

**ENVIRONMENTAL STUDIES****SYLLABUS****Subject Code: 10CIV18****I A MARKS: 25****No. of lecturing hours/week: 2Hrs****Exam hours: 2 Hrs****Total No. of lecturing hours: 26Hrs****Exam Marks: 50****PART A****UNIT I:**

Introduction: Environment & Ecosystem Components of Environment & its classification  
Ecosystem: Types & Structure of Ecosystem, Balanced ecosystem Human Activities – Food, Shelter, Economic & Social Security

**UNIT II:**

Impacts of Agriculture & Housing Impacts of Industry, Mining & Transportation Environmental Impact Assessment, Sustainable Development

**UNIT III:**

Natural Resources, Water resources – Availability & Quality aspects, Water borne diseases & water induced diseases, Fluoride problem in drinking water Mineral resources, Forest Wealth Material Cycles – Carbon Cycle, Nitrogen Cycle & Sulphur Cycle

**UNIT VI:**

Energy – Different types of energy, Conventional sources & Non Conventional sources of energy Solar energy, Hydro electric energy Nuclear energy, Biomass & Biogas Fossil Fuels, Hydrogen as an alternative energy

**UNIT V:**

Environmental Pollution – Water Pollution, Noise pollution, Land Pollution, Public Health Aspects

**PART B****UNIT VI:**

Climate change & Global Warming, Population Growth, Urbanization Automobile Pollution

**UNIT VII:**

Acid rain Ozone layer depletion Animal Husbandary

**UNIT VIII:**

Environmental Protection, Role of government, Legal aspects, Role of Non-governmental Organizations (NGOs) Environmental Education & Women Education

**Text Book**

Environmental Studies - Benny Joseph- Tata McGrawl - 2005

Environmental Studies - Dr. D L Manjunath, Pearson - 2006

Environmental Studies - Dr. S M Prakash, Elite Publishers - 2005

**Reference Books**

Principles of Environmental Science & Engineering - P Venugopala Rao, Prentice Hall of India.

Environmental Science & Engineering - Meenakshi, Prentice Hall of India

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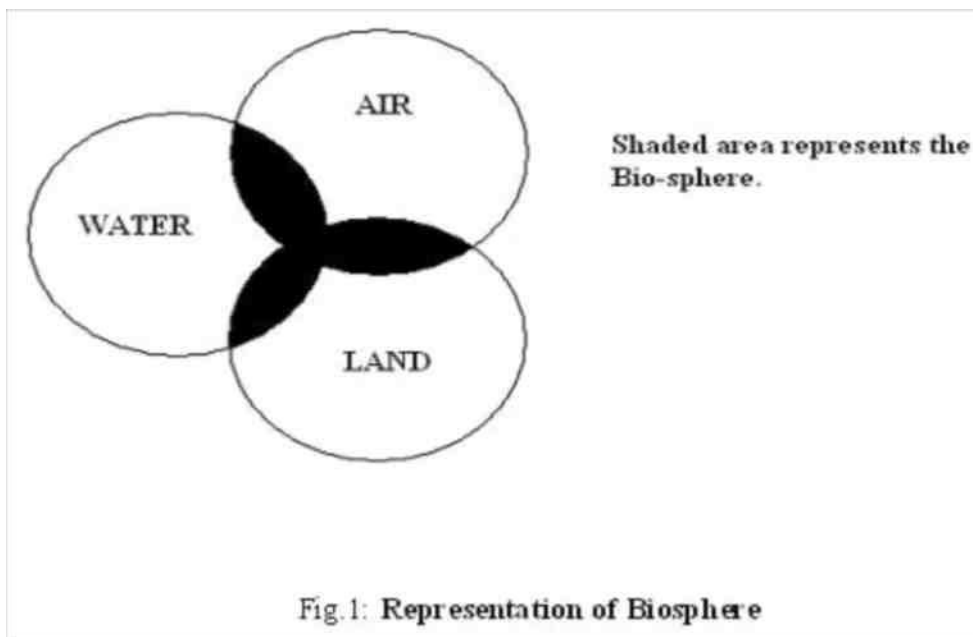
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## UNIT I

### ENVIRONMENT AND ECOSYSTEM

Environment can be defined as something that surrounds us.

Environment consists of three domains. viz, gaseous - air (atmosphere), liquid - water (Hydrosphere), and solid - land (lithosphere). These three domains meet at a common interface on the surface of the earth. This interface, a shallow life-bearing layer is the „Bio-Sphere“. Structure and functioning of the bio sphere is essentially dependent on the exchange of matter and energy that takes place continuously amongst the land surfaces, water bodies and atmosphere.



#### Components of the Environment

- Atmosphere
- Lithosphere
- Hydrosphere
- Biosphere

#### Structure of the atmosphere

The atmosphere of Earth is a layer of gases surrounding the planet Earth that is retained by Earth's gravity. The atmosphere protects life on Earth by absorbing ultraviolet solar radiation,

warming the surface through heat retention (greenhouse effect), and reducing temperature extremes between day and night.

Dry air contains roughly (by volume)

78.09% nitrogen,

20.95% oxygen,

0.93% argon,

0.038% carbon dioxide,

and small amounts of other gases.

Air also contains a variable amount of water vapor, on average around 1%.

### **Principal layers**

Earth's atmosphere can be divided into five main layers. These layers are mainly determined by whether temperature increases or decreases with altitude. From highest to lowest, these layers are:

#### **Exosphere**

The outermost layer of Earth's atmosphere extends from the exobase upward. Here the particles are so far apart that they can travel hundreds of kilometers without colliding with one another. Since the particles rarely collide, the atmosphere no longer behaves like a fluid. These free-moving particles follow ballistic trajectories and may migrate into and out of the magnetosphere or the solar wind. The exosphere is mainly composed of hydrogen and helium.

#### **Thermosphere**

Temperature increases with height in the thermosphere from the mesopause up to the thermo pause, then is constant with height. The temperature of this layer can rise to 1,500 °C (2,730 °F), though the gas molecules are so far apart that temperature in the usual sense is not well defined. The International Space Station orbits in this layer, between 320 and 380 km (200 and 240 mi). The top of the thermosphere is the bottom of the exosphere, called the exobase. Its height varies with solar activity and ranges from about 350–800 km (220–500 mi; 1,100,000–2,600,000 ft).

#### **Mesosphere**

The mesosphere extends from the stratopause to 80–85 km (50–53 mi; 260,000–280,000 ft). It is the layer where most meteors burn up upon entering the atmosphere. Temperature decreases with height in the mesosphere. The mesopause, the temperature minimum that marks the top of the mesosphere, is the coldest place on Earth and has an average temperature around -85 °C (-121.0 °F; 188.1 K). Due to the cold temperature of the mesosphere, water vapor is frozen, forming ice clouds (or Noctilucent clouds). A type of lightning referred to as either sprite, form many miles above thunderclouds in the trophosphere.

#### **Stratosphere**

The stratosphere extends from the tropopause to about 51 km (32 mi; 170,000 ft). Temperature increases with height, which restricts turbulence and mixing. The stratopause, which is the

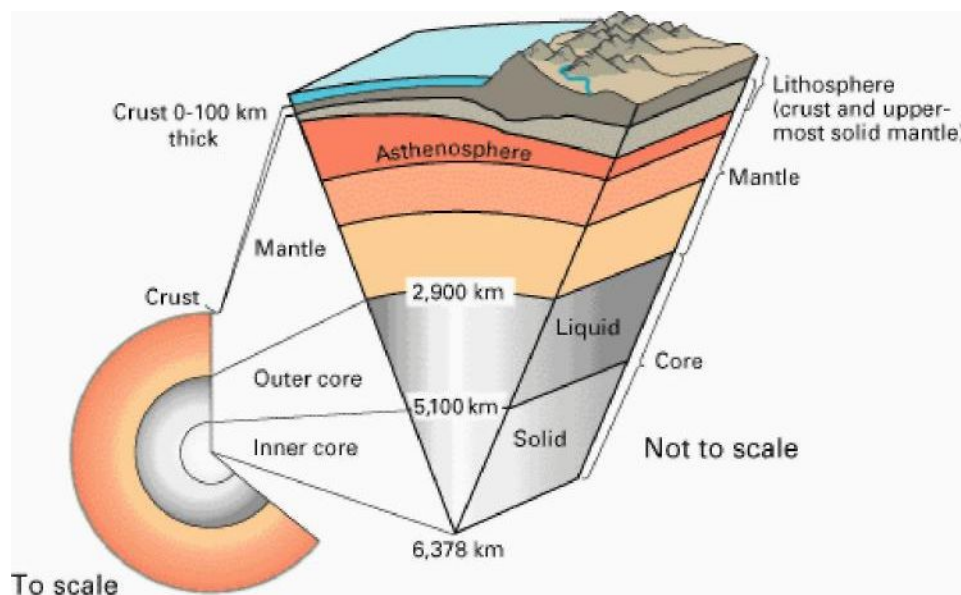
boundary between the stratosphere and mesosphere, typically is at 50 to 55 km (31 to 34 mi; 160,000 to 180,000 ft). The pressure here is 1/1000th sea level.

### Troposphere

The troposphere begins at the surface and extends to between 7 km (23,000 ft) at the poles and 17 km (56,000 ft) at the equator, with some variation due to weather. The troposphere is mostly heated by transfer of energy from the surface, so on average the lowest part of the troposphere is warmest and temperature decreases with altitude. This promotes vertical mixing (hence the origin of its name in the Greek word *trope*, meaning turn or overturn). The troposphere contains roughly 80%<sup>1</sup> of the mass of the atmosphere. The tropopause is the boundary between the troposphere and stratosphere.

### LITHOSPHERE

In the Earth, the lithosphere includes the crust and the uppermost mantle, which constitute the hard and rigid outer layer of the Earth. The lithosphere is underlain by the asthenosphere, the weaker, hotter, and deeper part of the upper mantle. The boundary between the lithosphere and the underlying asthenosphere is defined by a difference in response to stress: the lithosphere remains rigid for very long periods of geologic time in which it deforms elastically and through brittle failure, while the asthenosphere deforms viscously and accommodates strain through plastic deformation. The lithosphere is broken into tectonic plates. The uppermost part of the lithosphere that chemically reacts to the atmosphere, hydrosphere and biosphere through the soil forming process is called the pedosphere.



## The Crust

The crust of the Earth is composed of a great variety of igneous, metamorphic, and sedimentary rocks. The crust is underlain by the mantle. The upper part of the mantle is composed mostly of peridotite, a rock denser than rocks common in the overlying crust. The boundary between the crust and mantle is conventionally placed at the Mohorovicic discontinuity, a boundary defined by a contrast in seismic velocity. Earth's crust occupies less than 1% of Earth's volume.

The oceanic crust of the sheet is different from its continental crust. The oceanic crust is 5 km (3 mi) to 10 km (6 mi) thick<sup>[1]</sup> and is composed primarily of basalt, diabase, and gabbros. The continental crust is typically from 30 km (20 mi) to 50 km (30 mi) thick, and is mostly composed of slightly less dense rocks than those of the oceanic crust. Some of these less dense rocks, such as granite, are common in the continental crust but rare to absent in the oceanic crust.

Both the continental and oceanic crust "float" on the mantle. Because the continental crust is thicker, it extends both above and below the oceanic crust, much like a large iceberg floating next to smaller one. (The slightly lighter density of felsic continental rock compared to basaltic ocean rock also contributes to the higher relative elevation of the top of the continental crust.) Because the top of the continental crust is above that of the oceanic, water runs off the continents and collects above the oceanic crust. The continental crust and the oceanic crust are sometimes called sial and sima respectively. Due to the change in velocity of seismic waves it is believed that on continents at a certain depth sial becomes close in its physical properties to sima and the dividing line is called Conrad discontinuity.

The temperature of the crust increases with depth, reaching values typically in the range from about 200°C (392°F) to 400°C (752°F) at the boundary with the underlying mantle. The crust and underlying relatively rigid mantle make up the lithosphere. Because of convection in the underlying plastic (although non-molten) upper mantle and asthenosphere, the lithosphere is broken into tectonic plates that move. The temperature increases by as much as 30°C (about 50°F) for every kilometer locally in the upper part of the crust, but the geothermal gradient is smaller in deeper crust.

## The Mantle

The mantle is a highly viscous layer between the crust and the outer core. Earth's mantle is a rocky shell about 2,890 km (1,800 mi) thick that constitutes about 84 percent of Earth's volume. It is predominantly solid and encloses the iron-rich hot core, which occupies about 15 percent of Earth's volume. Past episodes of melting and volcanism at the shallower levels of the mantle have produced a thin crust of crystallized melt products near the surface, upon which we live. The gases evolved during the melting of Earth's mantle have a large effect on the composition and abundance of Earth's atmosphere. Information about structure and composition of the mantle either result from geophysical investigation or from direct geoscientific analyses on Earth mantle derived xenoliths.



Two main zones are distinguished in the upper mantle: the inner asthenosphere composed of plastic flowing rock, about 200 km thick, and the lowermost part of the lithosphere, composed of rigid rock, about 50 to 120 km thick

## **The Core**

The average density of Earth is  $5,515 \text{ kg/m}^3$ . Since the average density of surface material is only around  $3,000 \text{ kg/m}^3$ , we must conclude that denser materials exist within Earth's core. Further evidence for the high density core comes from the study of seismology.

Seismic measurements show that the core is divided into two parts, a solid inner core with a radius of  $\sim 1,220 \text{ km}$  and a liquid outer core extending beyond it to a radius of  $\sim 3,400 \text{ km}$ . The solid inner core was discovered in 1936 by Inge Lehmann and is generally believed to be composed primarily of iron and some nickel

## **ECOSYSTEM**

### **Introduction**

Living organisms and their non-living systems of the environment are inseparable, inter-related and interact upon each other. Any unit that includes all the organisms in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles, exchange of materials between living and non-living components within the system is known as „ECOSYSTEM“. The term eco-system was coined by Tansley in 1935. He defined it as “the system resulting from the integration of all the living and non-living factors of the environment”.

### **Components of Ecosystem**

As discussed above, an ecosystem has three distinctive components that can be identified as :

- non living or abiotic component including climate regime
- living or biotic component
- source of energy - light and heat

### **Abiotic Substances**

These comprise of inorganic and organic compounds present in the environment. The inorganic components of an ecosystem are oxygen, carbon dioxide, water, minerals etc., whereas carbohydrates, proteins, lipids, amino acids etc., are examples for organic material. The climate, light and heat can be either studied under abiotic component, or as separate entities. The predominant source of energy in the earth's biosphere is sun. The abiotic substances are circulated in the ecosystem through material cycles and energy cycles.

### **Biotic Substances**

Living organisms in the ecosystem - various species of plants and animals including microbes are termed as biotic components. They can be classified as producers (autotrophs) and consumers ( heterotrophs).

**Producers (Autotrophs)**

Autotrophs produce their own food from inorganic substances, using light or chemical energy. Green plants including the unicellular algae which contain the pigment chlorophyll are producers. They take up simple substances such as water, carbon di-oxide, and oxygen, as well as inorganic nutrients and produce biological molecules needed for life from the inorganic substances. This production activity is vital for the existence of the ecosystem as the products of photosynthesis support the life on earth.

The overall effect of photosynthesis is to unite the hydrogen atoms of water with the atoms of carbon di-oxide to form carbohydrate. In the process oxygen gets released. A generalized photosynthesis reaction can be represented as :



Energy obtained from solar radiation plays the key role in this process. Hence the photosynthetic activity is essentially brought about during day time, although some insignificant amount of photosynthesis takes place during night time utilizing the faint light emitted from the heavenly bodies.

**Consumers (Heterotrophs)**

The heterotrophs do not have the ability to produce their own food. All these species are consumers. Bacteria, although belong to plant kingdom are not capable of production and are classified as consumers. The animals which feed on plants are called herbivores. They are primary consumers. Those feeding on animals are called as carnivores which are secondary consumers. Another category of consumers which feed on both plants and animals are called as omnivores.

The two major aspects of eco-systems are  
Structure and function

Structure comprises of,

- > the composition of biological community including species (plants, animals and microbes), biomass, life cycles and distribution in space, tropic standpoint.
- > the quantity, distribution and cycling of the non-living materials such as major and micro nutrients, trace elements and water.
- > the range or gradient of conditions like temperature, light, rainfall, relative humidity, wind and topography.

Function involves,

- > the rate of biological energy flow i.e., production and respiration rates of the community
- > rate of materials or nutrient cycles biological / ecological regulation which includes regulation or organism by environment (photo periodism) and regulation of environment by organisms (nitrogen fixation by organism).

Thus, in any ecosystem, the structure and function are studied together.

From the trophic stand point, an ecosystem has two components.

- > Autotrophic Component
- > Heterotrophic Component

### **Autotrophic Component**

The fixation of light energy, use of simple inorganic substances like carbon and water, synthesis of hexose sugars to complex substances such as polysaccharide carbohydrates (starches) and further fat and protein synthesis predominate here.

### **Heterotrophic Component**

Utilization, rearrangement and decomposition of complex substances is predominate here. These are macro consumers such as herbivores, carnivores and omnivores and micro consumers such as decomposers, osmotrophs and saprotrophs.

From the functional stand point an ecosystem may be conventionally analyzed in terms of,

Energy Circuits

Food Chains

Diversity Patterns in Space and Time

Nutrient Cycles

Development and Evolution

Control (Cybernetics)

For descriptive purpose the various components of an ecosystem can be conveniently arranged in the following manner.

**Producers** - they are autotrophic organisms, largely green plants which are able to produce the required food materials from simple inorganic substance.

**Macro Consumers** - Heterotrophic organisms, chiefly animals which ingest other organisms or particulate organic matter. They are three types, viz., primary consumers (herbivores), secondary consumers (carnivores) and tertiary consumers (carnivores / omnivores).

**Micro Consumers** - Heterotrophic organisms, chiefly bacteria and fungi which break down complex compounds of dead organic matter, absorb some of the decomposition products and release inorganic nutrients that are usable by the producers together with organics. These are called composers.

The producers, green plants fix radiant energy in the presence of the green pigment, chlorophyll and with the help of minerals (C, H, O, N, P, Ca, Mg, Zn, Fe, etc.) taken from their soil and aerial environment and nutrient pool, they build up complex organic matter (carbohydrates, fats, amino acids, proteins, nucleic acids, etc.). Some ecologists prefer to call green plants as converters or transducers since plants only produce carbohydrates and not energy, once they convert radiant energy into chemical form. This energy is transferred to various other trophic levels like consumers. The dead organic matter comprising plant and animal material is then

broken down and decomposed into simple inorganic substances which finally reach the nutrient pool and made use by producer gain.

The two ecological processes of energy flow and mineral cycling involving interaction between physico-chemical environment and the biotic community is considered as the „heart“ of ecosystem dynamics. In an ecosystem, always energy flows in non-cyclic manner from sun to the decomposer via producers and macro consumers whereas the minerals keep moving in a cyclic manner.

## **ECOLOGY**

An ecosystem is a vast and complex natural system. It consists of large pools of material resources and living organisms supported by sources of energy. There is a constant exchange of materials and energy in the ecosystem. The dynamics of such systems in which we live has to be properly understood so that we live happily, at the same time keeping the health of the whole system in good condition. Study of the ecosystem in all aspects is called „ecology“. The definition of ecology is in the Greek words ekos, “the house”, and logos “knowledge of.

### **Classification of Ecosystems**

Ecosystems are broadly classified as :

- > Terrestrial Ecosystems - which encompass the activities that take place on land, and
- > Aquatic ecosystems - the system that exists in water bodies

These ecosystems can be further subdivided as :

Terrestrial ecosystem -

- > Forest ecosystem,
- > Mountain ecosystem
- > Desert ecosystem
- > Grassland ecosystem
- > Urban ecosystem

Aquatic ecosystem -

- > Marine ecosystem
- > Fresh water ecosystem
- > Estuarine ecosystem

### **Engineered ecosystem:**

An ecosystem which is fully designed and controlled by man is called „Engineered ecosystem“. A paddy field or a fish pond can be quoted as an example for this ecosystem.

### **Subdivisions of Ecology**

For ease of understanding, ecology is studied as following sub divisions:

> Aut ecology - deals with the study of the individual organism or an individual species. For example study of a tree in a forest

> Synecology - deals with the study of groups of organisms which are associated together as a unit. Studying the whole forest as an ecosystem falls under this category

> Terrestrial Ecology - Studies related to the ecosystem on land, that is terrestrial ecosystem are dealt under „Terrestrial ecology“

> Aquatic Ecology - deals with the studies of the ecosystem existing in water bodies such as ocean waters, rivers, estuaries and other surface water. Further this category is subdivided into marine ecology, and fresh water ecology - inland waters.

Several other subdivisions have also been created - such as desert ecology, mountain ecology, applied human ecology, insect ecology, microbial ecology, space travel ecology and many other classifications.

### **Components of the pond ecosystem:**

#### **Abiotic components :**

Water, dissolved oxygen, carbon dioxide, inorganic salts such as chlorides, nitrates, phosphates of calcium, sodium, potassium etc., A large number of organic compounds such as organic acids are also present.

**Biotic component** : Both producers and consumers are present in the pond

#### **Producers**

In a freshwater pond, two types of producers are present - the large plants- floating or growing along the shoreline, and the floating and suspended microscopic plants. Mostly the later variety is made up of different types of algae. They are distributed throughout the water as deep as sunlight penetrates. These small plants are called as phytoplankton. Individual algae cells are not visible, but when they are present in large quantity give a greenish hue to the water body.

#### **Consumers:**

Alongside the producers, a pond ecosystem contains consumers such as fish, insects, crabs etc. They include both primary consumers ( herbivores) and secondary consumers (carnivores). Tertiary consumers feeding on carnivores can also be present. These consumers are visible to naked eye, and hence called as macro consumers. There are microscopic sized consumers also. They are called as Zooplanktons, and are present at the surface of the water and as well at the bottom ( benthos).

The pond ecosystem accommodates a major consumer form including bacteria, fungus etc., which are called as decomposers. They are micro consumers and play a major role in breaking down the waste products of macro consumers, and dead consumer and producers organisms. But for the decomposers, the ecosystem cannot exist as it gets overloaded with waste products and dead organisms. They are great scavengers.

## Algal – Bacterial Symbiosis

In a pond ecosystem bacteria, the main decomposers feed on the biodegradable organic matter available to them in the form of waste matter discharged by animal species, and the dead organisms both animal and plant species. They consume oxygen for bio chemical oxidation of the organic matter, and for their own respiration. As a consequence carbon dioxide is liberated. This carbon dioxide is taken up by the algae that is abundantly available. The growth of algae is promoted by the presence of nutrients in water. Algae being able to carry out photosynthesis in the presence of sunlight take up the  $\text{CO}_2$  and release  $\text{O}_2$  which is readily taken up by bacteria. This cyclic activity is called Algal-Bacterial symbiosis which keeps the pond ecosystem in a balanced condition.

## BALANCED ECOSYSTEM:

As can be seen from the definition of an ecosystem discussed earlier, it is made up of different components. In the natural environment a balance or equilibrium exists among various organisms and abiotic components. This condition is known as ecological balance, and the system is called as „Balanced Ecosystem“. If any disturbance occurs due to natural or manmade activities, this balance gets upset and it will be no more a balanced ecosystem. If sufficient time is allowed for restoration, a balanced ecosystem will gradually reappear, but may not resemble the original system – a new balance or equilibrium condition appears.

## Food chain

The food chain consists of four main parts:

The Sun, which provides the energy for everything on the planet.

**Producers:** these include all green plants. These are also known as autotrophs, since they make their own food. Producers are able to harness the energy of the sun to make food. Ultimately, every (aerobic) organism is dependent on plants for oxygen (which is the waste product from

photosynthesis) and food (which is produced in the form of glucose through photosynthesis). They make up the bulk of the food chain or web.

**Consumers:** In short, consumers are every organism that eats something else. They include *herbivores* (animals that eat plants), *carnivores* (animals that eat other animals), *parasites* (animals that live off of other organisms by harming it), and *scavengers* (animals that eat dead animal carcasses). Primary consumers are the herbivores, and are the second largest biomass in an ecosystem. The animals that eat the herbivores (carnivores) make up the third largest biomass, and are also known as secondary consumers. This continues with tertiary consumers, etc.

**Decomposers:** These are mainly bacteria and fungi that convert dead matter into gases such as carbon and nitrogen to be released back into the air, soil, or water. Fungi, and other organisms that break down dead organic matter are known as *saprophytes*. Even though most of us hate those mushrooms or molds, they actually play a very important role. Without decomposers, the earth would be covered in trash. Decomposers are necessary since they recycle the nutrients to be used again by producers.

The table gives one example of a food chain and the trophic levels represented in it.

Grass →	Grasshopper →	Toad →	Snake →	Hawk →	Bacteria of decay
In general,					
<u>Autotrophs</u> (Producers) →	Herbivores (Primary Consumers) →	Carnivores (Secondary, tertiary, etc. consumers) →			Decomposers

### Types of food chain-

There are mainly two types of food chains operating in nature.

- a) Grazing food chain
- b) Detritus food chain.

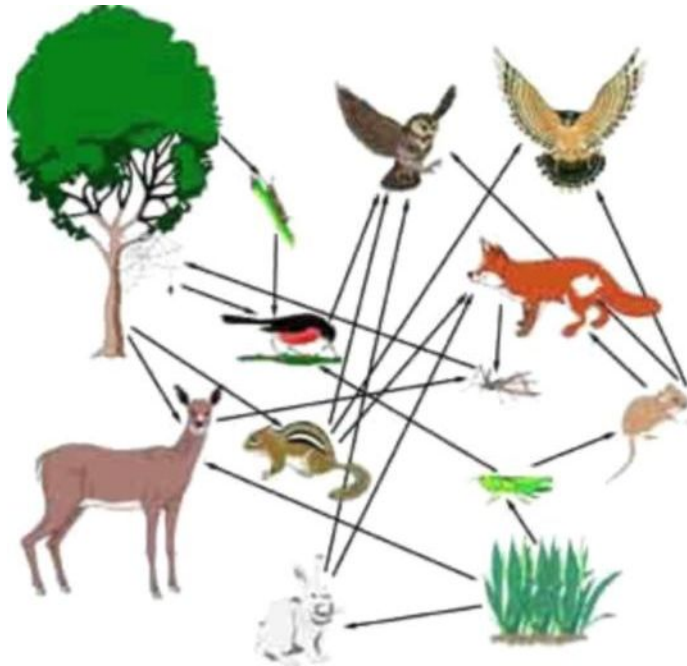
Grazing food chain is generally seen in ecosystems such as grassland, pond or lake where a substantial part of the net primary production is grazed on by herbivores (cattle and rodents). Usually upto 50% of the NPP is grazed on by these animals in their respective ecosystems and the remaining 50% goes to the decomposer organisms as dead organic matter. Thus, in these ecosystems, the food chain is herbivore based.

### Food Webs

A food web is a graphical description of feeding relationships among species in an ecological community, that is, of who eats whom (Fig. 1). It is also a means of showing how energy and materials (e.g., **carbon**) flow through a community of species as a result of these feeding relationships. Typically, species are connected by lines or arrows called "links", and the species are sometimes referred to as "nodes" in food web diagrams.

The pioneering animal ecologist **Charles Elton** (1927) introduced the concept of the food web (which he called food cycle) to general **ecological science**

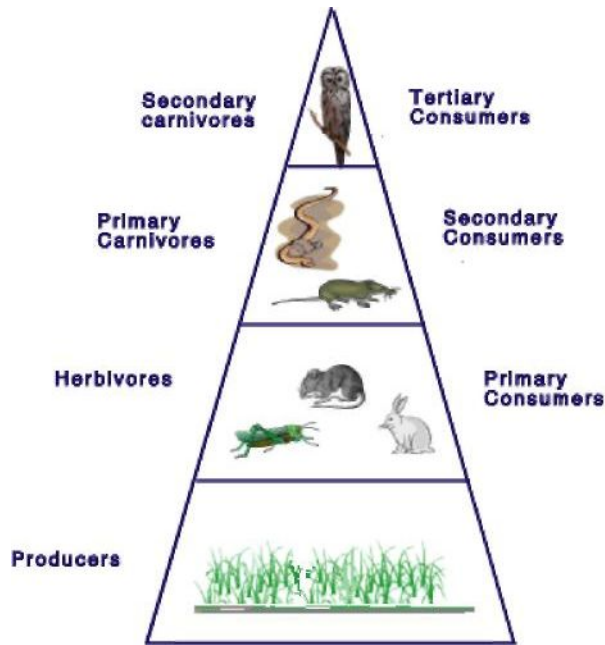
A food web differs from a food chain in that the latter shows only a portion of the food web involving a simple, linear series of species (e.g., predator, herbivore, plant) connected by feeding links. A food web aims to depict a more complete picture of the feeding relationships, and can be considered a bundle of many interconnected food chains occurring within the community. All species occupying the same position within a food chain comprise a trophic level within the food web. For instance, all of the plants in the foodweb comprise the first or "primary producer" trophic level, all herbivores comprise the second or "primary consumer" trophic level, and carnivores that eat herbivores comprise the third or "secondary consumer" trophic level. Additional levels, in which carnivores eat other carnivores, comprise a tertiary trophic level..



### Ecological Pyramids

An Ecological Pyramid (or Trophic pyramid) is a graphical representation designed to show the biomass or productivity at each trophic level in a given ecosystem. *Ecological Pyramids* begin with producers on the bottom and proceed through the various trophic levels, the highest of which is on top.





### The Pyramid of Energy

For example, the total amount of energy in a population of toads must necessarily be far less than that in the insects on which they feed.

The insects, in turn, have only a fraction of the energy stored in the plants on which they feed. This decrease in the total available energy at each higher trophic level is called the pyramid of energy.

The figures represent net production at each trophic level expressed in  $\text{kcal/m}^2/\text{yr}$ .

### The Pyramid of Biomass

Since all organisms are made of roughly the same organic molecules in similar proportions, a measure of their dry weight is a rough measure of the energy they contain.

A census of the population, multiplied by the weight of an average individual in it, gives an estimate of the weight of the population. This is called the biomass (or standing crop).

This, too, diminishes with the distance along the food chain from the autotrophs which make the organic molecules in the first place.

The figures represent the dry weight of organic matter (per square meter) at the time of sampling. Analysis of various ecosystems indicates that those with squat biomass pyramids (with conversion efficiencies between one trophic level and the next averaging 10% or better) are less likely to be disrupted by physical or biotic changes than those with tall, skinny pyramids (having conversion efficiencies less than 10%).

## The Pyramid of Numbers

Small animals are more numerous than larger ones. This graph shows the pyramid of numbers resulting when a census of the populations of autotrophs, herbivores, and two levels of carnivores was taken on an acre of grassland.

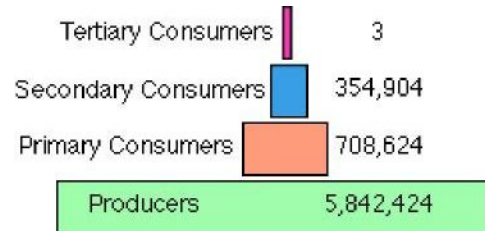
The pyramid arises because;

Each species is limited in its total biomass by its trophic level.

So, if the size of the individuals at a given trophic level is small, their numbers can be large and vice versa.

Predators are usually larger than their prey.

Occupying a higher trophic level, their biomass must be smaller. Hence, the number of individuals in the predator population is much smaller than that in the prey population. The figures represent number of individuals counted at each trophic level.



## HUMAN ACTIVITIES

Basic needs of food, clothing, shelter & energy requirements have to be met from the environmental resources in the ecosystem consisting of water, air & land. Human activities interfere with nature. There should be a mutually beneficial symbiosis between man & earth. Human populations should carefully use the resources & also preserve them for future generations.

### Food

Anything eaten to satisfy appetite & physiological growth to maintain all body process & temp., the basic need is food. Global food supply has improved enormously since the early 1960s. the agricultural sector on average has kept up with population growth & demand for agricultural produce. Agricultural production has increased & world food supplies are 18% higher than 30 years ago. In the year 1990 global grain yields per hectare were nearly 2.5 times the 1.15 tonnes per hectare of the 1930s. the International Commission on Irrigation and Drainage (ICID) estimated that current food production would have to double within the next 25 years. The slogan more crop per drop explains the objective to be achieved by ICID member countries.

From the last 40 years the Food & agricultural Organisation (FAO) of the United Nations is providing the information on each country's total food supplies.

At the World Food Summit in 1996, world leaders pledged to reduce the number of hungry people to around 400 million by 2015. The State of food Insecurity in the world 1999 (SOFI), at the current rate of progress a reduction of 8 million undernourished people a year is predicted. SOFI presents the first data on hunger in industrialized regions & around 34 million undernourished people are living in developed countries.

### Food Security

Food Security is the ability of all the people at all times to access enough food for an active & healthy life. The following three conditions must be fulfilled to ensure food security

- Food must be available
- Each person must have access to it
- The food utilized must fulfill nutritional requirements

## **Shelter**

Shelter or habitat refers to the physical & chemical factors of the place where the organisms live. In an ecosystem, plants & animals form the biotic community & habitat forms the abiotic community. The more specific these needs & localized the habitat to agricultural lands, livestock, roads & cities. Tropical forests are so important because they harbor at least 50% , & perhaps more, of the world's biodiversity. Direct observations, shows that these forests are declining. There is a uncertainty regarding the rate of loss, & the future, the possibility is that tropical forests will be reduced to 10-15% of their original extent by the end of 21<sup>st</sup> century.

UN declares that right to have a adequate housing is the human rights. In connection to this World Habitat Day on October 6<sup>th</sup> is celebrated to remind the basic need of human

In India, National Housing & Habitat Policy has formed to fulfill the growing the requirements of shelter & related infrastructure. This policy intends to promote sustainable development of habitat in the country, with a view to ensure equitable supply of land, shelter & services at affordable prices. The Central Govt. adopted the National Housing & Habitat Policy in th July 1998. Many centrally sponsored schemes such as Valmiki ambedkar Awas Yojana (VAMBAY), Swarna Jyanti Shahri Rojgar Yojana(SJSRY), Indira Awas Yojana etc are providing housing for rural & urban dwellers living below poverty line. Housing & Urban Development Corporation has been financing several housing schemes.

## **Economic & Social Security**

### **Economic Security**

The biotic environment of an individual is made up of members of the same or other species. Interspecific interactions may also be positive or negative. For example, symbiotic relationships involve the mutual benefit of the individuals involved, where as the competition for resources is deleterious to both. Thus socioeconomic security becomes prominent in environment. Traditional sources of economic security are assets, labor, family & charity.

A survey conducted by International Labour Organisation (ILO) highlights the facts that individual economic security promotes well being & tolerance, whilst also contributing to the growth & development of a nation. The report „Economic Security for a better World“ covering 85% of the world's population covering 90 countries, cautions that economic security remains out of reach for the vast majority of the world's workers. The ILO survey ( Socio Economic

Security Programme) also claims that only 8% of the people, fewer than 1 in 10, live in countries that provides favourable economic security.

Economic security is measured on the basis os seven forms of work related security. Depending

upon the national levels of economic security, countries are divided into four groups

- Pace setters ( with good policies, good institutions & good outcomes)
- Pragmatists (good outcome in spite of less impressive outcomes)
- Conventional (good & institution with less impressive outcomes)
- Much to be done Countries (weak or non-existent policies & institutions & poor outcomes)

### **Social Security**

Social security is one of the most important programs providing benefits to the worker/employee. The main strength of the social security system is that it acts as a facilitator, it helps people to plan their own future through insurance & assistance. The success of social security schemes however requires the active support & involvement of employees & employers.

The dimension & complexities of the problem in India can be measured by taking into consideration, the extent of labour force in the organised & unorganised sectors. The recent National Social Security Organisations (NSSO) survey of 1999-2000 has estimated that the workforce may account for 397 million out of which only 28 million were in the organized sector.

The organized sector includes primarily those establishments which are covered by the Factories Act 1948, the shops & commercial establishment Acts of the state govt., the Industrial Employment Standing Orders Act 1946, etc.

### **Indian Constitutional Provisions**

Matters related to social security are listed in the Directive Principles of State Policy & the subjects in the concurrent list ( List III in the seventh Schedule of the constitution of India)

Item No. 23 Social security & insurance; employment & Unemployment

Item No. 24 welfare of labour including conditions of work, Provident fund, employers liability, workmen's compensation, invalidity & old age pension maternity benefits

Part IV Directive Principles of State Policy

Article 42 Provisions for just & humane conditions of work & maternity relief

Article 41 Right to work, to education & to public assistance in certain cases

### **Social Security Laws**

The principal social security laws enacted in India are the following

- The Employee's State Insurance Act 1948 (ESI Act)
- The Employee's Provident Funds & Miscellaneous Provisions Act 1952, ( EPF & MP Act)
- The Workmen's Compensation Act 1923 (WC Act)
- The Maternity Benefit Act 1961 ( MB Act)
- The Payment of Gratuity Act 1972 (PG Act)

## UNIT II

### IMPACTS OF HUMAN ACTIVITIES

#### IMPACTS OF AGRICULTURE

**Agriculture** is the production of food and goods through farming. Agriculture was the key development that led to the rise of human civilization, with the husbandry of domesticated animals and plants (i.e. crops) creating food surpluses that enabled the development of more densely populated and stratified societies. The study of agriculture is known as agricultural science. Agriculture is also observed in certain species of ant and termite.

Agriculture encompasses a wide variety of specialties and techniques, including ways to expand the lands suitable for plant raising, by digging water-channels and other forms of irrigation. Cultivation of crops on arable land and the pastoral herding of livestock on rangeland remain at the foundation of agriculture. In the past century there has been increasing concern to identify and quantify various forms of agriculture. In the developed world the range usually extends between sustainable agriculture (e.g. permaculture or organic agriculture) and intensive farming (e.g. industrial agriculture).

Modern agronomy, plant breeding, pesticides and fertilizers, and technological improvements have sharply increased yields from cultivation, and at the same time have caused widespread ecological damage and negative human health effects. Selective breeding and modern practices in animal husbandry such as intensive pig farming (and similar practices applied to the chicken) have similarly increased the output of meat, but have raised concerns about animal cruelty and the health effects of the antibiotics, growth hormones, and other chemicals commonly used in industrial meat production.<sup>[4]</sup>

The major agricultural products can be broadly grouped into foods, fibers, fuels, and raw materials. In the 2000s, plants have been used to grow biofuels, biopharmaceuticals, bioplastics, and pharmaceuticals. Specific foods include cereals, vegetables, fruits, and meat. Fibers include cotton, wool, hemp, silk and flax. Raw materials include lumber and bamboo. Other useful materials are produced by plants, such as resins. Biofuels include methane from biomass, ethanol, and biodiesel. Cut flowers, nursery plants, tropical fish and birds for the pet trade are some of the ornamental products.

In 2007, one third of the world's workers were employed in agriculture. The services sector has overtaken agriculture as the economic sector employing the most people worldwide. Despite the

size of its workforce, agricultural production accounts for less than five percent of the gross world product (an aggregate of all gross domestic products).

### **Environmental Impacts**

Agriculture imposes external costs upon society through pesticides, nutrient runoff, excessive water usage, and assorted other problems. A 2000 assessment of agriculture in the UK determined total external costs for 1996 of £2,343 million, or £208 per hectare. A 2005 analysis of these costs in the USA concluded that cropland imposes approximately \$5 to 16 billion (\$30 to \$96 per hectare), while livestock production imposes \$714 million. Both studies concluded that more should be done to internalize external costs, and neither included subsidies in their analysis, but noted that subsidies also influence the cost of agriculture to society. Both focused on purely fiscal impacts. The 2000 review included reported pesticide poisonings but did not include speculative chronic effects of pesticides, and the 2004 review relied on a 1992 estimate of the total impact of pesticides.

A key player who is credited to saving billions of lives because of his revolutionary work in developing new agricultural techniques is Norman Borlaug. His transformative work brought high-yield crop varieties to developing countries and earned him an unofficial title as the father of the Green Revolution.

### **Livestock issues**

A senior UN official and co-author of a UN report detailing this problem, Henning Steinfeld, said "Livestock are one of the most significant contributors to today's most serious environmental problems". Livestock production occupies 70% of all land used for agriculture, or 30% of the land surface of the planet. It is one of the largest sources of greenhouse gases, responsible for 18% of the world's greenhouse gas emissions as measured in CO<sub>2</sub> equivalents. By comparison, all transportation emits 13.5% of the CO<sub>2</sub>. It produces 65% of human-related nitrous oxide (which has 296 times the global warming potential of CO<sub>2</sub>) and 37% of all human-induced methane (which is 23 times as warming as CO<sub>2</sub>). It also generates 64% of the ammonia, which contributes to acid rain and acidification of ecosystems. Livestock expansion is cited as a key factor driving deforestation, in the Amazon basin 70% of previously forested area is now occupied by pastures and the remainder used for feed crops through deforestation and land degradation, livestock is also driving reductions in biodiversity.

### **Land transformation and degradation**

Land transformation, the use of land to yield goods and services, is the most substantial way humans alter the Earth's ecosystems, and is considered the driving force in the loss of biodiversity. Estimates of the amount of land transformed by humans vary from 39–50%. Land

degradation, the long-term decline in ecosystem function and productivity, is estimated to be occurring on 24% of land worldwide, with cropland overrepresented. The UN-FAO report cites land management as the driving factor behind degradation and reports that 1.5 billion people rely upon the degrading land. Degradation can be deforestation, desertification, soil erosion, mineral depletion, or chemical degradation (acidification and salinization).

### **Eutrophication**

Eutrophication, excessive nutrients in aquatic ecosystems resulting in algal blooms and anoxia, leads to fish kills, loss of biodiversity, and renders water unfit for drinking and other industrial uses. Excessive fertilization and manure application to cropland, as well as high livestock stocking densities cause nutrient (mainly nitrogen and phosphorus) runoff and leaching from agricultural land. These nutrients are major nonpoint pollutants contributing to eutrophication of aquatic ecosystems.

### **Pesticides**

Pesticide use has increased since 1950 to 2.5 million tons annually worldwide, yet crop loss from pests has remained relatively constant. The World Health Organization estimated in 1992 that 3 million pesticide poisonings occur annually, causing 220,000 deaths. Pesticides select for pesticide resistance in the pest population, leading to a condition termed the 'pesticide treadmill' in which pest resistance warrants the development of a new pesticide. An alternative argument is that the way to 'save the environment' and prevent famine is by using pesticides and intensive high yield farming, a view exemplified by a quote heading the Center for Global Food Issues website: 'Growing more per acre leaves more land for nature'. However, critics argue that a trade-off between the environment and a need for food is not inevitable and that pesticides simply replace good agronomic practices such as crop rotation.

### **Climate Change**

Climate change has the potential to affect agriculture through changes in temperature, rainfall (timing and quantity), CO<sub>2</sub>, solar radiation and the interaction of these elements.<sup>[45][94]</sup> Agriculture can both mitigate or worsen global warming. Some of the increase in CO<sub>2</sub> in the atmosphere comes from the decomposition of organic matter in the soil, and much of the methane emitted into the atmosphere is caused by the decomposition of organic matter in wet soils such as rice paddies. Further, wet or anaerobic soils also lose nitrogen through denitrification, releasing the greenhouse gas nitric oxide. Changes in management can reduce the release of these greenhouse gases, and soil can further be used to sequester some of the CO<sub>2</sub> in the atmosphere.



## IMPACTS OF INDUSTRIALIZATION:

### Sources of pollution:

On basis of the points of generation, sources of pollution can be classified as:

- 1) **Single point source**: Chemical and related industries, power plants, petroleum refineries
- 2) **Multiple point source**: entire area involved in pollutant production, usually of different types.
- 3) **Line source**: fossil fuel burning in automation
- 4) **Non-point source**: transport vehicle, agricultural run offs. urban run off into rivers etc

### Causes of Industrial Pollution

Different industrial manufacturing processes require different substances who are toxic to the environment ,hence are pollutants.

Industrial pollution is caused by the introduction of the pollutants into the atmosphere at all the levels of air water and land and the alterations that it causes to the ecosystem.

This has impact on the structure and functioning of the ecosystem as well as man and hence the liberation of toxic substances from the industries is the main cause of industrial pollution.

Most of the times , the pollutants are not biodegradable (degraded by natural means) and hence theses non biodegradable pollutants remain in the atmosphere for hundreds or even a thousand of years .

Common pollutants as described by Smith (1977) are deposited matters (soot, smoke, dust, etc) ,gases (Sulphur dioxide, carbon monoxide, nitrogen oxide, hydrogen sulphide, ammonia. chlorine etc),Chemical compounds (aldehydes, arsines, phosgene, detergents, paints),metals (lead, zinc, mercury, chromium, copper etc)Economic poisons(herbicides, fungicides, etc), sewage, heat, radioactive substances etc

A few industrial pollutants and their sources and effects are as follows:

POLLUTANTS	SOURCES	EFFECTS ON MAN
1) <b>Aldehydes</b>	<b>Thermal decomposition of fat ,oil, glycerol</b>	<b>Irritate nasal and respiratory tracts</b>
2) <b>Ammonia</b>	<b>Chemical processes, dye making, explosives etc</b>	<b>Inflame upper respiratory passages</b>
3) <b>Arsines</b>	<b>Acid manufacture containing arsenic, metalindustry</b>	<b>Break down of RBC, jaundice , kidney failuree</b>



4)carbon monoxide	Motor exhausts, burning of fossil fuel	Breakdown of red blood cells, anemia
5)Hydrogen cyanides	Metal plating, blast furnace, chemical manufacturing	Nerve cell destruction
6)phosgenes	Chemical and dye manufacturing	Pulmonary pneumonia
7)sulphur dioxide	Coal and oil combustion	Respiratory ailments
8) petroleum and industrial hydrocarbons	Off shore wells, oil tankers, industrial wastes	
9)mercury	Chemical manufacture, caustic soda plants etc	Minamata disease
10)fluoride	Coal burning power plants, fluorinated water used in industries	fluorosis
11)Nitrates	fertilizer plants	methemoglobinemia
12) Cadmium	Zinc smelters	Itai-itai, kidney malfunction etc

Causes of industrial pollution/ sources and effects

### OTHER EFFECTS:

In addition to the effects of pollution there are several other aspects. The sewage that is liberated from the industry contains different toxic wastes like heavy metals, etc. These substances when liberated in the river or ocean, the qualities of the water are drastically changed.

It leads to the changes in the physical and chemical criteria of the water. This causes destruction of the phyto and zooplanktons which are the basis of the aquatic food chain, the BOD is increased and may drop to 4mg/ liter, Such conditions cause massive destruction of aquatic species.

The change of pH causes death of many larvae and newly born organisms. The pollutants get incorporated into the tissues of the organisms of aquatic food chain which then undergoes biomagnifications. In the ocean, since the productivity the liberation of sewages has created zones of dead regions around the coastal regions where not a single species survive, resulting in "dead regions".

The thermal pollution of industry is extremely important also. The increase of temperature causes death to sensitive organisms and also causes migration of normal fauna of the region. The worst

affected are the coral reefs which are the breeding nurseries of the ocean ,When these die out, the entire region of the sea turns into a dead zone.

The agricultural lands located near to the industries suffer immense pollution and the fertility of the soil gets decreased till it transforms into a barren land. Besides the exhausts liberated are a major source of air pollutant causing smog, acid rain, global warming, greenhouse effect, and a host of other diseases in man.

### **IMPACTS OF HOUSING ACTIVITY**

Activities associated with managing buildings over their life cycle ie planning, acquisition, operation / maintenance and refurbishment or disposal, have an enormous direct and indirect impact on the environment. The nationwide impacts of the built environment in the USA<sup>1</sup> are listed below and provide a useful cost indicator for Australia:

• Energy Use	42%	• Water use	24%
• Atmospheric emissions	40%	• Water effluents	20%
• Raw materials	30%	• Land use	15%
• Solid waste	25%	• Other releases	12%

### **Environmental Impacts of Building Materials**

Buildings are large entities and, as such, they impact upon the environment in various ways. Present-day designs clearly consume large quantities of physical resources such as materials, energy and money in their construction, maintenance and use; but they also can result in effects such as loss of amenity and biodiversity which are much more difficult to assess.

If we are going to build in ecologically-sustainable manner, or even substantially reduce the environmental impacts of current building approaches and practices, it will be necessary to consider the impact of a building over its full life-cycle, sometimes described as a 'cradle-to-grave' analysis. ('Cradle-to-reincarnation' may be more appropriate, as it more clearly raises the issues of re-use and recycling of materials.)

#### **The life-cycle of a building material can be considered to have five stages:**

- Mining/extraction/harvesting
- manufacture
- construction
- use

- demolition

For most building materials, the major environmental impacts occur during the first two stages but as waste-disposal problems increase, we are also being made increasingly aware of the impacts associated with the demolition stage. It is apparent that the energy used to produce the building material (its embodied energy) is only an approximate indicator of its environmental impact.

An Australian system, BMAS (Building Material Assessment System), based on life-cycle analysis, has been developed to compare the relative ecological impacts of various types of wall, floor and roof assemblies. Some indicative results are as follows (NB: High numbers indicate greater environmental impact; lower numbers indicate lesser impact):

#### WALLS

Timber Frame, Plasterboard	7.2
Steel Frame, Plasterboard	7.4
AAC Blocks - rendered	20.6
Clay Bricks - rendered	49.1

#### FLOORS

Timber, Brick Piers, Footings	41.9
Concrete Raft Slab	74.4

#### ROOFS

Timber Frame, Corrugated Steel	5.2
Timber Frame, Terracotta Tile	20.6

One thing suggested by these figures is that relatively small quantities of materials that have high impact (eg, steel), may be preferable to large quantities of materials that have lower impact (eg terracotta tile).

As always, designers, builders and building owners have to seek a balance between often conflicting considerations, appearance, comfort, ease of construction, maintenance costs, capital costs etc. Now, environmental impact is an added variable. However, it has been shown that if environmental considerations are included early in the design process, it is possible to

incorporate them without incurring additional costs.

The twentieth century has been one of incredible technological and social change, yet as a general rule; the theme current in the Modern movement in architecture at the beginning of this century remains valid today, albeit for different reasons...

#### Guidelines for Assessing and Choosing Materials

**Methods for assessing and choosing materials are based on the following guidelines:**

1. Environmental factors
2. Local materials and transport needs (savings)
3. Needs of occupants of dwellings
4. Need for appropriate building design for marketing
5. Need for financial viability/affordability
6. Need to make best use of current technology, through the Building Material Assessment System (see above).

**Each material is assessed at five stages of its life:**

- mining/extraction
- manufacture
- construction
- use
- demolition.

**The assessment is covered by 14 different parameters:**

- a) The damage to the environment during mining or harvesting of the basic material.
- b) How much damage in relation to the quantity of materials (what else is disturbed or damaged?).
- c) The source, size, or renewability of the basic material.
- d) The recycle content.
- e) Waste residue, solid or liquid, in production.
- f) The air pollution due to manufacture and production.

- g) The embodied energy
  - h) The energy consumed during transportation to site of usage.
  - i) The energy consumed on-site for erection or assembling. j)
- The on-site waste and packaging.
- k) The maintenance required during the life-cycle.
  - l) The environmental impact during the life-cycle (ie, toxic emissions).
  - m) The energy and effects associated with demolition/disposal at the end of the life-cycle. n)
- The recyclability of the demolished/dissembled material.

## IMPACTS OF MINING

Mining refers to the process of extracting metals and minerals from the earth. Gold, silver, diamond, iron, coal and uranium are just a few of the vast array of metals and minerals that are obtained by this process. In fact, mining is the source of all the substances that cannot be obtained by industrial processes or through agriculture. Mining reaps huge profits for the companies that own them and provides employment to a large number of people. It is also a huge source of revenue for the government. Despite its economic importance, the question that how does mining affect the environment is a pressing environmental issue.

### Effects of Mining on Environment

#### Effect on Land

*Deforestation:* Mining requires large areas of land to be cleared so that the earth could be dug into by the miners. For this reason, large scale deforestation is required to be carried out in the areas where mining has to be done. Besides clearing the mining area, vegetation in the adjoining areas also needs to be cut in order to construct roads and residential facilities for the mine workers. The human population brings along with it other activities that harm the environment. *Loss of Biodiversity:* The forests that are cleared for mining purposes are home to a large number of organisms. Indiscriminate clearing of the forests lead to loss of habitat of a large number of animals. This puts the survival of a large number of animal species at stake. The cutting down of trees in itself is a big threat to a number of plants and trees growing in the forests.

*Pollution:* Despite measures being taken to release the chemical waste into the nearby rivers through pipes, a large amount of chemicals still leak out onto the land. This changes the chemical composition of the land. Besides this, since the chemicals are poisonous, they make the soil unsuitable for plants to grow. Also, the organisms that live in the soil find the polluted environment hostile for their survival.

#### Effect on Water

*Pollution:* Chemicals like mercury, cyanide, sulfuric acid, arsenic and methyl mercury are used in various stages of mining. Most of the chemicals are released into nearby water bodies that lead to water. In spite of tailings (pipes) being used to dispose these chemicals into the water bodies, possibilities of leakage are always there. When the leaked chemicals slowly percolate through the layers of the earth, they reach the groundwater and pollute it. Surface run-off of just soil and rock debris, although non-toxic, can be harmful for vegetation of the surrounding areas.

*Loss of Aquatic Life:* Release of toxic chemicals into the water is obviously harmful for the flora and fauna of the water bodies. Besides the pollution, mining processes use water from nearby water sources. The result is that the water content of the river or lake from which water is being used gets reduced. Organisms in these water bodies do not have enough water for their survival.

River dredging is a method adopted in case of gold mining. In this method, gravel and mud is suctioned from a particular area of the river. After the gold fragments are filtered out, the remaining mud and gravel is released back into the river, although, at a location different from where they had been taken. This disrupts the natural flow of the river that may cause fishes and other organisms to die.

### **Spread of Diseases**

Sometimes the liquid waste that is generated after the metals or minerals have been extracted is disposed in a mining pit. As the pit gets filled up by the mine tailings, they become a stagnant pool of water. This becomes the breeding ground for water-borne diseases causing insects and organisms like mosquitoes to flourish.

Although the developed countries have tight norms regarding mining, such rules can be easily flouted in countries which lack strict monitoring of the procedures being followed for mining. The effects in such cases can be devastating for the environment. Be it due to ignorance of the regulations or just a freak accident, incidents like the Guyana spill of 1995 highlights the fact that issues like how mining affect the environment are worth some serious deliberation does.

## **ENVIRONMENTAL IMPACT ASSESSMENT**

Human activities create environmental impacts. The effects of these activities can be felt during their construction, and operation. It becomes difficult to mitigate or avoid the ill effects after establishing the project. Therefore the impacts that may arise later have to be visualized beforehand so that the developmental activities are harmonized with the environment. The exercise of visualizing or assessing the effects of a project on the environment before taking it up is called as „Environmental Impact Assessment (EIA)“. EIA makes it possible to integrate the environmental aspects into the developmental activities during initiation of the project. It prevents the environmental and economic liabilities that may arise in future. A proposed project can be shelved in the beginning itself if it is found to be detrimental to the environment.

EIA is conducted step by step in a systematic way.

### Steps in an EIA study

Step: 1            Description of the project and the site of construction.    Water and raw material requirement is estimated. Industrial processes, production etc are described.

Step: 2            Alternative sites for the project are evaluated for consideration

Step: 3            Base line data collection – It describes the existing environmental status of the study area which is the area covered in a certain radius with proposed project / industry as the centre.

In the baseline study data on the following aspects are collected:

Land and land use pattern.

Existing water resources - quantity and Quality wise

- Air quality

Meteorology and climate data such as temperature, wind speed and direction, rainfall, humidity etc.,

- Soil quality

- Seismological characteristics

- Noise, and traffic

- Biological environment

- \* Plant species

- \* animal species

- \* endangered species

- Agriculture potential

- Historical sites and monuments

- Tourist spots

- religious centres

- Wild life sanctuaries

- Schools, hospitals etc.,

- Demography, cultural and socio economic environment

- Any other environmentally significant parameter

The possible impacts of the proposed project on the existing environmental setting are assessed by superimposing the effects of the project on the existing environment. If the impacts are not acceptable, corrective measures are incorporated into the proposed project and then correlated with the existing environmental set up. If significant negative effects are not observed, the project can be permitted to be taken up. In case, even after taking protective measures the environment is going to be affected, permission will not be given to establish the proposed project. In the EIA exercise public are also allowed to participate and express their opinion.

Based on the outcome of the EIA studies a status report called „Environmental Impact Statement (EIS)“ is prepared which serves as a guideline for establishing environmentally sustainable activity.

In India Ministry of Environment and Forest (MOEF) guides and controls the EIA process through the state pollution control boards.

## **SUSTAINABLE DEVELOPMENT**

A characteristic which has set human beings apart from other species is their ability to control many aspects of the environment. Throughout the recorded history, man has struggled to manage his natural environment in order to improve his well being.

The quality of our environment is determined by the intricate processes of the human race making a living and enjoying life. In that process water, food, land and air are used. The changes produced during this use affect the health, comfort, aesthetic senses, efficiency and capacity of people to attain a satisfactory social adjustment. Use of essentials for life affects the dynamics of all plant and animal life on earth by altering the ecological balance. Another aspect - use of land and air as waste disposal sinks is impairing their quality. The disturbance has reached such levels that these resources are no longer usable for their designated purposes in many instances. The rapid increase in world's population and the accelerated rate of use of all natural resources are making the consequences of misuse more drastic and more widespread.

While living on the resource offered by the ecosystem it is necessary to maintain the sustenance levels of the ecosystem. This becomes very important while taking up developmental activities. Assessment of ecological changes and implementing preventive and corrective measures is an essential step in making the developmental activity ecologically sustainable.

A developmental scenario in which no damage is done to the ecosystem can be ideally termed as sustainable development. But this is not easy to achieve. Hence the developmental activity can be assumed to be sustainable when irreversible damage is not done to the environment; even if a stress is developed it can be overcome by adopting suitable corrective measures.



## UNIT III

### Natural Resources

#### WATER RESOURCES

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

97% of water on the Earth is salt water, leaving only 3% as fresh water of which slightly over two thirds is frozen in glaciers and polar ice caps.<sup>[1]</sup> The remaining unfrozen freshwater is mainly found as groundwater, with only a small fraction present above ground or in the air.

Fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. Water demand already exceeds supply in many parts of the world and as the world population continues to rise, so too does the water demand. Awareness of the global importance of preserving water for ecosystem services has only recently emerged as, during the 20th century, more than half the world's wetlands have been lost along with their valuable environmental services. Biodiversity-rich freshwater ecosystems are currently declining faster than marine or land ecosystems. The framework for allocating water resources to water users (where such a framework exists) is known as water rights.

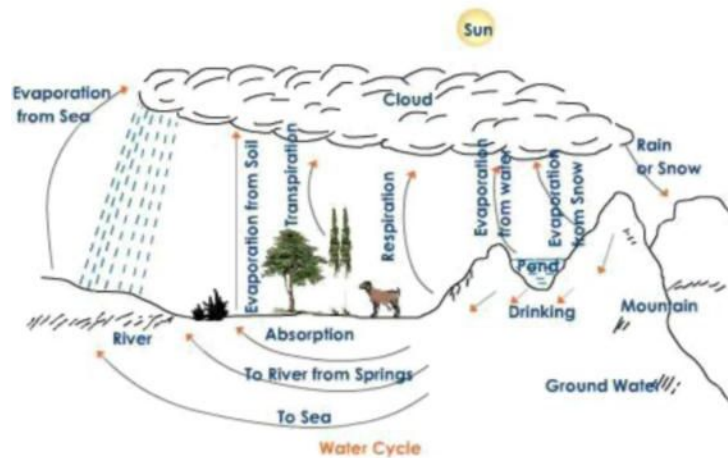
Our present day life highly banks upon the use of fossil fuels such as coal, natural gas, LPG, gasoline, etc. for the production of energy. Our reserves of fossil fuels are getting depleted at an alarming rate and they may get exhausted by the middle of 21<sup>st</sup> century. The reason for this shortage is that the rate of consumption of fossil fuels is much larger than the rate of their renewal.

Water is an indispensable commodity of life. Water determines the distribution, structure and function of organisms in the ecosystem.

Water occurs in three phases - solid, liquid (ice/snow) and gaseous (water vapour).

In liquid phase it is vital for the existence of life on this planet. In gaseous phase it is important for respiration in organisms and cycling, although the main reservoir pool of water is not the gaseous phase.

Therefore, water cycle is considered separately as "Hydrological Cycle".



### Importance of Water

- i) Required for solubilization of chemicals and several biochemical reactions like hydrolytic digestion of polymeric nutrients, photosynthesis, etc.
- ii) Important for the working of macromolecules, as a good ionizer, transport of materials, etc.
- iii) Acts as a habitat for hydrophytic and aquatic animals and as an agent of geological change.
- iv) Acts as an agent of energy transfer and use. Water is a tremendous factor in neutralising heat radiations of sunlight, so also acts as a 'temperature buffer'.

### Types of Water Cycle

There are two overlapping water cycles operating in nature.

- 1) Global water cycle
- 2) Biological water cycle.

Global water cycle does not involve life. Water evaporates from water bodies like seas and oceans (more than 75% of total evaporation), lakes and rivers. Condensation of vapour leads to precipitation in the form of rain, snow or hailstorm, which fall on the soil.

Most of the rainwater percolates into the soil, becomes a part of water table and seep into the ocean. Surface rain water and water formed by melting of ice and snow, flow into the rivers, streams and finally joins the sea.

A large amount of water remains underground as well as in the form of perennial snow in the polar regions and mountain peaks above snow line.

Global water cycle is in 'steady state' as total precipitation is balanced by total evaporation.

Biological water cycle involves the entry of water into living beings and then return to the physical environment. Underground water acts as a starting point.

**Water Utilization**

- a) Aquatic organisms take water from their surrounding.
- b) Terrestrial plants absorb water from the soil through their roots.
- c) Terrestrial animals obtain water from the plants they consume or take in water directly from different water bodies.

**Water Production**

- 1) Animals release water into the atmosphere by respiration in the form of vapours or to soil as fluid excretion.
- 2) Water returns to the environment after the death and decay of organisms (plants and animals).
- 3) A large part of water is given back to nature by plants, as they lose most of the absorbed water, by the process of transpiration.

Water vapour thus formed results in the formation of clouds, followed by rain and so enters the global water cycle. Thus, there is always the exchange of water between the global water cycle and biological water cycle.

In human body, water is of utmost physiological importance and has specific functions to perform. It acts as a solvent for the secretory and excretory products. It is a carrier of nutrient elements to the tissues and removes waste materials from them. It also acts as a regulator of body temperature. Water is more important than food. Deprivation of water brings about death much more quickly than that of food. The total body water constitution is 60-70% of adult body weight. Water is an essential constituent of all animals and vegetative matter. Over 80% of the earth's surface is covered by water in the form of relatively pure liquid in lakes, ponds and rivers, as a dilute salt solution in ocean or as nearly pure solid in snow fields, glaciers and other polar ice caps. Next to air, water is the most important substance for the existence of life on the earth.

Today water resources have been the most exploited natural systems since man's existence on the earth. Pollution of water bodies is increasing steadily due to rapid population growth, industrial proliferations, urbanizations, increasing living standards and wide spread human activities. Time is perhaps not too far when pure and clean water, particularly in densely populated industrialized water scarce areas may be inadequate for maintaining the normal living standards. Groundwater, river, seas, lakes, ponds and streams are founding it more and more difficult to escape from pollution. Many rivers of the world receive heavy flux of sewage and industrial effluent, domestic and agricultural waste which consists of substances varying from simple material to highly toxic hazardous chemicals.

## Water Borne Diseases

About 1.1 billion people in the world still lack access to safe water for drinking and 2.4 billion people have no basic sanitation. The large majorities of people are seriously affected by or die from preventable water and sanitation related diseases are rural dwelling and the urban poor in the developing countries. Current international estimate of deaths are due to water related diseases which range from 2.2 million to 5 million annually.

## Classification of Water Related Diseases

Water related diseases can be grouped into four general classes: water borne, water-washed, water-based and water related insect vectors. The first three classes are closely linked to people's lack of access to safe water supply.

## Classification of Water Related Diseases

Disease Classification	Description
Water Borne Diseases	Caused by the consumption of water contaminated by human or animal excreta (feces, urine) containing disease causing organisms such as bacteria, viruses, worms and amoebas
Water-Washed Diseases (Water Scared Diseases)	Caused by poor personal hygiene and skin or eye contacts with contaminated water and / or insufficient quantities of water for personal hygiene and washing Ex: Scabies, trachoma (eye infections), flea, lice, typhus
Water-based Diseases	Caused by parasite found in intermediate organisms living in contaminated water. These diseases are passed on to humans when they drink / wash with it. Ex: Dracunculiasis, Schistosomiasis, other helminthes
Water Related Insect- Vector Diseases	Caused by insects, especially flies and mosquitoes that breed in or feed near contaminated water sources.

Ex: Malaria, dengue, blindness, sleeping sickness,  
yellow fever.

### Description of Selected Water Borne Diseases

Disease	Description
Diarrhea	It is the most common type of water related illness and is caused by drinking water contaminated with disease causing bacteria, viruses and / or tiny parasites like worms / amoebas from human excreta. People who are sick with this have to defecate more often than usual which results in problem of dehydrations and malnutrition.
Dysentery	It is a more serious form of diarrhea and occurs when contaminated water is used for eating / drinking. The persons' feces will frequently contain blood or mucus. It spreads from person to person.
Cholera	It is a highly contagious diarrhea caused by drinking / eating food of water contaminated with the feces or vomit of an infected person. It can also be spread by dirty hands / flies. Cholera outbreaks commonly occur in crowded slums and in the aftermaths of major diseases where water and sanitation facilities are non-existent / damaged / destroyed. In severe cases rapid loss of body fluids leads to dehydration and shock.
Typhoid Fever	Typhoid is a gut infective caused by food / water contaminated with bacteria found in human excreta, and often occurs in epidemics. This disease results in high fever accompanied with diarrhea or vomiting.
Trachoma (Eye Infection)	It is a chronic form of conjunctivitis (pink eye) that get progressively worse and may last for months or many years. The disease is spread by touch of flies. Trachoma is a major cause of blindness in developing countries.

Malaria	Malaria is a disease caused by the micro organisms that are passed onto people who are bitten by malaria infected mosquitoes. People who suffer from malaria suffer from recurring attacks that cause shivers, fevers and aches.
Schistosomiasis	This disease is caused by blood flukes-tiny worms that begin their lives inside fresh water snails. After being released with water as free-swimming worms they penetrate the skin who are swimming, bathing or washing in contaminated water. Once in the blood stream, the worm cause victims to suffer from fever, pain in the lower abdomen over time this results in liver damage.
Trypanosomiasis (Sleeping Sickness)	This disease is a dangerous infection spread by infected flies commonly found much in woodland especially around water holes where flies breed. People suffer from fever, ache, fatigue and progressive confusion and difficulty in walking and talking.
Dracunculiasis (Guinea Worm)	This disease is resulted by small worms that enter people in bodies when they drink contaminated water. These worms in body can grow upto 50 cm in length or more just under the skin. The adult worm will form a blister on the skin, normally in the lower parts of the body or legs. When the blister pops, the worm will start to come out of the victim's body.

### Other Effects of Water-Borne Diseases

In addition to the immediate and often devastating health effects of water related diseases, affected individuals cannot work. Meager savings are exhausted, people become poor, cannot be productive in turn results in poverty. Water borne infections hamper absorption of food even when intake is sufficient causing malnutrition.

### Prevention and Solutions

#### Water-Borne Diseases

Provides wholesome water and good sanitation. Constructing sanitary latrines and treating wastewater to allow for biodegradation of human waste will help to curb diseases caused by pollution.

#### Water-Washed Diseases

They can be controlled effectively with better hygiene for which adequate freshwater is

necessary.

### **Water-Based Diseases**

Individuals can prevent infection from water-based diseases by washing vegetables in clean water and thoroughly cooking the food. Practicing filtration with nylon gauge clothes to remove guinea worms. Good hygiene, suitable disposal of human waste.

### **Water Related Insect-Vector Diseases**

The solution to water related vector diseases would appear to be clear to eliminate the insects that transmit diseases. Putting pesticides, there also have some negative effects. Alternate techniques include using bed nets / introducing predators and sterile insects. Another way is using biological methods and habitat management to reduce / eliminate the natural breeding grounds of the disease vectors. What is important is to have wholesome drinking water to reduce the incidence of diseases and also to reduce malnutrition. Sustainability needs to be addressed by moving away wherever possible from groundwater to surface water resources or groundwater recharge.

## **FLUORIDE PROBLEM IN DRINKING WATER**

### **Fluorosis**

Fluoride in water is mostly of geological origin. Waters with high levels of fluoride content are mostly found at the foot of high mountains and in areas where seas has made geological deposits. Ingestion of excess fluoride, most commonly in drinking water can cause fluorosis which affects the teeth (dental) (see photo) and bones (skeletal). Moderate amounts lead to dental effects, but long term ingestion of large amounts can lead to potentially severe skeletal problems.

Fluorosis is caused by excessive intake of fluoride. The dental effects of fluorosis develop made earlier than the skeletal effects in people exposed to large amounts of fluoride. Clinical dental fluorosis is characterized by staining and pitting of teeth. In more severe cases all the enamel may be damaged.

High level exposure to fluoride can lead to skeletal fluorosis (photos). Here, fluoride accumulates in the bone progressively over many years. The early symptoms of skeletal fluorosis include stiffness and pain in the joints. In severe cases the bone structure may change and ligaments may calcify resulting impairment of muscles and pain. Acute high level results in abdominal pain excessive saliva, nausea and vomiting.

### **Cause**

Acute high level is very rare and usually due to accidental contamination of drinking water. Moderate level chronic exposure ( $>1.5$  mg/l) is more common. People affected by fluorosis are often exposed to multiple sources of fluorosis, such as in food, water, air and excessive

toothpaste. However, drinking water is typically the most significant source.

### **Scope of the Problem**

The prevention of dental and skeletal fluorosis is most entirely clean. It is believed that fluorosis affects millions of people around the world, but as regard to dental fluorosis the very mild and mild forms are the most frequent.

### **Interventions**

Removal of excess fluoride in drinking water is difficult and expensive. The preferred option is to find a supply of safe drinking water with safe fluoride level where access to safe water is already limited, defluoridation may be the only option. Use of bone charcoal, contact precipitation, use of Nalgonda activated alumina. Since all method produces sludge with very high concentration of fluoride that has to be disposed off. Only water for drinking and cooking purposes should be treated.

### **FOREST WEALTH**

Forests are valuable source of biodiversity from which we derive various benefits like medicines, domesticated plants, animals, etc. Forest reduces the impact of raindrop by covering the surface of the land with litter and leaves. This results in reduction of soil erosion, in turn floods in rivers. It moderates climate. Forest provides livelihood for large sector of tribal people. It also fulfills timber, fuel-wood, fruits, fibre, recreation and other benefits. These are self managed ecosystems by way of managing and maintaining themselves in the absence of human interference. It maintains the natural ecological balance by providing habitat for various species of plants and animals.

They provide shelter to large number of animals and birds. Infact tropical rain forests are the best sources of diversity of animals. These animals are not only aesthetically valuable but represent a tremendous store of genes. These genes have been evolving over millions of years, so when one species of animals or plant become extinct, a very valuable source of genetic information is lost. Our wheat, rice, ragi, sugar cane, etc., are also descendants of once wild grasses.

Many forests have been damaged by cutting them to provide space of urbanization / agriculture / industry. Deforestation is the curse of modern civilization. Large reservoirs submerge land / forest along with upstream course of river and valuable animal species flora and fauna will be lost.

Deforestation is thought to induce regional and global climate changes. Trees releases substantial amount of moisture into the air, and about 97% of water through roots absorb from the soil is evaporated directly into the atmosphere as evapotranspiration. The moisture finds its way back to the earth in the hydrologic cycle. When large form is decimated, rainfall is likely to decline and drought may become more common in that region. The effective forest management include restricting cutting tress, reforestation, control of forest fire, replacing and recycling of forest products.

In India, 22% of the land is covered by forest i.e., around 60 million hectare. This workout to be



0.06 hectare/person which is far less than the world's average of 0.64 hectare/capita. It is required to know the prime causes of deforestation which includes increased population and industrialization, mineral exploration, construction of dam, transportation, over grazing, agricultural operation, illegal human trade, etc.

## **MINERAL RESOURCES**

Minerals are formed through geochemical process over a long span of period. India is rich in mineral reserves. Coal resource is the largest. India is the 5<sup>th</sup> largest producer of coal in the world with total reserve of coal estimated at 186044 million. India has the 5<sup>th</sup> largest deposit of bauxite in the world. 95% of India's lead-zinc resources are located in Rajasthan and Gujarat. Limestone is found in all the states of India. The country is relatively poor in gold, base metals, platinum, diamond, nickel, tungsten and rock phosphate. As population increases the demands on the mineral usage is also increasing rapidly. In the next 50 years most of our mineral resources will get exhausted. Therefore these non-renewable resources are to be consumed less and preventing wastage, recycling and reuse, choosing renewable alternative.

The mining extraction, purifying, refining and processing operations are likely to cause the following effects,

Disturbing landscape, forest, wildlife,

Releasing of toxic pollutants

Water and air pollution

Land degradation

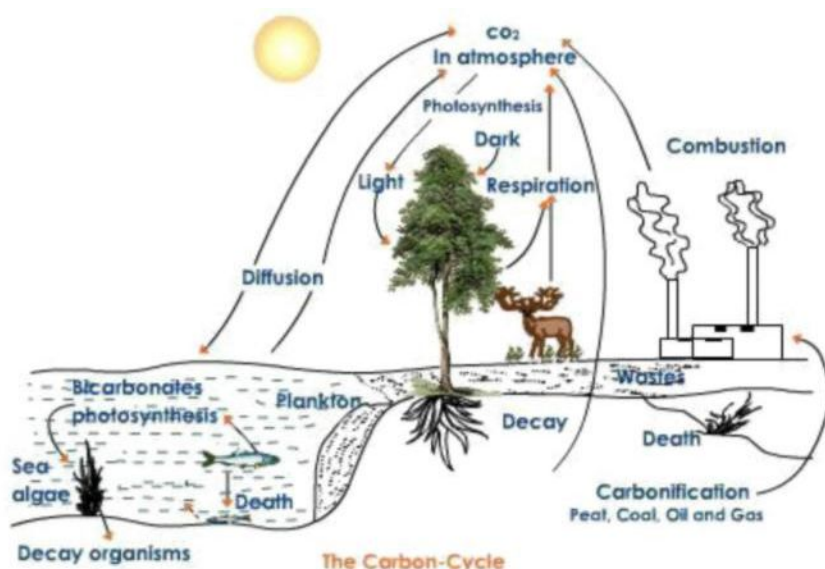
are to be suitably tackled while using mineral resources.

## **BIO-GEO-CHEMICAL CYCLE**

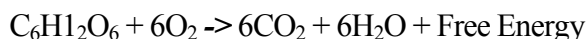
Nutrients, unlike energy are recycled in the ecosystem. There are about 40 chemical elements considered to be essential for living organisms. Materials are in limited quantity in the earth's system and to keep the system going continuously the only possibility is to regenerate the materials. The unique method evolved in nature is recycling materials continuously is by linking them in cyclic changes.

The macro-nutrients are C, H, O, P, K, I, N, S, Mg, Ca, etc., which have cycles with atmosphere while micro-nutrients like Cu, Fe, Co, etc., are soil based form edaphic cycles. The bio-geo-chemical cycles are of two varieties – sedimentary cycles and gaseous cycles. In sedimentary cycles the main reservoir is the soil, the sedimentary and other types of rocks of earth's crust. The gaseous cycles have their main reservoir of nutrients in the atmosphere and oceans. Examples are the oxygen, carbon, nitrogen, sulphur, etc. Both are driven by the flow of energy and both are tied up with the water cycle or the hydrologic cycle. In nutrient cycle, various chemical compounds of the main element are transferred while in hydrologic cycle a compound i.e., water is circulated as solid liquid and vapour phase.

## CARBON CYCLE



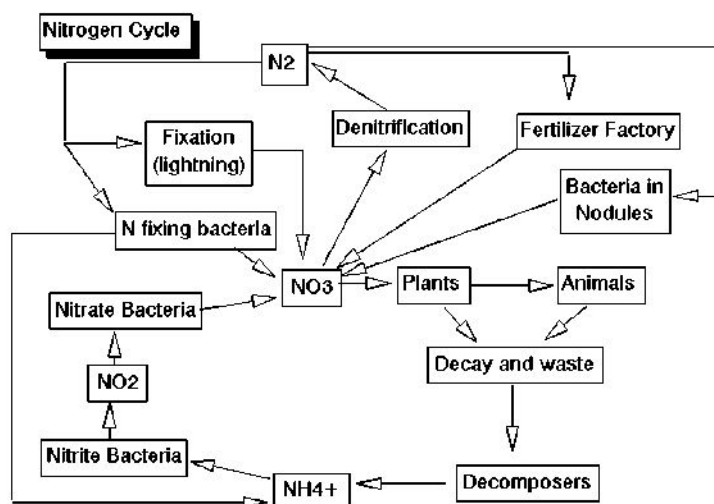
Carbon is an essential constituent of carbohydrates, proteins, fats and a large number of organic compounds. CO<sub>2</sub> of the atmosphere and that dissolved in the natural waters is the main source of carbon. Green plants use CO<sub>2</sub> in the process of photosynthesis to make carbohydrates. In doing so the green plants lock the radiant energy of the sun in the synthesized food. This energy is utilized by all living beings for their own activities. The evolved oxygen by the process of photosynthesis is used for most of the living things, the plants and animals. Thus all animals depend for their food on plants and animals. Thus all animals depend for their food on plants directly or indirectly. All organic compounds are also oxidized to CO<sub>2</sub> and water, both of which are utilized by plants in the process of photosynthesis.



The water goes down into the soil for the use of plants.

The atmosphere and natural waters must be replenished with CO<sub>2</sub>. Most of the CO<sub>2</sub> is returned to atmosphere and natural water by plants and animals through the process of respiration. Bacteria and fungi also return CO<sub>2</sub> to the atmosphere and natural water into the soil by acting chemicals upon the dead plants and animals and their waste such as urine and faeces. It should also be noted that coal, petroleum, etc., are also noted that coal, petroleum, etc., are also the part of carbon cycle and are formed in nature by living organisms. Decomposition of microorganism are very important in breaking down dead material with the release of carbon back to the carbon cycle. All the carbon of plants, herbivores, carnivores and decomposers is not respired, but some are fermented and some are stored. The carbon compounds such as methane that are lost to the food chain after fermentation are readily oxidized to CO<sub>2</sub> by a number of reactions occurring in the atmosphere.

## NITROGEN CYCLE



Nitrogen is an essential constituent of animal and plant matter as it forms proteins, which are the building blocks of life. The ultimate source of nitrogen is atmospheric nitrogen but neither plants nor animals are capable of assimilating free nitrogen. Thus the process of converting atmospheric nitrogen to useful nitrogenous compounds by plants, passing it to animals and then the decomposition of these compounds to give back free nitrogen in the atmospheres is called Nitrogen Cycle. It is because of the nitrogen cycle that the percentage of nitrogen remains constant in the air.

The process of conversion of free nitrogen of the air to useful nitrates is termed as nitrogen fixation.

### Biological nitrogen fixation

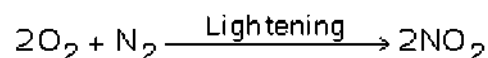
When nitrogen fixation is brought about by micro-organisms the process is called biological nitrogen fixation.

Examples: Rhizobium, a nitrogen fixing bacteria present in the roots of leguminous plants, fixes atmospheric nitrogen to the soil. Azotobacter and Clostridium are other free-living nitrogen fixing bacteria.

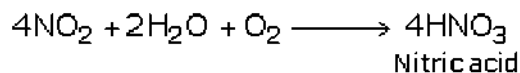
### Physical fixation

When nitrogen fixation is brought about by physical process it is called physical fixation. For example, during lightening and thunder, atmospheric nitrogen and oxygen combine to form nitrogen dioxide.

By the addition of compost and fertilizers.



Nitrogen dioxide so formed dissolves in rain water to form nitric acid, which goes into the soil. This nitric acid reacts with minerals of the soil to form soluble nitrates.



B) How does nitrogen enter the body of plants and animals?

The nitrates in the soil are absorbed by plants as mineral salts. Plants convert the inorganic nitrates to organic proteins.

The proteins from the plants enter the body of animals in form of food.

C) How is nitrogen returned to the soil?

When plants and animals die their bodies decompose. The organic proteins undergo a series of chemical changes, brought about by micro-organisms e.g. ammonifying bacteria, nitrosomonas, nitrosococcus. These changes convert the proteins back to inorganic nitrates.

In humans and animals some proteins are broken down to ammonia and carbon dioxide, which forms urea and is excreted out as urine. Their waste matter is also treated by micro-organisms to convert it into inorganic nitrates.

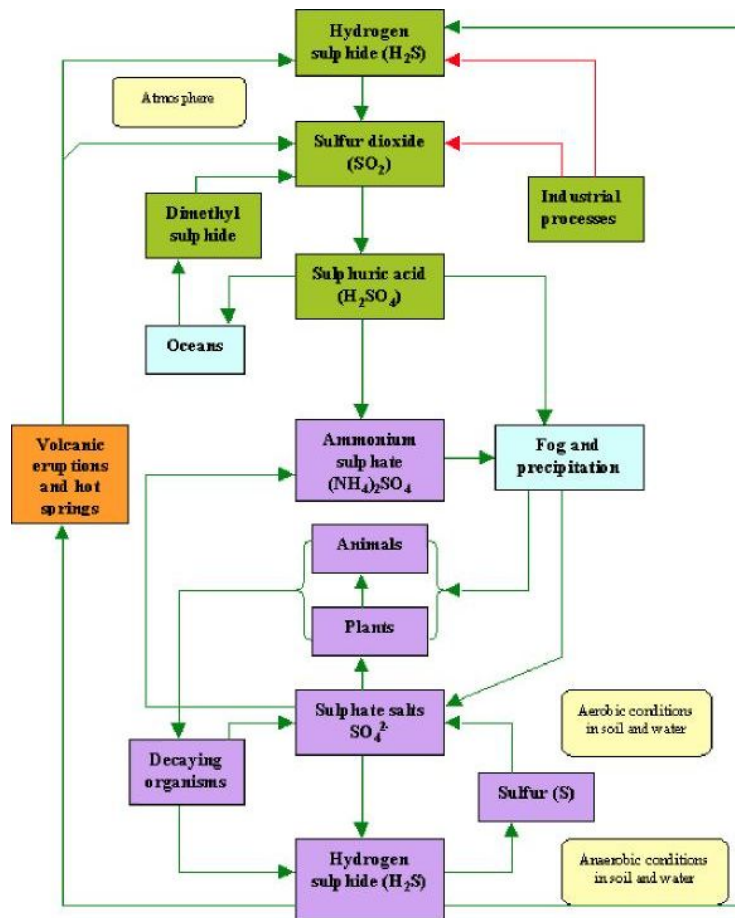
D) How does nitrogen enter the atmosphere?

Certain bacteria found in the soil called denitrifying bacteria convert nitrates of the soil to free nitrogen. Although this decreases the fertility of the soil it is inevitable.

#### Micro-organisms involved in Nitrogen Cycle

	Micro-organisms	Role in nitrogen Cycle
1. (a)	Rhizobium bacteria	Nitrogen fixation
(b)	Azotobacter and Clostridium	Nitrogen fixation
(c)	Blue green algae like Nostoc	Nitrogen fixation in water
2. (a)	Ammonifying bacteria	Converts protein to ammonia
(b)	Nitrosomonas	Converts ammonia to nitrites
(c)	Nitrosococcus	Converts nitrites to nitrates
3.	Denitrifying bacteria	Converts nitrates into free nitrogen

## SULPHUR CYCLE



Sulphur is one of the components that make up proteins and vitamins. Proteins consist of amino acids that contain sulphur atoms. Sulphur is important for the functioning of proteins and enzymes in plants, and in animals that depend upon plants for sulphur. Plants absorb sulphur when it is dissolved in water. Animals consume these plants, so that they take up enough sulphur to maintain their health.

Most of the earth's sulphur is tied up in rocks and salts or buried deep in the ocean in oceanic sediments. Sulphur can also be found in the atmosphere. It enters the atmosphere through both natural and human sources. Natural recourses can be for instance volcanic eruptions, bacterial processes, evaporation from water, or decaying organisms. When sulphur enters the atmosphere through human activity, this is mainly a consequence of industrial processes where sulphur dioxide (SO<sub>2</sub>) and hydrogen sulphide (H<sub>2</sub>S) gases are emitted on a wide scale.

When sulphur dioxide enters the atmosphere it will react with oxygen to produce sulphur trioxide gas ( $\text{SO}_3$ ), or with other chemicals in the atmosphere, to produce sulphur salts. Sulphur dioxide

may also react with water to produce sulphuric acid ( $\text{H}_2\text{SO}_4$ ). Sulphuric acid may also be produced from dimethylsulphide, which is emitted to the atmosphere by plankton species.

All these particles will settle back onto earth, or react with rain and fall back onto earth as acid deposition. The particles will then be absorbed by plants again and are released back into the atmosphere, so that the sulphur cycle will start over again.

## Unit-1V

### ENERGY & ENVIRONMENT

#### ENERGY:

It is great word, which is defined as the ability or capacity to do work.

We use energy to do work and make all movements. When we eat, our body's transform the food into energy to do work. When we run or walk or do some work, we „burn“ energy in our bodies. Cars, planes, boats machinery etc. also transform energy into work. Work means moving or lifting something, warming or lifting something, warming or lighting something. There are many sources of energy that help to run the various machines invented by man.

Energy is measured in BLU (British Thermal Unit) or Joule (Named after the English Physicist type of energy). One Joule after the amount of energy required to lift 1 pound (approx 400g) about 9 inches (23cm). It takes 1000 Joules to equal a Btu. It would take 2 million Joules to make a pot of coffee. A price of buttered tarts contains 315 kilo Joules of energy.

#### Kinds of energy

Kinetic energy: it is the energy of motion

Potential energy: It is the energy due to position or energy stored.

#### Types of energy

Light, chemical. Mechanical, heat, electric, atomic, sound.

All these forms of energy can be broken down either into kinetic or potential energy.

#### Sources of energy

##### Primary Energy Sources

:

**Energy resources are mined or otherwise obtained from the environment.**

Ex. a. Fossil fuels: coal, lignite, crude oil, Natural gas etc.

b. Nuclear fuels: Uranium, Thorium, other nuclear used in friction reaction.

c. Hydro energy : It is energy of falling water, used to turn a turbine.

d. Geo thermal: The heat from the underground stream .

e. Solar energy: Electromagnetic radiation from the Sun.

f Wind energy: The energy from moving air used by wind mills.

g. Tidal energy: The energy associated with the rise and fall of the tidal waters.

#### Global energy consumption patterns

Transportation consumes about 24% of the energy, 40% for industry, 30% for domestic and commercial purposes and remaining 6% for other uses including agriculture.

The top 20 richest countries of the world consumes 80 of the natural gas 65% of the oil and 50 of the coal produced every year while these countries have only one fifth of the world's population. One third of the world's population is about two billion people, lack access to adequate energy supplies, they mainly depend on fuel wood, dung, coal, charcoal and kerosene for cooking and heating. U.S.A is the largest energy consumer in the world.

Table 1: **Different Sources of Energy**

Energy Source	Percentage of total energy	Sub total percentage
<b>Non- renewable Sources</b>		
Oil	32	
Coal	21	
Natural gas	23	
Nuclear	6	82
<b>Renewable Sources</b>		
Bio mass (mainly wood)	11	
Solar, wind, hydro and Geothermal power	7	18
<b>TOTAL</b>		100

### Energy Status of India

India's energy status is not promising. Presently, the country consumes about 100 million tones of coal and 32,5 million tones of oil annually. Official estimate report that 40 billion tones of coal are available but only one half this is recoverable which means it is less than the projected demand of 23 billion tones of coal till the year 2020.

On the other hand the projected demand for hydroelectric power by 2020 is 12 times more than the present installed capacity of nearly 15, 000 MW.

India's oil deposits is about 400 million tones as against the world oil reserve of 750,000 million tones. Gas reserves of our country are about 100 million cubic meters, as against world's reserves of 63,000 million cubic meters. Here, one can conclude that the energy Scenario of India is blank.

### Renewable and Non- Renewable Energy Sources

#### Renewable or inexhaustible energy sources:

These are the resources that can be generated continuously. These are mostly biomass based which are renewed over relatively short period of time and then available in unlimited amount in nature. These include conventional energy sources like: firewood, petrol plants, plant biomass, animal dung, water energy etc.

**Non-conventional energy sources** like solar energy, wind energy, tidal energy, geothermal energy and dendro thermal energy etc. These can reproduce themselves in nature and can be



harvested continuously through a sustained planning and proper management.

### **Non- renewable or exhaustible energy sources:**

These are available in limited amount and develop over a longer period of time. Hence, they cannot be replenished in the quantities they are being consumed in a given period of time. Non-Conventional energy sources like nuclear energy etc.

Development of modern technological civilizations is chiefly based on the non-renewable sources. These reserves are fast depleting and within a few decades they will get exhausted. The unwise and exploitative use of renewable energy sources have forced these resources in the category of non- renewable energy sources as the rate of production of these sources become much less than the rate of their utilization.

## **ELECTROMAGNETIC RADIATION**

An electromagnetic radiation is energy in the form of a wave due to changing electric and magnetic fields. There are different forms of electromagnetic radiation, each with different wavelengths (i.e. Distance between successive peaks or troughs in the wave) and energy content. Such radiation travels through space at the speed of light, which is about 3, 00 000 kilometers/sec.

Cosmic rays, gamma rays, x-rays and ultra violet radiation are known as Ionizing radiation because they have energy to knock electrons from atoms and change them to positively charged ions. The resulting highly reactive electrons and ions can disrupt living cells, interfere with body processes and cause many types of sickness, including various cancers.

The other forms of electromagnetic radiation do not contain enough energy to form ions and are known as Non- ionizing radiation.

The visible light that can be detected by our eyes is a form of non- ionizing radiation that occupies only a small portion of full range or spectrum of different types of electro magnetic radiation.

Fig. given the details of Electromagnetic Spectrum.

High energy + Short wave length	Sun	Low energy + long wave length
Ionising radiation		Non Ionising radiation

Cosmic Rays	Gamma rays	X-ray rays	Far U V waves	Near UV waves	/	Near infra red waves	Far infra red waves	Micro waves	TV waves	Radio waves
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Wave length (meters)

## HYDRO ELECTRICAL ENERGY

Electricity produces from waterpower is known as hydroelectric energy. The potential energy of falling water captured and converted to mechanical energy by water wheel powered the start of industrial revolution. Wherever head or change in elevation could be found, river and stream were dammed and mills were built.

**Large Scale Hydro power:** in this case a high dam is built across a large river to create a reservoir, water is allowed to flow through huge pipes laid along the steep hill slopes (falling) at controlled rates, thus spinning turbines ( prime movers) and in turn generators producing electricity.

**Small hydropower:** In this case a low dam with no reservoir (or only a small one) is built across a small stream and the water used to spin turbine to produce electricity.

**Pumped Storage hydropower:** In this case the surplus electricity conventional power plant is used to lift water from a lake or tail race to another reservoir at a higher elevator, water in the upper reservoir is released to spin the turbine for generating electricity.

In 2001, hydro power supplied about 7% of the world's total commercial energy, 20% of the world's electricity. It supplies 99% of the electricity in Norway, 75% in New Zealand and 50% in developing countries and 25% in China.

In India the generation of hydro electricity has been emphasized right from the beginning of the First Five Year plan. By the end of Fourth plan, India was able to generate 6.9 thousand MW of hydro electricity, contributing 42% of the total power generation capacity. But due to increase in demand, by the end of Eighth plan it fell down to 25% only. The hydropower potential of India is estimated to be  $4 \times 10^6$  k w –hours. Till now we have utilized only a little more than 11% of this potential.

Because of increasing concern about the harmful environment and social consequences of large dams, there has been growing pressure on the World Bank and other development agencies to stop funding new large scale hydro power projects.

According to a study by world commission on Dams, hydropower in tropical countries is a major emitter of green house gases. This occurs because reservoirs that power the dams can trap rotting vegetation, which can emit green house gases such as Carbon dioxide and Methane.

Small-scale hydropower projects eliminate most of the harmful environmental effects of large-scale projects. However their power output can vary with seasonal changes in the stream flow.

Advantages	Disadvantages
* Moderate to high net energy.	* High construction cost
* High efficiency (80%)	* High environmental impact
* Low cost electricity emission from biomass decay in shallow tropical reservoirs.	* High carbon dioxide
* Long life span	* Floods natural areas.

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* No carbon dioxide emission during operation	* Coverts land habitat to lake habitat.
* May provide flood control below dam.	* Danger of collapse
* Provides water for year-round Irrigation.	* Uproots People.
* Reservoir is useful for fishing and recreation	* Decreases fish harvest Below dam

Above are the advantages of and disadvantages of using large-scale hydropower plants to generate electricity

According to the United Nations, only about 13% of the World's exploitable potential for hydropower has been developed. Much its un trapped potential is in South Asia, (China), South America and parts of Russia.

## FOSSILS FUELS

Fossils fuels (oil, coal, natural gas) are energy rich substances that have formed from the remains of organisms that lived 200 to 500 million years ago. During the stage of the Earth's evolution, large amount of dead organic matter had collected. Over million of years, this matter was buried under layers of sediment and converted by heat and pressure into coal, oil and natural gas.

Chemically, fossil fuels largely consist of hydrocarbons, which are compounds of hydrogen and carbon. Some fossils fuel also contains smaller quantities of other compounds. After the accumulating sediments exerted increasing heat and pressure for millions of years on the ancient organisms hydrocarbons were formed. Most common among them are petroleum, coal and natural gas. However Geologists have identified other types of hydrocarbon rich deposits, which can serve as fuels. Such deposits are: oil shale, tar sands and gas hydrates. However, they are not widely used due to the fact that they are very costly to extract and refine.

Majority of fossil fuels are being used in transportation, industries heating and generation of electricity.

Crude petroleum is refined into gasoline; diesel and jet fuel that power the world's transportation system.

Coal is mostly used in the generation of electricity (thermal power). Natural gas is used for commercial and domestic purposes like heating, air conditioning and as fuels for stoves and for other heating appliances.

Once we discovered the fossil fuel we began consuming them at an increasing rate. From 1859 to 1969, total oil production was 227 billion barrels (1 barrel=159 lts). 50% of this total was extracted during the first 100 years, while the next 50% was extracted in next 10 years.

Today, fossil fuels are considered to be non-renewable for the reason that their consumption rate is far in excess of the rate of their formation.

**Coal :**

About 250 to 350 million years ago coal was formed on earth in hot, damp regions. Almost 27350 billion metric tones of known coal deposits occur on our planet. Out of which about 56% are located in Russia, 28% in USA and Canada. India has about 5% of world's coal reserve and that too not of very good quality in term of heat capacity. West Bengal, Jharkhand, Orissa, Andhra Pradesh, Madhya Pradesh and Maharashtra are the major coal producing states of India.

Mainly, there are three types of coal: Anthracite or hard coal ( 90% carbon content) Bituminous or soft coal (85% carbon content) Lignite or brown coal (70% carbon content)

The present annual extraction rate of coal is about 3000 million metric tones, at this rate coal reserves may last for about 200 hundred years and if its use is increased by 2% per year then it will last for another 65 years.

**Petroleum:**

Convenience of petroleum or mineral oil and its greater energy content as compared to coal on weight basis has made it the lifeline of global economy. Petroleum is cleaner fuel when compared to wood or coal as it burns completely and leaves no residue. Petroleum is unevenly distributed like any other mineral. There are 13 countries in the world having 67% of the petroleum reserves which together form the OPEC (Organization of petroleum exporting countries). Six regions in the world are rich in petroleum – USA, Mexico, Russia and West Asian countries. Saudi Arabia oil producing has one fourth of the world oil reserves. The total oil reserves of our planet is about 356.2 billion metric tones out of this annually we are exporting about 28% million metric tones. Hence the existing reserves would last for about 40 – 50 years. About 40% of the total energy consumed in the entire world is now contributed by oil.

The oil bearing potential of India is estimated to be above one million square kilometers is about one third of the total geographic area. Northern plains in the Ganga-Brahmaputra valley, the coastal strips together with their off-shore continental shelf (Bombay High), the plains of Gujarat, the Thar Desert and the area around Andaman and Nicobar Islands.

**Natural gas:**

Natural gas mainly consists of Methane ( $\text{CH}_4$ ) along with other inflammable gases like Ethane and propane. Natural gas is least polluting due to its low Sulphur content and hence is clearest source of energy. It is used both for domestic and industrial purposes. Natural gas is used as a fuel in thermal plants for generating electricity as a source of hydrogen gas in fertilizing industry and as a source of carbon in tyre industry.

The total natural gas reserves of the world is about 600 000 billion meters, out of this Russia has 34%, Middle East 18%, North America 17%, Africa and Europe 9% each and Asia 6%. Annual production of natural gas is about 1250 billion cubic meters and hence it is expected to last for

about 50-100 years. In India gas reserves are found in Tripura, Jaisalmer, off shore areas of Bombay and Krishna-Godavari Delta.

### Environmental effects of Using Fossil Fuels:

**Acid rain:** When fossil fuels are buried, Sulphur, Nitrogen and Carbon combine with oxygen to form compounds known as oxide. These oxides when released into the atmosphere, they react with water form and result in the formation of Sulphuric acid, Nitric acid and Carbonic acid. These acids can harm biological quality of forests, soils, lakes and streams.

**Ash particles:** Ash particles are the un burnt fuel particles. However with strict imposition of Government regulations, perubben are provided to trap these particles. Petro and natural gas generate less ash particles than coal, diesel or gasoline.

**Global warming:** Carbon dioxide is a major by product of fossil combustion and this gas is known as green house gas. Green house gas absorbs solar heat reflected off the earth's surface and retains this heat, keeping the Earth warm and habitat for living organisms. Rapid industrialization between 19<sup>th</sup> and 20<sup>th</sup> centuries however has resulted in increasing fossil fuel emissions, raising the percentage of carbon dioxide by about 28%. This drastic increase has led to global warming that could cause environmental problems, including disrupted weather patterns and polar ice cap melting.

Metal hydrides, charcoal powders, graphite nanofibers and glass micro spheres containing hydrogen will not explode or burn if a vehicle's tank is ruptured in an accident. Such tanks would be much safer than current gasoline tanks.

### Advantages and Disadvantages of various fossil fuels

#### Conventional oil

Advantages	Disadvantages
* Ample supply for 40-90 years	* Need to find substitute within
50 years	
* Low cost (with huge substitute)	* Artificially low price
encourages waste and discourages search for alternative	
* High net energy yield	* Air pollution when burnt
* Easily transported within and between countries	* Released carbon dioxide when burnt
* Low land use	* Moderate water pollution
* Technology is well developed	

Efficient distribution system

#### Heavy oils from oil shale and Tar sand

<b>Advantages</b>	<b>Disadvantages</b>
* Moderate existing supplies	* High costs
* Large potential supplies	* Low net energy yield
* Easily transport within and between countries	* Large amount of water needed to process
* Efficient distribution system in place	* Severe land disruption
* Technology is well developed	* Water pollution from mining residues
* Air pollution when burnt	
* Carbon dioxide emissions when burnt	

### c. Conventional Natural gas

<b>Advantages</b>	<b>Disadvantages</b>
* Ample supplies (125 years)	* Non renewable resources
* High net energy yield	* Releases carbon dioxide when burnt
* Low cost ( with huge subsidies) can leak from pipelines	* Methane ( a green house gas)
* Less air pollution than other fossil fuels	* Shipped across ocean as highly explosive LNG
* Moderate environmental impact at wells because of low prices	* Sometimes burnt off and wasted
* Easily transported by pipelines	* Requires pipelines
* Low land use	
* Food fuel for fuel cells and gas turbines	

### Coal

<b>Advantages</b>	<b>Disadvantage</b>
* Ample supplies (225-900years)	* Very high environmental impact
* High net energy yield	* Several land disturbance air pollution and water pollution
* Low cost (with huge substitutes)	* High land use (including mining)
* Mining and combustion technology well developed	* Severe threat to human health
* Air pollution can be reduced with	* High carbon dioxide emissions developed when burnt
* Releases radio active particles and mercury into air.	

### NUCLEAR ENERGY

Nuclear energy is non- renewable source of energy, which is released during fission

(disintegration) or fusion (union) of selected radioactive materials. Nuclear power appears to be the only hope for large scale energy requirements when fossil fuels are exhausted. The reserves of nuclear fuels is about ten times more than fossil fuels and its major advantage is that even small quantities can produce enormous amounts of energy. For example, a ton of uranium –235 can produce an energy equivalent 3 million tones of coal or 12 million barrels of oil. Nuclear energy has been successfully used in the generation of electricity in spaceships, marine vessels, chemical and food-processing industry.

**Nuclear fission:** Nuclear fission reaction are based on the fission of  $U_{235}$  nuclei by thermal neutrons

$92U_{235}$

The energy from these nuclear reactions is used to heat water in the reactor and generates steam to drive a steam turbine.

High temperature gas-cooled reactors and Fast Breeder reactors convert non fissionable  $Pu_{239}$  and  $U_{233}$

**Nuclear fusion** It is based on deuterium-deuterium and deuterium-tritium reaction

The deuterium-deuterium reactions promise an unlimited source of energy will take several more years due to the technical problem. Nuclear fusion is also known as thermo nuclear reaction.

**Environmental impact :** Nuclear fission power reactor generate large quantities of radio active fission waste products, which may remain dangerous for thousand of years. In addition these are no safe disposal methods.

## SOLAR ENERGY

The solar energy originates from the thermonuclear fusion reaction taking place in the Sun. It is one of the potential non-conventional energy source. The earth continuously receives energy from the Sun, part of which is absorbed while the remaining is emitted back into space. Out of the solar radiations reaching the earth 92% consists radiations in the range of 315 to 1400 nm. 45% of this is in the visible range and emits radiations in the infra-red region (2μ to 40μ). The heat equivalent of the solar radiation reaching the earth is estimated to be about  $2.68 \times 10^{17}$  Joules per year.

Solar energy being non- polluting and non-depletable is considered as renewable energy and thus fits into the principle of sustainability. But only 0.25 to 0.5 % of the solar energy reaching the earth is utilized for photosynthesis. Utilisation of solar energy is to gain popularity among the masses due to expensive nature.

In India, solar photovoltaic systems are being installed by Department of Non- Conventional energy resources for lighting, running of TV sets, water pumping etc. In India, there has been steady rise in demand for solar photovoltaic system.

Solar cells are used to convert the impinging solar radiation directly of this method is that no mechanical movement of parts is needed. The reliability of the operation is extraordinarily high. Even under severe space conditions a maintenance free life span of ten or more years has been achieved. Only disadvantage is that, its cost is very high.

For a solar power station with a capacity of 1000 Mw, a land of surface of about 12 km<sup>2</sup> is



required.

### **Advantages of solar energy**

Solar energy is free and it is available locally in abundance.

Solar energy is pollution free.

Systems are easy to install, generate and maintain.

System can be specifically designed according to individual requirements.

Supply of hot water is instant and uninterrupted

Recurring fuel costs are zero

Heating 100 liters of water to 60°C by solar system results in an energy saving of 1200-1500 units (kilowatts hours) of electricity per year.

### **BIOMASS**

Biomass is the term used to describe the organic matter produced by photosynthesis that exists on the Earth's surface. The source of all energy in biomass is the Sun, the biomass acting as a kind of chemical energy store. Traditionally the extraction of energy from biomass is split into three distinct categories:

**Solid biomass:** The use of trees, crop residues animal and human waste, household or industrial residues for direct combustion to provide heat.

**Biogas:** It is obtained by anaerobically (without air) digesting the organic material to produce methane. Animal waste and municipal waste are two common feedstocks for anaerobic digestion.

**Liquid bio-fuels:** They are obtained by subjecting organic materials to one of the various chemical or physical processes to produce a usable, combustible liquid fuel. Bio fuels such as vegetable oils or ethanol are often processed from industrial or commercial residues such as biogas or from energy crops grown specially for these purposes.

### **Biomass use in the development world**

More than two billion people in the developing world use biomass for the majority of their household energy needs. Biomass is also widely used for non-domestic appliances. Biomass is available in varying quantities throughout the developing world. In recent decades, with the threat of global deforestation much focus has been given to the efficient use of biomass.

**Biomass resources:** They are renewable energy resources. Natural Biomass resources vary in type and content depending upon the geographical location. World's biomass producing areas are classified into three distinctive regions.

Temperate regions: Produce wood, crop residues like straw, vegetable leaves, human and animal waste.

Arid and Semi arid regions: Produce very little excess vegetation for fuel. People living in these



areas are often the most affected by desertification and have difficulty in finding sufficient wood fuel.

Humid tropical regions: Produce abundant wood supplies, crop produces, animal and human wastes, commercial industrial agro and food processing residues. Many of the world's poorer countries are found in these regions and hence there is a high incidence of domestic biomass use. Tropical areas are currently the most seriously affected by deforestation, logging and land clearance for agriculture.

**Activities including Commercial utilization of Biomass-** Biomass can be used for a variety of commercial tobacco curing providing direct heat for brick burning, for lime burning and cement kilns.

In India, sugar mills are rapidly turning to bagasse, the leftover of cane after it is crushed and its juice extracted to generate electricity. This is mainly done to clean up the environment, cut down power cost and additional revenue. According to current estimates, about 3500 MW of power can be generated from bagasse in the existing 430 sugar mills of the country. Around 270 MW of power has already been commissioned and more are under construction. The advantages of biomass is that it can be locally sourced.

**Biomass energy and environment:** Concern for the environment was one of the major inspirations for early research and development work on improved stoves. Initially, one environment concern dominated the improved stove work, saving trees. Today, this is considerably downplayed. At the same time, other environmental issues have become dominant. Large scale combustion of biomass is only environmentally feasible if carried out on a sustainable basis. For obvious continual large-scale exploitation of biomass resources without care for its replacement and regeneration will cause environmental damage and also Jeopardize the fuel source itself.

#### **Benefits of Biomass energy:**

- \* Renewable or recyclable energy source (Stored solar energy)
- \* Less waste directed to landfills.
- \* Decrease reliance on imported energy sources.
- \* Potential rural development and job creation.
- \* can generate renewable electricity when the Sun is not shining and the wind is not blowing.

#### **BIOGAS**

Biogas is obtained by an aerobically (without air) digesting organic material to produce a combustible gas known as methane. Animal waste and municipal waste are two common feed stocks for an aerobic digestion.

At present biogas technology provides an alternative source of energy in rural India for cooking. It is particularly useful for village households that have their own cattle. Through a simple process cattle dung is used to provide the gas. The residual dung is used as manure. India has world's largest cattle population - 400 million, thus offering tremendous potential for biogas plants. Biogas production has the capacity to provide us with about half of our energy needs either burned for electricity production or piped into current gas lines for use. It just has to be done and made a priority. Though about 3.71 million biogas plants in India up to March 2003 are successfully in operation but still it is utilizing only 31% of the total estimated potential of 12 million plants. The pay back period of the biogas plant is only 2 to 3 years. Rather in the case of

community and industrial Biogas plants is even less. Therefore biogas electrification at Community Panchayat level is required to be implemented. A sixty cubic feet approx 2 m<sup>3</sup> biogas plant can serve the needs of one average family.

The charge from the biogas generation consists of dung and waste in the form of slurry. The fermentation is carried out between 35 to 50°C. About 160 liters of gas is produced per kg of cow dung and heating value of the gas is 490 kilocalories on 160 liters basis.

The average composition of biogas is methane 55%, Hydrogen 7.4%, Carbon dioxide 39%, Nitrogen 2.6%, Water- traces. The average gross calorific value of the gas is 5300 kcal /cubic meters.

## **HYDROGEN AS AN ALTERNATIVE FUTURE SOURCE OF ENERGY**

### **Alternative energy sources**

Other alternative source of energy for future is the nuclear energy derived from nuclear fission or nuclear fusion processes. The use of nuclear energy mainly requires its conversion into electrical energy. Out of the world's total energy requirement only 20% constitutes electrical energy. The rest of the 80% requirement is energy in the form of heat. Conversion of nuclear energy into chemical energy for storage and transportation and disposal of nuclear waste are the problems of this technique.

### **Hydrogen as fuel**

Hydrogen is an important alternative energy source. Some advantages of hydrogen are:

Hydrogen is abundantly available in the combined form as water.

- Use of hydrogen as fuel provides pollution free atmosphere because its combustion product is water.

Time required for regeneration of hydrogen is short.

Automobile engine burning hydrogen is about 25 to 50% more efficient than an automobile engine burning gasoline (petrol).

Heat of combustion per gram of hydrogen is more than twice that of jet fuel.

Hydrogen-oxygen fuel cells provide other possibilities of powering motor vehicles.

Hydrogen is excellent reducing agent and produces less atmospheric pollution than carbon. So it can replace coal in many industrial processes.

The changes in our way of life by adopting widespread uses of hydrogen are referred to as 'hydrogen economy'.

### **Hydrogen economy**

Although hydrogen looks as very good future fuel, the problems associated with its economy are:

#### **Availability**

Hydrogen is not available as such. It does not occur in a free state in nature. The cheap production of hydrogen is a basic requirement of hydrogen economy. The source of hydrogen is water and using nuclear energy or solar energy might generate it.

**Transportation**

Hydrogen gas has explosive flammability and so is difficult to handle. This causes problem to its storage and transportation. A solution for this is the use of Fe-Ti alloy, which absorbs hydrogen and results in the formation of fine silvery powder. Heating the powder safely releases hydrogen gas. Such storage system is safer than storage of hydrogen as gas or liquid.

**Platinum scarcity**

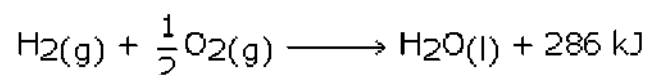
Platinum is required as catalyst in oxygen-hydrogen fuel cells. The demand of platinum exceeds the supply. This will cause problems for fuel cells, which are highly promising energy source for automobiles.

**Cost**

Hydrogen is an expensive fuel because its cost of production is high.

**Use of liquid hydrogen as fuel**

Liquid hydrogen is used as an important rocket fuel because of its low mass and high enthalpy of combustion. The chemical reaction involved is:



Both reactants  $\text{H}_2$  and  $\text{O}_2$  are stored as liquids in separate tanks. The advantage of using hydrogen as a rocket fuel is:

The product of combustion is water.

There is no emission of environmental pollutants such as  $\text{CO}$ ,  $\text{SO}_2$ , oxides of nitrogen, hydrocarbons, etc.

Although during the 'lift off operations, these propellants power shuttle's main engine for about 8.5 min, liquid hydrogen cannot be used much because the extraction of it from water is an expensive procedure

**Advantages and disadvantages of hydrogen****Advantages**

- Can be produced from water.
- Low environmental impact.
- No carbon dioxide emissions if produced from water.
- Good substance for oil.
- Competitive price if environmental and social costs are included in cost comparisons.
- Easier to store than electricity.
- Safer than gasoline an natural gasoline.
- High efficiency 65-95% in full cells.

### Disadvantages

- Not found in nature.
- Energy is needed to produce fuel
- Negative net energy.
- Carbon dioxide emission if produced from carbon containing compounds.
- Non- renewable if generates by fossil fuels or nuclear power.
  
- High costs.
- Short driving range for current fuel cells cars.
- No fuel distribution system in place
- Excessive hydrogen leaks may deplete ozone.

## UNIT V

### ENVIRONMENTAL POLLUTION

#### NOISE POLLUTION

##### **Definition:-**

The present generation and the coming generations have to solve three grave problems, namely, population poverty and pollution if they have to survive. Pollution being the most dangerous problem like cancer in which death is sure but slow. Environment pollution is assuming dangerous proportions all through the globe and India is not free from this poisonous disease. This is the gift of modern living, industrialization and urbanization. Unless timely action is taken we have a forlorn and bleak future for the world.

The word noise is derived from the Latin term *nausea*. It has been defined as unwanted sound, a potential hazard to health and communication dumped into the environment with regard to the adverse effect it may have on unwilling ears.<sup>1</sup>

Noise is defined as unwanted sound. Sound, which pleases the listeners, is music and that which causes pain and annoyance is noise. At times, what is music for some can be noise for others<sup>2</sup>

Section 2 (a) of the Air (Prevention and Control of Pollution) Act, 1981 includes noise in the definition of „air pollutant“.

Section 2(a) air pollution means any solid, liquid or gaseous substance including noise present in the atmosphere such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

According to Encyclopedia Britannica: In acoustic noise is defined as any undesired sound.

In Chambers 21st Century Dictionary the definition of noise has undergone a change. Noise pollution stands carved out as a phrase separately from noise. The two are defined as under: Noise- a sound; a harsh disagreeable sound, or such sound; Pollution- an excessive or annoying degree of noise in a particular area, e.g. from traffic or aero plane engines.

Pollution is a noise derived from the verb pollute. Section 2 (c) of the Environment (Protection) Act, 1986 defines environmental pollution to mean the presence in the environment of any environmental pollutant. Section 2 (b) of the said Act defines environmental pollutant to mean any solid, liquid or gaseous substance present in such concentration as may be, or tends to be injurious to environment.

Noise can be described as sound without agreeable musical quality or as an unwanted or undesired sound. Thus noise can be taken as a group of loud, non harmonious sounds or vibrations that are unpleasant and irritating to ear.

**Measurement:-**

A decibel is the standard for the measurement of noise. The zero on a decibel scale is at the threshold of hearing, the lowest sound pressure that can be heard, on the scale acc. To smith, 20 db is whisper, 40 db the noise in a quiet office. 60 db is normal conversation, 80 db is the level at which sound becomes physically painful.

The Noise quantum of some of the cities in our country indicate their pitch in decibel in the noisiest areas of corresponding cities, e.g. Delhi- 80 db, Kolkata - 87, Bombay-85, Chennai-89 db etc.

**Sources of Noise Pollution: -**

Noise pollution like other pollutants is also a by- product of industrialization, urbanizations and modern civilization.

Broadly speaking, the noise pollution has two sources, i.e. industrial and non- industrial. The industrial source includes the noise from various industries and big machines working at a very high speed and high noise intensity. Non- industrial source of noise includes the noise created by transport/vehicular traffic and the neighborhood noise generated by various noise pollution can also be divided in the categories , namely, natural and manmade. Most leading noise sources will fall into the following categories: roads traffic, aircraft, railroads, construction, industry, noise in buildings, and consumer products

**1. Road Traffic Noise:-**

In the city, the main sources of traffic noise are the motors and exhaust system of autos , smaller trucks, buses, and motorcycles. This type of noise can be augmented by narrow streets and tall buildings, which produce a canyon in which traffic noise reverberates.

**2. Air Craft Noise: -**

Now-a-days , the problem of low flying military aircraft has added a new dimension to community annoyance, as the nation seeks to improve its nap-of-the- earth aircraft operations over national parks, wilderness areas , and other areas previously unaffected by aircraft noise has claimed national attention over recent years.

**3. Noise from railroads: -**

The noise from locomotive engines, horns and whistles, and switching and shunting operation in rail yards can impact neighboring communities and railroad workers. For example, rail car

retarders can produce a high frequency, high level screech that can reach peak levels of 120 dB at a distance of 100 feet, which translates to levels as high as 138, or 140 dB at the railroad worker's ear.

#### **4. Construction Noise:-**

The noise from the construction of highways, city streets, and buildings is a major contributor to the urban scene. Construction noise sources include pneumatic hammers, air compressors, bulldozers, loaders, dump trucks (and their back-up signals), and pavement breakers.

#### **5. Noise in Industry: -**

Although industrial noise is one of the less prevalent community noise problems, neighbors of noisy manufacturing plants can be disturbed by sources such as fans, motors, and compressors mounted on the outside of buildings. Interior noise can also be transmitted to the community through open windows and doors, and even through building walls. These interior noise sources have significant impacts on industrial workers, among whom noise-induced hearing loss is unfortunately common.

#### **6. Noise in building: -**

Apartment dwellers are often annoyed by noise in their homes, especially when the building is not well designed and constructed. In this case, internal building noise from plumbing, boilers, generators, air conditioners, and fans, can be audible and annoying. Improperly insulated walls and ceilings can reveal the sound of amplified music, voices, footfalls and noisy activities from neighboring units. External noise from emergency vehicles, traffic, refuse collection, and other city noises can be a problem for urban residents, especially when windows are open or insufficiently glazed.

#### **7. Noise from Consumer products:-**

Certain household equipment, such as vacuum cleaners and some kitchen appliances have been and continue to be noisemakers, although their contribution to the daily noise dose is usually not very large.

#### **Harmful Effects:**

On Human Being, Animal and Property: Noise has always been with the human civilization but it was never so obvious, so intense, so varied & so pervasive as it is seen in the last of this century. Noise pollution makes men more irritable. The effect of noise pollution is multifaceted & inter related. The effects of Noise Pollution on Human Being, Animal and property are as follows:

I. It decreases the efficiency of a man:- Regarding the impact of noise on human efficiency there are number of experiments which print out the fact that human efficiency increases with noise reduction. A study by *Sinha & Sinha* in India suggested that reducing industrial booths could improve the quality of their work. Thus human efficiency is related with noise.

II. Lack of concentration:- For better quality of work there should be concentration , Noise causes lack of concentration. In big cities , mostly all the offices are on main road. The noise of traffic or the loud speakers of different types of horns divert the attention of the people working in offices.

III. Fatigue:- Because of Noise Pollution, people cannot concentrate on their work. Thus they have to give their more time for completing the work and they feel tiring

IV. Abortion is caused: - There should be cool and calm atmosphere during the pregnancy. Unpleasant sounds make a lady of irritable nature. Sudden Noise causes abortion in females.

V. It causes Blood Pressure: - Noise Pollution causes certain diseases in human. It attacks on the person's peace of mind. The noises are recognized as major contributing factors in accelerating the already existing tensions of modern living. These tensions result in certain disease like blood pressure or mental illness etc.

VI. Temporary or permanent Deafness:- The effect of noise on audition is well recognized. Mechanics , locomotive drivers, telephone operators etc. All have their hearing . Impairment as a result of noise at the place of work. Physicist, physicians & psychologists are of the view that continued exposure to noise level above. 80 to 100 db is unsafe, Loud noise causes temporary or permanent deafness.

VII. EFFECT ON VEGETATION Poor quality of Crops:- Now is well known to all that plants are similar to human being. They are also as sensitive as man. There should be cool & peaceful environment for their better growth. Noise pollution causes poor quality of crops in a pleasant atmosphere.

VIII. EFFECT ON ANIMAL:- Noise pollution damage the nervous system of animal. Animal loses the control of its mind. They become dangerous.

IX. EFFECT ON PROPERTY:- Loud noise is very dangerous to buildings, bridges and monuments. It creates waves which struck the walls and put the building in danger condition. It weakens the edifice of buildings.

### **Legal Control:-**

#### **(a) Constitution of India**

Right to Life:- Article 21 of the Constitution guarantees life and personal liberty to all persons. It is well settled by repeated pronouncements of the Supreme Court that right to life enshrined in



Article 21 is not of mere survival or existence. It guarantees a right of persons to life with human dignity. Any one who wishes to live in peace, comfort and quiet within his house has a right to prevent the noise as pollutant reaching him.

**Right to Information:-** Every one has the right to information know about the norms and conditions on which Govt. permit the industry which effect the environment.

**Right to Religion and Noise:-** Right to religion does not include right to perform religious activities on loud speaker and electronic goods which produce high velocity of noise.

**Directive Principal of State Policy:-** The state has the object to make the environment pollution free.

**Fundamental Duties:-** every citizen of the country has the fundamental duty to clean the environment.

### **(b) Cr.P.C. Section 133**

Here Section 133 is of great importance. Under Crpc. Section 133 the magisterial court have been empowered to issue order to remove or abate nuisance caused by noise pollution Sec 133 empower an executive magistrate to interfere and remove a public nuisance in the first instance with a conditional order and then with a permanent one. The provision can be utilized in case of nuisance of environment nature. He can adopt immediate measure to prevent danger or injury of a serious land to the public. For prevention of danger to human life, health or safety the magistrate can direct a person to abstain from certain acts.

### **(c) I.P.C. Public Nuisance 268-295**

Chapter IV of Indian Penal code deals with offences relating to public health, safety, ....decency , morals under Sections 268, 269, 270, 279, 280, 287, 288, 290 291 294. Noise pollution can be penalized with the help of above section. Private remedies suits in the area may related to public nuisance under A299. This article punishment in case of Public nuisance law of torts covers. A person is guilty of public nuisance who does any act or is guilty of an illegal omission which causes any common injury, danger, or annoyance to the pubic or to the people in general who dwell or occupy property in the vicinity or which must necessarily cause injury, obstruction danger or annoyance to persons who may have occasion to use any public right. A common nuisance is not excused on the ground that it causes some convenience or advantage. Who ever commits a public nuisance in any case not otherwise punishable by this code, shall be punished

with fine, which may extend to Rs. 200.

**(d) Law of Torts Noise pollution is considered as civil wrong:-**

Under law of torts, a civil suit can be filed claiming damages for the nuisance. For filing a suit under law of torts a plaintiff is required to comply with some of the requirement of tort of nuisance which are as follows:-

1. There should be reasonable interference.

2. Interference should be with the use & enjoyment of land.

3. In an action for nuisance actual damage is required to be proved. As a general rule either the presence or absence of malice does not matter. But in some cases deviation from the rule has been made.

**(e) Factories Act Reduction of Noise and Oil of Machinery:-**

The Factories Act does not contain any specific provision for noise control. However, under the Third Schedule Sections 89 and 90 of the Act, noise induced hearing loss, is mentioned as notifiable disease. Similarly, under the Modal Rules, limits for noise exposure for work zone area have been prescribed.

**(f) Motor Vehicle Act. Provision Relation to use of horn and change of Engine:-**

In Motor vehicle Act rules regarding use horns and any modification in engine are made.

**(g) Noise Pollution Control Rule 2000 under Environment Protection Act 1996:-**

Further for better regulation for noise pollution There are The Noise Pollution ( Regulation and Control ) Rules, 2000 – in order to curb the growing problem of noise pollution the government of India has enacted the noise pollution rules 2000 that includes the following main provisions:-

1. The state government may categories the areas in the industrial or commercial or residential

2. The ambient air quality standards in respect of noise for different areas have been specified.

3. State government shall take measure for abatement of noise including noise emanating from vehicular movement and ensure that the existing noise levels do not exceed the ambient air quality standards specified under these rules.

4. An area not less than 100 m around hospitals educations institutions and court may be declares as silenceare for the purpose of these rules.

5. A loud speaker or a public address system shall not be used except after obtaining written permission from the authority and the same shall not be used at night. Between 10 pm to 6 am.

6. A person found violating the provisions as to the maximum noise permissible in any particular area shall be liable to be punished for it as per the provision of these rules and any other law in force.

### Schedule

Day		Time	NightTime
(A)	Industrialarea	75	70
(B)	Commercialarea	65	55
(C)	Residentialarea	55	45
(D)	Silence Zone	50 40*dB	

- There are rules framed by the government regarding noise pollution and known as Noise Pollution control and Regulation Rules, 1999. On 11-10-2002 govt brought in an amendment in the rules. The amendment empowered the state government to permit use of loudspeakers or public address system during night hours between 10 pm to 12 pm in the mid night on or during the cultural or religious occasions for a limited period not exceeding 15 days.

- In this case supreme observed that Right to life enshrined in Article 21 is not of mere survival or existence. It guarantees a right of persons to life with human dignity. There in are included all the aspects of life which go to make a person life meaningful complete and worth living. Every body who wished to live in peace , comfort and quiet with in his house has a right to prevent the noise as pollutant reaching him. No one claim a right to noise to create noise even in his own premises which would travel beyond his precincts and cause nuisance to neighbors or others.

### Conclusion:-

We have made the law relating to noise pollution but there is need to creating general awareness towards the hazardous effects of noise pollution. Particularly, in our country the people generally lack consciousness of the ill effects which noise pollution creates ad how the society including they themselves stand to beneficiary preventing generation and emission of noise pollution. The target area should be educational institutions and more particularly school. The young children of impressionable age should be motivated to desist from playing with firecrackers, use of high sound producing equipments and instruments on festivals, religious and social functions, family get-togethers and celebrations etc. which cause noise pollution. Suitable chapters can be added into textbooks, which teach civic sense to the children and teach them how to be good and responsible citizen which would include learning by heart of various fundamental duties and that would obviously include learning not to create noise pollution and to prevent if generated by others. Holding of special talks and lectures can be organized in the schools to highlight the menace of noise pollution and the role of the children in preventing it . For these purpose the state must pay its role by the support and cooperation of non-government organizations (NGOs) can also be enlisted.

## **Land pollution**

Land pollution basically is about contaminating the land surface of the Earth through dumping urban waste matter indiscriminately, dumping of industrial waste, mineral exploitation, and misusing the soil by harmful agricultural practices. Land pollution includes visible litter and waste along with the soil itself being polluted. The soil gets polluted by the chemicals in pesticides and herbicides used for agricultural purposes along with waste matter being littered in urban areas such as roads, parks, and streets.

### **Land Pollution Comprises Of: Solid Waste and Soil Pollution**

**Solid Waste:** Semisolid or solid matter that are created by human or animal activities, and which are disposed because they are hazardous or useless are known as solid waste. Most of the solid wastes, like paper, plastic containers, bottles, cans, and even used cars and electronic goods are not biodegradable, which means they do not get broken down through inorganic or organic processes. Thus, when they accumulate they pose a health threat to people, plus, decaying wastes also attract household pests and result in urban areas becoming unhealthy, dirty, and unsightly places to reside in. Moreover, it also causes damage to terrestrial organisms, while also reducing the uses of the land for other, more useful purposes.

Some of the sources of solid waste that cause land pollution are:

Wastes from Agriculture: This comprises of waste matter produced by crop, animal manure, and farm residues.

Wastes from Mining: Piles of coal refuse and heaps of slag.

Wastes from Industries: Industrial waste matter that can cause land pollution can include paints, chemicals, and so on.

Solids from Sewage Treatment: Wastes that are left over after sewage has been treated, biomass sludge, and settled solids.

Ashes: The residual matter that remains after solid fuels are burned.

Garbage: This comprises of waste matter from food that are decomposable and other waste matter that are not decomposable such as glass, metal, cloth, plastic, wood, paper, and so on.

**Soil Pollution:** Soil pollution is chiefly caused by chemicals in pesticides, such as poisons that are used to kill agricultural pests like insects and herbicides that are used to get rid of weeds. Hence, soil pollution results from:

- . Unhealthy methods of soil management. .
- Harmful practices of irrigation methods.

Land pollution is caused by farms because they allow manure to collect, which leaches into the nearby land areas. Chemicals that are used for purposes like sheep dipping also cause serious land pollution as do diesel oil spillages.

### **What are the Consequences of Land Pollution?**

Land pollution can affect wildlife, plants, and humans in a number of ways, such as:

- Cause problems in the respiratory system
- Cause problems on the skin
- . Lead to birth defects
- Cause various kinds of cancers

The toxic materials that pollute the soil can get into the human body directly by:

- . Coming into contact with the skin
- Being washed into water sources like reservoirs and rivers
- . Eating fruits and vegetables that have been grown in polluted soil
- . Breathing in polluted dust or particles

### **How can Land Pollution be Prevented?**

- . People should be educated and made aware about the harmful effects of littering .
- Items used for domestic purposes ought to be reused or recycled
- Personal litter should be disposed properly
- . Organic waste matter should be disposed in areas that are far away from residential places . Inorganic matter such as paper, plastic, glass and metals should be reclaimed and then recycled

## UNIT VI

### CLIMATIC CHANGE AND GLOBAL WARMING

Carbon di-oxide is a natural constituent of atmosphere, but now, its concentration is increasing at an alarming rate. According to an estimate, CO<sub>2</sub> level is expected to be doubled by 2030 A.D.

The term „Green House Effect“ is also called as „Atmospheric Effect“, „Global Warming“ or „CO<sub>2</sub> Problem“.

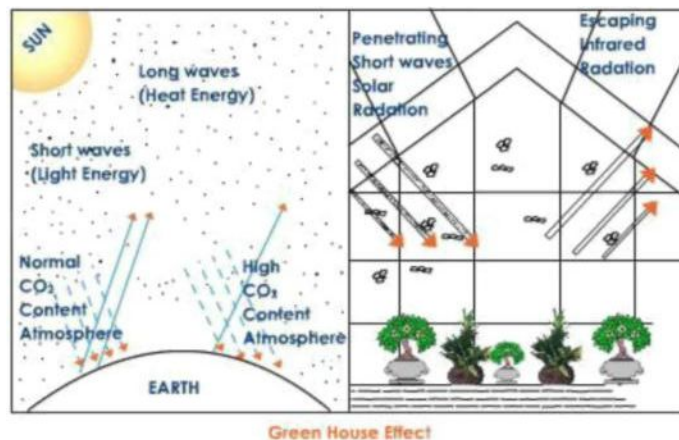
Human activities are changing the composition as well as behaviour at an unprecedented rate. The pollutants from a wide range of human activities are increasing the global atmospheric concentration of certain heat trapping gases, which act like a blanket, trapping close to the surface that would otherwise escape through the atmosphere to the outer space. This process is known as „Green House Effect“. Green House is that body which allows the short wave length incoming solar radiation to come in, but does not allow the long wave outgoing terrestrial infra red radiation to escape. The progressive warming up of the earth's surface due to blanketing effect of manmade CO<sub>2</sub> in the atmosphere is called „Green House Effect“. (Figure 1).

The four major green house gases, which cause adverse effects are CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and CFC's. Among these CO<sub>2</sub> is the most common and important green house gas. In addition, ozone and SO<sub>2</sub> are also act as serious pollutants in causing global warming.

#### **Green House Effect**

Green house is usually a type of glasshouse used for raising tender plants. Air inside the green house is usually warmer than the outside, though it receives less solar radiation due to the carbon dioxide present inside, produced by plants (by respiration). This is called 'green house effect'.

In nature, gases like carbon dioxide, methane and water vapour are called 'green house gases' because these absorb the long wavelength infrared radiations emitted by the earth's surface. Dust and clouds also prevent the dissipation of these heat radiations, so also exert green house effect. Certain human activities have resulted in increased production of carbon dioxide leading to its increased concentration in the atmosphere. This has lead to disturbances in the climatic conditions of the environment and has caused conditions which may melt away polar as well as alpine ice resulting in 18 - 20 meters rise in sea level and submerge vast areas of land.



## Sources

A number of industrial as well as agricultural operations generate and emit waste gases into the atmosphere. Burning of fossil fuel emit CO<sub>2</sub>, growing paddy, or live stock releases methane. The use of aerosols and coolants in refrigerators and air conditioning devices or sprays releases chlorofluorocarbons into the atmosphere. These gases create a canopy in the atmosphere and trap the solar radiation reflected back from the earth's surface leading to atmospheric and climatic changes.

## Green House Effect on Global Climate

A huge amount of CO<sub>2</sub> gets introduced into the environment from furnaces of power plants, fossil fuel burning, vehicular exhaust and breathing of animals, but the ocean may not be able to absorb this increased CO<sub>2</sub> and the plants also cannot utilize the whole during photosynthesis. So, much of CO<sub>2</sub> is still left in the atmosphere, which is supposed to be responsible for increasing the atmospheric temperature.

As a result of rise of temperature of earth, the oceans get warm up and sea level would rise flooding low lying regions. A slight increase in sea level could have profound effects on habitation and coastal land. In temperate regions, the winter will be shorter and warmer and the summer will be longer and hotter. A warmer climate is likely to make some cities extremely hot. There will be enormous increase in rainfall, but the problem of desertification, drought and soil erosion will further worsen. The most obvious effect of climate change will be on agriculture. Because CO<sub>2</sub> is a natural fertilizer, the plants will grow larger and faster with increasing CO<sub>2</sub> in the atmosphere. The abnormal fast growth results in increase of yield but the soil fertility goes down at a very fast rate.

Scientists believe, the average global temperature will be higher than ever in the past thousand years.

The global warming trend can cause significant climatic changes. Human society is highly dependent on the earth's climate pattern and human adaptations determine the availability of

food, fresh water and other resources for sustaining life. The social and economic characteristics of a society have also been shaped largely by adapting to the seasonal and year to year patterns of temperature and rainfall.

Some potential effects associated with the enhanced green house effect and the associated global warming is as follows.

### **Water Resources**

Due to changes in precipitation pattern and increased evaporation the quality and quantity of water available for drinking, irrigation, industrial use, electric generation, aquatic life, etc., are significantly affected.

### **Coastal Resources**

An estimate of 50 cm rise in sea level by the year 2100, could inundate more than 8000 Km of dry land.

### **Health**

Changing pattern of temperature and precipitation may produce new breeding sites for pests, shifting the range of infectious diseases. Heat stress mortality could increase due to higher temperature over longer periods.

### **Oceans**

Oceans can provide sources for the increased water vapour because of the earth's increased temperature. On the other hand, the thermal holding capacity of the oceans would delay and effectively reduce the observed global warming. In addition, oceans play an important role in the global green house gas budgets. The ocean biota, primarily phytoplankton is believed to remove at least half of the anthropogenic CO<sub>2</sub> added to the atmosphere. The ocean sink of CO<sub>2</sub> is called „Biological CO<sub>2</sub> Pump“.

### **Vegetation**

Vegetation changes due to climatic change would affect the hydrologic cycle. The biggest impact of CO<sub>2</sub> induced climatic change would be changing precipitation form lead to overall lower rainfall amount or drought during growing season with increased frequency and severity. However, the rise in atmospheric CO<sub>2</sub> should cause increase in photosynthesis, growth and productivity of the earth's vegetation. Thus the change in climate on vegetation has less adverse impact. Higher temperature could increase forest susceptibility to fire, disease and insect damage.

### **Clouds and Water Vapour**

Global warming will lead to an increase in the amount of water vapour in the atmosphere and because water vapour is a powerful green house gas, lead to an increase into the warming. However, tropical storm clouds reach higher in the atmosphere under warmer conditions. Then the clouds would produce more rain thus adding less water vapour to the middle troposphere.

### **Sea Ice**

Increased temperature would tend to melt ice and result in increased absorption of solar energy



by the ocean. However, a decrease in sea ice would also lead to larger heat fluxes from the ocean to the atmosphere. Thus, the interaction among the atmosphere, the ocean, sea ice and the interaction of sea ice to climate change need to be observed and quantified.

### **Global Climate**

It is even postulated by scientists that melting of glaciers and the release of the resultant cold water in large quantities could affect the major sea currents in the Atlantic Ocean. The ocean currents of Atlantic in fact, act as a heat conveyer of the planet regulating the global climate. If the heat conveyer is interrupted, the northern hemisphere would plunge into an ice age and the southern hemisphere will be facing severe drought.

In general, global warming is likely to make the weather more unpredictable in the coming years.

### **Prevention of Global Warming**

The major steps to be taken for the reduction of green house gases includes, improving the energy efficiency of electric generation, as well as switching to less polluting fossil fuels. Following are some of the suggestions to prevent global warming.

Reduction and elimination of green house gases emission that is disturbing the climate. Clean electricity technologies including wind turbine, solar panels and hydrogen fuel cells are continually improving, becoming more efficient, economical and capable of competing with polluting gas and coal power plants.

Biofuels including ethanol and bio-diesel could substantially cut down the CO<sub>2</sub> emission from automobiles.

Sustainable farming and forestry techniques look up carbon in plants and soils and provide new revenues to rural communities.

Besides protecting the climate, CO<sub>2</sub> emission control techniques dramatically reduce air pollution provide communities with higher quality of life and climate.

Conservation and produce energy that causes no environmental damage with cost less than building new power plants. They lower electricity bills and reduce constraints on energy systems.

### **Kyoto Protocol**

The Kyoto protocol is a legally binding international agreement to reduce green house gas emissions. It was initially negotiated during a meeting held at Kyoto, Japan in 1977. The protocol commits in industrialized countries to reducing emissions of six green house gases by 5% before 2012.

### **Global Dimming**

In contrast to global warming there is another phenomenon called „Global Dimming“. Scientists have observed that 2-4% reduction in the amount of solar radiation reaching the earth's surface,

due to increase in cloud cover aerosols and particulates in the atmosphere. Higher temperature leads to an increased cloud cover. The scattered light through the clouds boosts the plant's adsorption of CO<sub>2</sub> and photosynthesis process. Thus global dimming is a process working against global warming to some extent.

## POPULATION GROWTH

Anthropologists believe the human species dates back at least 3 million years. Our distant ancestors lived a precarious existence as hunters and gatherers. This way of life kept their total numbers small (<10 million). After agriculture was invented, communities evolved that could support more people. World population expanded to about 30 crore by A.D.1 and continued to grow at moderate rate. But after the beginning of the industrial revolution, the living standards rose and wide spread famines and epidemics diminished in some regions and population growth accelerated. The population climbed to about 76 crore in 1750 and reached 100 crore around 1800. In 1800, the vast majority of the world's population (86%) resided in Asia (65%) and Europe (21%). In 2000, the world had 610 crore human habitants. This number could rise to more than 900 crore in the next 50 years. For the last 50 years world population multiplies more rapidly than ever before.

Improved medicine, sanitation and nutrition have produced a major decline in death rates. Throughout the 20<sup>th</sup> Century, it has occurred in developing countries with astonishing speed. Birth rate (number of live births / 1000 population / year) have also been falling in most of the Western Countries now. In South Asia and Africa, birth rates remain quite high. Endemic poverty, low levels of education and weak family planning programmes have kept the average number of children born to each women is over six. But even here there has been some progress. The world population adds more than quarter million people daily and this rapid growth is placing enormous pressure on environment. The US population has doubled from 135 million to more than 270 million during last 60 years. China's population is 1.2 Billion and despite the government policy of permitting only one child per couple, it is still growing at an annual rate of 1.1%.

India has nearly 1 Billion people living on approximately 1/3 of the land of either to US or China. India's current population growth rate (number of persons added / subtracted from a population in a year due to natural increase and net migration expressed as percentage of population at the beginning of the time period) is 1.9%.

The increase in average life expectancy has led to the population of older people to grow at a rate of 2.8% per year world wide. A parallel trend has been a reduction in fecundity and fertility and so the overall population growth has been less only 1.6% per year. The consequences is an ageing (trend of more people to live to reach old age while fewer children are born) society with a proportionately high number of older people.

Poverty, low literacy and education levels among women, lack of consistent support from government, poor planning and bureaucratic inefficiency are some of the reasons why family planning programme has not been a big success.

Environmental Implications of Population Growth

Population growth and urbanization will place a greater pressure on natural resources, but there are eco-friendly alternatives that could mitigate the problem to certain extent.

Rapid population growth will overstress the earth's natural resources and crowd out undomesticated plant and animal species. All people want to be fed, clothed, housed and have access to clean water. To meet these requirements, water, land, forest and other natural resources must be exploited to some degree. As population increases, more resources are needed to meet the basic requirements. More forest must be cut down to provide wood for housing and fuel. More cleared land is needed for agriculture and development. All of these are finite. More than 99% of the world's food supply comes from the land, while less than 1% from oceans and other aquatic habitats. The continued production of an adequate food supply is directly depended an ample fertile land, fresh water, energy, plus the maintenance of biodiversity. As the human population grows, the requirements for these resources also grow. Even if these resources are never depleted, on a per capita basis they will decline significantly because they must be divided among more people.

At the same time as people consume these resources, they produce waste that is put back into the air, land and water. The greater amount of waste from larger populations put more stress on ecosystems.

It is true that the highest population growth rates are found the developing countries. However, because affluent countries consume more resources, they remain the primary contributors to certain global environmental problems like global warming. The G7 nations, the US, Canada, Britain, France, Germany, Japan and Italy represents only 10% of global population but consumes 40% of fossil fuels as well as forest commodities. Because consumption rates are so high in these countries, even small increase in population can have a significant impact.

As the world population continues to grow geometrically, great pressure being placed an agriculture lands, water, energy and biological resources. According, the World Bank and the U.N., from 1-2 billion humans are now malnourished indicating a combination of insufficient food, low income and inadequate distribution of food. In China, about 80 million are now malnourished and hungry. It is reported that there is an imbalance between population growth and resources.

Water is critical for all crops which require large amount of water during their growing season. For example, a hectare of corn will require more than 5 million litres of water during one growing season. This means that more than 8 million litres of water per hectare must reach the crop. In total, agricultural production consumes more fresh water by agriculture. Competition for water resources among individuals, regions and countries is already occurring with the current world population. In China, where more than 300 cities already short of water, these shortages are intensifying. Water resources, are under great stress as populous cities, states and

countries require and withdraw more water from rivers, lakes and aquifers. Every year, a major threat to maintaining future water supplies is the continuing over-draft of surface and groundwater resources.

Diseases associated with water, rob people's health, nutrients and livelihood. This problem is more serious in developing countries.

Fossil energy is another prime resource used for food production. Nearly 80% of the world's fossil energy used each year is used by the developed countries and part is expended in producing high animal protein diets. The intensive farming technologies of developed countries use massive amounts of fossil energy for fertilizer, pesticides, irrigation, etc., as a substitute for human labour. In general, developing countries have been relying heavily on fossil energy, especially for fertilizers and irrigation to augment their food supply.

In addition, we must keep in mind the environment, population and economic problems of developing countries often have global effects. It is in the interest of industrial nations to help poorer countries to pursue comprehensive development efforts to reduce poverty and lower birth rates. Moreover, because many technologies and consumption patterns that originate in industrial nations spread to the rest of the world, these countries have a responsibility to develop environmentally friendly technologies and sustainable consumption pattern.

## **URBANIZATION**

In the last four decades, the population of India has increased at a very rapid rate and has more than doubled. The spread of urbanization and the rapid expansion of urban countries across the country have in the absence of basic infrastructure, created vast urban slums. The estimate of the proportion of urban people living in slum varies from 20% to 30% of the population of the urban centers. Each day almost 15,000 people move into urban areas from villages resulting in 25-50% of population of the country live in crowded densely populated cities and major towns.

The presence of migrants combined with poor civic amenities in the urban areas creates low living standards for slum dwellers. Improper and inadequate management of urban waste has led to the prevalence of unhygienic conditions that create a breeding ground for all manner of epidemics.

However, avoidance of slum creation totally impossible as the city master plan implementation becomes impossible, as all rules and regulations of city planning gets violated. It is very difficult to create sufficient infrastructure within a short interval of time. This ends up with formation of slums, where individual houses do not have proper latrines and not even public tap or borewell water supply system provided for thousands of slum dwellers.

There are a number of schemes designed to improve urban infrastructure such as centrally assisted programmes for construction of individual and community latrines. There are schemes for water supply to small towns with population less than 20,000. Initiatives create infrastructure for the urban poor include, schemes to provide drinking water, drainage and

lighting to notified slums. The urban basic service schemes – 1986 promotes women and child development, low cost water supply and sanitation. A programme for environmental improvement of urban schemes was introduced in 1974.

## **AUTOMOBILE POLLUTION**

The automobile is the symbol of modern science and technology and is indispensable for transporting goods and people.

When fuel like kerosene, diesel, petrol burn a lot of smoke is released into the atmosphere. These fuels are all mixture of various hydrocarbons of different molecular masses and formulae. Of these, octane constitutes a major component of gasoline. Besides pollutant  $\text{CO}_2$ ,  $\text{CO}$ , Unburnt Carbon,  $\text{SO}_2$ , Hydrocarbon, Acids, Alcohols,  $\text{NO}_2$ , etc., enter the atmosphere. Hydrocarbon produce a number of petrochemical oxidants and petrochemical smog which posses physiological damaging effects on human beings.

The private automobile is one of the most desired items of consumption today and demand for it seems insatiable. The automobiles contribute to a wide range of environmental problems like air and noise pollution adding to solid waste, accelerating global warming, taking heavy toll on human life.

At low levels air pollutants irritate the eyes and cause inflammation of the respiratory tract. It can also create skin allergies. Carbon monoxide form automobile emission can cause head ache at lower levels and mental impairment and even death at higher levels. The particulate matter emission can reduce visibility, soil the clothes, corrode metals and erode buildings. On large scale, air pollution leads to acid rain, ozone depletion and global warming.

## UNIT VII

### ENVIRONMENTAL ISSUES CONTENTS

#### ACID RAIN

The term was first coined by ROBERT ANGUS SMITH in the year 1852.

#### What is Acid Rain?

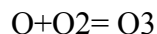
Acid rain is a form of air pollution in which airborne acids produced by electric utility plants and other sources fall to Earth in distant regions. The major contributors, called PRECURSORS to the acid are the common air pollutants, like Sulphur dioxide and Nitrogen oxides. Through a variety of chemical reactions the gases form Sulphuric acid and Nitric acid, which are the two acids responsible for the acid rain.

#### How is acid produced?

Nitric oxide can react with oxygen O<sub>2</sub> to form nitrogen dioxide which can be broken down again by Sunlight(hv) to give Nitric oxide and an oxygen radical (O).

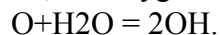


The oxygen radical then enables the formation of Ozone (O<sub>3</sub>)

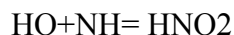


The presence of ozone causes the formation of more nitrogen dioxide by its reaction with nitric oxide.  $\text{NO} + \text{O}_3 = \text{NO}_2 + \text{O}_2$

Or, the oxygen radical reacts with water to give the hydroxyl radical (OH)



This radical then reacts with nitric oxide to give nitrous acid (HNO<sub>2</sub>) and nitrogen dioxide to give nitric acid (HNO<sub>3</sub>). It also combines with Sulphur dioxide to produce Sulphuric acid



#### Where does the 'precursors' come from?

While Nitric oxide and Sulphur dioxide are produced biogenic ally (in nature), there are major anthropogenic (man made) sources of both these polluting gases. Sometimes, natural production of the gases is much higher than human production, but these natural emissions tend to be spread over large area, dispersing their effects, while the man – made emissions are concentrated around the source of their production.

#### Biogenic Sources (Or Natural Sources)

Volcanic eruptions and decay of organic matter produce significant amounts of Sulphur dioxide. Nitrogen oxides are also generated by push fires as well as by microbial process (in Soil) and lightning discharges.

**Anthropogenic Sources (or manmade sources)**

Nitrogen oxides are produced mainly from the burning of fossil fuels such as Diesel and petrol in automobiles and from power stations burning coal.

Sulphur dioxide is formed primarily in the burning of (Sulphur containing) Coal, fossil fuels and in metal smelters.

**How are acids deposited?**

- Acid pollutants are deposited on the ground either in wet form through rain, fog or snow. As dry matter, such as gases or particulates, falling directly from the atmosphere to the ground.
- The term acid deposition describes all these possibilities and therefore – generally preferred to “acid rain”.
- Environmental problems from dry deposition tend to occur closer to the source of the pollution. Wet deposition can occur upto hundreds of kilometer away in a different region or country, because microscopic aerosol droplets can be carried in clouds.

**How can we reduce acid rain?**

- The most effective way to reduce the incidence of acid deposition is to reduce the emission of its causes – The “PRECURSORS”, nitrogen oxides and Sulphur dioxide.

- Nitrogen oxide reduction.

The main method of lowering the levels of nitrogen oxides is by a process known as “Catalytic reduction”. Catalytic reduction is used in Industry & in motor vehicles.

**Example**

In a motor vehicles the Catalytic converter will convert much of the nitric oxide from the engine gases to the nitrogen and oxygen. Nitrogen is not there in the actual fuels or power stations. It is introduced from the air when combustion occurs. Using less air in combustion can reduce emissions of nitrogen oxides.

Temperature also has an effect on emission. Lower the temperature of combustion, lower will be the production of nitrogen oxides.

Temperatures can be lowered by using processes such as two stage combustion and flue gas recirculation water injection or by modifying the design of the burner.

**Sulphur dioxide reduction:**

There are several methods to lower the Sulphur dioxide emission from Coal – fired stations. Simplest of the lot is using Coal with low Sulphur content and physical coal cleaning.

Most Complex is by the process of “FLUE GAS DESULPHURISATION” and “FLUIDISED BED COMBUSTION”.

**Physical coal cleaning:**

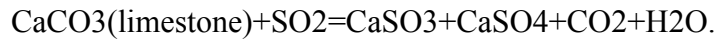
Coal can be cleaned because, Sulphur in Coal is often in the form of mineral impurities (pyrites).



This is achieved by finely crushing the Coal.

Flue gas Desulphurization:

In this method the Sulphur dioxide (flue gas) is absorbed using lime stone. This method is the most effective of removing Sulphur dioxide. The process generates Solid wastes (Calcium Sulphate,  $\text{CaSO}_3$  and  $\text{CaSO}_4$ ) which require disposal.



Fluidized bed combustion

In this process, coal is crushed and passed into a fluidized “bed” for combustion.

The bed consists of fine particles of an absorbent material such as lime stone. Hot air is passed through it and this causes the particles to behave as though they are a fluid.

The sulphur dioxide can then be absorbed by the lime stone particles in the bed.

Fluidized bed combustion can be operated at lower temperatures and therefore produce less nitrogen oxide, but once again, solid waste is created and requires disposal.

### **What is affected by acid rain?**

The acids in the acid rain can react chemically with any object they contact. Acids are corrosive chemical that react with other chemical by giving up hydrogen atoms. Acid rain or acid deposition has an adverse effect on environmental eco system as well as humans, animals, buildings, textiles etc.

**Soil:** Acid rain dissolves in Soil and washes away nutrients needed by the plants. It can also dissolve toxic substances such as aluminum & mercury, releasing these toxins to pollute water or to poison plants that absorb them.

**Trees:** Removal of useful nutrients from the soil, acid rain slows the growth of plants, particularly trees. It also attacks trees more directly by eating holes in the waxy coating of needles & leaves, causing brown dead spots.

Acid rain has been blamed for the decline of Spruce forests on the highest ridges of Apalachian Mountains in the eastern United States. In the black forest of South Western Germany, half of the trees are damaged from the acid rain.

**Agriculture:** Most farm crops are less affected by acid rain than the forest. Farmers can prevent acid rain damage by monitoring the condition of the soil and, when necessary, adding crushed lime stone to the soil to neutralize acid.

**Surface water:** Acid rain falls into streams, lakes and marshes. Due to this the water life is destroyed. All Norway’s major rivers have been damaged by acid rain, severely reducing the fish life.

**Plants and Animals:** The effects of acid rain on wild life can be far reaching, if a population of one plant or animal is adversely affected by acid rain, animals that feed on that organism may also suffer ultimately an entire ecosystem may become endangered. Land animals dependent on aquatic organisms are also affected.



**Man made structure:** Acid rain and dry deposition of acidic particles damage building, statues, automobiles, and other structures made of stone metal or any other material exposed to weather for long periods. Parthenon in Greece and the Taj- Mahal in India, are deteriorating due to acid deposition.

**Human health:** Acidification of Surface water cause little direct harm to human health, it is safe to swim in even the most acidified lakes.

**In the air:** acids join with other chemicals to produce urban smog, which can irritate the lungs an make breathing difficult, especially for people with respiratory diseases. Solid particles of sulphates can damage the lungs.

Acid rain and Global warming: Acid pollution has one surprising effect that may be beneficial. Sulphates in the upper atmosphere reflect some sunlight out into the space, and thus tend to slow down global warming.

## **OZONE LAYER DEPLETION**

Ozone layer was discovered by a French physicist CHARLES FABRY and HENRI BUISSON in 1913.

Its properties were explored in detail by G.M.B.DOBSON, a British Meteorologist.

Dobson established a worldwide network of ozone monitoring stations which operate even today.

The total amount of zone in a column overhead is measured in “DOBSON Unit” (DU), 1DU=0.01mm

Ozone layer a region of the atmosphere from 19 to 48 km above the earth’s surface.

Although the concentration of ozone in the ozone layer is very small, it is vitally important to life because it absorbs biologically harmful ultra violet (UV) radiation emitted from the Sun.

UV radiation is divided into three categories basd on its wave length, ie., UV-A, UV-B, UV-C.

Most of the UV-A (315 to 400nm) reaches the surface this radiation is significantly less harmful, although it can potentially cause genetic damage.

UV-B (280 to 315nm) radiation is the main cause of Sun burn, excessive exposure can also cause genetic damage, resulting in problems such as Skin cancer. It rapidly damages biota of all types. UV-C < 280nm, the ozone layer is very effective at screening out UV-B, for radiation with a wave length of 290nm, the intensity at Earth’s surface is 350 million times weaker at the top of the atmosphere.

### **Stratospheric Ozone layer:**

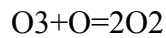
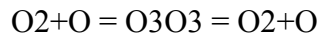
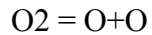
Atomic oxygen O, oxygen molecules O<sub>2</sub> and Ozone O<sub>3</sub> are involved in the ozone – oxygen

cycle.

Ozone is formed in the Stratosphere when oxygen molecules dissociate after absorbing the ultraviolet photon whose wave length is shorter than 240nm.

This produces two oxygen atoms. The atomic oxygen then combines with O<sub>2</sub> to create ozone O<sub>3</sub>

Ozone molecules absorb UV light between 310 and 200nm, following which ozone splits into a molecule of O<sub>2</sub> and O. The process O<sub>3</sub> generation and splitting repeats as per the equations below.



Under normal conditions the creation and destruction of ozone molecules is roughly constant and ultimately result in effect absorption

Of short wave length ultraviolet radiations in the stratospheric region.

Life underneath is thus protected from the harmful solar radiations.

The average thickness of ozone layer in stratosphere is approximately 300DU.

**Ozone hole:** Certain human produced pollutants lead to destroy the stratosphere ozone and causing an imbalance between formation and dissociation of ozone. This decrease in the ozone level is called depletion or thinning of ozone layer or zone hole.

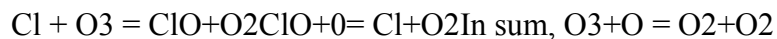
#### **Cause of Ozone depletion:**

Ozone can be destroyed by a number of free radical catalyst, like hydroxyl (OH), the nitric oxide (NO), atomic chlorine (Cl) and Bromine (Br).

All of these are generated by both natural and anthropogenic (man made) sources.

At present most of the OH and NO in the stratosphere is of natural origin, but human activity has dramatically increased the chlorine and bromine.

- These elements are found in certain stable organic compounds, particularly chlorofluorocarbons (CFCs).
- Once in the stratosphere, the Cl and Br atoms are liberated from the parent compounds by the action of ultra violet light and can destroy ozone molecules in a catalytic cycle.



Final result is an oxygen molecule and a chlorine atom, which then reinitiates the cycle.

- A Single chlorine atom would keep on destroying ozone for up to two years. On a per atom basis, bromine is even more efficient than chlorine at destroying ozone, but there is much less bromine in the atmosphere. As a result both chlorine and Bromine contribute significantly to the overall ozone depletion.
- CFCs were used in air – conditioning / cooling units as aerosol spray propellants prior to the 1980s and in the cleaning process of electronic components.
- CFCs when reach the Stratosphere, are dissociated by ultraviolet light to release chlorine atoms.
- The chlorine atoms act as Catalyst, and can breakdown many thousands of ozone molecules before removed from the Stratosphere.
- It is calculated that CFC molecules takes an average of 15 years to go from Ground level up to the upper atmosphere, and it can stay there for about a century, destroying up to one hundred thousand ozone molecules during that times.
- The Antarctic ozone hole is an area of the Antarctic Stratosphere in which the recent ozone levels have dropped to as low as 33% of their Pre- 1975 values.
- The ozone hole occurs during the Antarctic spring, from September to early December, as strong westerly winds start to circulate around the continent and create an atmospheric container, within this “polar vortex”, over 50% of the lower stratospheric ozone is destroyed during the Antarctic spring.
- The overall cause of ozone depletion is the presence of chlorine – containing source gases (primarily CFCs and related hydrocarbons). In the presence of UV light, these gases dissociate releasing chlorine atoms, which then go on to catalyze ozone destruction. The chlorine catalyzed ozone depletion can take place in the gas phase, but it is dramatically enhanced in the presence of polar stratospheric clouds (PSCs)
- Most of the ozone that is destroyed is in the lower stratosphere. Warming temperatures near the end of Spring break up the vortex around mid – December.  
As warm ozone – rich air flows in from lower latitudes, the PSCs are destroyed, the ozone depletion process shuts down, and the ozone hole heals.
- The decrease in the ozone layer was predicted in the early 1980s to be roughly 7% over a sixty – year period.

The term Ozone depletion for distinct but related, observations: a slow decline (about 3% per decade) in the total amount of ozone in the earth's stratosphere and much larger, but seasonal, decrease in Stratospheric ozone over the earth's polar regions during the same period. Cause of both trends is believed to be the Catalytic destruction of ozone by atomic chlorine and bromine.

The reactions that take place on polar stratospheric clouds (PSCs) are of great importance. The PSCs only form in extreme cold. The Antarctic stratosphere is colder than the Arctic, and the PSCs form more readily, which is the reason for ozone hole formation over Antarctic. This is why the Arctic zone holes are not as deep. In middle latitudes declines are about 3% below pre-1980 values for 35-60N and about 6% for 35-60S. In the tropics, there are no significant trends.

**Consequences of Ozone depletion:**

- Since the ozone layer absorbs UV-B light from the Sun, ozone layer depletion is expected to increase surface UV-B levels, which could lead to damage, including increase in skin cancer.
- Scientists have estimated that a one percent decrease in Stratospheric ozone would increase the incidence of skin cancers by 2%
- A direct correlation has been observed between cataract formation in eyes and UV radiations.
- An increase of UV radiation would also affect crops like rice.
- At ground level ozone is generally recognized to be a health risk, as ozone is toxic due to its strong oxidant properties
- Presently, ozone at ground level is produced mainly by the action of UV radiation as exhaust gases, from vehicles.
- Lower trophic level organisms shall be the worst sufferers as they have a simple cell wall for their protection against UV radiation. With the primary trophic levels drastically impaired the entire ecosystems could collapse.

**Current events and future trends.**

- In 1994 UN General Assembly voted to designate September 16 as “World Ozone day”.
- A 2005 IPCC summary of ozonic issue observed that global average amount of ozone depletion is now approximately stabilized.
- The thickness of the ozone layer over Europe which has decreased by 8% since the 1980s has now slowed down to about 4% a decade. The Antarctic ozone hole reached its largest ever size in September 2000 at 11.5 million Square miles.

**ANIMAL HUSBANDRY**

- Animal husbandry or live stock implies the breeding, feeding and managing animals for the production of food, fiber, work and pleasure.
- Animals furnish about 28% of the world's total value of agricultural products. They supply a much higher proportion of human food in the developed countries than elsewhere.
- Traditional husbandry practices are closely associated with the degree of control needed over the animals that are kept and with the uses to which they are put.

**Types of Livestock**

The term “livestock is vague and may be defined narrowly or broadly.

Domesticated animals such as cows, pigs, deer, goats, sheep, horses, donkeys, chickens, yaks are livestock's. Hence the definition of livestock includes mammals and birds.

On a broader view, “livestock” could incorporate the international rearing of butterflies, silk & honey bees.

Purpose of Animal husbandry

- Meat: The production of a useful form of dietary, protein & energy.
- Dairy products: Mammals can be used as a source of Milk, which can be turned into various dairy products.
- Using such livestock can often yield several times the food energy of slaughtering the animal

outright.

- Fiber: Livestock produce a range of fiber or textile, Example: Sheep, can make leather, etc.
- Fertilizer: Manure can be spread on fields to increase crop yields. Manure is also used to make plaster for walls and floors and can be used as fuels for fires.
- Labour: Animals such as horses, donkies, yaks can be used for transportation of men & material, Agricultural purposes & even in military.
- Land management: The grazing of livestock is used to control weeds etc.

### **Impacts of Animal Husbandry on Environment:**

•If livestock are very large in numbers or unnaturally concentrated numbers, their most basic needs can place burdens on ecosystems. However, such environmental impacts can be eliminated or lessened by regulating the number of animals in a given area and other animal husbandry techniques.

•Impacts of animal husbandry on environment can be summarized as follows:

**On vegetation:** animal husbandry causes unfavorable changes in vegetation composition and structure as a result of overgrazing. Damage by animals can cause soil erosion, while roughening up of the ground can also create better conditions for germination & hence of plant regeneration.

**On global warming:** Methane is a major green house gas. The annual global generation of methane from ruminants accounts for 15% of total amount released into the atmosphere. This rate is increasing steadily at 1% per year. It is interesting to note that cattle produce methane 2 to 3 times more than that from the ruminants.

**On water sources:** Inadequately protected wells and watering places can easily be contaminated by animal waste, which is a big health risk.

Proper care should be taken in controlling the quantity of liquid & solid fertilizers, so that the positive effects on soil fertility & soil structure are enhanced.

**On soil:** Fodder growing within a crop rotation system can have positive effects on soil structure & soil fertility. However, when mineral fertilizers and herbicides are used in fodder production, surface water & ground water may get contaminated.

## UNIT VIII

### ENVIRONMENTAL LEGAL ASPECTS

#### ENVIRONMENTAL PROTECTION ACTS

##### Introduction

Constitution of India has a number of provisions demarcating the responsibility of the central and state government towards „Environmental Protection“. The state’s responsibility has been laid down under article 48-A which reads as follows, “the state shall endeavor to protect and improve the environment and safeguard the forests and wildlife of the country”. Environmental protection has been made a fundamental duty of every citizen of this country under article 51-A(g) which reads as “it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures”. Article 21 reads as, “no person shall be deprived of his life or personal liberty except according to procedure established by law”.

##### Definition of Environment under Indian Law

According to section 2(a) of Environmental Protection Act (1986), „Environment“ includes, (i) water, air and land, (ii) the interrelationship which exists among and between, (a) water, air and land and (b) human beings, other living creatures, plants, micro-organisms and property.

Various statutes / legislations are enacted in India exclusively for Environment Protection are,

- (a) The Water (Prevention and Control of Pollution) Act, 1974
- (b) The Air (Prevention and Control of Pollution) Act, 1981
- (c) The Environmental Protection Act, 1986
- (d) The Forest Conservation Act, 1980
- (e) The Wild Life Protection Act, 1972
- (f) The Public Liability Insurance Act, 1991, etc.

##### Water Pollution Act

The objective of the Water Prevention and Control of Pollution Act was to provide for the

prevention and control of water pollution and maintaining or restoring of wholesomeness of water for the establishment with a view to carrying out the purpose aforesaid, of boards for the prevention and functions relating thereto and for matters connected therewith.

### **Functions of Central Board**

- (a) Promote cleanliness of streams and wells in different areas of the state.
- (b) Advise the central government on any matter concerning the prevention and control of water pollution
- (c) Co-ordinate the activities of the state boards and resolve disputes among them.
- (d) Provide technical assistance and guidance to the state board, carryout and sponsor investigations and research relating to problems of water pollution.
- (e) Organize through mass media, a comprehensive programme regarding the prevention and control of water pollution.
- (f) Collect, compile and publish technical and statistical data relating to water pollution and the measure devised for its effective prevention and control and prepare manuals, codes regarding the treatment and disposal of sewage and trade effluents.
- (g) Establish and recognize a laboratory to enable the board to perform its functions under this section effectively, including the analysis of samples of water from any stream or well of samples of any sewage or trade effluents.

### **Functions of State Board**

- (a) To plan a comprehensive programme for the prevention, control or abatement of pollution of stream and wells in the state and to secure the execution there of.
- (b) To advise the state government on any matter concerning the prevention, control or abatement of water pollution
- (c) To collect and disseminate information relating to water pollution, prevention, control or abatement of water pollution.
- (d) To encourage, conduct and participate the investigations and research relating to problems of water pollution.
- (e) To collaborate with central board in organizing the training of persons engaged in programmes relating to water pollution, prevention, abatement and treatment.

- (f) To inspect effluent treatment plants trade waste and domestic waste.
- (g) To lay down, modify standard for trade and domestic wastes.
- (h) To evolve economical and reliable methods of treatments, utilization of treated effluent for agriculture and disposal into land.
- (i) To lay down standards of treatment of sewage and trade effluents to be discharged into a stream during dry weather flow.
- (j) To advise state government with respect to the location of any industry the carrying on which is likely to pollute a stream or well.

### **Importance of Section 24 of Water Act, 1974**

No person should knowingly cause or permit any poisonous, noxious or polluting matter determined in accordance with such standards as may be laid down by the state board to enter into any stream or well or sewer or on land.

However, a person shall not be party of an offence under subsection (1), by reason only of having done or could to be done by any of the following acts namely;

- (a) Constructing bridge, weir, dam, sluice, dock, pier, drain or sewer or other permanent works which he has a right to construct, improve or maintain.
- (b) Depositing any material on the bank or in the bed of any stream for the purpose of reclaiming land or for supporting repairing or protecting the bank or bed of such stream provided such materials are not capable of polluting such streams.
- (c) Polluting into any stream by any sand or gravel or other natural deposit which has flowed from or been deposited by the current of such stream.

Whoever contravention of provisions of section (24) shall be punishable with imprisonment upto six years and with fine. Even the municipality corporation, companies, government departments also be prosecuted under water act. Varieties of powers are given to the central / state boards to make application to courts for restrains apprehended pollution of water in streams and wells.

### **Air (Prevention and Control of Pollution) Act, 1981**

„Air Pollution” means the presence in the atmosphere of any air pollutant. Air pollution means any solid, liquid or gaseous substances (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or



plants or property or environment.

The objective of the Act is to provide for the prevention, control and abatement of air pollution for the establishment with a view to carrying out the aforesaid purpose of boards for conferring on and assigning to such boards powers and functions relating there and for matters connected therewith.

### **Functions of Central Board**

The main function of the central board as specified in Section 16 of the act shall be to improve the quality of air and to prevent, control or abate air pollution in the country.

- (a) Advice to central government on any matter related to air quality
- (b) To execute nation wide awareness programme
- (c) Co-ordinate with state boards and resolve disputes among them
- (d) To provide technical assistance and guidance to state boards
- (e) Sponsor research and investigation regarding problem of air pollution
- (f) Collect technical and statistical data to prepare manuals, code, guide related to air.
- (g) To lay down standards for the quality of air.

### **Importance of Various Section of Air Act**

**Section 19** – Declaration of air pollution control area

**Section 10** – Lays down the standards for emission of air pollutants from automobiles

### **Penalty for Contravention of Certain Provision of the Act**

Whoever contravenes any of the provisions of this act or any order or direction issued there under for which no penalty has been elsewhere provided in this act shall be punishable with imprisonment for a term which may extend to 3 month or with a fine extend to Rs. 10,000/- or with both.

Both companies and government departments are also prosecuted under the Air Act.

No court shall take cognizance of any offence except on a complaint made by any person who has given notice of not less than 60 days, in the manner prescribed of the alleged offence and his intention to make a complaint to the board.

**Environmental Protection Act, 1986 (EPA)**

Terms like „Environment“, environmental pollutants, environmental pollution and hazardous substance defined under EPA 1986.

- (a) „Environment“ includes water, air and land and the interrelationship which exists among and between them and human beings, other living creature, plants, micro-organisms and property.
- (b) „Environmental Pollutant“ means any solid, liquid or gaseous substances present in such concentration as may be or tend to be injurious to environment.
- (c) „Environment Pollution“ means the presence in the environment of any environmental pollutants.
- (d) „Hazardous Substance“ means any substance or preparation which by reason of its chemical or physico-chemical properties or handling is liable to cause harm to human beings, other living creatures, plants, micro-organisms, property of the environment.

**General Powers of the Central Government under EPA**

Subject to the provisions of the act, the central government shall have power to take all such measures as it seems necessary or expedient for the purpose of protecting and improving the quality of the environmental pollution.

In particular and without prejudice to the generality of the provisions of sub-section (1) such measures may include measures with respect to all or any of the following matters.

- (a) Co-ordination of actions by the state government officers.
- (b) Planning and execution of nation wide programme on „Environmental Pollution“.
- (c) Laying down standards for emissions or discharge of environmental pollutants from various sources whatsoever.
- (d) Laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution.
- (e) Laying down procedures to safeguard hazardous substances.
- (f) Examination of such manufacturing process, materials and substances as are likely to cause environmental pollution.
- (g) Carrying out and sponsoring investigation and research.

- (h) Inspection of the premises, plants, equipment, machinery, manufacturing or other processes, material or substances.
- (i) Establishment or recognition of environmental laboratories and institutions to carry out function entrusted to them.
- (j) Preparation of manuals, codes, guides, etc.

**Section 4** – Appointment of officers and their powers and functions

**Section 5** – Power to give directions

**Section 6** – Rules to regulate environmental pollution

Under EPA pollution of land and soil is also covered. Penalties for violation under EPA are also listed. Companies and government may also be prosecuted under EPA.

### **The Forests Conservation Act, 1980**

„Non Forest Purpose“ means the breaking up or clearing of any forest, land or portion thereof for the cultivation of tea, coffee, spices, rubber, palms, oil bearing plants, horticultural crops, medicinal plants or plantation crops.

It is well known that breaking up the soil or clearing of the forest land affects seriously reforestation or regeneration of forests and therefore, such breaking up of soil can only be permitted after taking into consideration all aspects of the question, the over all advantages and disadvantages to the economy of the country. Environmental conditions, ecological imbalance that is likely to occur, its effects on the flora and the fauna in the area, etc., it was therefore thought that the entire control of the forest areas should vest in the central government. With that end in view, Section 2 provided that prior approval of the central government should be obtained before permitting the use of the forest land for non-forest purposes.

### **Current Requirements that should be met before declaring an area into a Wild Life Sanctuary / National Park under Forest Act**

- (a) The state government may by notification in the office declare the provisions of their chapter applicable to any forest land or wasteland which is not included in a reserve forest, but which is the property of the government.

- (b) The forest land and waste land included in any such notification shall be called a „Protected Forest“.
- (c) No such notification shall be made unless the nature and extent of the rights of government and of private persons in or over the forest land or wasteland comprised therein have been inquired into and recorded at a survey or settlement, or in such other manner as the state government thinks sufficient.

### **Section 35 - Protection of Forests for Special Purposes**

- 1) The state government may, by notification in the Official Gazette, regulate or prohibit in any forest or wasteland.
- 2) The state government may, for any, such purpose, construct on its own expense, in or upon any forest or wasteland, such work on it thinks fit.
- 3) No notification shall be made under subsection (1) nor shall any work begun under subsection (2) until after the issue of notice to the owner of such forest or land calling on him to show cause, within a reasonable period to be specified in such notice, why such notification shall not be made or work constructed, as the case may be and until such objections, if any and any evidence he may produce in support of the same, have been heard by an officer duly appointed for that purpose and have been considered by the state government.

### **Role of NGO Organization**

=> Creating awareness among people on current environmental issues and their solutions.

=> Being involved in the protection of human right to have a clean environment. =>

Conducting participatory rural appraisal.

=> Transferring information through newsletter, brochures, articles, audiovisuals, etc. =>

Helping the village administrative officials in the preparation, application and execution of projects on environmental protection.

There are more than 10,000 NGOs in India ranging from National Agencies to local groups. The Ministry of Environment and Forests (MOEF) is increasingly extending support to NGO activity and routing many of its own programme through them.

**Environmental Education**

The Environmental Ministry has been organizing National Environmental Awareness Campaigns (NEAC), every year in order to spread the messages of environmental conservation across society. Each year's campaign has a specific theme. The district level programme called Paryavaran Vahini was launched to promote and support for Environmental Legislation in order to ensure compliance.

**Women Education**

Until recently Indian women stood for a significant tradition and culture since the vedic age. However, they are suppressed, neglected and harassed due to gender discrimination. They suffer from malnutrition, education, etc. They are underpaid. Women suffered all sorts of abuse by men.

Now the government has revealed that progress cannot be achieved without adopting women welfare programmes specially women education. So special care (reservations and incentives) has been taken to provide education, health, job and other facilities to women.