanity would most like be destroyed. This is for several reasons. Firstly, most major cities would be destroyed by incoming warheads. However, this would leave some areas untouched. Thes e areas would most likely be reached by radioactive fall-out blown by the wind. These would be the immediate repurcussions. Later, the world would go into what is called "Nuclear Winter". Global temperatures would drop significantly, as well as the amount of sunlight received by the earth. This is very similar to what is believed happened to the dinosaurs. It is believed that a large asteroid collided with the earth, and stirred up a lot of dust into the atmosphere. This blotted out the sun, and plants died. With very few plants to eat, the dinosaurs (and many other animals) went extinct. Nuclear winter would be a lot like this. The only difference is that there the dust would be raised up by impacting nuclear warheads and their explosions. Additionally, the dust would be radioactive. The combination of radioactivity, lack of food, and lowering temperatures cause a Nuclear Holocaust, with the chances of humans surviving it very low.

UNIT-IV

GREEN ENVIRONMENTAL ISSUES

4.1. CLEAN DEVELOPMENT MECHANISM

History and Objectives of the Mechanism:

Clean Development Mechanism (CDM) is an economic instrument for inducing initiatives to meet the challenges faced by the impending threat of climate change. It is a mechanism for promoting technology transfer and investment from developed countries to the developing countries for projects to reduce the emissions of Greenhouse Gases (GHGs). The mechanism allows the governments or private parties of developed countries to make investment for emission reduction projects in developing countries and, in turn, get the benefit in terms of "Certified Emission Reduction (CER)" which could be credited against their national emission reduction targets.

The concept of CDM owes its origin to the Kyoto Protocol (1997) under the UN Framework Convention on Climate Change (UNFCCC) mooted at the United Nations Conference on Environment and Development (Earth Summit) in 1992. The Convention on Climate Change and the follow-up initiatives were prompted by the increasing evidence of global warming triggered by anthropogenic emissions of Greenhouse Gases (GHGs) which include Carbon Dioxide, Nitrous Oxide, Methane, Halogenated Hydrocarbon and Tropospheric Ozone. According to an assessment, doubling of carbon dioxide concentration in the atmosphere or an equivalent increase of a mixture of greenhouse gases can cause 1.5 to 4.5^{o}C rise in global temperature with associated impacts such as sea level rise,
Floods and droughts.

Purpose

The purpose of the CDM is to promote clean development in developing countries, i.e., the "non-Annex I" countries (countries that aren't listed in Annex I of the Framework Convention). The CDM is one of the Protocol's "project-based" mechanisms in that the CDM is designed to promote projects that reduce emissions. The CDM is based on the idea of emission reduction "production". These reductions are "produced" and then subtracted against a hypothetical "baseline" of emissions. The emissions baseline are the emissions that are predicted to occur in the absence of a particular CDM project. CDM projects are "credited" against this baseline, in the sense that developing countries gain credit for producing these emission cuts. The CDM is one of the "flexibility mechanisms" that is defined in the Kyoto Protocol. The flexibility mechanisms are designed to allow Annex B countries to meet their emission reduction commitments with reduced impact on their economies (IPCC, 2007).The flexibility mechanisms were introduced to the Kyoto Protocol by the US government.

For participation in CDM, all countries are required to meet the following prerequisites:

- □ Ratification of the Kyoto Protocol;
- □ Establishment of a National CDM Authority; and

□ Willingness for voluntary participation in CDM.

In addition to the aforesaid pre-requisites, the developed countries should also comply with the following requirements as stipulated in the Protocol:

□ National System for the estimation of GHG emissions;
□ National registry and annual inventory;
□ Accounting system for sale and purchase of emission reductions; and
□ Establishment of assigned amount as per emission limitation and reduction Commitment to reduce their overall GHG emission by at least 5 per cent below 1990 levels in the first commitment period of 2008-2012.

The eligibility criteria for the CDM projects include the following:

□ The projects must be approved by all parties involved;
□ The projects should promote sustainable development in host countries;
□ The projects should result in real, measurable and long term benefits towards climate change mitigation; and
□ The emission reduction should be additional to what would have otherwise occurred without the projects.

Institutional structure

The institutional structure created for implementation of CDM includes three new entities:

□ Executive Board;
□ Designated National Authority; and
□ Designated Operational Entity.

Sequence of the CDM project cycle: actors and activities

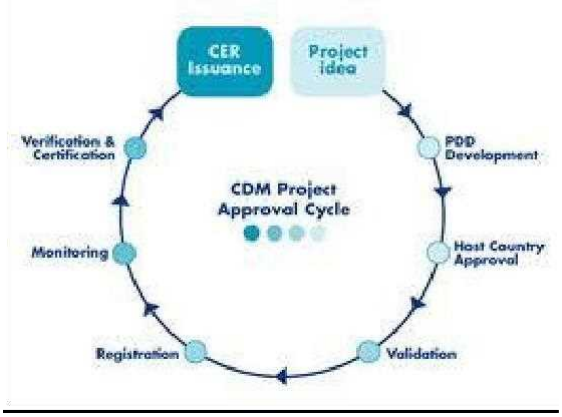
Stage	Actors	Activities
1.	Project Proponent	Project design
2.	Host Country Designated National Authority (DNA)	Project approval
3.	Designated Operational Entity (DOE)	Validation of the project design document
4.	CDM Executive Board (EB)	Registration of the project
5.	Project Proponent	Project Implementation and Monitoring
6.	Designated Operation Entity (DOE)	Verification andcertification of emission reduction from the project.
7.	CDM Executive Board (EB)	Issuance of Certified Emission Reductions (CERs)

The Clean Development Mechanism (CDM) Project Cycle

The Clean Development Mechanism of the Kyoto Protocol defines a series of steps necessary to develop certified emissions reductions (CERs):

1. Project Design

2. Project Validation
3. Host Country Approval
4. Registration with the CDM Executive Board
5. Implementation and Monitoring
6. Verification/Certification and Issuance of CERs
7. Sale of CERs



1.ProjectDesign

The first step starts with a determination of whether the project concept would qualify as a CDM project, including screening against project criteria, estimating the magnitude of emissions reductions, and preparing a Project Design Document (PDD) to meet certain specifications. The PDD must address the following key issues:

- Establishing the "baseline" for the project, which represents the anthropogenic emissions that would occur in the absence of the proposed project activity? The current flaring of gas may be an important consideration in establishing this baseline.
- Demonstrating "additionality," which in essence is a demonstration that the proposed project is not "business as usual." While this criterion has proved to be controversial on some projects, a series of guidelines is now available for making the additionality demonstration. and there is precedent for landfill gas recovery projects of the type envisioned.
- A monitoring methodology that effectively addresses gas flow and composition.

It is also critical to provide a basis for legal ownership of the project activity, i.e. the rights to the gas generated at landfill or wastewater treatment plant.

2.ProjectValidation

Validation is the process by which the PDD is independently evaluated by a "designated operation entity" (DOE) against the requirements of the CDM. The DOE must be a third party, separate and apart from the project developer and preparer of the PDD. Information submitted to the DOE should include comments by the local stakeholders and a summary of how due account was taken of any such comments, as well as an analysis of any environmental impact of the project's activity.

Based on its review, the DOE issues a validation report and opinion as to the adequacy of the PDD. The project developer/PDD consultant must respond to queries and comments to the satisfaction of the DOE for the final validation report to be issued.

3. Host Country Approval

Upon validation of the proposed project by the DOE, the following documentation must be submitted to the designated national authority (DNA) for host country approval:

1. The validation report.
2. The PDD, including a description of how the project will contribute to sustainable development.
3. If required by local law, an approved environmental impact assessment.
4. A written commitment to deliver an annual report on the results of monitoring, certification, and issuance of CERs.

Once the DNA requirements have been satisfied, a Letter of Approval is issued for the project.

4. Registration with the CDM Executive Board

Following the issuance of the Letter of Approval, a request for registration is submitted to the CDM Executive Board in the form of the validation report, including the PDD, the written approval of the DNA and an explanation of how this takes into account any comments received. The CDM Executive Board reviews the proposal and may invite public comment or ask for additional information/details before rejecting or accepting the proposal, which becomes a public document once submitted to the CDM Executive Board. Registration is a formal acceptance by the CDM Executive Board of a validated project as a CDM project activity and is the official recognition of the project feasibility to generate CER.

5. Implementation and Monitoring

Once the project has been validated, detailed engineering activities can be undertaken in parallel with the CDM approval process. Typically, construction would not occur until after CDM Executive Board approval. Monitoring of emissions reductions, as specified in the PDD monitoring plan, would then be implemented. In order to calculate the emissions reductions, the emissions of the project activity have to be subtracted from the reference scenario or Baseline outlined in the PDD.

6. Verification/Certification and issuance of CERs

Verification is required by a DOE, separate and apart from the preparer of the PDD and the DOE responsible for project validation, in order to demonstrate that actual emissions reductions are consistent with the PDD. A certification report is required on an annual basis to quantify the actual emissions reductions achieved during that period. The second DOE conducts on-site inspections, reviews monitoring results, and provides a verification report to the CDM Executive Board. The certification constitutes a request to the CDM Executive Board for issuance of CERs equal to the verified amount of reductions from the project. This issuance should be considered final 15 days after the day of receipt of the request for issuance, unless issues are raised by the CDM Executive Board or other parties involved. The requisite amount of CERs is then deposited in the registry account of the project developer.

7. Sale of CERs

The process of negotiating the sale of the CERs can usually start as the PDD is being finalized. A Term Sheet spelling out the terms of the agreement is initially prepared and later used for

drafting the so-called Emissions Reductions Purchase Agreement (ERPA). These agreements define the amount of CERs to be transferred, the purchase price, the time period of delivery, and other relevant conditions. ENVIRON is experienced in developing these agreements and working with the buyers in the emissions reductions marketplace, e.g., World Bank's Prototype Carbon Fund, tenders by national governments, brokers, and private sector buyer

Benefits and beneficiaries of the CDM

The CDM has the potential of multi-faceted benefits and multiple beneficiaries

Benefits

- Global reduction of greenhouse gases.
- Lesser cost of climate change mitigation.
- Additional benefits through reduction of other pollutants besides GHGs.
- Opening a market for carbon investment.
- Additional financial resources and alternative technologies.
- Initiatives for adaptation to climate change impacts.
- Focus on sustainable development.
- Scope for cooperation at various levels (national, sub-regional, Regional and global).

Beneficiaries

- Developed countries.
- Countries with economy in transition.
- Developing countries.
- Small inland countries.
- Public sector.
- Private sector.

4.2 CARBON FOOTPRINT

INTRODUCTION:

'Carbon footprint' measures the total greenhouse gas emissions caused directly and indirectly by a person, organization, event or product.

The footprint considers all six of the Kyoto Protocol greenhouse gases: Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6).

A carbon footprint is measured in tones of carbon dioxide equivalent (tCO2e). The carbon dioxide equivalent (CO2e) allows the different greenhouse gases to be compared on a like-for-like basis relative to one unit of CO2. CO2e is calculated by multiplying the emissions of each of the six greenhouse gases by its 100 year global warming potential (GWP).

The main types of carbon footprint for organizations are:

A) ORGANISATIONAL CARBON FOOTPRINT

Emissions from all the activities across the organization, including buildings' energy use, industrial processes and company vehicles.

An organizational or business carbon footprint measures the direct and indirect greenhouse gas emissions arising from all of an organization's activities. A good place to get an estimation of your business carbon footprint is our carbon footprint indicator. Read more about organizational carbon footprints below.

- Types of emissions
- Why calculate
- How to calculate - organizational carbon footprints
- How we can help

The Greenhouse Gas Protocol* standard is commonly used to categorize an organization's emissions into 3 groups or 'scopes':

- **Scope 1 - Direct emissions**
  Direct emissions resulting from activities within the organization's control. Includes on-site fuel combustion, manufacturing and process emissions, refrigerant losses and company vehicles.
- **Scope 2 - Indirect emissions: electricity and heat**
  Indirect emissions from electricity, heat or steam purchased and used by the organization.
- **Scope 3 - Indirect emissions: other**
  Any other indirect emissions from sources not directly controlled by the organization. Examples include: employee business travel, outsourced transportation, waste disposal, water usage and employee commuting.

Under the Greenhouse Gas Protocol, an organization must include scope 1 and 2 emissions within its carbon footprint. There is broad discretion about which scope 3 emissions should be included in a business carbon footprint - for example; organizations often include waste disposed to landfill and employee business travel from scope 3.

If you have your energy usage details, use our carbon footprint calculator to calculate your organizational carbon footprint.

* The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, revised edition. World Business Council for Sustainable Development and World Resources Institute.

The 2 main reasons for calculating an organizational carbon footprint are that it will help you to:

- **Manage and reduce emissions**
  Reducing your business carbon footprint often results in cost savings. Analyzing your organization's carbon footprint will help you to identify and prioritize areas for potential reduction.

- **Reporting**
  More and more organizations want to be able to demonstrate their carbon footprint for reasons of:
  - **Mandatory reporting requirements**
    Climate change legislation such as the Carbon Reduction Commitment Energy Efficiency Scheme (CRC) or EU Emissions Trading Scheme require such reporting, for example.
  - **Corporate social responsibility (CSR)**
    Showing that you are behaving in a responsible and ethical way is becoming ever more important
  - **Responding to requests**
    Partners, customers and investors are increasingly interested in carbon emissions data. There are also carbon reporting initiatives such as the Carbon Disclosure Project.

Steps:

The basic 6 steps required to calculate a carbon footprint for an organization are as follows:

1. Establishment of the assessment boundaries:
   • Organizational
   • Operational
   • Greenhouse gases
2. Collection of data.
3. Calculation of emissions using appropriate emissions factors
4.Convert usage into CO2 equivalent
5.Verifying the results (optional)
6.Reporting the carbon footprint

1. Method definition
You need to have a consistent method to get accurate results – especially if you are going to rely on lots of different people to collect and interpret data.
Good sources of standards include:

- Greenhouse Gas Protocol
  Free set of commonly used standards
- International Organization for Standardization, ISO 14064
  Builds on many of the concepts introduced by the GHG Protocol

2. Establishment of the assessment boundaries:
You will need to define:

- Organizational boundaries
  What parts of the organization are included? This can be complex for large organizations with many subsidiaries, joint ventures or leased assets.
- Operational boundaries
  All **scope 1** and **scope 2** emissions should be included, but the organization can choose which **scope 3** emissions to include.

When choosing a boundary try to take account of how your organization works, other reporting periods, legislative requirements, and the practicalities of data collection.

3. Collate data
It is important to collect data as thoroughly and accurately as possible. The main sources of data are usually:

- **Gas and electricity** – meter readings or bills (kWh)
- **Other fuels** – usage in liters, kWh, MJ, liters
- **Transport** – usage by fuel type (if this is not possible estimate it based on the mileage of the vehicles and fuel economy assumptions)

4.ConvertusageintoCO2equivalent
The carbon footprint is measured in tones CO2 equivalent (tCO2e). This is calculated by converting the data you have collected. You should always use conversions from credible sources, see our conversion factor tables. It is important that you identify any data gaps and list the assumptions you have made in calculating the footprint.

5.Verifyingtheresults(optional)
To add credibility, it makes sense for a third party to verify your carbon footprint. The Carbon Trust Standard is one such company that can do this – as well as helping you to measure, reduce, and communicate your carbon footprint.

6.Reportingthecarbonfootprint
Make sure you carbon footprint is presented clearly and honestly. This means providing complete information about each of the steps above, including methods, footprint boundaries, data quality and assumptions. Also - try to keep a consistent approach over different years, explaining any changes in reporting or business structure that might impact the footprint.

B) PRODUCT CARBON FOOTPRINT

Emissions over the whole life of a product or service, from the extraction of raw materials and manufacturing right through to its use and final reuse, recycling or disposal.

A product carbon footprint measures the greenhouse gas emissions at each stage of the product's life.

A product carbon footprint measures the greenhouse gas emissions at each stage of the product's life. This includes:

- Extraction, production and transportation of raw materials
- Manufacture or service provision
- Distribution
- End-use
- Disposal/recycling

At each stage greenhouse gas emissions can result from such sources as: energy use, transportation fuel refrigerant losses from air conditioning units and waste. In the case of a "service product" the life-cycle stages are defined across the duration of the service.

Measuring a product's carbon footprint offers a number of benefits, including:

- **Attracting customers**
  Customers are becoming increasingly aware of the environmental impact of the goods and services they use. Working with the Carbon Trust Foot printing Companyor demonstrating a lower footprint than competitor products can deliver competitive advantage.
- **Brand identity**
  Reporting product carbon footprints shows that an organization takes its social responsibility seriously.
- **Leadership**
  Reporting your products' carbon footprints will support your corporate responsibility programme and enhance your reputation.
- **Cost savings**
  Identifying areas where greenhouse gas emissions can be reduced often results in cost savings - in terms of transport energy, waste and packaging for example.
- **Emissions savings**
  Looking at the whole supply chain could help you identify savings.

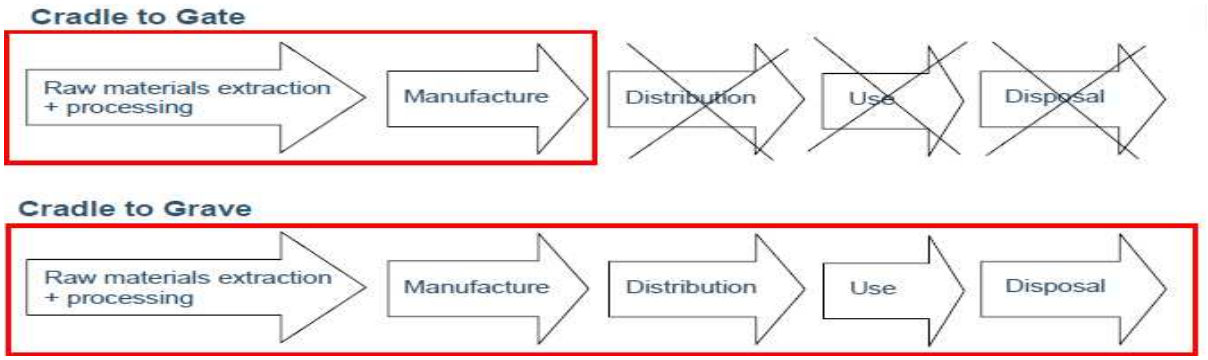
The basic steps required to calculate a carbon footprint for a product are as follows:

1. Analyze the materials and supply chain processes.
2. Build a supply chain map for the product.
3. Define the assessment boundaries (including the selection of greenhouse gases and the emissions sources which will be included).
4. Data collection
5. Calculation of emissions using appropriate emissions factors.

1. The **primary footprint** is a measure of our direct emissions of CO2 from the burning of fossil fuels including domestic energy consumption and transportation (e.g. car and plane). We have direct control of these.

2. The **secondary footprint** is a measure of the indirect CO2 emissions from the whole lifecycle of products we use - those associated with their manufacture and eventual breakdown. To put it very simply – the more we buy the more emissions will be caused on our behalf.

Product Carbon Footprints are commonly expressed either as 'cradle to gate' footprints, or 'cradle to grave' depending on the life-cycle stages included.



4.3 CARBON CREDIT

INTRODUCTION

Carbon credits are a tradable permit scheme. It is a simple, non-compulsory way to counteract the greenhouse gasses that contribute to climate change and global warming. Carbon credits create a market for reducing greenhouse emissions by giving a monetary value to the cost of polluting the air. The Carbon Credit is this new currency and each carbon credit represents one tonne of carbon dioxide either removed from the atmosphere or saved from being emitted. Carbon credits are also called emission permit. Carbon credit is in the Environment and Pollution Control subject. Carbon credits are certificates awarded to countries that are successful in reducing emissions of greenhouse gases.

GENERATIONOFCARBONCREDITS

Carbon credits are generated as the result of an additional carbon project. Carbon credits can be created in many ways but there are two broad types:

1. Sequestration (capturing or retaining carbon dioxide from the atmosphere) such as afforestation and reforestation activities.
2. Carbon Dioxide Saving Projects such as use of renewable energies

These credits need to be authentic, scientifically based and Verification is essential. Carbon credit trading is an innovative method of controlling emissions using the free market.

NEEDFORCARBONCREDITS

Over millions of years, our planet has managed to regulate concentrations of greenhouse gases through sources (emitters) and sinks (reservoirs). Carbon (in the form of CO2 and methane) is emitted by volcanoes, by rotting vegetation, by burning of fossil fuels and other organic matter. But CO2 is absorbed, by trees, forests or by some natural phenomenon like photosynthesis and also oceas to some extent.

TYPES OF CARBON CREDIT

There are two main markets for carbon credits:
A) Compliance Market credits
B) Verified Market credits (VERs)

VALUE OF CARBON CREDITS

Carbon credits create a market for reducing greenhouse gases emissions by giving a monetary value to the cost of polluting the air such as carbon emitted by burning of fossil fuels. This means that carbon becomes a cost of business and is seen like other inputs such as raw materials or labor.

Carbon credits are measured in tonnes of carbon dioxide.
1 credit = 1 tonne of CO2.
Each carbon credit represents one metric ton of C02 either removed from the atmosphere or saved from being emitted. The carbon credit market creates a monetary value for carbon credits and allows the credits to be traded.
For each tonne of carbon dioxide that is saved or sequestered carbon credit producers may sell one carbon credit.

4.4 CARBON SEQUESTRATION or CARBON CAPTURE AND STROAGE or SCRUBBING OF CO_2

Carbon sequestration is the capture of carbon dioxide (CO_2) and may refer specifically to:

- "The process of removing carbon from the atmosphere and depositing it in a reservoir." When carried out deliberately, this may also be referred to as carbon dioxide removal, which is a form of geoengineering.
- The process of carbon capture and storage, where carbon dioxide is removed from flue gases, such as on power stations, before being stored in underground reservoirs.
- Natural biogeochemical cycling of carbon between the atmosphere and reservoirs, such as by chemical weathering of rocks.

Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

Carbon dioxide is naturally captured from the atmosphere through biological, chemical or physical processes. Some anthropogenic sequestration techniques exploit these natural processes, while some use entirely artificial processes.

Carbon dioxide may be captured as a pure by-product in processes related to petroleum refining or from flue gases from power generation.CO_2 sequestration includes the storage part of carbon capture and storage, which refers to large-scale, permanent artificial capture and sequestration of

industrially produced CO_2 using subsurface salineaquifers, reservoirs, ocean water, aging oil fields, or other carbon sinks.

STEPS :

A) Capturing or Scrubbing
B) Transporation
C) Sequestration or Storage

A) CAPTURING or SCRUBBING OF CO_2:

TECHNOLOGIES:
Broadly, three different types of technologies for scrubbing of CO_2 exist:

2. post-combustion,
3. pre-combustion, and
4. oxyfuel combustion
5. Chemical looping

1. **Post-Combustion:** In post combustion capture, the CO_2 is removed after combustion of the fossil fuel — this is the scheme that would be applied to fossil-fuel burning power plants. Here, carbon dioxide is captured from flue gases at power stations or other large point sources. The technology is well understood and is currently used in other industrial applications, although not at the same scale as might be required in a commercial scale power station.

2. **Pre-Combustion** : The technology for pre-combustion is widely applied in fertilizer, chemical, gaseous fuel (H_2, CH_4), and power production. In these cases, the fossil fuel is partially oxidized, for instance in a gasifier. The resulting syngas (CO and H_2O) is shifted into CO_2 and more H_2. The resulting CO_2 can be captured from a relatively pure exhaust stream. The H_2 can now be used as fuel; the carbon dioxide is removed before combustion takes place. There are several advantages and disadvantages when compared to conventional post combustion carbon dioxide capture. The CO_2 is removed after combustion of fossil fuels, but before the flue gas is expanded to atmospheric pressure. This scheme is applied to new fossil fuel burning power plants, or to existing plants where re-powering is an option. The capture before expansion, i.e. from pressurized gas, is standard in almost all industrial CO_2 capture processes, at the same scale as will be required for utility power plants.

3. **Oxy-Fuel Combustion:** In oxy-fuel combustion the fuel is burned in oxygen instead of air. To limit the resulting flame temperatures to levels common during conventional combustion, cooled flue gas is re-circulated and injected into the combustion chamber. The flue gas consists of mainly carbon dioxide and water vapor, the latter of which is condensed through cooling. The result is an almost pure carbon dioxide stream that can be transported to the sequestration site and stored. Power plant processes based on oxy fuel combustion are sometimes referred to as "zero emission" cycles, because the CO_2 stored is not a fraction removed from the flue gas stream (as in the cases of pre- and post-combustion capture) but the flue gas stream itself. A certain fraction of the CO_2 generated during combustion will inevitably end up in the condensed water. To warrant the label "zero emission" the water would thus have to be treated or disposed of appropriately. The technique is promising, but the initial air separation step demands a lot of energy.

4. **Chemical looping combustion (ClC):** Chemical looping uses a metal oxide as a solid oxygen carrier. Metal oxide particles react with a solid, liquid or gaseous fuel in a fluidized bed combustor, producing solid metal particles and a mixture of carbon dioxide and water vapor. The water vapor is condensed, leaving pure carbon dioxide which can then be sequestered. The solid metal particles are circulated to another fluidized bed where they react with air, producing heat and regenerating metal oxide particles that are re circulated to the fluidized bed combustor.

5. **Calcium looping:** A variant of chemical looping is calcium looping, which uses the alternating carbonation and then calcinations of a calcium oxide based carrier as a means of capturing CO_2.

B) TRANSPORT:

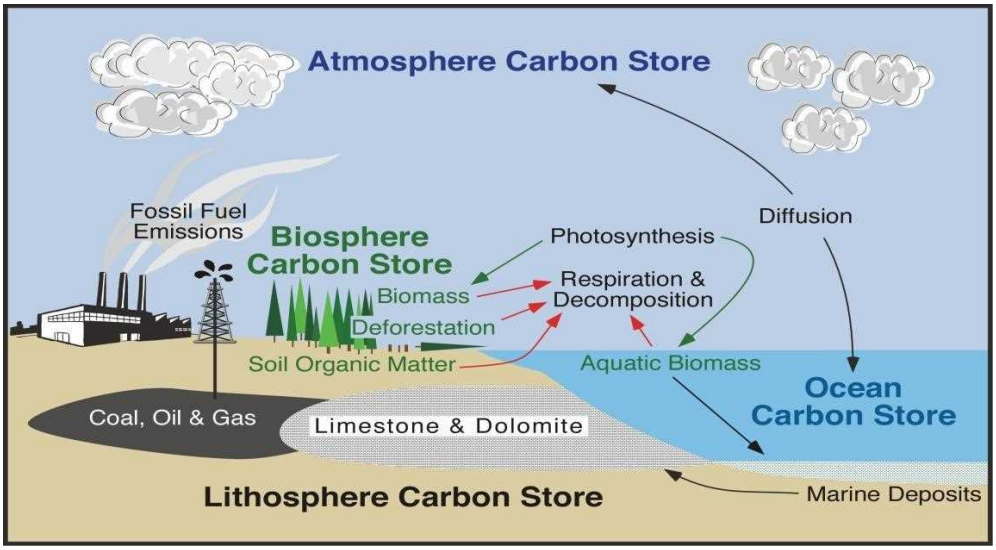
After capture, the CO_2 would have to be transported to suitable storage sites. This is done by pipeline, which is generally the cheapest form of transport. In 2008, there were approximately 5,800 km of CO_2 pipelines in the United States, used to transport CO_2 to oil production fields where it is then injected into older fields to extract oil. The injection of CO_2 to produce oil is generally called Enhanced Oil Recovery or EOR.

In addition, there are several pilot programs in various stages to test the long-term storage of CO_2 in non-oil producing geologic formations.

A COA conveyor belt system or ship could also be utilized for transport. These methods are currently used for transporting CO_2 for other applications.

C) SEQUESTRATION or STORAGE:

Various forms have been conceived for permanent storage of CO_2. These forms include gaseous storage in various deep geological formations (including saline formations and exhausted gas fields), liquid storage in the ocean, and solid storage by reaction of CO_2 with metal oxides to produce stable carbonates.



i) GEOLOGICAL STORAGE: Also known as geo-sequestration, this method involves injecting carbon dioxide, generally in supercritical form, directly into underground geological formations. Oil fields, gas fields, saline formations, unmineable coal seams, and saline-filled basalt formations have been suggested as storage sites. Various physical (e.g., highly impermeable cap rock) and geochemical trapping mechanisms would prevent the CO_2 from escaping to the surface.

Enhanced oil recovery:CO_2 is sometimes injected into declining oil fields to increase oil recovery. This option is attractive because the geology of hydrocarbon reservoirs is generally well understood and storage costs may be partly offset by the sale of additional oil that is recovered. Disadvantages of old oil fields are their geographic distribution and their limited capacity, as well as the fact that subsequent burning of the additional oil so recovered will offset much or all of the reduction in CO_2 emissions.

Unmineable coal seams can be used to store CO_2 because the CO_2 molecules attach to the surface of coal. The technical feasibility, however, depends on the permeability of the coal bed. In the process of absorption the coal releases previously absorbed methane, and the methane can be recovered (enhanced coal bed methane recovery). The sale of the methane can be used to offset a portion of the cost of the CO_2 storage. Burning the resultant methane, however, would produce CO_2, which would negate some of the benefit of sequestering the original CO_2.

II) OCEAN STORAGE:

Another proposed form of carbon storage is in the oceans. Several concepts have been proposed:

- 'Dissolution' injects CO_2 by ship or pipeline into the ocean water column at depths of 1000 – 3000 m, forming an upward-plume, and the CO_2 subsequently dissolves in seawater.
- Through 'lake' deposits, by injecting CO_2 directly into the sea at depths greater than 3000 m, where high-pressure liquefies CO_2, making it denser than water, and forms a downward-plume that may accumulate on the sea floor as a 'lake', and is expected to delay dissolution of CO_2 into the ocean and atmosphere, possibly for millennia.
- Use a chemical reaction to combine CO_2 with a carbonate mineral (such as limestone) to form bicarbonate(s), for example: $CO_2 + CaCO_3 + H_2O \rightarrow Ca(HCO_3)_2(aq)$. However, the aqueous bicarbonate solution must not be allowed to dry out, or else the reaction will reverse.
- Store the CO_2 in solid clathrate hydrates already existing on the ocean floor,[23][24] or growing more solid clathrate.

The environmental effects of oceanic storage are generally negative, and poorly understood. Large concentrations of CO_2 could kill ocean organisms, but another problem is that dissolved CO_2 would eventually equilibrate with the atmosphere, so the storage would not be permanent.In addition, as part of the CO_2 reacts with the water to form carbonic acid, H_2CO_3, the acidity of the ocean water increases.

The bicarbonate approach would reduce the pH effects and enhance the retention of CO_2 in the ocean, but this would also increase the costs and other environmental effects.

III) MINERAL STORAGE:

In this process, CO_2 is exothermically reacted with available metal oxides, which in turn produces stable carbonates. This process occurs naturally over many years and is responsible for a great amount of surface limestone. The reaction rate can be made faster, for example by

reacting at higher temperatures and/or pressures, or by pre-treatment of the minerals, although this method can require additional energy.
Carbon sequestration by reacting naturally occurring Mg and Ca containing minerals with CO_2 to form carbonates has many unique advantages. Most notable is the fact that carbonates have a lower energy state than CO_2, which is why mineral carbonation is thermodynamically favorable and occurs naturally (e.g., the weathering of rock over geologic time periods). Secondly, the raw materials such as magnesium based minerals are abundant. Finally, the produced carbonates are unarguably stable and thus re-release of CO_2 into the atmosphere is not an issue. However, conventional carbonation pathways are slow under ambient temperatures and pressures. The significant challenge being addressed by this effort is to identify an industrially and environmentally viable carbonation route that will allow mineral sequestration to be implemented with acceptable economics

4.5 POLLUTER PAYS PRINCIPLE

The polluter pays principle (PPP) is a basic economic idea that firms or consumers should pay for the cost of the negative externality they create. The polluter pays principle usually refers to environmental costs, but it could be extended to any external cost.

In a purely free market, you would only face your private costs. However, for goods with negative externalities, there are additional external costs, e.g. damage to the environment. This means the social cost of some goods are greater than the private cost.

The polluter pays principle is simply the idea that we should pay the total social cost including the environmental costs. This requires some authority or government agency to calculate our external costs and make sure that we pay the full social cost. A simple example, is a tax on petrol. When consuming petrol, we create pollution. The tax means the price we pay more closely reflects the social cost.

The polluter pays principle is a way of 'internalizing the externality'. It makes the firm / consumer pay the total social cost, rather than just the private cost. (Social cost = private cost+ external cost)

The polluter pays principle is an important basis of international law. In 1972, the OECD (Organisation for Economic Co-operation and Development)wrote Guiding Principles concerning International Economic Aspects of Environmental Policies, stating:

" The polluter should bear the expenses of carrying out the above-mentioned measures decided by public authorities to ensure that the environment is in an acceptable state."

The polluter pays principle was incorporated into the 1992 Rio summit the declaration stated:

"National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that **the polluter should, in principle, bear the cost of pollution**, with due regard to the public interest and without distorting international trade and investment."

Difficulties of implementing polluter pays principle

- It can be difficult to measure how much pollution is produced, e.g. firms may try to hide the extent of their pollution.
- It can be difficult to impose regulations or tax on firms from other countries. For example, when we contribute to global warming, the problem effects everyone around the world, but it can be difficult to create international agreements to impose penalties on those polluting.
- Pollution havens. These are countries which have weaker environmental legislation and firms can escape taxes and regulations on pollution by shifting production to those countries.
- Some costs are unexpected and occur after the event. e.g. in building nuclear power plant.
- Administration costs of collecting information and implementing tax. For example, a few drunks late at night may make a lot of noise and disturb the neighbourhood, but it would be impractical to impose a tax on those who make noise after a hard-days night. Administration costs have prevented the extension of congestion charge to smaller cities like Manchester – even though in principle it would make economic sense to have a charge for those who cause the external cost of congestion.

4.6 GREEN BUILDING or GREEN CONSTRUCTION OR SUSTAINABLE BUILDING

"A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

Green construction or **sustainable building** refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition.

Objectives:
- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation

Buildings can be rated for their environmentally sustainable construction. One such rating system is the LEED (Leadership in Energy and Environmental Design).
This building rating system was developed by the U.S. Green Building Council (GBC)
The other rating systems are BREEAM (Building Research Establishment's Environmental Assessment method -United Kingdom)and CASBEE (Comprehensive Assessment System for Building Environmental Efficiency-Japan) help consumers determine a structure’s level of environmental performance.

What is LEED?

Leadership in Energy and Environmental Design (LEED) is a rating system devised by the United States Green Building Council (USGBC) to evaluate the environmental performance of a building and encourage market transformation towards sustainable design.

The system is credit-based, allowing projects to earn points for environmentally friendly actions taken during construction and use of a building.

What types of buildings can use LEED?

LEED certification is available for all building types including new construction and major renovation; existing buildings; commercial interiors; core and shell; schools and homes. LEED systems for neighborhood development, retail and healthcare are currently pilot testing. To date, there is over 4.5 billion square feet of construction space involved with the LEED system.

How does LEED work?

LEED is a point based system where building projects earn LEED points for satisfying specific green building criteria. Within each of the seven LEED credit categories, projects must satisfy particular prerequisites and earn points.

The rating system addresses six major areas:
1. Sustainable sites;
2. Water efficiency;
3. Energy and atmosphere;
4. Materials and resources;
5. Indoor environmental quality; and
6. Innovation and design process.

LEED certification levels:
four progressive levels according to the following scale:
Certified 40–49 points
Silver 50–59 points
Gold 60–79 points
Platinum 80 points and above

In 2004, the European Commission initiated the Green Building Program (GBP). This program aims at improving the energy efficiency and expanding the integration of renewable energies in non-residential buildings in Europe on a voluntary basis.

Green building materials offer specific benefits to the building owner and building occupants:

- Reduced maintenance/replacement costs over the life of the building.
- Energy conservation.
- Improved occupant health and productivity.
- Lower costs associated with changing space configurations.
- Greater design flexibility.

Green building material/product selection criteria

1. Resource efficiency
2. Indoor air quality
3. Energy efficiency
4. Water conservation
5. Affordability

1. Resource Efficiency can be accomplished by utilizing materials that meet the following criteria:

- **Recycled Content**: Products with identifiable recycled content, including postindustrial content with a preference for postconsumer content.
- **Natural, plentiful or renewable**: Materials harvested from sustainably managed sources and preferably have an independent certification (e.g., certified wood) and are certified by an independent third party.
- **Resource efficient manufacturing process**: Products manufactured with resource-efficient processes including reducing energy consumption, minimizing waste (recycled, recyclable and or source reduced product packaging), and reducing greenhouse gases.
- **Locally available**: Building materials, components, and systems found locally or regionally saving energy and resources in transportation to the project site.
- **Reusable or recyclable**: Select materials that can be easily dismantled and reused or recycled at the end of their useful life.
- **Recycled or recyclable product packaging**: Products enclosed in recycled content or recyclable packaging.
- **Durable**: Materials that are longer lasting or are comparable to conventional products with long life expectancies.

2. Indoor Air Quality (IAQ) is enhanced by utilizing materials that meet the following criteria:

- **Low or non-toxic**: Materials that emit few or no carcinogens, reproductive toxicants, or irritants as demonstrated by the manufacturer through appropriate testing.
- **Minimal chemical emissions**: Products that have minimal emissions of Volatile Organic Compounds (VOCs). Products that also maximize resource and energy efficiency while reducing chemical emissions.
- **Low-VOC assembly**: Materials installed with minimal VOC-producing compounds, or no-VOC mechanical attachment methods and minimal hazards.
- **Moistureresistant**:Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.
- **Healthfully maintained**: Materials, components, and systems that require only simple, non-toxic, or low-VOC methods of cleaning.
- **Systems or equipment:** Products that promote healthy IAQ by identifying indoor air pollutants or enhancing the air quality.

3. Energy Efficiency can be maximized by utilizing materials and systems that meet the following criteria:

- Materials, components, and systems that help reduce energy consumption in buildings and facilities.

4. Water Conservation can be obtained by utilizing materials and systems that meet the following criteria:

- Products and systems that help reduce water consumption in buildings and conserve water in landscaped areas.

5. Affordability can be considered when building product life-cycle costs are comparable to conventional materials or as a whole, are within a project-defined percentage of the overall budget.

BENEFITS OF GREEN BUILDING

Buildings have an enormous impact on the environment, human health, and the economy. The successful adoption of green building strategies can maximize both the economic and environmental performance of buildings.

1. Environmental benefits 2.Economic benefits 3.Social benefits

1. Environmental benefits:

- Enhance and protect biodiversity and ecosystems
- Improve air and water quality
- Reduce waste streams
- Conserve and restore natural resources

2. Economic benefits:

- Reduce operating costs
- Create, expand, and shape markets for green product and services
- Improve occupant productivity
- Optimize life-cycle economic performance

3. Social benefits:

- Enhance occupant comfort and health
- Heighten aesthetic qualities
- Minimize strain on local infrastructure
- Improve overall quality of life

4.7 GREEN COMPUTING ORGREEN IT OR ICT SUSTAINABILITY

Definition :"the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems — efficiently and effectively with minimal or no impact on the environment"

Introduction:

The primary objective of such a program is to account for the triple bottom line (or "People, Planet, Profit").

The term "green computing" was probably coined shortly after the Energy Star program began.

The goals are similar to green chemistry namely to reduce the use of hazardous materials; maximize energy efficiency during the product's lifetime; and promote recyclability or biodegradability of defunct products and factory waste.
The Green Electronics Council offers the **Electronic Products Environmental Assessment Tool** (EPEAT) to assist in the purchase of "green" computing systems.
Climate Savers Computing Initiative (CSCI) is an effort to reduce the electric power consumption of PCs in active and inactive states. The name stems from the World Wildlife Fund's Climate Savers program, which was launched in 1999. The WWF is also a member of the Computing Initiative.

In 1992, the U.S. Environmental Protection Agency launched Energy Star, a voluntary labeling program that is designed to promote and recognize energy-efficiency in monitors, climate control equipment, and other technologies. This resulted in the widespread adoption of sleep mode among consumer electronics. Concurrently, the Swedish organization TCO Development launched the TCO Certification program to promote low magnetic and electrical emissions from CRT-based computer displays; this program was later expanded to include criteria on energy consumption, ergonomics, and the use of hazardous materials in construction

So why should a company promote green, or energy efficient computing?

- Climate Change: First and foremost, conclusive research shows that CO2 and other emissions are causing global climate and environmental damage
- Savings: Green computing can lead to serious cost savings over time.
- Reliability of Power: Energy efficient systems helps ensure healthy power systems. Also, more companies are generating more of their own electricity, which further motivates them to keep power consumption low.
- Computing Power Consumption has Reached a Critical Point: Data centers have run out of usable power and cooling due to high densities.

Here are some steps that can be taken:

- Power-down the CPU and all peripherals during extended periods of inactivity.
- Try to do computer-related tasks during contiguous, intensive blocks of time, leaving hardware off at other times.
- Power-up and power-down energy-intensive peripherals such as laser printers according to need.
- Use liquid-crystal-display (LCD) monitors rather than cathode-ray-tube (CRT) monitors.
- Use notebook computers rather than desktop computers whenever possible.
- Use the power-management features to turn off hard drives and displays after several minutes of inactivity.
- Minimize the use of paper and properly recycle waste paper.
- Dispose of e-waste according to federal, state and local regulations.
- Employ alternative energy sources for computing workstations, servers, networks and data centers.

Approaches to green computing

1. Virtualization

Computer virtualization is the process of running two or more logical computer systems on one set of physical hardware. The concept originated with the mainframe operating systems of the

1960s, but was commercialized for x86-compatible computers only in the 1990s. With virtualization, a system administrator could combine several physical systems into virtual machines on one single, powerful system, thereby unplugging the original hardware and reducing power and cooling consumption.

Eg:Intel Corporation and AMD

2. Power management

The Advanced Configuration and Power Interface (ACPI), an open industry standard, allows an operating system to directly control the power saving aspects of its underlying hardware. This allows a system to automatically turn off components such as monitors and hard drives after set periods of inactivity. In addition, a system may hibernate, where most components (including the CPU and the system RAM) are turned off. ACPI is a successor to an earlier Intel-Microsoft standard called Advanced Power Management, which allows a computer's BIOS to control power management functions.

Some programs allow the user to manually adjust the voltages supplied to the CPU, which reduces both the amount of heat produced and electricity consumed. This process is called under volting. Some CPUs can automatically under volt the processor depending on the workload.

3. Low performance computers

As of 2007, several personal computer vendors (e.g., Everex, Linutop, Systemax, Zonbu and OLPC) ship dedicated low-power PCs. These systems provide minimal hardware peripherals and low performance processors, which makes them impractical for applications that require a lot of processing power such as computer gaming and video production. A low power PCs is usually much smaller than traditional desktop. The limited capacity for upgrades, low performance and proprietary may lead to shorter life spans and greater difficulty in repair. **Older laptops** may provide similar performance with low power consumption. Reusing second-hand laptops may be an even more energy and material efficient alternative to such systems.

Routers, such as those compatible with the Linksys WRT54G, may be adapted for use in low power applications using replacement firmware.

4. More efficient components

4.1**: Power supply:** Desktop computer power supplies (PSUs) are generally 70–75% efficient, dissipating the remaining energy as heat.

4.2: **Storage:** Smaller form factor (e.g. 2.5 inch) hard disk drives often consume less power than physically larger drives.

4.3: **Display :**LCD monitors typically use a cold-cathode fluorescent bulb to provide light for the display. Some newer displays use an array of light-emitting diodes(LEDs) in place of the fluorescent bulb, which reduces the amount of electricity used by the display.

5. Materials recycling

Recycling computing equipment can keep harmful materials such as lead, mercury, and hexavalent chromium out of landfills, but often computers gathered through recycling drives are shipped to developing countries where environmental standards are less strict.
Eg: printer cartridges, paper, and batteries

4.8 NANOTECHNOLOGY

Definition

The systematic manipulation of matter on the length scale 1-100 nm to produce useful new engineered structures, materials, or devices.
Nanotechnology (NT) can be defined as the creation and use of materials, devices and systems in a size range of molecular and atomic scale (Nano-scale1).
As it deals with the manipulation of molecules it is also termed as molecular manufacturing.
The prefix, "Nano" of Nanotechnology describes a scale nanometer.

Nanometre

A nanometre is thousand millionth of a metre (1 nm = 10-9 m). Some practical examples for knowing the nanometre scale are as follows:
It is comparable to

- 1/80.000 of the diameter of a human hair (Institute of Nanotechnology, 2002) or
- 1/10.000 times the size of a bacteria (Drexler, 1986, p.11) or
- 1000 times smaller than the present micro-metre devices or
- 10 times the diameter of a hydrogen atom.

An early promoter of the industrial applications of NT, Albert Franks, defined it as 'that area of science and technology where dimensions and tolerances in the range of 0.1nm to 100 nm play a critical role'

Challenging Environmental Issues

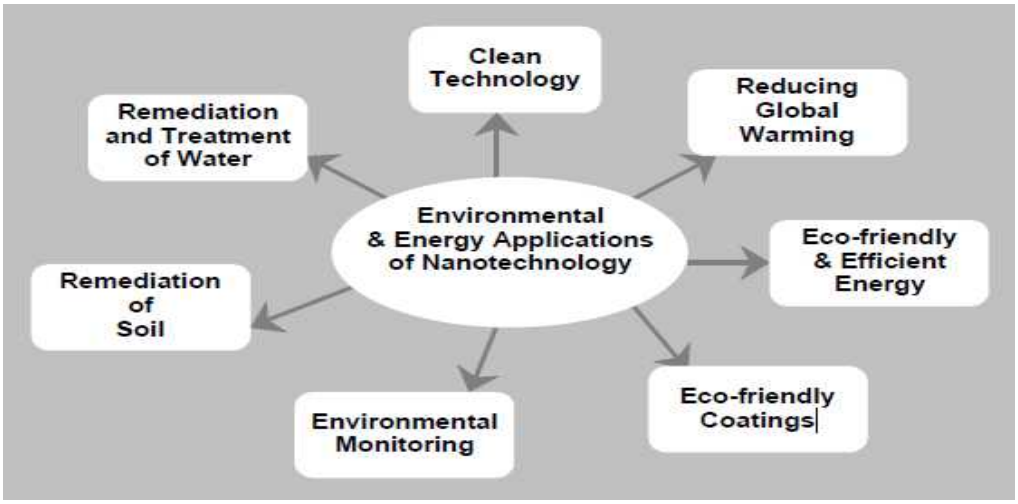
• Legacy Pollutants
  – Chlorinated Solvents
  – PCBs, PAHs, Chlorinated Pesticides (e.g.DDT)
  – Lead, cadmium, chromium
• Emerging Contaminants
  – Pharmaceuticals & Personal Care Products
  – Newer pesticides
  – Engineered Nanoparticles & their byproducts?
• Common water constituents
  – Salinity, hardnes

Potential Applications of Nanotechnology

Most environmental applications of nanotechnology fall into three categories:
(i) Remediation and Mitigation
(ii) Pollution Prevention
(iii) Sensors for environmental agents
(iv)Green nanotech

Possible applications of Nano Materials

1. As reactants eg: Nano Zero Valent Iron, Nano Silver
2. As catalysts eg: Nano TiO_2, Nano CeO_2
3. As adsorbents eg: Carbon Nano tubes (CNTs), Mag-PCMAs
4. As sensors eg: CNTs (Carbon nano tubes)



Remediation and Mitigation:

Contamination of subsurface soil and groundwater by organic and inorganic contaminants is an extensive and vexing environmental problem that stands to benefit from nanotechnology.
Nanotechnology offers the ability to effectively enable contaminant treatment in situ and ex-situ. The process begins with the injection of nanoparticles into a contaminated aquifer via an injection well. The nanoparticles are then transported to the source of contamination by the groundwater flow where they then degrade the contaminant. Nanoparticles can sequester (via adsorption or complexation), immobilizing them, or they can degrade the contaminants to less harmful compounds. Contaminant transformations are typically redox reactions. When the nanoparticle is the oxidant or reductant, it is considered reactive.

Generating less pollution during the manufacture of materials. One example of this is how researchers have demonstrated that the use of silver nanoclusters as catalysts can significantly reduce the polluting byproducts generated in the process used to manufacture propylene oxide. Propylene oxide is used to produce common materials such as plastics, paint, detergents and brake fluid.

Producing solar cells that generate electricity at a competitive cost. Researchers have demonstrated that an array of silicon nanowires embedded in a polymer results in low cost but high efficiency solar cells. This, or other efforts using nanotechnology to improve solar cells, may result in solar cells that generate electricity as cost effectively as coal or oil.

Increasing the electricity generated by windmills. Epoxy containing carbon nanotubes is being used to make windmill blades. The resulting blades are stronger and lower weight and therefore the amount of electricity generated by each windmill is greater.

Cleaning up of organic chemicals polluting groundwater. Researchers have shown that iron nano particles can be effective in cleaning up organic solvents that are polluting groundwater. The nano particles disperse throughout the body of water and decompose the organic solvent in place this method can be more effective and cost significantly less than treatment methods that require the water to be pumped out of the ground.

Capturing carbon-dioxide in power plant exhaust. Researchers are developing nanostructers membrane designed to capture carbondioxide in the exhaust stacks of power plants instead of releasing it into the air.

Clearing volatile organic compounds (VOC) from air. Researchers have demonstrated a catalyst that breaks down VOCs at room temperatue. The catalyst is composed of porous manganese oxide in which gold nano particles can be embedded.

Reducing the cost of fuel cells: changing the space of platinum atoms used in a fuel cell increases the catalytic ability of the platinum. This allows the fuel cell to function with about 80%, less platinum significantly reducing the cost of fuel cell.

Storing hydrogen for fuel cell powered cars: Using grapheme layers to increase the binding energy of hydrogen to the graphene surface in a fuel tank results in higher amount of hydrogen storage and a lighter weight fuel tank. This could help in the development of practical hydrogen fueled cars.

4.9 ISO 14000

The ISO is a specialized international organization whose members are the national standards bodies of 111 countries.

• All standards developed by ISO are voluntary
• ISO 14000 is a series of international standards on environmental management.
• "ISO 14000" is the first international attempt to standardize environmental management practices around the world.
• ISO 14000 will help integrate the environmental management systems of companies that trade with each other in all corners of the world.

Scope and Status of ISO 14000

Organization Standards that can be used to implement and evaluate the environmental management system (EMS) within an organization. Included are:

- the ISO 14000 series of EMS standards;
- the ISO 14010 series of environmental auditing standards; and
- the ISO 14030 series of standards for environmental performance evaluation.

Product Standards that can be used to evaluate environmental impacts from products and processes. Included in this subgroup are:

- the ISO 14020 series of environmental labeling standards;
- the ISO 14040 series of life-cycle analysis standards; and
- the ISO 14060 series of product standards**.**

Environmental Labeling

– Type I programs are referred to as "practitioner “programs which are product or product category based, similar to the Environmental Choice Program or Germany's BlueAngel Program.

– Type II programs are based on common terms and definitions which can be used for self-declared claims.

– Type III programs are based on a "report card "concept, much like existing nutrition labels.

4.10ROLE OF IT IN THE ENVIRONMENT AND HUMAN HEALTH

Technology has played a key role in the development of human society. Modern technologies such as information technology have changed the human lifestyle. Development of sophisticated instruments like computers, satellites, telecommunication instruments etc have resulted in total revolution in almost all spheres of life.

The important role of information technology in environment and human health are as follows:

1. Remote sensing: Remote Sensing according to Campbell(1987) is the science of deriving information about the earth's land water areas form images acquired at a distance. It relies upon measurement of electromagnetic energy reflected or emitted from the features of interest.
Regardless of the orientation of the various definitions of Remote Sensing, the acquisition of images of earth surface features, using sensors, through the electromagnetic spectrum, the synoptic view advantage and Remote Sensing's ability to provide data for scientific technological and sustainable management and monitoring of the environment offer a convergence.
The Electro-magnetic spectrum (EMS) is the physical basis for Remote Sensing. It is an abstract idea and diagram of forms of electromagnetic energy for illuminating earth surface features. The source of energy is divided according to wavelengths.

Steps:
Briefly stated, the process of Remote Sensing involves
1) Making observation using sensors (camera, scanners, radiometers, radar, and lasers) mounted on platforms (ground, aircraft, satellites, balloons) which may be at considerable height from the earth surface.
2)Then, recording the observations on a suitable medium (photographic films and magnetic tapes) or transmitting/down linking the data to a ground receiving station where the data are corrected for geometric and radiometric distortions.
3) Output products can be provided in computer compatible tapes (CC T) for users that made requests for the data. Remote sensing serves as a tool for environmental resources (biotic, abiotic and cultural) assessment and monitoring. Remote sensing has some fundamental advantages that make it a veritable tool in environmental monitoring and management and impact studies.

2. GIS (GEOGRAPHICAL INFORMATION SYSTEM)

GIS and Environmental Impacts Assessment:
Tomlin (199O) defines a GIS as 'a configuration of computer hardware and software specially designed for the acquisition, maintenance and use of cartographic data'.
GIS as a powerful set of tools for collecting, storing and retrieving at will, transforming and displaying spatial data from the real world.
The point of note is that a GIS is a computer-assisted system for the acquisition, storage, analysis and display of geographically are spatially referenced data. GIS is indeed a new application-

based field that has lend itself to varieties of human endeavors ranging from business, facility management to environmental management and resource application areas. Eedy (1995) has described GIS as a veritable tool in environmental assessment because it:

- Stores large multidisciplinary datasets.
- Identify complex interrelationship between environmental characteristics.
- Evaluate changes over time.
- Can be systematically updated and used for more than one project.
- Serve as a dataset for a variety of mathematical models.
- Store and mampulate3D in addition to 2D files.
- Serve the interests of the general public as well as technical analyst.

Capabilities of GIS:

GIS also have the capability for site impact prediction (SIP), wider area prediction (WAP), cumulative effect analysis (CEA), and environmental audits and for generating trend analysis within an environment.

Rodriquez -Bachiller (1995) commenting on its application in ETA studies submits that it is a veritable tool for generating terrain maps for slope and drainage analysis, land resources information system for land management, soil information system, geo scientific modeling of geological formations, disaster planning related to geographically localized catastrophe monitoring development, contamination and pollution monitoring, flood studies, linking of environmental database and constructing global database for environmental modeling.

Erickson (1994) suggested 4 four ways of using GIS for EIA. These are:

- **Overlay method:** This involves overlaying of different layers of interest of the study area to achieve the needed result.
- **Checklist method:** This is the listing of environmental components, attributes and processes categorized under different groups.
- **Matrix method:** This is the relating of specific project activities to specific types of impacts.
- **Network method:** This defines a network of possible impacts that may be triggered by project activities. It involves project actions, direct and indirect impacts.

Use of GIS in EIA

1 .**In Project definition**: During project identification and definition, the project proponent conducts feasibility studies and defines the usefulness of the study. GIS can be very well used for defining the project by showing the location of the project and its need can be established with respect to other geographical identities like source of raw material, market for selling, source of labourer, climatic conditions favorable for the project etc.

2. **In evaluating environmental and visual impacts**:

Using GIS various types of visual impacts can be evaluated like, how a road will look like? How much portion of the road will be visible from a particular point? By using DEM we can calculate and visualize the impact on ground levels either in filling or cutting and area of quarries etc (Oterholm, 1999).

3 .**In scoping system:** GIS can serve as a basis for scoping of environmental effects. Once the basic databases are available, a GIS based system may provide better-targeted guidelines for EIS. A centralized institutional scoping structure, where by EIS guidelines are issued by a single entity, is found to be important for the operation of such a system as it can enjoy the Economies

of scale and scope involved in setting up and operating a GIS system for scoping purpose (Haklay et al., 1998).

4. **In impact significance determination**: A spatial impact assessment methodology based on the assumption that the importance of environmental impact is dependent, among other things, on the spatial distribution of the effects and of the affected environment. For each environmental component like- air, water, biological resources etc., impact indices are calculated based on the spatial distribution of impacts (Antunes et al., 2001). The fact that GIS is not used in practice to the extent that it could be used in principle may also be the due to a number of limitations of GIS like:

Ø Availability of digital data
Ø Cost of start up
Ø System maintenance
Ø Database construction
Ø Availability of hardware and software

3. National management Information system (NIMS) - database for research and development

4. Environmental Information system (ENVIS): It was been created by MoEF in India for generating network of database for pollution control, clean technologies etc.

Database: Database is the collection of inter-related data on various subjects in computerized form which can be retrieved whenever required. Now the data regarding birth and death rates, immunization and sanitation programs can be maintained more accurately than before in computers at health centers. Database is also available about the diseases like malaria, fluorosis, AIDS etc. The Ministry of Environment and Forests, Government of India has taken up the task of compiling a database on various environmental issues like wildlife, forests cover, wasteland etc.

3. **Human health:** Information technology also plays a key role in human health. It helps the doctors to monitor the health of people of that area. The information regarding outbreak of epidemic diseases from remote areas can be sent more quickly to the district administration to take corrective measures. Now, patients can seek help of a super specialist doctor placed at far off distance. Many hospitals now, take on-line help of experts to provide better treatment and services to their patients. This has become possible only because of advancement of IT in the recent times.

UNIT-V

ENVIRONMENTAL EHICS, ENVIRONMENTAL IMPACT ASSESMENT AND ROLE OF NGOs

5.1 ENVIRONMENTAL EHICS

Excessive rise in population, rampant industrialization and rapid growth in industrial sectors has led to a great deterioration of Indian environment. However, Environmental management is now accepted as a major guiding factor for National Development in India. Over the last few decades there has been a progressive & strengthening of official involvement in environmental management with increased scientific technical, administrative and legislative back up at the central and state levels.

ENVIRONMENTAL LAWS

Following is a list of major Environmental Acts and Rules applicable in India.
• The Water (Prevention & Control of Pollution) Act 1974 (as amended upto 1998).
• The Water (Prevention &control of Pollution) cess Act, 1977 (as amended by Amendment Act 1991).
• The Air (Prevention & Control of Pollution) Act 1981 as amended by Amendment Act 1986
• Environment (Protection) Act 1986.
• Hazardous Waste (Management & Handling) Rules 1989.
• The Public Liability Insurance Act 1991.
• Environment Protection Amendment Rule 1983.
• Manufacture, Storage and Import of Hazardous Chemicals (Amendment) Rules 1984.
• The Factories Act 1984.
• The Forest Conservation Act 1980.
• The Notification on Environment Impact Assessment 1994.
Besides this there are a large number of RULES and AMENDEMENTS and a plethora of STATE LAWS. Only Major acts are briefly discussed here.

5.1.1 THE ENVIRONMENT (PROTECTION) ACT (EPA)

An Act to provide for the protection and improvement of environment and for matters connected there with:
Whereas the decisions were taken at the United Nations Conference on the Human Environment held at Stockholm in June, 1972, in which India participated, to take appropriate steps for the protection and improvement of human environment
The Environment (Protection) Act, 1986 not only has important constitutionals implications but also an international background.
This Act may be called the Environment (Protection) Act, 1986. It extends to the whole of India.

Powers and Functions of the Boards

(i) Co-ordination of actions by the State Governments, officers and other authorities--
   (a) Under this Act, or the rules made there under, or
   (b) Under any other law for the time being in force which is relatable to the objects of this Act;

(ii) Planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution;

(iii) Laying down standards for the quality of environment in its various aspects;

(iv) Laying down standards for emission or discharge of environmental pollutants from various sources whatsoever:

Provided that different standards for emission or discharge may be laid down under this clause from different sources having regard to the quality or composition of the emission or discharge of environmental pollutants from such sources;

(v) Restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards;

(vi) Laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents;

(vii) Laying down procedures and safeguards for the handling of hazardous substances;

(viii) Examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution;

(ix) Carrying out and sponsoring investigations and research relating to problems of environmental pollution;

(x) Inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and giving, by order, of such directions to such authorities, officers or persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution;

(xi) Establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act;

(xii) collection and dissemination of information in respect of matters relating to environmental pollution;

(xiii) Preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution;

(xiv) Such other matters as the Central Government deems necessary or expedient for the purpose of securing the effective implementation of the provisions of this Act.

Appointment of officers and their Powers and Functions

Without prejudice to the provisions , the Central Government may appoint officers with such designation as it thinks fit for the purposes of this Act and may entrust to them such of the powers and functions under this Act as it may deem fit.

Power to give directions

Notwithstanding anything contained in any other law but subject to the provisions of this Act, the Central Government may, in the exercise of its powers and performance of its functions under this Act, issue directions in writing to any person, officer or any authority and such person, officer or authority shall be bound to comply with such directions.[3]

Explanation--For the avoidance of doubts, it is hereby declared that the power to issue directions under this section includes the power to direct--

(a) the closure, prohibition or regulation of any industry, operation or process; or
(b) stoppage or regulation of the supply of electricity or water or any other service.

RULES TO REGULATE ENVIRONMENTAL POLLUTION

(1) The Central Government may, by notification in the Official Gazette, make rules in respect of all or any of the matters referred
(2) In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely:--

(a) the standards of quality of air, water or soil for various areas and purposes;
(b) the maximum allowable 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 the carrying on process and operations in different areas;
(f) the procedures and safeguards for the prevention of accidents which may cause environmental pollution and for providing for remedial measures for such accidents.

Prevention, Control and Abatement of Environmental Pollution
Persons carrying on industry operation, etc., not to allow emission or discharge of environmental pollutants in excess of the standards
Persons handling hazardous substances to comply with procedural safeguards
Furnishing of information to authorities and agencies in certain cases.

Environmental Laboratories

(1) The Central Government[15] may, by notification in the Official Gazette,--

(a) establish one or more environmental laboratories;
(b) recognize one or more laboratories or institutes as environmental laboratories to carry out the functions entrusted to an environmental laboratory under this Act.

(2) The Central Government may, by notification in the Official Gazette, make rules specifying--

(a) the functions of the environmental laboratory;
(b) the procedure for the submission to the said laboratory of samples of air, water, soil or other substance for analysis or tests, the form of the laboratory report thereon and the fees payable for such report;
(c) such other matters as may be necessary or expedient to enable that laboratory to carry out its functions.

Penalty for Contravention of the Provisions of the Act and the Rules, orders and directions

(1) Whoever fails to comply with or contravenes any of the provisions of this Act, or the rules made or orders or directions issued there under, shall, in respect of each such failure or contravention, be punishable with imprisonment for a term which may extend to five years with fine which may extend to one lakh rupees, or with both, and in case the failure or contravention continues, with additional fine which may extend to five thousand rupees for every day during

which such failure or contravention continues after the conviction for the first such failure or contravention.

(2) If the failure or contravention continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years

5.1.2 THE AIR (PREVENTION & CONTROL OF POLLUTION) ACT

It is also a comprehensive legislation with more than fifty sections. It makes provisions, inter alia, for Central and State Boards, power to declare pollution control areas, restrictions on certain industrial units, authority of the Boards to limit emission of air pollutants, power of entry, inspection, taking samples and analysis, penalties, offences by companies and Government and cognizance of offences etc.

The Act specifically empowers State Government to designate air pollution areas and to prescribe the type of fuel to be used in these designated areas. According to this Act, no person can operate certain types of industries including the asbestos, cement, fertilizer and petroleum industries without consent of the State Board. The Board can predicate its consent upon the fulfillment of certain conditions. The Air Act apparently adopts an industry wide "best available technology" requirement. As in the Water Act, courts may hear complaints under the Act only at the instigation of, or with the sanction of, the State Board.
The Government passed this Act in 1981 to clean up our air by controlling pollution. It states that sources of air pollution such as industry, vehicles, power plants, etc., are not permitted to release particulate matter, lead, carbon monoxide, sulfur dioxide, nitrogen oxide, volatile organic compounds (VOCs) or other toxic substances beyond a prescribed level. To ensure this, Pollution Control Boards (PCBs) have been set up by Government to measure pollution levels in the atmosphere and at certain sources by testing the air. This is measured in parts per million or in milligrams or micrograms per cubic meter. The particulate matter and gases that are released by industry and by cars, buses and two wheelers is measured by using air-sampling equipment. However, the most important aspect is for people themselves to appreciate the dangers of air pollution and reduce their own potential as polluters by seeing that their own vehicles or the industry they work in reduces levels of emissions. This Act is created to take appropriate steps for the preservation of the natural resources of the Earth which among other things includes the preservation of high quality air and ensures controlling the level of air pollution.
The main objectives of the Act are as follows:
(a) To provide for the prevention, control and abatement of air pollution.
(b) To provide for the establishment of central and State Boards with a view to implement the Act.
(C) To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution
Air pollution is more acute in heavily industrialized and urbanized areas, which are also densely populated. The presence of pollution beyond certain Limits due to various pollutants discharged through industrial emission is monitored by the PCBs set up in every state.

Powers and Functions of the Boards
Central Pollution Board: The main function of the Central Board is to implement legislation created to improve the quality of air and to prevent and control air pollution in the country. The

Board advises the Central Government on matters concerning the improvement of air quality and also coordinates activities, provides technical assistance and guidance to State Boards and lays down standards for the quality of air. It collects and disseminates information in respect of matters relating to air pollution and performs functions as prescribed in the Act.

State Pollution Control Boards: The State Boards have the power to advise the State Government on any matter concerning the prevention and control of air pollution. They have the right to inspect at all reasonable times any control equipment, industrial plant, or manufacturing process and give orders to take the necessary steps to control pollution.

They are expected to inspect air pollution control areas at intervals or whenever necessary. They are empowered to provide standards for emissions to be laid down for different industrial plants with regard to quantity and composition of emission of air pollutants into the atmosphere. A State Board may establish or recognize a laboratory to perform this function. The State Governments have been given powers to declare air pollution control areas after consulting with the State Board and also give instructions to ensure standards of emission from automobiles and restriction on use of certain industrial plants.

Penalties: The persons managing industry are to be penalized if they produce emissions of air pollutants in excess of the standards laid down by the State Board. The Board also makes applications to the court for restraining persons causing air pollution. Whoever contravenes any of the provision of the Act or any order or direction issued is punishable with imprisonment for a term which may extend to three months or with a fine of Rs 10,000 or with both, and in case of continuing offence with an additional fine which may extend to Rs 5,000 for every day during which such contravention continues after conviction for the first contravention.

5.1.3 THE WATER (PREVENTION & CONTROL OF POLLUTION) ACT

The government formulated this act in 1974 to prevent the pollution of water by industrial, agricultural and household wastewater that can contaminate our water sources.

Wastewaters with high levels of pollutants that enter wetlands, rivers, lakes, wells as well as the sea are serious health hazards. Controlling the point sources by monitoring the levels of different pollutants is one way to prevent pollution, by punishing the polluter. Individuals can also do several things to reduce water pollution such as using biodegradable chemicals for household use, reducing the use of pesticides in gardens, and identifying polluting sources at work places and in industrial units where oil are or other petroleum products and heavy metals are used. Excessive organic matter, sediments and infecting organism from hospital wastes can also pollute our water. Citizen needs to develop a watchdog force to inform authorities to appropriate actions against different types of water pollution. However, preventing pollution is better than trying to cure the problems it has created, or punishing offenders.

The main objectives of the Water Act are to provide for prevention, control and abatement of water pollution and the maintenance or restoration n of the wholesomeness of water. It is designed to assess pollution levels and punish polluters. The Central Government and State Government have set up PCBs to monitor water pollution.

The Water Act 1974 with certain amendments in 1978 is an extensive legislation with more than sixty sections for the prevention and control of water pollution. Among other things, the Act provides for constitution of central and State Boards for preventing water pollution, power to take water samples and their analysis, discharge of sewage or trade effluents, appeals, revision, minimum and maximum penalties, publication of names of offenders, offences by companies and Government departments, cognizance of offences, water laboratories, analysis etc. Prevention and control of water pollution is achieved through a permit or 'consent administration' procedure. Discharge of effluents is permitted by obtaining the consent of the State Water Board, subject to any condition they specify. Any person who fails to comply with a directive of the State cannot, however, entertain in suit under this Act unless the suit is brought by, or with the sanction of the State Board.

WATER POLLUTION CESS ACT 1977

According to this Act, anyone consuming water has to pay certain amount of cess depending on
1. Whether the industry is using water for industrial cooling, spraying in mine pits or boilers feed,
2. For domestic purposes,
3. in processing, whereby water gets polluted and pollutants are easily biodegradable, and
4. in processing whereby water gets polluted and the pollutants are not easily bio-degradable and are toxic. Those industries that had installed a suitable treatment plant for the treatment of industrial effluents can get a rebate of 70 per cent on the cess payable.

5.1.4 WILD LIFE PROTECTION ACT

The Act is adopted by all states in India except J&K, which has its own Act
The act is aimed to protect and preserve wild life. Wild life refers to all animals and plants that are not domesticated. India has rich wild life heritage; it has 350 species of mammals, 1200 species of birds and about 20,000 known species of insects. Some of them are listed as 'endangered species' in the Wild life (Protection) Act. The Act envisages national parks and wild life sanctuaries as protected areas to conserve wild life. Wild life populations are regularly monitored and management strategies formulated to protect them.
The Act covers the rights and non-rights of forest dwellers too,- it provides restricted grazing in sanctuaries but prohibits in national parks. It also prohibits the collection of non-timber forest produce which might not harm the system. The rights of forest dwellers recognized by the Forest policy of 1988 are taken away by the Amended Wild life Act of 1991.
The act, a landmark in the history of wildlife legislation in our country by which wildlife was transferred from State list to concurrent list in 1976, thus giving power to the Central Government to enact the legislation. In India, nearly 134 animal species have been regarded as threatened. A National Wildlife action plan has been prepared whose objective is to establish a network of scientifically managed areas such as national parks, sanctuaries and biosphere reserves, to cover representative and viable samples of all significant bio-geographic subdivisions within the country.

The major activities and provisions in the act can be summed up as follows:
1. It defines the wildlife 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 wildlife 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 Sliper Orchid, Pitcher plant etc. is also provided under the Act.
5. The act provides for setting up of National Parks, Wild life 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 of 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.

5.1.5 FOREST CONSERVATION ACT

The Indian Forest Act of 1927 consolidated all the previous laws regarding forests that were passed before the 1920s. The Act gave the Government and Forest Department the power to create Reserved Forests, and the right to use Reserved Forests for Government use alone.
It also created Protected Forests, in which the use of resources by local people was controlled. Some forests were to be controlled by the village community, and these were called village Forests. The Act remained in force till the 1980s when it was realized that protecting forests for timber production alone was not acceptable. The other values of protecting the services that forests provide and its valuable assets such as biodiversity began to overshadow the importance of their revenue earnings from timber.
This led to the Forest Conservation Act of 1980 and its amendment 1988. India's first Forest Policy was enunciated in 1952. Between 1952 and 1988, the extent of deforestation was so great that it became essential to formulate a new policy on forests and their utilization. The earlier forest policies had focused only on revenue generation. In the 1980's it became clear that forests must be protected for their other functions such as the maintenance of soil and water regimes centered around ecological concerns. It also provided for the use of goods and services of the forest for its local inhabitants.
The new policy framework made conversion of forests into other uses much less possible. Conservation of the forests as a natural heritage finds a place in the new policy, which includes the preservation of its biological diversity and genetic resources. It also values meeting the needs of local people for food, fuel wood, fodder and Non Timber Forest Produce or NTFPs. It gives priority to maintaining environmental stability and ecological balances. It expressly states that the network of Protected Areas should be strengthened and extended.

The Forest Conservation Act of 1980 was enacted to control deforestation, It ensured that forestlands could not be de-reserved without prior approval of the Central Government, This was created as some states had begun to dereserve the Reserved Forests for non-forest use. These states had regularized encroachments and resettled 'project Affected people' from development projects such as dams in these de-reserved areas. The need for a new legislation became urgent. The Act made it possible to retain a greater control over the frightening level of deforestation in the country and specified penalties for offenders.

Penalties for offences in Reserved Forests:

• No person is allowed to make clearing or ser fire to a reserved forest. Cattle are not permitted to trespass into the reserved forest, cutting, collecting of timber, bark or leaves, quarrying or collecting any forest products is punishable with imprisonment for a term of six months or with a fine which may extended to Rs 500 or both.

Penalties for offences in protected Forests:

• A person who commits any of the following offences like cutting of trees, stripping the bark or leaves of trees, set fire to such forests or permits cattle to damage any tree, shall be punishable with imprisonment for a term which may extended to six months or with a fine which any extended to Rs 500 or both.

• Any forest officer even without an order from the magistrate or a warrant can arrest any person against whom a reasonable suspicion exists.

5.1.6 ISSUES INVOLVED IN THE ENFORCEMENT OF ENVIRONMENTAL LEGISLATION-PUBLIC AWARENESS

It is necessary to create awareness about the norms and projected environmental restrictions under which organization may have environmental regulations and legislations rests with a number of different agencies. Central government is responsible for enforcement of various environmental legislation for less polluting small scale industries. There is an urgent need to use a range of measures to complement regulations.

It should be a must for all potential polluters to apply permission to operate, discharge or emit any pollutants. In addition there should be a greater monitoring. The technique of environmental assessment is applied to ensure that the significance of potential environmental impacts of proposed projects are critically examined during the planning process. Another way of increasing awareness on environmental protection is the introduction of voluntary scheme under which companies which would meet certain standard of environmental property of their products.

The various expectations in different types of pollution are as follows:

1. Water Pollution:

Under the water resource act of the country it should be criminal offence to cause or knowingly permit the entry in to controlled water of any poisonous, noxious or polluting matter or any other solid matter, trade or sewage effluent without the consent. Accidental spillage or discharge of such materials should be treated as an offence.

2. Air Pollution:

The legal responsibility about air pollution may be found in terms of the environmental protection act, covering two complementary systems of air pollution (1) the most potentially polluting activities. The major sources of air pollution are (a) Emission from industrial sources (b) Emission from motors vehicles, (c) Emission from other sources.

Thus, to prevent air pollution, rules and regulations are required to be framed.

3. Wastes Disposal:

They may be regulatory bodies for waste disposal, waste collection. These should also be directives relating to waste on the disposal of waste oil, the disposal of polychlorinated biphenyl, and polychlorinated phenyls.

After the united Nation's Conference on Human Environment in 1972 the Environmental legislation got a fresh impieties Indian first systematic approach in dealing with the environmental issues started from water Act of 1974. This Act was amended in 1988 and a new section 33 A was introduced which empowers state boards to issue directives to any person to close any industry and to stop or regulate supply of water and electricity. Because of the continuing environmental degradation and the Bhopal gas tragedy in 1974 the central government enacted fresh legislation for adopting more strict environmental policies.

Environmental Protection Act 1986 is one of the most significant legislation to protect the environment. Under Article 48A, the addition was made to the directive principles of state policy as the state shall endeavors to protect and improve the environment and safeguard the forests and wildlife of the country. Article 51A (g| imposes high responsibility on every citizen to protect the environment and improve natural resources, including forests, lakes, rivers and wildlife.

Every citizen has a choice of few records to mitigate pollution. These are (1) a common law and action (2) a writ petition for completing the agency to enforce the law and (3) a citizen suit.

An upcoming industry must submit No Objection Certificate in respect of pollution before it starts the implementation process. In case of a large project, it should submit Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to the Govt. of India for final clearance of the project.

Recently Supreme Court of India emphasized on the need to strengthen some institutional machinery to enforce antipollution law across the state. Supreme Court has further suggested that Government should set up special courts exclusively to deal with cases relating to violation of environmental laws. Supreme Court has also suggested that chemical industries should be treated separately. In 1996, Supreme Court has ordered Union Government and local authorities to keep clean the historical places on a regular basis.

AWARENES:

It is evident that the growing number of poor people, in developing countries due to the rapid population growth complex with economic constraints contributes to the degradation of environment and the renewable to the degradation of environment and the renewable sources like water, forests, and extinction of various species on which the man depends.

For these, greater awareness is needed. Due care is necessary to harness the natural resources, so that the quality of the environment does not deteriorate. It is unfortunate to note that degradation of environment continues inspire of environmental legislations and standardization. One of the reasons for this is improper implementation of the various environmental laws and standards. The most important reason may lack of awareness and understanding the implicate environmental degradation.