ENVIRONMENTAL STUDIES

SYLLABUS

Subject Code: 15CIV18 **I A MARKS: 10**

No. of lecturing hours/week: 2Hrs **Exam hours: 2 Hrs**

Total No. of lecturing hours: 25Hrs **Exam Marks: 40**

Module 1

UNIT I:

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

2 Hours

UNIT II:

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

3 Hours

Module 2

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

3Hours

UNIT VI:

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

3 Hours

Module 3

UNIT V:

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

2 Hours

UNIT VI:

Global Environmental Issues : Population Growth, Urbanization, Land Management, Water & Waste Water Management

3 Hours

Module 4

UNIT VII:

Air Pollution & Automobile Pollution: Definition, Effects – Global Warming, Acid rain & Ozone layer depletion, Controlling measures

3Hours

UNIT VIII:

Solid Waste Management, E - Waste Management & Biomedical Waste Management - Sources, Characteristics & Disposal methods.

2 Hours

Module 5

UNIT IX:

Introduction to GIS & Remote sensing, Applications of GIS & Remote Sensing in Environmental Engineering Practices

2 Hours

UNIT X:

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

3 Hours

Course Objectives:

1. To identify the major challenges in environmental issues and evaluate possible solutions.
2. Develop analytical skills, critical thinking and demonstrate socio-economic skills for sustainable development.
3. To analyze an overall impact of specific issues and develop environmental management plan.

Course Outcome:

Students will be able to,

1. Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
2. Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment,
3. Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components
4. Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues

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
- R.J.Ranjit Daniels and Jagadish Krishnaswamy, (2009), **"Environmental Studies",**
- Wiley India Private Ltd., New Delhi.
- R Rajagopalan, **"Environmental Studies – From Crisis to Cure**", Oxford
- University Press, 2005,

Reference Books

- Principles of Environmental Science & Engineering - P Venugopala Rao, Prentice Hall of India. Environmental Science & Engineering - Meenakshi, Prentice Hall of India
- Erach Bharucha, **"Text Book of Environmental Studies"**, for UGC, University
- press, 2005
- G.Tyler Miller Jr., **"Environmental Science – working with the Earth"**, Tenth
- Edition, Thomson Brooks /Cole, 2004

CONTENTS

UNIT X:

Module 1

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.

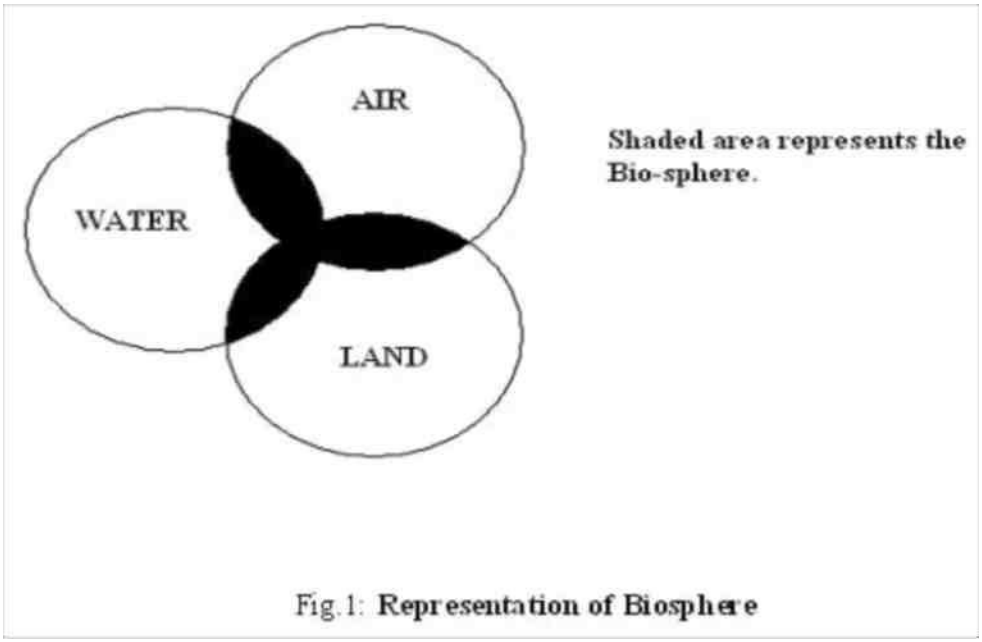


Fig.1: **Representation of Biosphere**

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 mesophere, 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

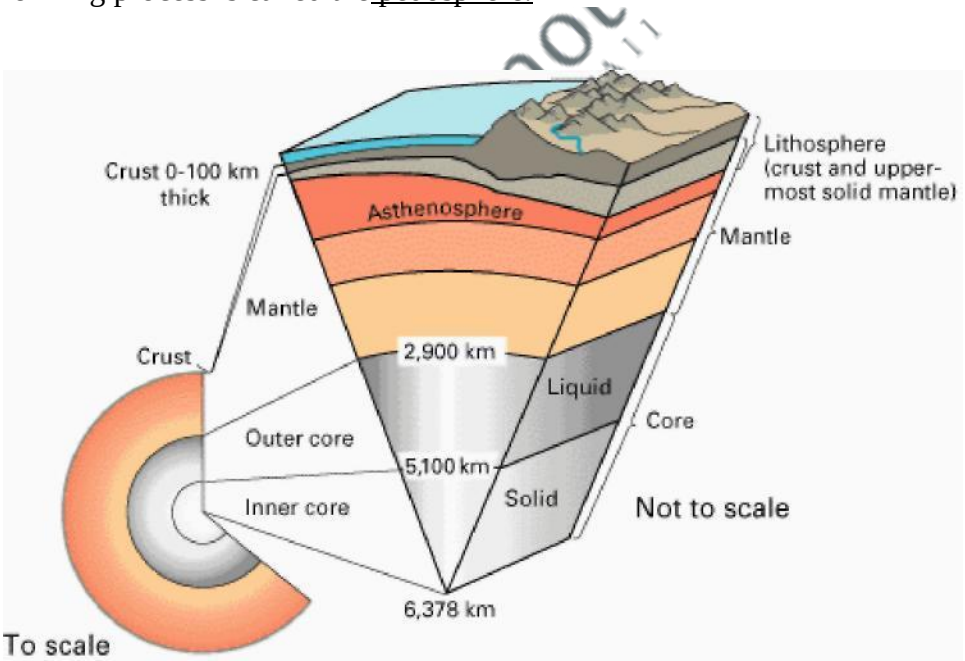
boundary between the stratosphere and mesosphere, typically is at 50 to 55 km (31 to 34 mi; 160,000 to 180,000 ft). The pressure here is 1/1000th sea level.

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%[1] 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[1] 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 kg/m^3. Since the average density of surface material is only around 3,000 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 ~1,220 km and a liquid outer core extending beyond it to a radius of ~3,400 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 aboitic 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 :

$H_2O + CO_2$ + light energy Chlorophyll Carbohydrate + 0_2

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 studies 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
- Esturine 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 CO_2 and release O_2 which is readily takenup 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,					
Autotrophs (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.

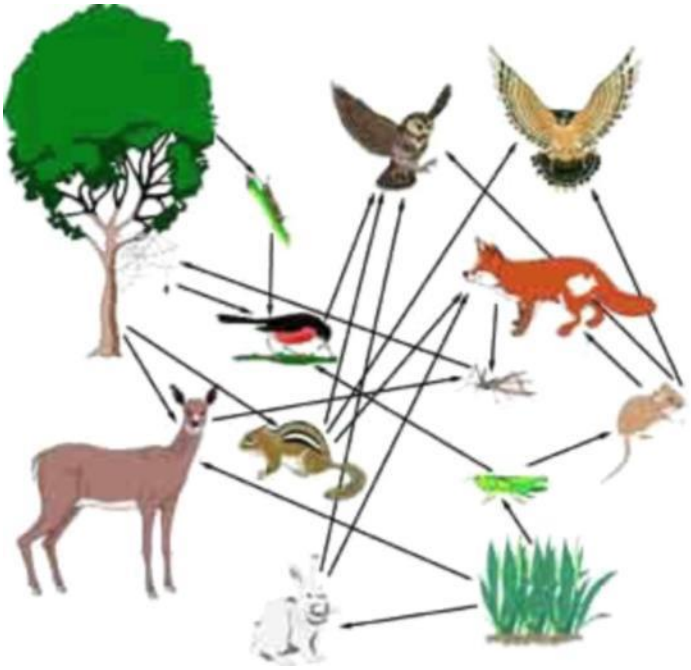
Grazing food chain is generally seen in ecosystems such as grassland, pond or lake where a substantial part of the net primary production is grazed on by herbivores (cattle and rodents). Usually upto 50% of the NPP is grazed on by these animals in their respective ecosystems and the remaining 50% goes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

Food Webs

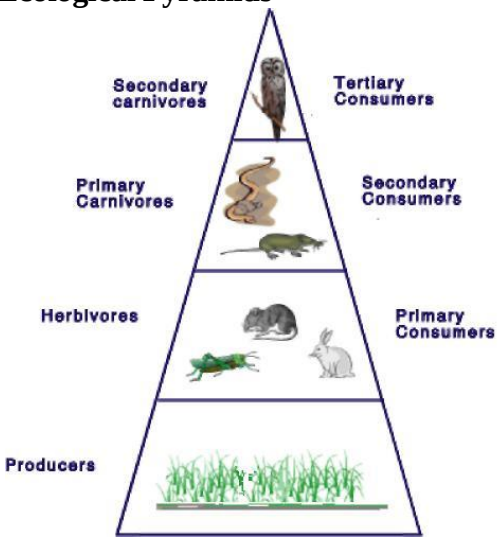
A food web is a graphical description of feeding relationships among species in an ecological community, that is, of who eats whom (Fig. 1). It is also a means of showing how energy and materials (e.g., **carbon**) flow through a community of species as a result of these feeding relationships. Typically, 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" tropic 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

Conversions efficiencies are always much less than 100%. At each link in a food chain, a substantial portion of thesun's energy - originally trapped by a photosynthesizing autotroph - is dissipated back to the environment (ultimately as heat).

Thus it follows that the total amount of energy stored in the bodies of a given population is dependent on its trophic level.

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 kcal/m^2/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).

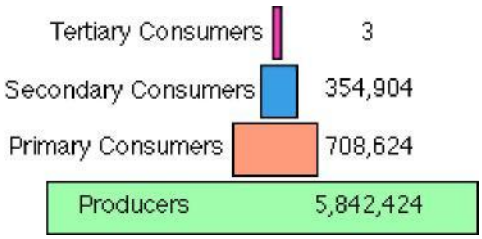
This, too, diminishes with the distance along the food chain from the autotrophs which make the organic molecules in the first place.

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 populationshould carefully use the resources & also preserve them for future generations.

Food

Anything eaten tosatisfy 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 2.5times the 1.15 tonnes per hectare of the 1930s. the International Commission on Irrigation of Drainage (ICID) estimated that current food production would have to double with in the rest 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 Nationsis providing the information on each countries total food supplies.

At the World Food Summit in 1996, world leaders pledged to reduce the number of hungry people toaround 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 from 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 worlds 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 21st century.

UN declares that right to have a adequate housing is the human rights. In connection to this World Habitat Day on October 6th 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 Jyanthi 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 Oranisation (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 ILOsurvey (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 in to four groups

- Pace setters (with good polices, good institutions & good outcomes)
- Pragmatists (good outcome inspite of less impressive outcomes)
- Conventional (good & institution with less impressive outcomes)
- Much to be done Countries (weak or non existant 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 origanised & unorganized 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 Facories 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 Scheduleof the constitution of Indial)
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 Pricniples 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.[4]

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_2 equivalents. By comparison, all transportation emits 13.5% of the CO_2. It produces 65% of human-related nitrous oxide (which has 296 times the global warming potential of CO_2,) and 37% of all human-induced methane (which is 23 times as warming as CO_2. 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_2, solar radiation and the interaction of these elements.[45][94] Agriculture can both mitigate or worsen global warming. Some of the increase in CO_2 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_2 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 so urce*** : 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)*Aldehydes*	**Thermal decomposition of fat ,oil, glycerol**	**Irritate nasal and respiratory tracts**
2)Ammonia	**Chemical processes, dye making, explosives etc**	**Inflame upper respiratory passages**
3)Arsines	**Acid manufacture containing arsenic, metalindustry**	**Break down of RBC, jaundice , kidney failuree**

4)carbon monoxide	**Motor exhausts, burning of fossil fuel**	**Breakdown of red blood calls ,anemia**
5)Hydrogen cyanides	**Metal plating, blast furnace, chemical manufacturing**	**Nerve cell destruction**
6)phosgenes	**Chemical and dye manufacturing**	**Pulmonary pneumonia**
7)sulphur di oxide	**Coal and oil combustion**	**Respiratory ailments**
8) petroleum and industrial hydrocarbons	**Off shore wells, il 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 in to 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 f 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[1] 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 canbe 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.

Module 2

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.[1] 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.

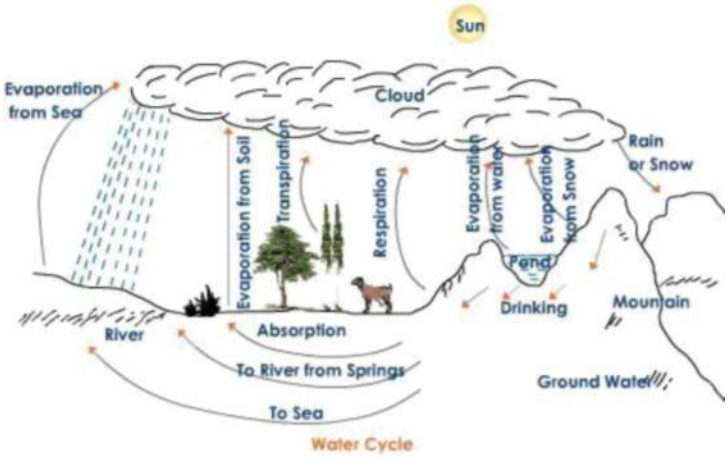
Our present day life highly banks upon the use of fossil fuels such as coal, natural gas, LPG, gasoline, etc. for the production of energy. Our reserves of fossil fuels are getting depleted at an alarming rate and they may get exhausted by the middle of 21st century. The reason for this shortage is that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

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.
Dracunchliasis (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-Bone Diseases

In addition to the immediate and often devasting 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 worksout 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

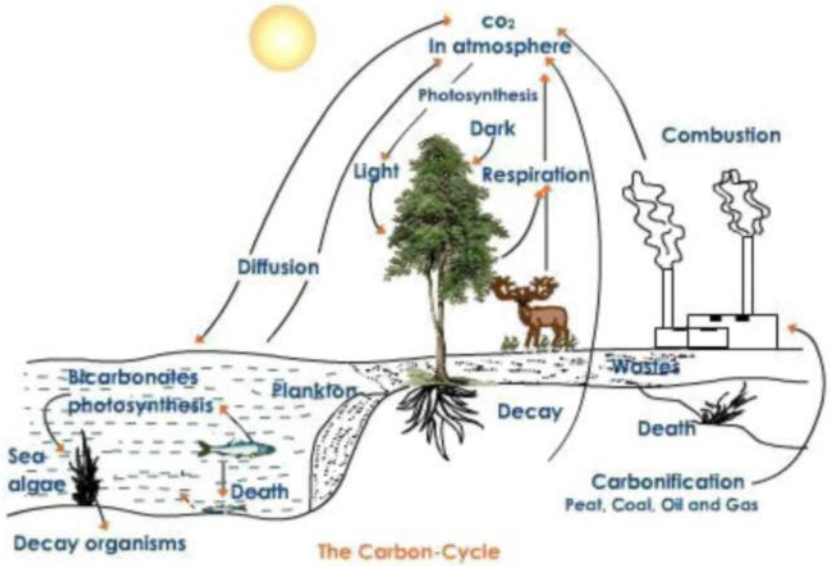
Minerals are formed through geochemical process over a long span of period. India is rich in mineral reserves. Coal resource is the largest. India is the 5th largest producer of coal in the world with total reserve of coal estimated at 186044 million. India has the 5th largest depost of bauxite in the 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 edophic 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



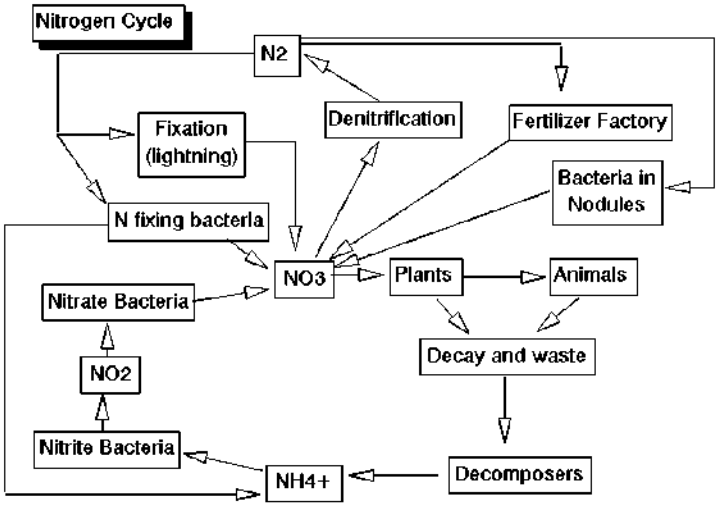
Carbon is an essential constituent of carbohydrates, proteins, fats and a large number of organic compounds. CO_2 of the atmosphere and that dissolved in the natural waters is the main source of carbon. Green plants use CO_2 in the process of photosynthesis to make carbohydrates. In doing so the green 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_2 and water, both of which are utilized by plants in the process of photosynthesis.

$$C_6H1_2O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Free Energy}$$

The water goes down into the soil for the use of plants.
The atmosphere and natural waters must be replenished with CO_2. Most of the CO_2 is returned to atmosphere and natural water by plants and animals through the process of respiration. Bacteria and fungi also return CO_2 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_2 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.

$$4NO_2 + 2H_2O + O_2 \longrightarrow \underset{\text{Nitric acid}}{4HNO_3}$$

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.

$$4NO_2 + 2H_2O + O_2 \longrightarrow \underset{\text{Nitric acid}}{4HNO_3}$$

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.

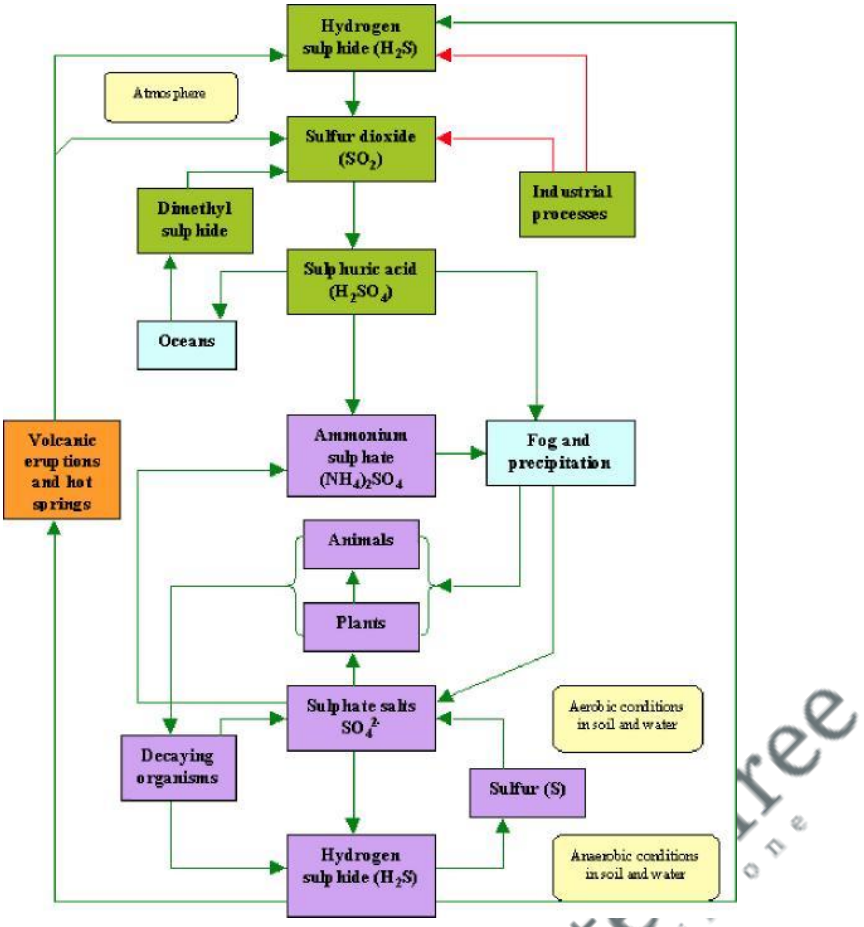
D) How does nitrogen enter the atmosphere?

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_2) and hydrogen sulphide (H_2S) gases are emitted on a wide scale.

When sulphur dioxide enters the atmosphere it will react with oxygen to produce sulphur trioxide gas (SO_3), or with other chemicals in the atmosphere, to produce sulphur salts. Sulphur dioxide may also react with water to produce sulphuric acid (H_2SO_4). Sulphuric acid may also be produced from demethylsulphide, 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 than 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 trans form 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
Non- renewable Sources		
Oil	32	
Coal	21	
Natural gas	23	
Nuclear	6	82
Renewable Sources		
Bio mass (mainly wood)	11	
Solar, wind, hydro and Geothermal power	7	18
TOTAL		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

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 to 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 X 10^{11} k w –hours. Till now we have utilized only a little move 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.

* 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 was227 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, damped 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 vary good quality in term of heat capacity. West Bengal, Jharkhand, Orissa, Andhra Pradesh, Madya Pradesh and Maharastra 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 lasts 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 exisisting 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 (Bobay Hihgh), the plains of Gujarat, the Thar Desert and the area around Andaman and Nicobar Islands.

Natural gas:

Natural gas mainly consists of Methane (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 Sulhuric 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 hour gas. Green hour 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^{th} and 20^{th} centuries however has resulted in increasing fossils fuel emissions, raining 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 hydra rides, charcoal powders, graphite nanofibers and glass micro spheres containing hydrogen will not explode or burn of 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
* Amply supply for 40-90years	* Need to find substitute within
50 years	
* Low cost (with huge substitute)	* Artificially low price
encourages waste and dis	
courages search for alternative	
* High net energy yield	* Air pollution when burnt
* Easily transported within and	* Released carbon dioxide when
between countries	when burnt
* Low land use	* Moderate water pollution
* Technology is well developed	

Efficient distribution system

Heavy oils from oil shale and Tar sand

Advantages	Disadvantages
* 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

Advantages	Disadvantages
* 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 import 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

Advantages	Disadvantage
* Ample supplies (225-900years)	* Very high environmental impact
* High net energy yield pollution and water pollution	* Several land disturbance air
* 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

$92 U_{235}$

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

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

Nuclear fusion It is based on deurterium-deuterium and deuterium-tritum reaction

The deuterium-deuterium re actions 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 mm. 45% of this is in the visible range and emits radiations in the infra-red region (2u to 40u). The heat equivalent of the solar radiation reaching the earth is estimated to be about 2,68x 10 Joules per year.

Solar energy being non- polluting and non-deplets is considered as renewable energy and thus fills 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 need. 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^2 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 un interrupted
Recurring fuel costs are zero
Heating 100 liters of water to 60o 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 photo synthesis 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, house hold or industrial residues for direct combustion to provide heat.

Biogas: it is obtained an aerobically (without air) digesting the organic material to produce ethane. Animal waste and municipal waste are two common feed stocks 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 used widely used for non-domestic appliances. Biomass is available in varying quantities through out 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 recourses**.** Natural Biomass resources vary in type and content depending upon the geographical location. World"s biomass producing areas are classifieds 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 differently 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 praising 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 m3 biogas plant can serve the needs of one average family.

The charge fro the biogas generation consists f dung and waste in the form of slurry. The fermentation is carried out between 35 to 500C. 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%, Waster- traces. The average gross calorific value of the gas is 5300 kilo cals /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.

Automobiles 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:

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)} + 286\ kJ$$

Both reactants H_2 and 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 CO, 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.

Module 3

UNIT V

Environmental Pollution

Water Pollution

Domestic sewage comprises spent water from kitchen, bathroom, lavatory, *etc.* The factors which contribute to variations in characteristics of the domestic sewage are daily per capita use of water, quality of water supply and the type, condition and extent of sewerage system, and habits of the people. Municipal sewage, which contains both domestic and industrial wastewater, may differ from place to place depending upon the type of industries and industrial establishment. The important characteristics of sewage are discussed here.

Temperature

The observations of temperature of sewage are useful in indicating solubility of oxygen, which affects transfer capacity of aeration equipment in aerobic systems, and rate of biological activity. Extremely low temperature affects adversely on the efficiency of biological treatment systems and on efficiency of sedimentation. In general, under Indian conditions the temperature of the raw sewage is observed to be between 15 and 35 ^{0}C at various places in different seasons.

The pH

The hydrogen ion concentration expressed as pH, is a valuable parameter in the operation of biological units. The pH of the fresh sewage is slightly more than the water supplied to the community. However, decomposition of organic matter may lower the pH, while the presence of industrial wastewater may produce extreme fluctuations. Generally the pH of raw sewage is in the range 5.5 to 8.0.

Colour and Odour

Fresh domestic sewage has a slightly soapy and cloudy appearance depending upon its concentration. As time passes the sewage becomes stale, darkening in colour with a pronounced smell due to microbial activity.

Solids

Though sewage generally contains less than 0.5 percent solids, the rest being water, still the nuisance caused by the solids cannot be overlooked, as these solids are highly degradable and therefore need proper disposal. The sewage solids may be classified into dissolved solids, suspended solids and volatile suspended solids. Knowledge of the volatile or organic fraction of solid, which decomposes, becomes necessary, as this constitutes the load on biological treatment units or oxygen resources of a stream when sewage is disposed off by dilution. The estimation of suspended solids, both organic and inorganic, gives a general picture of the load on sedimentation and grit removal system during sewage treatment. Dissolved inorganic fraction is to be considered when sewage is used for land irrigation or any other reuse is planned.

Nitrogen and Phosphorus

The principal nitrogen compounds in domestic sewage are proteins, amines, amino acids, and urea. Ammonia nitrogen in sewage results from the bacterial decomposition of these organic constituents. Nitrogen being an essential component of biological protoplasm, its concentration is important for proper functioning of biological treatment systems and disposal on land. Generally, the domestic sewage contains sufficient nitrogen, to take care of the needs of the biological treatment. For industrial wastewater if sufficient nitrogen is not present it is required to be added externally. Generally nitrogen content in the untreated sewage is observed to be in the range of 20 to 50 mg/L measured as TKN.

Phosphorus is contributing to domestic sewage from food residues containing phosphorus and their breakdown products. The use of increased quantities of synthetic detergents adds substantially to the phosphorus content of sewage. Phosphorus is also an essential nutrient for the biological processes. The concentration of phosphorus in domestic sewage is generally adequate to support aerobic biological wastewater treatment. However, it will be matter of concerned when the treated effluent is to be reused. The concentration of PO_4 in raw sewage is generally observed in the range of 5 to 10 mg/L.

Chlorides

Concentration of chlorides in sewage is greater than the normal chloride content of water supply. The chloride concentration in excess than the water supplied can be used as an index of the strength of the sewage. The daily contribution of chloride averages to about 8 gm per person. Based on an average sewage flow of 150 LPCD, this would result in the chloride

content of sewage being 50 mg/L higher than that of the water supplied. Any abnormal increase

should indicate discharge of chloride bearing wastes or saline groundwater infiltration, the latter adding to the sulphates as well, which may lead to excessive generation of hydrogen sulphide.

Organic Material

Organic compounds present in sewage are of particular interest for environmental engineering. A large variety of microorganisms (that may be present in the sewage or in the receiving water body) interact with the organic material by using it as an energy or material source. The utilization of the organic material by microorganisms is called metabolism. The conversion of organic material by microorganism to obtain energy is called catabolism and the incorporation of organic material in the cellular material is called anabolism.

To describe the metabolism of microorganisms and oxidation of organic material, it is necessary to characterize quantitatively concentration of organic matter in different forms. In view of the enormous variety of organic compounds in sewage it is totally unpractical to determine these individually. Thus a parameter must be used that characterizes a property that all these have in common. In practice two properties of almost all organic compounds can be used: (1) organic compound can be oxidized; and (2) organic compounds contain organic carbon.

In environmental engineering there are two standard tests based on the oxidation of organic material: 1) the Biochemical Oxygen Demand (BOD) and 2) the Chemical Oxygen Demand (COD) tests. In both tests, the organic material concentration is measured during the test. The essential differences between the COD and the BOD tests are in the oxidant utilized and the operational conditions imposed during the test such as biochemical oxidation and chemical oxidation. The other method for measuring organic material is the development of the Total Organic Carbon (TOC) test as an alternative to quantify the concentration of the organic material.

Biochemical Oxygen Demand (BOD): The BOD of the sewage is the amount of oxygen required for the biochemical decomposition of biodegradable organic matter under aerobic conditions. The oxygen consumed in the process is related to the amount of decomposable organic matter. The general range of BOD observed for raw sewage is 100 to 400 mg/L. Values in the lower range are being common under average Indian cities.

Chemical Oxygen Demand (COD): The COD gives the measure of the oxygen required for

chemical oxidation. It does not differentiate between biological oxidisable and nonoxidisable material. However, the ratio of the COD to BOD does not change significantly for particular waste and hence this test could be used conveniently for interpreting performance efficiencies of the treatment units. In general, the COD of raw sewage at various places is reported to be in the range 200 to 700 mg/L.

In COD test, the oxidation of organic matter is essentially complete within two hours, whereas, biochemical oxidation of organic matter takes several weeks. In case of wastewaters with a large range of organic compounds, an extra difficulty in using BOD as a quantitative parameter is that the rate of oxidation of organic compounds depends on the nature and size of its molecules. Smaller molecules are readily available for use by bacteria, but large molecules and colloidal and suspended matters can only be metabolized after preparatory steps of hydrolysis. It is therefore not possible to establish a general relationship between the experimental five-day BOD and the ultimate BOD of a sample, *i.e.*, the oxygen consumption after several weeks. For sewage (with $k=0.23\ d^{-1}$ at 20^oC) the BOD_5 is 0.68 times of ultimate BOD, and ultimate BOD is 87% of the COD. Hence, the COD /BOD ratio for the sewage is around 1.7.

Toxic Metals and Compounds

Some heavy metals and compounds such as chromium, copper, cyanide, which are toxic may find their way into municipal sewage through industrial discharges. The concentration of these compounds is important if the sewage is to treat by biological treatment methods or disposed off in stream or on land. In general these compounds are within toxic limits in sanitary sewage; however, with receipt of industrial discharges they may cross the limits in municipal wastewaters.

Effect of Industrial Wastes

Wastewaters from industries can form important component of sewage in both volume and composition. It is therefore necessary that details about nature of industries, the quantity and characteristics of the wastewater and their variations, which may affect the sewerage system and sewage treatment process, should be collected.

In case, where wastewaters high in suspended solids and BOD are to be accepted, provision should be made in the design of the treatment plant to handle such wastes. In certain instances, it is more economical to tackle the industrial waste at the source itself. Where, the wastewater has high or low pH, corrective measures are necessary before admitting them to the sewers or the

treatment plant. Toxic metals and chemicals having adverse effects on biological treatment processes, or upon fish life in a natural water course, or render the receiving water stream unfit as a source of water supply, should be brought down to acceptable limits at the source itself. Oil and grease in excessive amounts not only add considerably to the cost of treatment, but also pose a disposal problem. The industrial wastewaters may be discharged into public sewers if the effluents meet the tolerance limits prescribed by the authority. If the wastewaters are to be discharged into inland surface waters, tolerance limits set by the concerned authority should be satisfied.

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 likes 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 forbid 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.1

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 others2

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 tent to 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 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 means 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 laud, 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 nosiest 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 soundof-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 irriative 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 of permanent Deafness:- The effect of nose 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. Physictist, 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 looses 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 enviorment 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

	Area	DayTime	NightTime
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	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 obliviously 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

GLOBAL ENVIRONMENTAL ISSUES

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 20th 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 an 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 lead to the population of older people to grow at a rate of 2.8% per year worldwide. 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.

Land Management

Definitions

Land

The part of the earth that is not covered by water

An area of the earth's surface, including all elements of the physical and biological environment that influence land use. It refers not only to soil, but also landforms, climate, hydrology, vegetation and fauna, together with land improvements such as terraces and drainage works.
Land can also be defined in relation to ownership, demarcation, or use as any portion, large or small, of the surface of the earth, considered by itself, or as belonging to an individual or a people, as a country, estate, farm, or tract.; or in respect to its nature or quality; soil; as, wet land; good or bad land.
Land use
The management of land to meet specified socio-economic objectives. Land use is described by the purposes for which the land is used, and the types and sequences of development, conservation and environmental management activities carried out upon the land.
Tin order words, it refers to the purpose to which land is committed, including the production of goods (such as crops, timber and manufactures) and services (such as defence, recreation, biodiversity and natural resources protection). Some land uses, such as cropping, have a characteristic land cover pattern.

Land management practice

This refers to the means by which the land management objective is achieved - the 'how' of land use (For example cultivation practices such as minimum tillage or direct drilling).
Some land management practices, such as waste disposal, tillage and rotation systems, may be discriminated by characteristic land cover patterns.

Tenure

- The form of an interest in land. Some forms of tenure (such as pastoral or mineral leases or nature conservation reserves) relate directly to land use and land management.

Land capability and suitability

- Land capability assesses the limitations to land use imposed by land characteristics and specifies management options. Land suitability (part of the process of land evaluation) is the fitness of a given type of land for a specified kind of land use.

Land resources

- Land resources are the resources of climate, water, soils, forests, pastures and wildlife, on which agriculture, forestry and other forms of rural land use depend.

Land degradation - the reduction or loss of the biological or economic productivity from rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands.
Land degradation usually results from unsustainable land use. It destroys land resources

Components of land:

Soil

The interface between the atmosphere and the lithosphere, and in interface with the hydrosphere. The soil derive its components from these spheres and support the growth of many plants and animals
Soil is a complex mixture of eroded rock, mineral nutrients, decaying organic material, water, air and millions of microscopic organisms involved in the process of rotting and breaking down of dead organic material and re-incorporating their nutrients into the soil
Global context of land use
Humans make use of the land they inhabit to a degree unmatched by any other species. Land represents about 29 percent of the earth's surface. The uses to which this land is put (land-use morphology) vary

considerably from place to place.
For example in the US, land is more or less equally divided among forest, pasture, crops, and built-up areas. On the other hand, 75 percent of the land in the Democratic Republic of the Congo (DRC) is forested, and only about 10 percent is devoted to crops and pasture.

- Useable land is an especially precious commodity in some countries due to constraints imposed by geography, population density, climate, and other factors. For example, in the Netherlands, land reclamation from the sea is part of efforts to increase the amount of land available for economic use.

Also in Japan, where most of the population is crowded onto the narrow coastal plains that lie between the mountainous interior and the sea, engineers create additional land by filling bays and harbours.
The land area available for human use are becoming more threatened to permanently reduce as a result of increasing natural disasters such as flood, earthquake, tsunamis combined with slowly rising sea levels. For example, devastating floods are constitute regular scenario in Bangladesh as a result of extensive deforestation in the mountains upstream, torrential monsoon rainfall, and occasional tidal waves in the Bay of Bengal.
In most countries, increasing pressure to use land for economic development is leading to conflict. Farmland, wetlands or other land close to cities may be sought by developers to convert into suburbs, motorways, or shopping centres.
Conservationists may resist efforts to replace natural forests with tree plantations, ranches, or farms. Developing countries are particularly often faced with a dilemma. Their need for money leads them to liquidate their forests and modify their savannas to obtain cash crops for export, yet they must conserve these same ecosystems to guarantee resources for the future.

Land Use Planning:

The limited supply of land and the increasing demand for land use for alternative uses calls seriously for land use planning
Among the pressures on the use of land by man the need for housing, the importance of fertile land to grow food, land for industry, land for recreation such as parks, sportsfields and nature and game reserves, and various other land uses.
In order to balance the different needs and priorities, land use planning must be undertaken at all levels
The key to good land use planning is communication between the different land users to achieve a balance of land use and zoning that will satisfy as many people as possible.

Land use for food production

Food production involves the use fertilisers, pesticides, genetically developed species, crop rotation and machinery all of which tend to have effects on the land environment. Care must be taken to ensure that intensive farming methods do not affect the environment negatively.
For example, if a farmer puts too much fertiliser onto his land, it may be washed into rivers and streams where it may cause pollution which may reduce the quality of water required for other purposes.
It has been estimated that about 11 percent of the earth's total available land area is occupied by farmlands.
Land use for agricultural purposes varies from place to place and is affected by the climate, culture, population pressure, and soil quality.

The amount of land given over to farming however varies greatly from country to country.
Soil and land use planning

The soil is a major land resource especially for food production. A knowledge of the soil is important for effective land use planning.
Soil Surveys provide extensive land use planning information such as limitations for certain uses
Modern soil survey for land use planning involves the use of advanced techniques that make use of satellite, GIS etc.
Soil survey helps in soil classification which may be on its capability, or suitability for a proposed use
For example, land that is endowed with fertile soil is good for crop production and should not be used for industrial estate, commercial centre, or for recreation.

Planning rural land use and management

Agricultural purposes constitute the major land-use in the rural areas. There are two parts of land-use planning with regards to rural areas. – physical and socio-economic. Physical planning has to do with spatial, environmental and infrastructural aspects.
Spatial planning involves identification of its location for reference purposes, and gives context to the plan. Spatial factors add dimensions and magnitude to the area and strengthens the contextual reference to it.
Environmental planning aspect takes into consideration ecologically related issues that are unique to the local community. These are issues that have to do with the norms of land-use in the local community.
Climatic conditions and other land-use practices in to agricultural practices determine the presence of such environmental problems as deforestation, and associated problems as erosion and land degradation.
Infrastructural aspect of planning focus on basic facilities that are essential for life support in a community – housing, transportation, utility such as water for agricultural cultivation and domestic use, electricity, sanitary waste disposal, and communication facilities

URBAN WASTE MANAGEMENT

Waste management is an essential aspect of urban land-use and management especially as waste contribute majorly to the problems associated with improper land-use approach.

Definition of Waste

- Waste refers to unwanted or unusable. Other terms used for waste materials include rubbish, trash, refuse, garbage, or junk. When waste has been disposed of improperly or carelessly disposed of in plain sight, it is called litter. Waste is said to be dumped if it has been deliberately left somewhere to avoid the management or disposal cost

Classification of wastes

Wastes can be categorized on the basis of their
physical nature (solid waste, semi-solid, liquid, gaseous),
chemical nature (organic wastes- technically, waste containing carbon, including paper, plastics, wood, food wastes, and yard wastes. In practice -material that is more directly derived from plant or animal sources, and which can generally be decomposed)
Inorganic waste - composed of material other than plant or animal matter, such as sand, dust, glass, and many synthetics)

• Sources (domestic, municipal, industrial, clinical, electronic, institutional waste, construction and demolition, commercial), properties (biodegradable, radioactive, hazardous)

Key Facts on Waste Issues

- Only between 25 and 55 per cent of all waste generated in large cities is collected by municipal authorities.
- More than five million people die each year from diseases related to inadequate waste disposal systems.
- solid waste disposal was among their biggest environmental concerns.
- More than half of the world's municipal waste is generated in developed countries.
- Industrialized countries generate more than 90 per cent of the world's annual total toxic and hazardous waste, mostly from the chemical and petrochemical industries.
- There are more than 80,000 tons of irradiated fuel and hundreds of thousands of tons of other radioactive waste accumulated so far from the commercial generation of electricity from nuclear power.
- Irradiated fuel can take hundreds of thousands of years to decay into a harmless substance.

Waste disposal methods

OCEAN DUMPING

Advantages:

- convenient
- inexpensive
- source of nutrients, shelter and breeding

Disadvantages:

- ocean overburdened
- distruction of food sources
- killing of plankton
- desalination

SANITARY LANDFILL

Advantages:

- volume can increase with little addition of people/equipment
- filled land can be reused for other community purposes

Disadvantages:

- completed landfill areas can settle and requires maintenance
- requires proper planning, design, and operation

INCINERATION

Advantages:

- requires minimum land
- can be operated in any weather
- produces stable odor-free residue
- refuse volume is reduced by half

Disadvantages:

- expensive to build and operate
- high energy requirement
- requires skilled personnel and continuous maintenance unsightly - smell, waste, vermin

OPEN DUMPING
Advantages:
- inexpensive

Disadvantages:
- health-hazard - insects, rodents etc.
- damage due to air pollution
- ground water and run-off pollution

RECYCLING Advantages:
- key to providing a livable environment for the future

Disadvantages:
- expensive
- some wastes cannot be recycled
- technological push needed
- separation of useful material from waste difficult

Waste minimization
Waste minimization is a methodology used to achieve waste reduction, primarily through reduction at source, but also including recycling and re-use of materials.
Some of the main benefits include:
- improved bottom line through improved process efficiency
- reduced burden on the environment, with improved public image and compliance with legislation

LANDSCAPE DEFINITION

What is a landscape
A heterogeneous land area composed of a cluster of interacting components that is repeated in a similar format throughout. The emphases lie on
- spatial arrangement
- interaction among diverse landscape components
- resulting landscape processes A landscape is distinguished by its
- component units (e.g. the pattern of farms, cultivation, vegetation, hills, valley etc)
- Spatial arrangement of those components

Characteristics of a landscape
- One landscape can be differentiated from another based on the component units, and how
- they are arranged
- Five characteristics are usually repeated across a landscape
- a cluster of ecosystem types
- the flows of interaction among the ecosystems of the cluster
- the geomorphology and climate
- the set of disturbance regime
- the relative abundance of ecosystems within a cluster

Water & Waste Water Management

Treatment and safe disposal of wastewater is necessary. This will facilitate protection of

environment and environmental conservation, because the wastewater collected from cities and towns must ultimately be returned to receiving water or to the land. Once the minimum effluent quality has been specified, for maximum allowable concentrations of solids (both suspended and dissolved), organic matter, nutrients, and pathogens, the objective of the treatment is to attain reliably the set standards. The role of design engineer is to develop a process that will guarantee the technical feasibility of the treatment process, taking into consideration other factors such as construction and maintenance costs, the availability of construction materials and equipment, as well as specialized labour.

Primary treatment alone will not produce an effluent with an acceptable residual organic material concentration. Almost invariably biological methods are used in the treatment systems to effect secondary treatment for removal of organic material. In biological treatment systems, the organic material is metabolized by bacteria. Depending upon the requirement for the final effluent quality, tertiary treatment methods and/or pathogen removal may also be included.

Today majority of wastewater treatment plants use aerobic metabolism for the removal of organic matter. The popularly used aerobic processes are the activated sludge process, oxidation ditch, trickling filter, and aerated lagoons. Stabilization ponds use both the aerobic and anaerobic mechanisms. In the recent years due to increase in power cost and subsequent increase in operation cost of aerobic process, more attention is being paid for the use of anaerobic treatment systems for the treatment of wastewater including sewage. Recently at few places the high rate anaerobic process such as Upflow Anaerobic Sludge Blanket (UASB) reactor followed by oxidation pond is used for sewage treatment.

Characterization of Wastewater

The wastewater after treatment is ultimately disposed on to land or into the water body. Normally the treatment consists of removal of SS and organic matter either in suspended or soluble form, which consumes DO from the water body. The plant can be designed for 100%

removal of this pollutant, but the treatment will become uneconomical. In addition, the existing watercourses can assimilate certain portion of pollution load without seriously affecting the environment. Thus, major portion of pollutants are removed in treatment plants and the remaining treatment is left with natural purification process. Therefore, before proceeding with the design of the treatment plant, it is essential to determine

1) The characteristics of the raw wastewater, and

2) The required degree of treatment i.e., the required characteristics of the treatment plant effluent.

The characteristic of the wastewater differs from industry to industry and from city to city for domestic wastewater, depending upon the standard of living of the people and commercial and industrial activities in the city. In absence of any data for Indian cities, the per capita SS can be considered as 90 to 95 gm per day and BOD as 40 to 45 gm/day. The BOD associated with suspended solids is usually at a rate of 0.25 kg of BOD per kg of SS.

Characteristics of the Treatment plant effluent

The required quality of treatment plant effluent is dictated by the quality requirements of the receiving water. The quality requirements of the receiving water are established either by law or by vigorous engineering analysis giving consideration to natural purification or self-purification that occurs in the receiving water. It can either be regulated by Stream Standards looking in to assimilative capacity of the water body or discharge standards which will be implemented uniformly under jurisdiction of the authority without looking in to the rive water quality at specific location. In India the effluent standards required for domestic sewage and industrial effluent is available on the Central Pollution Control Board (CPCB) website (http://cpcb.nic.in/GeneralStandards.pdf).

Classification and Application of Wastewater Treatment Methods

The degree of treatment required can be determined by comparing the influent wastewater characteristics to the required effluent characteristics, adhering to the regulations. Number of different treatment alternatives can be developed to achieve the treated wastewater quality.

Classification of Treatment Methods

The individual treatment methods are usually classified as:

> Physical unit operations
> Chemical unit processes
> Biological unit processes.

Physical Unit Operations: Treatment methods in which the application of physical forces predominates are known as physical unit operations. Most of these methods are based on physical forces, e.g. screening, mixing, flocculation, sedimentation, flotation, and filtration.

Chemical Unit Processes: Treatment methods in which removal or conversion of contaminant is brought by addition of chemicals or by other chemical reaction are known as chemical unit processes, for example, precipitation, gas transfer, adsorption, and disinfection.

Biological Unit Processes: Treatment methods in which the removal of contaminants is brought about by biological activity are known as biological unit processes.

- This is primarily used to remove biodegradable organic substances from the wastewater, either in colloidal or dissolved form.
- In the biological unit process, organic matter is converted into gases that can escape to the atmosphere and into bacterial cells, which can be removed by settling.
- Biological treatment is also used for nitrogen removal and for phosphorous and sulphate removal from the wastewater.

The different treatment methods used in wastewater treatment plant are classified in three different categories as:

- *Primary Treatment :* Refers to physical unit operations.
- *Secondary Treatment:* Refers to chemical and biological unit processes.
- *Tertiary Treatment:* Referes to any one or combination of two or all three i.e., physical unit operations and chemical or biological unit processes, used after secondary treatment.

Elements of plant Analysis and Design

The important terms used in analysis and design of treatment plants are (CPHEEO, 1993): ***Flow Sheet****:* It is the graphical representation of a particular combination of unit operations and processes used in treatment.

Process Loading Criteria (or designed criteria): The criteria used as the basis for sizing the individual unit operation or process is known as process loading criteria.

Solid Balance: It is determined by identifying the quantities of solids entering and leaving each unit operation or process.

Hydraulic profile: This is used to identify the elevation of free surface of wastewater as it flows through various treatment units.

Plant Layout: It is spatial arrangement of the physical facilities of the treatment plant identified in the flow sheet.

Types of Reactors Used

a) ***Batch Reactor***: These reactors are operated as fill and draw type. In this the wastewater flow is not continuous in the reactor. The reactors are operated in batch mode with fill time, reaction time, and withdrawal time. For example, BOD test, Sequencing Batch Reactor (SBR). The reactor content may be completely mixed to ensure that no temperature or concentration gradient exists. All the elements in the reactor, under batch mode of operation, are exposed to treatment for the same length of time for which the substrate is held in the reactor. Hence, they are like ideal plug flow reactors.

b) ***Plug-Flow (tubular flow) Reactor***: In this reactor, the fluid particles pass through the tank and are discharged in the same sequence in which they enter in the tank. The particles remain in the tank for a time equal to theoretical detention time. There is no overtaking or falling behind; no intermixing or dispersion. Longitudinal dispersion is considered as minimum and this type can occur in high length to width ratio of the tanks. For example, grit chamber, aeration tank of ASP with high length to width ratio.

c) ***Continuous-flow Stirred Tank (Complete – mixed) reactor***: In this reactors, particles are dispersed immediately throughout the tank as they enter the tank. Thus, the content in the reactor are perfectly homogeneous at all points in the reactor. This can be achieved in square, circular or rectangular tank. The particles leave the tank in proportion to their statistical population. The concentration of the effluent from the reactor is the same as that in the reactor.

d) ***Arbitrary Flow***: Any degree of partial mixing between plug flow and completely mixing condition exists in this reactor. Each element of the incoming flow resides in the reactor for different length of time. It is also called as intermixing or dispersed flow and lies between ideal plug flow and ideal completely mixed reactor. This flow condition can be used in practice to describe the flow conditions in most of the reactors.

e) ***Packed Bed Reactor****:* They are filled with some packing medium, such as, rock, slag, ceramic or synthetic plastic media. With respect to flow they can be anaerobic filter, when completely filled and no air is supplied, or aerobic (trickling filter) when flow is intermittent or submerged aerobic filter when compressed air is supplied from the bottom.

f) ***Fluidized Bed Reactor****:* This reactor is similar to packed bed except packing medium is expanded by upward movement of fluid (or air) than resting on each other in fixed bed. The porosity or degree of fluidization can be controlled by controlling flow rate of fluid (wastewater or air).

Flow Patterns of Reactors

The flow pattern in the reactors depends on mixing conditions in them. This mixing in tern depends upon the shape of the reactor, energy spent per unit volume of the reactor, the size and scale of the unit, up-flow velocity of the liquid, rate of biogas generation (in an anaerobic reactors) or the rate of gas supplied (in an aerobic reactor), etc. Flow pattern affect the time of exposure to treatment and substrate distribution in the reactor. Depending upon the flow pattern the reactors can be classified as:

(a) Batch reactors,
(b) Ideal plug flow reactors,
(c) Ideal completely-mixed flow reactors,
(d) Non -ideal, dispersed flow reactors, and
(e) Series or parallel combinations of the reactors.

Module 4

UNIT VII

ENVIRONMENTAL ISSUES CONTENTS

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 CO_2, CO, Unburnt Carbon, SO_2, Hydrocarbon, Acids, Alcohols, 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.

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_2 level is expected to be doubled by 2030 A.D.

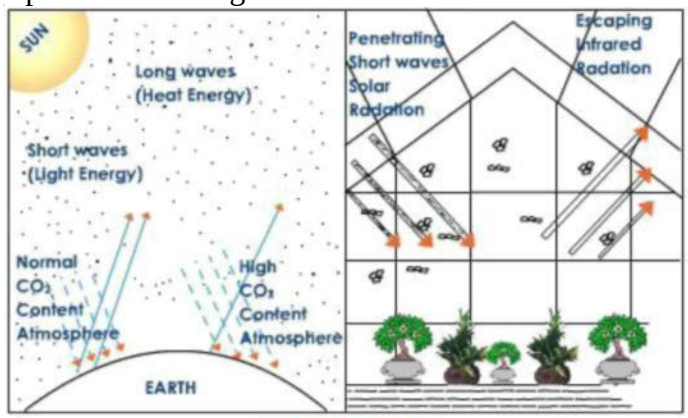
The term "Green House Effect" is also called as "Atmospheric Effect", "Global Warming" or "CO_2 Problem".

Human activities are changing the composition as well as behaviour at an unprecedented rate. The pollutants form 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_2 in the atmosphere is called "Green House Effect". (Figure 1).

The four major green house gases, which cause adverse effects are CO_2, CH_4, N_2O and CFC"s. Among these CO_2 is the most common and important green house gas. In addition, ozone and SO_2 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.



Green House Effect

Sources

A number of industrial as well as agricultural operations generate and emit waste gases into the atmosphere. Burning of fossil fuel emit CO_2, 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_2 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_2 and the plants also cannot utilize the whole during photosynthesis. So, much of CO_2 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_2 is a natural fertilizer, the plants will grow larger and faster with increasing CO_2 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

2. 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_2 added to the atmosphere. The ocean sink of CO_2 is called "Biological CO_2 Pump".

Vegetation

Vegetation changes due to climatic change would affect the hydrologic cycle. The biggest

impact of CO_2 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_2 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

3. 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_2 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_2 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_2 and photosynthesis process. Thus global dimming is a process working against global warming to some extent.

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 O2 to form nitrogen dioxide which can be broken down again by Sunlight(hv)to give Nitric oxide and an oxygen radical (O).
$2NO + O_2 = 2N_2NO_2 + hv = NO+O$
The oxygen radical then enables the formation of Ozone (O_3)
$O+O_2= {}_{O3}$
The presence of ozone causes the formation of more nitrogen dioxide by its reaction with nitric oxide. $NO+O_3= NO_2+O_2$
Or, the oxygen radical reacts with water to give the hydroxyl radical (OH)
$O+H_2O = 2OH.$
This radical then reacts with nitric oxide to give nitrous acid (HNO2) and nitrogen dioxide to give nitric acid (HNO_3). It also combines with Sulphur dioxide to produce Sulphuric acid
$HO+NH= HNO_2$

NH_2+HO= HNO_3SO_2+2HO = H_2SO_4

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, $CaSO_3$ and $CaSO_4$) which require disposal.
$CaCO_3$(limestone)+SO_2=$CaSO_3$+$CaSO_4$+CO_2+H_2O.

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 through 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 DEPLECTION

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 is 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 O2 and Ozone O3 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 O2 to create ozone O3

Ozone molecules absorb UV light between 310 and 200nm, following which ozone splits into a molecule of O2 and O. The process O3 generation and splitting repeats as per the equations below.

$O_2 = O+O$
$O_2+O = O_3$
$O_3 = O_2+O$
$O_3+O=2O_2$

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 preset most of the OH and NO is 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.

$Cl + O_3 = ClO + O_2 ClO + 0 = Cl + O_2$
In sum, $O_3 + O = O_2 + O_2$

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.

•CFC″s were used in air – conditioning / cooling units as aerosol spray propellants prior to the 1980″s and in the cleaning process of electronic components.

•CFC″s when reach the Stratosphere, are dissociated by ultraviolet light to relase 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 upto 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 vertex”, over 50% of the lower stratospheric ozone is destroyed during the Antarctic spring.

•The overall cause of ozone depletion is th presence of chlorine – containing source gases (primarily CFC″s 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 (PSC″s)

•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 PSC″s are destroyed, the ozone depletion process shuts down, and the ozone hole heals.
•The decrease in the ozone layer was predicted in the early 1980″s 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 (PSC″s) are of great importance. The PSC″s only form in extreme cold. The Antarctic stratosphere is colder than the Arctic, and the PSC″s 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 bout 3% below pre-1980 values for 35-60N and bout 6% for 35-60S. In the topics, 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 recognize to be a health risk, as ozone is toxi 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 tropic 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 1980″s 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.

UNIT VIII

Solid waste

Solid wastes are the wastes arising from human activities and are normally solid as opposed to liquid or gaseous and are discarded as useless or unwanted. Focused on urban waste (MSW) as opposed to agricultural, mining and industrial wastes.

- *Integrated Solid Waste Management* (ISWM) is the term applied to all the activities associated with the management of society's wastes.
- In medieval times, wastes discarded in the streets led to the breeding of rats and the associated fleas which carried the bubonic plague. The lack of management of solid wastes thus led to the Black Plague which killed half of 14th century Europe.
- USPHS has traced 22 human diseases to improper solid waste management.
- Solid wastes also have a great potential to pollute the air and water. Mining tailings from Colorado gold and silver mines will probably being spilling arsenic into the water supply forever. Just finished toxic metal treatment facility in Park City, Utah.
- Materials Flow - The best way to reduce solid wastes is not to create them in the first place. Others methods include: decrease consumption of raw material and increase the rate of recovery of waste materials.
- Technological advances - Increased use of plastics and fast, pre-prepared foods.

Solid Waste Management

- Solid waste management is the control of :

- generation, materials are identified as being no longer value
- storage, management of wastes until they are put into a container
- collection, gathering of solid wastes and recyclable materials and the transport of these materials where the collection vehicle is emptied. 50% or higher of the total cost.
- processing, source separated (at the home) vs. commingled (everything together) is a big issue. Includes: physical processes such as shredding and screening, removal of bulky material, and chemical and biological processes such as incineration and composting.
- transfer and transport, small trucks to the biggest trucks allowable
- disposal of solid waste, landfilling with or without attempting to recover resources.

in a manner that is in accord with:

- public health
- economics
- engineering
- conservation
- aesthetics
- public attitudes

- Final disposal at the turn of the century included:

- dumping on land in
- dumping water
- plowing into soil
- feeding to hogs
- incineration

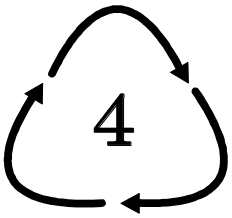
Sources, Composition, and Properties of Solid Waste

1. Sources of Solid Waste

- MSW, Municipal Solid Waste, is the primary focus of this course, which excludes industrial, mining and agricultural wastes.

A. Residential and Commercial

- Residential:Generated by me and you: Organic (combustible) and inorganic (non-combustible), food, paper, garden trimmings, glass, white goods, waste oil, spent cans of insecticide.
- Commercial: stores, restaurants, hotels, car repair: paper, plastic.
- *Commingled*. Mixed wastes, not separated at the source.
- *Putrescible*, wastes that will decompose rapidly primarily food.
- Plastics, contain a numerical code, 1 through 7, which is stamped on the bottom of the container inside a small triangle.



- Polyethylene terephthalate (PETE/1), 2-liter soda bottle
- High-density polyethylene (HDPE/2), milk bottles

- Special Wastes:
- Bulky items: furniture, lamps.
- Electronics
- Major appliances (white goods)
- Batteries, oil and tires

- Household hazardous wastes:
- paint
- cleaners
- bug and garden sprays

B. Institutional and others

- Generated by government buildings, schools, prisons and hospitals.
- Does not include medical wastes which are typically incinerated and manufacturing wastes from prisons.
- Construction and Demolition. Road repair, sewer jobs, renovations: wood, concrete, steel, shingles, electrical parts.
- Municipal Services. Street cleaning, parks, catch basins: trimmings, food, paper, sweepings, dead animals, abandoned vehicles.
- Treatment Plant Sludges.

C. Industrial Wastes

- SIC (Standard Industrial Classification) codes. Excludes process and hazardous wastes.
- SIC 32 - Stone, clay and glass products from the manufacture of flat glass etc., yielding glass, gypsum (sulfur source) abrasives, etc.

D. Agricultural Wastes

- Enormous quantities from planting, harvesting from row, field, tree and vine crops and animal husbandry, feedlots.

2. Composition of Solid Waste

- Composition describes the individual components that make up solid waste and the distribution of these components by weight.

3. Variation in Distribution

- Highly variable, local studies should be considered, collected data is expensive and of limited value; make sure that collected data is useful before collecting.
- Location, warmer more affluent communities generate more wastes.
- Season, More yard and food wastes in the summer; more glass and metals in the winter.

Risks and Problems Associated with Solid wastes

- If solid wastes are not managed properly, there are many negative impacts that may result.
- Some of the most important are mentioned in the following list. The relative importance of
- each depends very much on local conditions.
- Uncollected wastes often end up in drains, causing blockages which result in flooding and unsanitary conditions.
- Flies breed in some constituents of solid wastes, and flies are very effective vectors
- that spread disease.
- Mosquitoes breed in blocked drains and in rainwater that is retained in discarded cans, tires and other objects. Mosquitoes spread disease, including malaria and dengue.
- Rats find shelter and food in waste dumps. Rats consume and spoil food, spread disease, damage electrical cables and other materials and inflict unpleasant bites.
- The open burning of waste causes air pollution; the products of combustion include dioxins which are particularly hazardous.
- Aerosols and dusts can spread fungi and pathogens from uncollected and decomposing wastes.
- Uncollected waste degrades the urban environment, discouraging efforts to keep streets and open spaces in a clean and attractive condition. Solid waste management is a clear indicator of the effectiveness of a municipal administration - if the provision of this service is inadequate large numbers of citizens (voters) are aware of it. Plastic bags are a particular aesthetic nuisance and they cause the death of grazing animals which eat them.
- Waste collection workers face particular occupational hazards, including strains from lifting, injuries from sharp objects and traffic accidents. Dumps of waste and abandoned

vehicles block streets and other access ways.

- Dangerous items (such as broken glass, razor blades, hypodermic needles and other healthcare wastes, aerosol cans and potentially explosive containers and chemicalsfrom industries) may pose risks of injury or poisoning, particularly to children and people who sort through the waste.
- Heavy refuse collection trucks can cause significant damageto the surfaces of roads that were not designed for such weights.
- Waste items that are recycled without being cleaned effectively or sterilized can transmit infection to later users. (Examples are bottles and medical supplies.)
- Polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of water supplies. Chemical wastes (especially persistent organics) may be fatal or have serious effects if ingested, inhaled or touched and can cause widespread pollution of water supplies.
- Large quantities of waste that have not been placed accordingto good engineering practice can slip and collapse, burying and killing people.
- Waste that is treated or disposed of in unsatisfactory ways can cause a severe aesthetic nuisance in terms of smell and appearance.
- Liquids and fumes, escaping from deposits of chemical wastes (perhaps formed as a result of chemical reactions between components in the wastes), can have fatal or other serious effects.
- Landfill gas (which is produced by the decomposition of wastes) can be explosive if it is allowed to accumulate in confined spaces (such as the cellars of buildings).
- Methane (one of the main components of landfill gas) is much more effective than carbon dioxide as a greenhouse gas, leading to climate change.
- Fires on disposal sites can cause major air pollution, causing illness and reducing visibility, making disposal sites dangerously unstable, causing explosions of cans, and possibly spreading to adjacent property.
- Former disposal sites provide very poor foundation support for large buildings, so buildings constructed on former sites are prone to collapse.

Electronic waste (E-waste) Management

Introduction

This term applies to consumer and business electronic equipment that is near or at the end of its useful life. There is no clear definition for electronic waste (e-waste) at this time, but if you can plug it in to an electrical outlet or it contains circuit boards or chips, it is most likely e-waste. These products can contain heavy metals like cadmium, lead, copper, and chromium that can contaminate the environment. DO NOT dispose of these items in the trash or your recycling bins.

Examples of electronic waste include, but not limited to:

TVs, computer monitors, printers, scanners, keyboards, mice, cables, circuit boards, lamps, clocks, flashlight, calculators, phones, answering machines, digital/video cameras, radios, VCRs, DVD players, MP3 and CD players

Kitchen equipment (toasters, coffee makers, microwave ovens)

Laboratory equipment** (hot plates, microscopes, calorimeters)

Broken computer monitors, television tubes (CRTs)

E-waste Treatment & Disposal Methods

E-waste is a complex mixture of hazardous and non-hazardous waste, which consists of items of economic value. Therefore, it requires specialized segregation, collection, transportation, treatment and disposal. The following sections attempt a conceptual understanding of WEEE/ E-waste management based on existing management systems in developed countries.

Mechanism of E-waste Trade
Mechanism of WEEE/ E-waste trade can be explained in terms of three elements.
1. Material Flow
2. Life Cycle
3. Geographical Boundary

Disposal Methods

1. Land filling: It is one of the most widely used methods for disposal of e-waste. In land filling, trenches are made on the flat surfaces. Soil is excavated from the trenches and waste material is buried in it, which is covered by a thick layer of soil. Modern techniques like secure landfill are provided with some facilities like, impervious liner made up of plastic or clay, leachate collection basin that collects and transfer the leachate to wastewater treatment plant. The degradation processes in landfills are very complicated and run over a wide time span.

The environmental risks from land filling of e-waste cannot be neglected because the conditions in a landfill site are different from a native soil, particularly concerning the leaching behaviour of metals. Mercury, cadmium and lead are the most toxic leachate. Lead has been found to leach from broken lead containing glass, such as the cone glass of cathode ray tubes from TVs and monitors. Cadmium also leaches into soil and ground water. In addition, it is known that cadmium and mercury are emitted in diffuse form or via the landfill gas combustion plant. Landfills are also prone to uncontrolled fires, which can release toxic fumes. Therefore, land filling does not appear to be an environmentally sound treatment method for substances, which are volatile and not biologically degradable (Cd, Hg,), persistent (Poly Chlorinated Biphenyls) or with unknown behaviour in a landfill site (brominated flame retardants).

2. Incineration: It is a controlled and complete combustion process, in which the waste material is burned in specially designed incinerators at a high temperature (900-1000oC). Advantage of incineration of e-waste is the reduction of waste volume and the Utilization of the energy content of combustible materials. Some plants remove iron from the slag for recycling. By incineration some environmentally hazardous organic substances are converted into less hazardous compounds.

Disadvantage of incineration are the emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion. e-waste incineration plants contribute significantly to the annual emissions of cadmium and mercury. In addition, heavy metals not emitted into the atmosphere are transferred to slag and exhaust gas residues and can re-enter the environment on disposal. Therefore, e waste incineration will increase these emissions, if no reduction measures like removal of heavy metals are taken.

3. Recycling of e-waste: Monitors & CRT, keyboards, laptops, modems, telephone boards,

hard drives, floppy drives, Compact disks, mobiles, fax machines, printers, CPUs, memory chips, connecting wires & cables can be recycled.

Recycling involves dismantling i.e. removal of different parts of e-waste containing dangerous substances like PCB, Hg, separation of plastic, removal of CRT, segregation of ferrous and nonferrous metals and printed circuit boards.

Recyclers use strong acids to remove precious metals such as copper, lead, gold. The value of recycling from the element could be much higher if appropriate technologies is used.

The existing dumping grounds in India are full and overflowing beyond capacity and it is difficult to get new dumping sites due to scarcity of land. Therefore recycling is the best possible option for the management of e-waste.

Re-use: It constitutes direct second hand use or use after slight modifications to the original functioning equipment. It is commonly used for electronic equipments like computers, cell phones etc. Inkjet cartridge is also used after refilling. This method also reduces the volume of e-waste generation. We can use above mentioned methods for treatment and disposal of e-waste. The better option is to avoid its generation. To achieve this, buy back of old electronic equipments shall be made mandatory. This can considerably reduce the volume of e- waste generation.

Bio Medical Waste Management

Introduction

All human activities produce waste. We all know that such waste may be dangerous and needs safe disposal. Industrial waste, sewage and agricultural waste pollute water, soil and air. It can also be dangerous to human beings and environment. Similarly, hospitals and other health care facilities generate lots of waste which can transmit infections, particularly HIV, Hepatitis B & C and Tetanus, to the people who handle it or come in contact with it.

Most countries of the world, especially the developing nations, are facing the grim situation arising out of environmental pollution due to pathological waste arising from increasing populations and the consequent rapid growth in the number of health care centres. India is no exception to this and it is estimated that there are more than 15,000 small and private hospitals and nursing homes in the country. This is apart from clinics and pathological labs, which also generate sizeable amounts of medical waste.

India generates around three million tonnes of medical wastes every year and the amount is expected to grow at eight per cent annually. Creating large dumping grounds and incinerators is the first step and some progressive states such as Maharashtra, Karnataka and Tamil Nadu are making efforts despite opposition.

Bio-medical waste

Bio-medical waste means “any solid and/or liquid waste including its container and any intermediate product, which is generated during the diagnosis, treatment or immunization of human beings or animals.

Biomedical waste poses hazard due to two principal reasons – the first is infectivity and other toxicity.

Bio Medical waste consists of

- Human anatomical waste like tissues, organs and body parts
- Animal wastes generated during research from veterinary hospitals
- Microbiology and biotechnology wastes
- Waste sharps like hypodermic needles, syringes, scalpels and broken glass
- Discarded medicines and cytotoxic drugs
- Soiled waste such as dressing, bandages, plaster casts, material contaminated with blood, tubes and catheters
- Liquid waste from any of the infected areas
- Incineration ash and other chemical wastes

CATEGORIES OF BIOMEDICAL WASTE

WASTE CATEGORY	TYPE OF WASTE	TREATMENT AND DISPOSAL OPTION
Category No. 1	Human Anatomical Waste (Human tissues, organs, body parts)	Incineration@ / deep burial*
Category No. 2	Animal Waste (Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals and colleges, discharge from hospitals, animal houses)	Incineration@ / deep burial*
Category No. 3	Microbiology & Biotechnology Waste (Wastes from laboratory cultures, stocks or specimen of live micro organisms or attenuated vaccines, human and animal cell cultures used in research and infectious agents from research and industrial laboratories, wastes from production of biologicals, toxins and devices used for transfer of cultures)	Local autoclaving/ microwaving / incineration@
Category No. 4	Waste Sharps (Needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	Disinfecting (chemical treatment@@ / autoclaving / microwaving and mutilation / shredding##
Category No. 5	Discarded Medicine and Cytotoxic drugs (Wastes comprising of outdated, contaminated and discarded medicines)	Incineration@ / destruction and drugs disposal in secured landfills
Category No. 6	Soiled Waste (Items contaminated with body fluids including cotton, dressings, soiled plaster casts, lines, bedding and other materials contaminated with blood.)	Incineration@ / autoclaving / microwaving
Category No. 7	Solid Waste (Waste generated from disposable items other than the waste sharps such as tubing, catheters, intravenous sets, etc.)	Disinfecting by chemical treatment@@ / autoclaving /

		microwaving and mutilation / shredding##
Category No. 8	Liquid Waste (Waste generated from the laboratory and washing, cleaning, house keeping and disinfecting activities)	Disinfecting by chemical treatment@@ and discharge into drains
Category No. 9	Incineration Ash (Ash from incineration of any biomedical waste)	Disposal in municipal landfill
Category No.10	Chemical Waste (Chemicals used in production of biologicals, chemicals used in disinfecting, as insecticides, etc.)	Chemical treatment @@ and discharge into drains for liquids and secured landfill for solids.

Chemical treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.
** Mutilations / Shredding must be such as to prevent unauthorised reuse.
There will be no chemical pre-treatment before incineration. Chlorinated plastics shall not be incinerated.
* Deep burial shall be an option available only in towns with population less than five lakh and in rural areas.

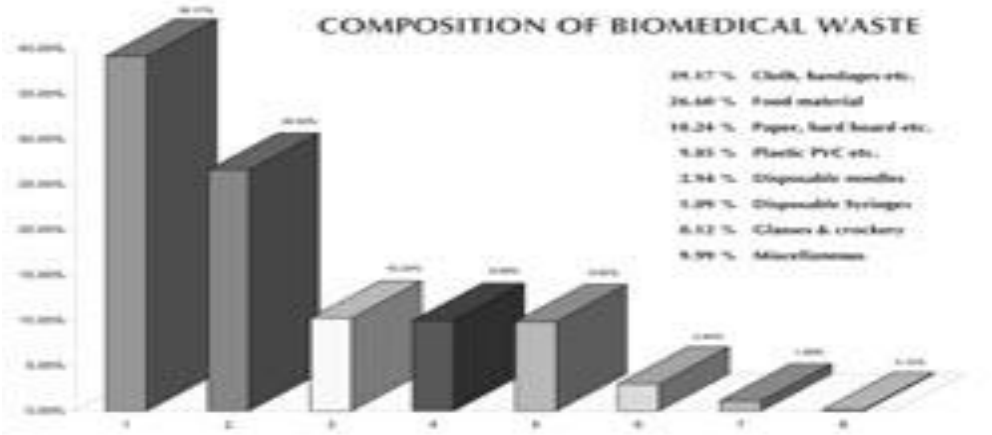
COLOUR CODING AND TYPE OF CONTAINER SCHEDULE II

Colour Coding	Type of Container	Waste Category	Treatment options as per Schedule I
Yellow	Plastic bag	Cat.1,Cat.2, Cat.3 and Cat.6	Incineration/ deep burial
Red	Disinfected container/ plastic bag	Cat.3, Cat.6, and Cat.7	Autoclaving/Micro waving/ Chemical Treatment
Blue/ White Translucent	Plastic Bag/ puncture proof container	Cat.4 and Cat.7	Autoclaving/Micro waving/ Chemical Treatment and destruction/ shredding
Black	Plastic bag	Cat.5, Cat.9, and Cat.10 (solid)	Disposal in secured landfill

Notes:
Colour coding of waste categories with multiple treatment options as defined, shall be selected depending on treatment option chosen.
Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
Categories 8 and 10 (liquid) do not require containers/bags.
Category 3 if disinfected locally need not be put in containers/bags.

Composition of BMW

The typical Hospital solid waste composition is as follows (based on CPCB report)



- Segregation

Segregation refers to the basic separation of different categories of waste generated at source and thereby reducing the risks as well as cost of handling and disposal. Segregation is the most crucial step in bio-medical waste management. Effective segregation alone can ensure effective bio-medical waste management. The BMWs must be segregated in accordance to guidelines laid down under schedule 1 of BMW Rules, 1998.

How does segregation help?

Segregation reduces the amount of waste needs special handling and treatment

Effective segregation process prevents the mixture of medical waste like sharps with the general municipal waste.

Prevents illegally reuse of certain components of medical waste like used syringes, needles and other plastics.

Provides an opportunity for recycling certain components of medical waste like plastics after proper and thorough disinfection.

Recycled plastic material can be used for non-food grade applications.

Of the general waste, the biodegradable waste can be composted within the hospital premises and can be used for gardening purposes.

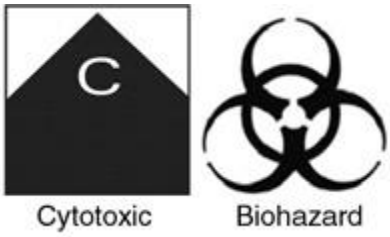
Recycling is a good environmental practice, which can also double as a revenue generating activity.

Reduces the cost of treatment and disposal (80 per cent of a hospital's waste is general waste, which does not require special treatment, provided it is not contaminated with other infectious waste)

Proper labelling of bins

The bins and bags should carry the biohazard symbol indicating the nature of waste to the patients and public.

Schedule III (Rule 6) of Bio-medical Waste (Management and Handling) Rules, 1998 specifies the Label for Bio-Medical Waste Containers / Bags as:



Label shall be non-washable and prominently visible

- Collection

The collection of biomedical waste involves use of different types of container from various sources of biomedical wastes like Operation Theatre, laboratory, wards, kitchen, corridor etc. The containers/ bins should be placed in such a way that 100 % collection is achieved. Sharps must always be kept in puncture-proof containers to avoid injuries and infection to the workers handling them.

- Storage

Once collection occurs then biomedical waste is stored in a proper place. Segregated wastes of different categories need to be collected in identifiable containers. The duration of storage should not exceed for 8-10 hrs in big hospitals (more than 250 bedded) and 24 hrs in nursing homes. Each container may be clearly labelled to show the ward or room where it is kept. The reason for this labelling is that it may be necessary to trace the waste back to its source. Besides this, storage area should be marked with a caution sign.

- Transportation

The waste should be transported for treatment either in trolleys or in covered wheelbarrow. Manual loading should be avoided as far as for as possible. The bags / Container containing BMWs should be tied/ lidded before transportation. Before transporting the bag containing BMWs, it should be accompanied with a signed document by Nurse/ Doctor mentioning date, shift, quantity and destination.

Special vehicles must be used so as to prevent access to, and direct contact with, the waste by the transportation operators, the scavengers and the public. The transport containers should be properly enclosed. The effects of traffic accidents should be considered in the design, and the driver must be trained in the procedures he must follow in case of an accidental spillage. It should also be possible to wash the interior of the containers thoroughly.

Personnel safety devices

The use of protective gears should be made mandatory for all the personnel handling waste.

- Gloves: Heavy-duty rubber gloves should be used for waste handling by the waste retrievers. This should be bright yellow in colour. After handling the waste, the gloves should be washed twice. The gloves should be washed after every use with carbolic soap and a disinfectant. The size should fit the operator.
- Aprons, gowns, suits or other apparels: Apparel is worn to prevent contamination of clothing and protect skin. It could be made of cloth or impermeable material such as plastic. People working in incinerator chambers should have gowns or suits made of non-inflammable material.
- Masks: Various types of masks, goggles, and face shields are worn alone or in combination, to provide a protective barrier. It is mandatory for personnel working in the incinerator chamber to wear a mask covering both nose and mouth, preferably a gas mask with filters.

- Boots: Leg coverings, boots or shoe-covers provide greater protection to the skin when splashes or large quantities of infected waste have to be handled. The boots should be rubber-soled and anti-skid type. They should cover the leg up to the ankle.

Types of Treatment Processes

There are mainly five technology options available for the treatment of Bio-Medical Waste or still under research can be grouped as

1. Chemical processes
2. Thermal processes
3. Mechanical processes
4. Irradiation processes
5. Biological processes

1. Chemical processes
These processes use chemical that act as disinfectants. Sodium hypochlorit, dissolved chlorine dioxide, peracetic acid, hydrogen peroxide, dry inorganic chemical and ozone are examples of such chemical. Most chemical processes are water-intensive and require neutralising agents.

2. Thermal processes
These processes utilise heat to disinfect. Depending on the temperature they operate it is been grouped into two categories, which are Low-heat systems and High-heat systems
Low-heat systems (operates between 93-177°C) use steam, hot water, or electromagnetic radiation to heat and decontaminate the waste.
Autoclave & Microwave are low heat systems.
Autoclaving is a low heat thermal process and it uses steam for disinfection of waste. Autoclaves are of two types depending on the method they use for removal of air pockets are gravity flow autoclave and vacuum autoclave.
Microwaving is a process which disinfect the waste by moist heat and steam generated by microwave energy
High-heat systems (operates between 540-8,300°C) employ combustion and high temperature plasma to decontaminate and destroy the waste.
Incinerator & Hydroclaving are high heat systems. Hydroclaving - is steam treatment with fragmentation and drying of waste
Incineration - is a burn technology

3. Mechanical processes
These processes are used to change the physical form or characteristics of the waste either to facilitate waste handling or to process the waste in conjunction with other treatment steps. The two primary mechanical processes are
Compaction - used to reduce the volume of the waste
Shredding - used to destroy plastic and paper waste to prevent their reuse. Only the disinfected waste can be used in a shredder.

4. Irradiation processes
Exposes wastes to ultraviolet or ionizing radiation in an enclosed chamber. These systems

require post shredding to render the waste unrecognizable.

5. Biological processes -
Using biological enzymes for treating medical waste. It is claimed that biological reactions will not only decontaminate the waste but also cause the destruction of all the organic constituents so that only plastics, glass, and other inert will remain in the residues.

Disposal of Wastes

- Disposal of Sharps

Blades and needles waste after disinfection should be disposed in circular or rectangular pits.
Such pits can be dug and lined with brick, masonry, or concrete rings.
The pit should be covered with a heavy concrete slab, which is penetrated by a galvanized steel pipe projecting about 1.5 m above the slab, within internal diameter of upto 20 mm.
When the pipe is full it can be sealed completely after another has been prepared.

- Radioactive waste from medical establishments

It may be stored under carefully controlled conditions until the level of radioactivity is so low that they may be treated as other waste.
Special care is needed when old equipment containing radioactive source is being discarded

- Mercury control

Wastes containing Mercury due to breakage of thermometer and other measuring equipment need to be given
Proper attention should be given to the collection of the spilled mercury, its storage and sending of the same back to the manufacturers.
Must take all measures to ensure that the spilled mercury does not become part of biomedical wastes
Waste containing equal to or more than 50 ppm of mercury is a hazardous waste and the concerned generators of the wastes including the health care units are required to dispose the waste as per the norms.

- Standard For Liquid Waste

The effluent generated from the hospitals must confirm to the following:

Parameter	Permissible limit
pH	6.5 – 9.0
Suspended solids	100 mg/l
Oil and grease	10 mg/l
BOD	30 mg/l
COD	250 mg/l
Bioassay test	90% survival of fish after 96 hours in 100% effluent

These limits are applicable to those hospitals which are either connected with sewers that have no terminal sewage treatment plant or not connected to public sewers that have terminal facilities. In addition, the general standards as notified under the Environment (Protection) Act, 1986 shall be applicable.

- Waste minimization:

Waste minimization is an important first step in managing wastes safely, responsibly and in a cost effective manner. This management step makes use of reducing, reusing and recycling principles. There are many possible routes to minimize the amount of both general waste and biomedical wastes within the health care or related facility. Alternative technologies for biomedical waste minimization (e.g., microwave treatment; hammer mill) have been investigated and are not considered to be practical. Some of the principles of waste minimization are listed below and will be developed further in the long-term strategy.

Different Types of BMW according to WHO

The World Health Organisation (WHO) has classified medical wastes according to their weight, density and constituents into different categories. These are:

- Infectious: material-containing pathogens in sufficient concentrations or quantities that, if exposed, can cause diseases. This includes waste from surgery and autopsies on patients with infectious diseases, sharps, disposable needles, syringes, saws, blades, broken glasses, nails or any other item that could cause a cut;

- Pathological: tissues, organs, body parts, human flesh, foetuse, blood and body fluids, drugs and chemicals that are returned from wards, spilled, outdated, contaminated, or are no longer required;

- Radioactive: solids, liquids and gaseous waste contaminated with radioactive substances used in diagnosis and treatment of diseases like toxic goiter; and

- Others: waste from the offices, kitchens, rooms, including bed linen, utensils, paper, etc.

Occupational health hazards

The health hazards due to improper waste management can affect

- The occupants in institutions and spread in the vicinity of the institutions
- People happened to be in contact with the institution like laundry workers, nurses, emergency medical personnel, and refuse workers.
- Risks of infections outside hospital for waste handlers, scavengers and (eventually) the general public
- Risks associated with hazardous chemicals, drugs, being handled by persons handling wastes at all levels
- Injuries from sharps and exposure to harmful chemical waste and radioactive waste also cause health hazards to employees.

Hazards to the general public

The general public's health can also be adversely affected by bio-medical waste.

- Improper practices such as dumping of bio-medical waste in municipal dustbins, open spaces, water bodies etc., leads to the spread of diseases.
- Emissions from incinerators and open burning also lead to exposure to harmful gases which can cause cancer and respiratory diseases.
- Exposure to radioactive waste in the waste stream can also cause serious health hazards.
- An often-ignored area is the increase of in-home healthcare activities. An increase in the number of diabetics who inject themselves with insulin, home nurses taking care of terminally ill patients etc., all generate bio-medical waste, which can cause health hazards.
- Bio-medical waste can cause health hazards to animals and birds too
- Plastic waste can choke animals, which scavenge on open dumps.
- Injuries from sharps are common feature affecting animals.
- Harmful chemicals such as dioxins and furans can cause serious health hazards to animals and birds.
- Heavy metals can even affect the reproductive health of the animals
- Change in microbial ecology, spread of antibiotic resistance

Dos and Don'ts
Ensure
1. that the used product is mutilated.
2. that the used product is treated prior to disposal.
3. that the used product is segregated
Do not
1. reuse plastic equipment.
2. mix plastic equipment with other wastes.
3. burn plastic waste.

Conclusion:

We need innovative and radical measures to clean up the distressing picture of lack of civic concern on the part of hospitals and slackness in government implementation of bare minimum of rules, as waste generation particularly biomedical waste imposes increasing direct and indirect costs on society. The challenge before us, therefore, is to scientifically manage growing quantities of biomedical waste that go beyond past practices. If we want to protect our environment and health of community we must sensitize our selves to this important issue not only in the interest of health managers but also in the interest of community.

Module 5

Unit IX

Geographic information system

Geographic Information System (GIS) is an information storage system of huge spatially referenced databases. Nowadays, soil information can be collected in digital form or converted from analogue to digital form, and stored in the GIS. The GIS databases with their layer of information about soil properties and on soil environment, can be used to create digital soil maps.
GIS is instrumental in delineation of different land-use, land-use suitability mapping and modeling. One of the most useful applications of GIS for planning and management is the land-use suitability mapping and analysis. Land-use suitability analysis aims at identifying the most appropriate spatial pattern for future land uses according to specify requirements, preferences, or predictors of some activity. GIS could be used in land-use suitability analysis with regards to land suitability/habitant for animal and plant species, geological favorability, suitability of land for agricultural activities, landscape evaluation and planning, environmental impact assessment, selecting the best site for the public and private sector facilities, and regional planning.

HISTORY OF GEOGRAPHIC INFORMATION SYSTEMS

The geographic roots of GIS go back some 2 500 years and have their basis in geographic exploration, research and theory building. In the early 1960s the assembled geographic knowledge began to be formalized as computer tools functioning to input, store, edit, retrieve, analyze and output natural resources information. The first GIS was the Canada Geographic Information System and it marked the inception of worldwide efforts to formalize and automate geographic principles to solve spatial problems. After more than 40 years of development, GIS is now a mainstay for addressing geographic problems in a wide variety fields apart from natural resources
GIS, or Geographic Information System, is a group of processes that collect and analyze data. The resulting information forms the basis for making quality decisions related to land, the oceans, lakes and resources management, as well as transportation and retailing. GIS technology integrates spacial and administrative information into one system, bringing together scientific disciplines, such as geography, cartography, remote sensing, photogrammetry, surveying, geodesy and statistics. It allows users to process and manipulate data in a variety of ways, giving them access to everything from tax information, to the location of utility cables and pipes, to property ownership.

Applications

Street Network
One of GIS's practical applications is street network control. Finding the right location when given an address is important to the postal service, police and fire departments, and it can be used to schedule vehicle-routing for transportation departments. It's also vital for developers in its capacity for site selection and analysis, as it provides relevant information about the quality of the site and geographical features that may, or may not, be desirable for builders. Street networks can also be employed in security-related activities when preparing evacuation routes.
Natural Resources
GIS is employed in the natural resource management of rivers, recreational grounds, flooded

areas, wetlands, farming lands, woodlands, and wildlife. It is used in Environmental Impact Analysis, scrutinizing the effect of various projects on the environment. GIS is involved in analyzing the hazards of toxins to land or groundwater. Water quality management is yet another GIS application, used to control wildlife habitats and to foresee the migration routes of animals.

Land

GIS is employed in land management, as a tool for preparing zoning and land subdivision plans, and in mapping. Individuals, businesses and corporations can utilize GIS for examining the features of land lots. As GIS has direct access to information about land ownership, accuracy in land title transfers is also realized with this system.

Facilities Management

GIS proves helpful in facilities management, as well as utility and construction companies, because of its ability to access the location of cables and pipes. Utility companies also use GIS to track energy use and to plan for improvements, and commercial property owners can use GIS to plan the maintenance of their facilities.

Application of GIS

GIS is a relatively broad term, which can refer to a number of technologies and processes, so it is attached to many operations; in engineering, planning, management, transport/logistics and analysis.

History of Development

During the 1854 cholera outbreak in London, English physician *John Snow* used points to represent the locations of some individual cases, possibly the earliest use of a geographic methodology in epidemiology. His study of the distribution of cholera led to the source of the disease, a contaminated water pump (the *Broad Street Pump*, whose handle he had disconnected, thus terminating the outbreak) within the heart of the cholera outbreak.

This historical became the advent of the usage of spatial data for analysis and planning in many fields including Civil Engineering.

GIS and Civil Engineering

An advanced information system like GIS plays a vital role and serves as a complete platform in every phase of infrastructure life cycle. Advancement and availability of technology has set new marks for the professionals in the infrastructure development areas. Now more and more professionals are seeking help of these technologically smart and improved information systems like GIS for infrastructure development. Each and every phase of infrastructure life-cycle is greatly affected and enhanced by the enrollment of GIS.

- **Planning:** In planning its major contribution is to give us with an organized set of data which can help professionals to combat complex scenarios relating to the selection of site, environmental impact, study of ecosystem, managing risk regarding the use of natural resources, sustainability issues, managing traffic congestion, routing of roads and pipelines etc.

- **Data Collection:** Precise and accurate data is the core driving factor of any successful project. GIS is equipped with almost all those tools and functions that enables user to have access to the required data within a reasonable time.
- **Analysis:** Analysis is one of the major and most influential phases of infrastructure life cycle. Analysis guides us about the validity or correctness of design or we can say that analysis is a method which supports our design. Some of the analyses that can be performed by GIS are:
    - Water distribution analysis
    - Traffic management analysis
    - Soil analysis
    - Site feasibility analysis
    - Environment impact analysis
    - Volume or Area analysis of catchment
    - River or canals pattern analysis
    - Temperature and humidity analysis

Construction: It is the stage when all layout plans and paper work design come into existence in the real world. The GIS helps the professionals to understand the site conditions that affect the schedule baseline and cost baseline. To keep the construction within budget and schedule GIS guides us about how to utilize our resources on site efficiency by:

- Timely usage of construction equipment.
- Working Hours
- Effects of seasonal fluctuations.
- Optimizing routes for dumpers and concrete trucks
- Earth filling and cutting
- Calculation of volumes and areas of constructed phase thereby helping in Estimation and Valuation.

Operations: Operations are controlled by modeling of site data and compared by the baselines prepared in planning phase. Modeling of site may be in the form of raster images or CAD drawings. These can help us to keep track of timely operations of activities.

GIS can help to make a record of work that has been completed and can give us visualization in the form of thematic maps which will guide us about rate of operations, completed operations and pending operations.

Remote Sensing

Remote sensing relies on detecting differences in the reflected or emitted radiation from different areas on the land surface over a range of wavelengths. It can be carried out from several platforms but mainly aircraft and spacecraft (Satellites) and the data are recorded as photographs or in digital form. When data are recorded in photographic form, they have to be transformed to digital data to enable computer processing. Data from remote sensing constitute input for GIS which can be synthesized with other data such as spatial data (roads, rivers, buildings, boundaries), and attribute data that describes the properties of a spartial feature in the GIS. Such attribute data for soil may be pH, texture, soil depth etc. up to predominant predetermined soil series in a defined area.

Remote sensing provides information for GIS use. Such data include those that are difficult to obtain through conventional means.

Generally, Remote sensing refers to the activities of recording/observing/perceiving (**sensing**) objects or events at far away (**remote**) places. In remote sensing, the **sensors** are not in direct contact with the objects or events being observed. The information needs a physical **carrier** to travel from the objects/events to the sensors through an intervening medium. The electromagnetic radiation is normally used as an information carrier in remote sensing. The output of a remote sensing system is usually an image representing the scene being observed. A further step of image analysis and interpretation is required in order to extract useful information from the image. The human visual system is an example of a remote sensing system in this general sense.

In a more restricted sense, remote sensing usually refers to the technology of acquiring information about the earth's surface (land and ocean) and atmosphere using sensors onboard airborne (aircraft, balloons) or spaceborne (satellites, space shuttles) platforms.

Remote sensing has a wide range of applications in many different fields:

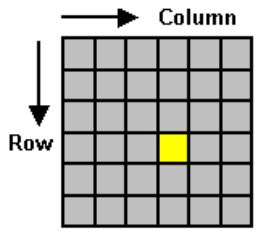
- Coastal applications: Monitor shoreline changes, track sediment transport, and map coastal features. Data can be used for coastal mapping and erosion prevention.
- Ocean applications: Monitor ocean circulation and current systems, measure ocean temperature and wave heights, and track sea ice. Data can be used to better understand the oceans and how to best manage ocean resources.
- Hazard assessment: Track hurricanes, earthquakes, erosion, and flooding. Data can be used to assess the impacts of a natural disaster and create preparedness strategies to be used before and after a hazardous event.
- Natural resource management: Monitor land use, map wetlands, and chart wildlife habitats. Data can be used to minimize the damage that urban growth has on the environment and help decide how to best protect natural resources.

Remote Sensing applications perform many features including:

- Change Detection — Determine the changes from images taken at different times of the same area
- Orthorectification — Warp an image to its location on the earth.

- Spectral Analysis — For example, using non-visible parts of the electromagnetic spectrum to determine if a forest is healthy
- Image Classification — Categorization of pixels based on reflectance into different land cover classes (e.g. Supervised classification, Unsupervised classification and Object Oriented Classification)

Remote Sensing Images



Remote sensing images are normally in the form of digital images. In order to extract useful information from the images, image processing techniques may be employed to enhance the image to help visual interpretation, and to correct or restore the image if the image has been subjected to geometric distortion, blurring or degradation by other factors. There are many image analysis techniques available and the methods used depend on the requirements of the specific problem concerned. In many cases, image segmentation and classification algorithms are used to delineate different areas in an image into thematic classes. The resulting product is a thematic map of the study area. This thematic map can be combined with other databases of the test area for further analysis and utilization.

Geostatistics

Geostatistics is a subset of statistics specialized in analysis and interpretation of geographically referenced data. In other words, geostatistics comprises statistical techniques that are adjusted to spatial data. Typical questions of interest to a geostatistician are: How does a variable vary in space? What controls its variation in space? Where to locate samples to describe its spatial variability? How many samples are needed to represent its spatial variability? What is a value of a variable at some new location? What is the uncertainty of the estimate? In the most pragmatic context, geostatistics is an analytical tool for statistical analysis of sampled field data. Today, geostatistics is not only used to analyse point data but also increasingly in combination with various GIS layers: e.g. to explore spatial variation in remote sensing data, to quantify noise in the images and for their filtering (e.g. filling of the voids/missing pixels), to improve generation of DEMs and for their simulations, to optimize spatial sampling, selection of spatial resolution for image data and selection of support size for ground data. .

Soil science is one of the major basis in life sciences for the development of Geostatistics though it has its application in other disciplines. It also have some overlap with GIS and spatial statistics in general.

Unit X

ENVILRONMENTAL LEGAL ASPECTS

ENVIRONMENTAL PROTECTION ACTS

Introduction

Constitution of India has a number of provisions demacrating 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 read 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 read 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 proerty.

Various statues / 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 steam 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 carryout 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 cleaning 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 NGO"s 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.