ENVIRONMENTAL STUDIES, I/II SEM B.E.- VTU
UNIT 1 & 2

PRESENTATION BY

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ENVIRONMENT AND ECOLOGY

Environment can be defined as something that surrounds us. Though our primary interest is the environment of man, we cannot exist in isolation. Human activity has to be understood in relation to other forms of life that exists in both animal and plant kingdom. Therefore it is necessary to deal with the environment of all life forms.

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.

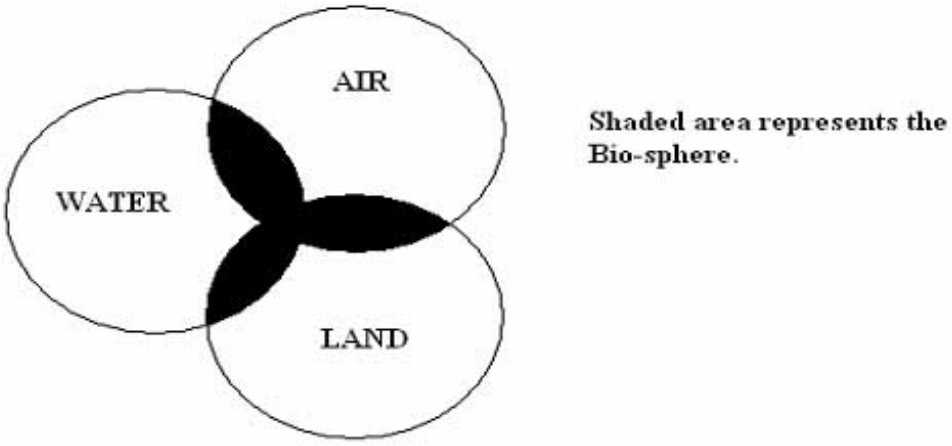

Fig.1: **Representation of Biosphere**

ECOSYSTEM

The bio-sphere is made up of the living system consisting of plant and animal kingdom, and the non-living components including minerals, water etc., The entire system is sustained by the source of energy, the Sun. Organisms belonging to different species either of plant kingdom or animal kingdom interact among themselves as well with the physical environments they occupy. This system is called ecological system or ecosystem.

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 $\xrightarrow{\text{Chlorophyll}}$ 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.

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.

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". It is knowing what makes our dwelling place function. Figure 2 defines the focus of Ecology.

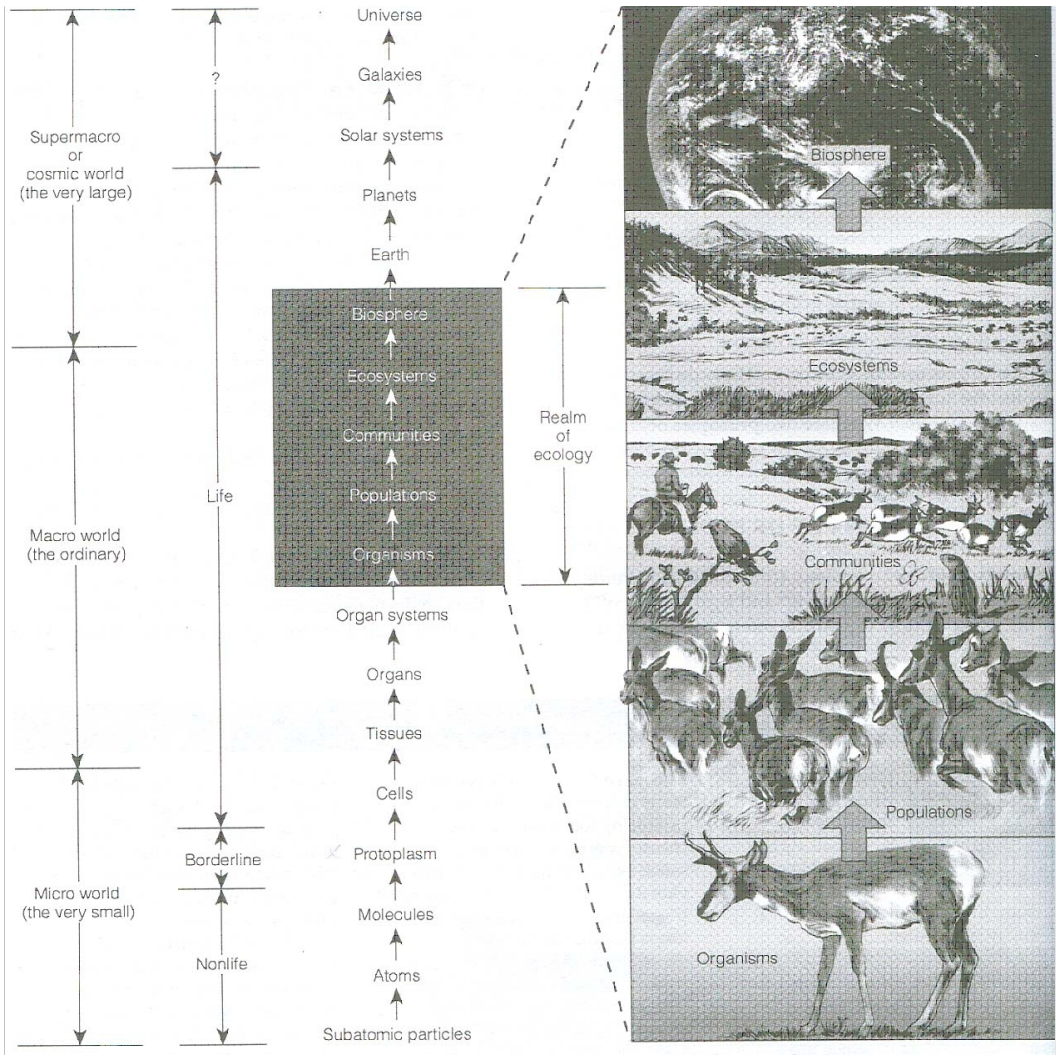

Fig. 2: **Organisation of matter in nature and focus of Ecology**

Classification of Ecosystems / Ecology

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.

Examples of Ecosystems

Two examples are given in the following sketches:

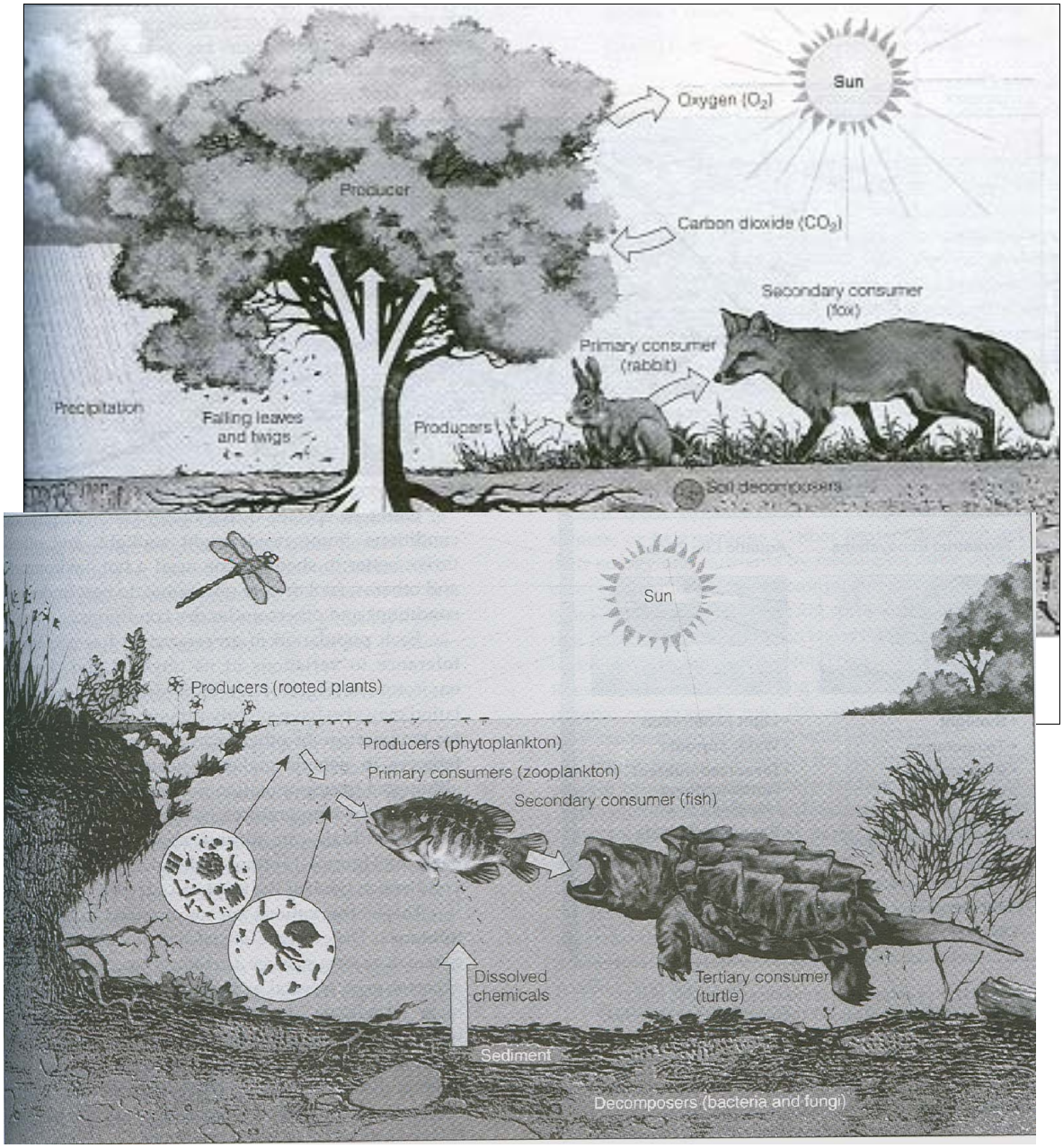

Fig. 4: **Components of an Aquatic (Pond) Ecosystem.**

Components of the pond ecosystem:

Abiotic : 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.

ENVIRONMENTAL IMPACTS OF HUMAN ACTIVITIES

All living beings including man are dependant on their environment for existence. But every manmade activity has some impact on the environment. More often it is harmful than benign. But human beings cannot live without taking up these activities for their food, shelter, comfort, security and many other needs. The following activities cause major impacts on the environment:

- Agriculture
- Housing
- Transportation
- Industries
- Water resources projects including irrigation projects
- Power Generation
- Mining
- Tourism
- Socio-Economic activities
- Defence related activities
- Petroleum processing
- Urbanization
- Commercial deforestation
- Providing public amenities such as water supply, sanitation, electricity, telephone, transportation etc.,
- Religious places – public activities

The list is not exhaustive. Every activity of the man from birth to death has its impact on the environment. Some of the major impacts are listed below :

Activities and Impacts

Activity	Impacts
Agriculture	- Soil erosion - Discharge of nutrients into water bodies / ground water - Discharge of pesticides into the environment. These pesticides end up in the food chain of the ecosystem. Endosulfan problem of cashew nut farms in Kerala which has crippled human beings is a living example. - Imposing Water burden on water resources - Water pollution
Water Resources projects	- Deforestation

	- Submergence of forest and other lands - Water logging problems - Evacuation and rehabilitation of people and villages - Disturbance to wild life - Masquito breeding
Housing	- Extraction of construction material - Cutting of forests - Energy utilization - Stress on water resources - Urban centres impose heavy burden on the environment - Disruption of storm water drainage pattern
Transportation	- Deforestation for constructing roads and railways - Utilization of valuable agricultural land for construction of airports which change the land use pattern - Air pollution - Noise pollution - Disruption of wild life habitats - Pollution of marine waters due to harbours
Industries	- Pressure on land and other natural resources for raw material - Water pollution - Air pollution - Noise pollution - pressure on transport systems
Power Generation	- Hydroelectric plants – submergence of valuable lands, deforestation, disruption of wild life etc., - Thermal power plants create water pollution, air pollution and thermal pollution problem besides requiring large quantity of water - Power transmission lines lead to deforestation - Thermal power plants require coal. Coal mining is environmentally critical activity. Also coal has to be hauled over long distances creating transportation related problems

	- Nuclear power plants carry the risk of radioactive hazards - Global warming / climate change and acid rain are related to combustion of fossil fuels in thermal power plants.
Mining	- Deforestation - Large tracts of land is made barren - Air pollution - Water pollution - Soil erosion - Transportation of ores imposes heavy burden on transport facilities
Tourism and Religious activities	- Create congestion - Transport problems - Sanitation problems - Water supply related problems - Spread of diseases - Social problems - Accumulation of plastic and other solid wastes
Human Habitation and Urbanization	- Growth of urban centres create all sorts of environmental problems like air, water and noise pollution, traffic related problems sanitation problems etc., - Solid waste generation - Water burden - Social tensions

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 before hand 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 qualitywise
- 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 is assessed by superimposing the effects of the project on the existing environment. If the impacts are not acceptable, corrective measures are incorporated into the proposed project and then correlated with the existing environmental set up. If significant negative effects are not observed, the project can be permitted to be taken up. In case, even after taking protective measures the environment is going to be affected, permission will not

be given to establish the proposed project. In the EIA exercise public are also allowed to participate and express their opinion.

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

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

Sustainable Development

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

The quality of our environment is determined by the intricate processes of the human race making a living and enjoying life. In that process water, food, land and air are used. The changes produced during this use affect the health, comfort, aesthetic senses, efficiency and capacity of people to attain a satisfactory social adjustment. Use of essentials for life affects the dynamics of all plant and animal life on earth by altering the ecological balance. Another aspect - use of land and air as waste disposal sinks is impairing their quality. The disturbance has reached such levels that these resources are no longer usable for their designated purposes in many instances. The rapid increase in world's population and the accelerated rate of use of all natural resources are making the consequences of misuse more drastic and more widespread. While living on the resource offered by the ecosystem it is necessary to maintain the sustenance levels of the ecosystem. This becomes very important while taking up developmental activities. Assessment of ecological changes and implementing preventive and corrective measures is an essential step in making the developmental activity ecologically sustainable.

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

Session – 7
Unit – III

MATERIAL CYCLES

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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".

The two major aspects of eco-systems are

(i) structure and

(ii) 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,

(i) the rate of biological energy flow i.e., production and respiration rates of the community

(ii) rate of materials or nutrient cycles

(iii) 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 component.

(i) Autotrophic Component

(ii) 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,

(i) Energy Circuits

(ii) Food Chains

(iii) Diversity Patterns in Space and Time

(iv) Nutrient Cycles

(v) Development and Evolution

(vi) Control (Cybernetics)

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

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

(ii) **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).

(iii) **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.

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.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Free Energy

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

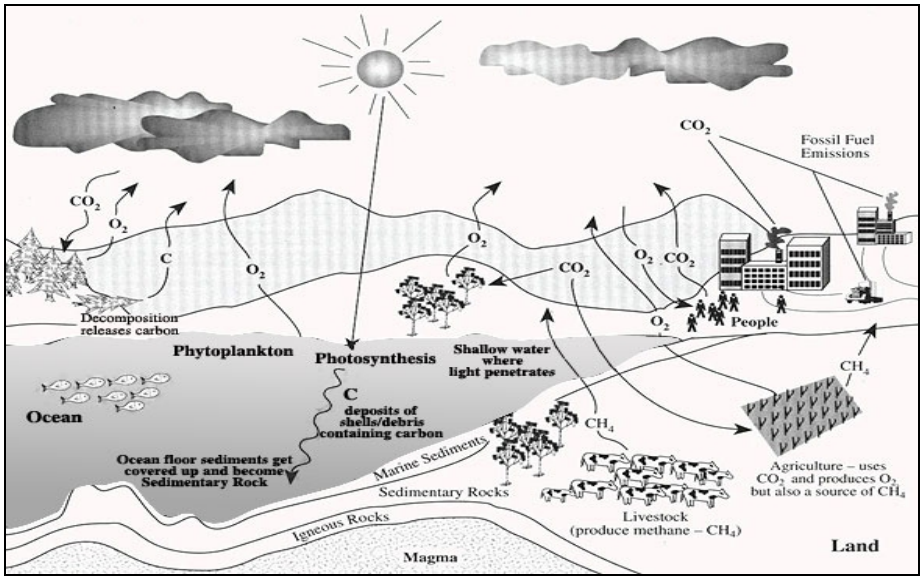


Figure 1 Carbon Cycle

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 micro-organism 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

Of all the elements that plants absorb from soil, nitrogen is the most important element for plants growth. It is required for amino acids, proteins, enzymes, chlorophyll, nucleic acids and many other compounds. But the atmospheric nitrogen is not utilized directly. Nitrogen undergoes many changes in the nitrogen cycle like, nitrogen fixation, nitrogen assimilation, ammonification, nitrification, denitrification (Figure 2).

Nitrogen fixation or conversion of free nitrogen of atmosphere into biologically acceptable form or nitrogenous compounds is referred to as nitrogen fixation. The fixation of nitrogen requires an investment of energy. Before nitrogen can be fixed, it must be activated so that the molecular nitrogen must be split into two atoms of free nitrogen. In physico-chemical process nitrogen combines with oxygen (as ozone) during lightening or electrical discharges in the clouds and produces different oxygen oxides. These nitrogen oxides get dissolved in rain water and on earth's surface, they react with mineral compounds to form nitrates and nitrogenous compounds.

$N_2 + 2(O) \rightarrow$ electric changes $\rightarrow 2NO$

$2NO + 2(O) \rightarrow 2NO_2$

$2NO_2 + (O) \rightarrow N_2O_5$

$N_2O_5 + H_2O \rightarrow 2HNO_3$

$2HNO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$

Biological nitrogen fixation is carried by some blue-green algae in the oceans, lakes and soils. Symbiotic bacteria (rhizobium) living in root nodules of leguminous plants and few other plants can fix nitrogen. Certain free living nitrogen fixing bacteria also fix nitrogen. Fixed nitrogen means nitrogen incorporated in a chemical compound that can be utilized by plants and animals. The actual fixation steps involves with two atoms of nitrogen combined with 3 atoms of hydrogen to form 2 molecules of ammonia. The activation and fixing, the two steps require a net input of 147 Kilo Calories. Once ammonia or ammonium ion appeared in the soil, it can be absorbed by the roots of plants and the nitrogen can be incorporated into amino acids and then to protein.

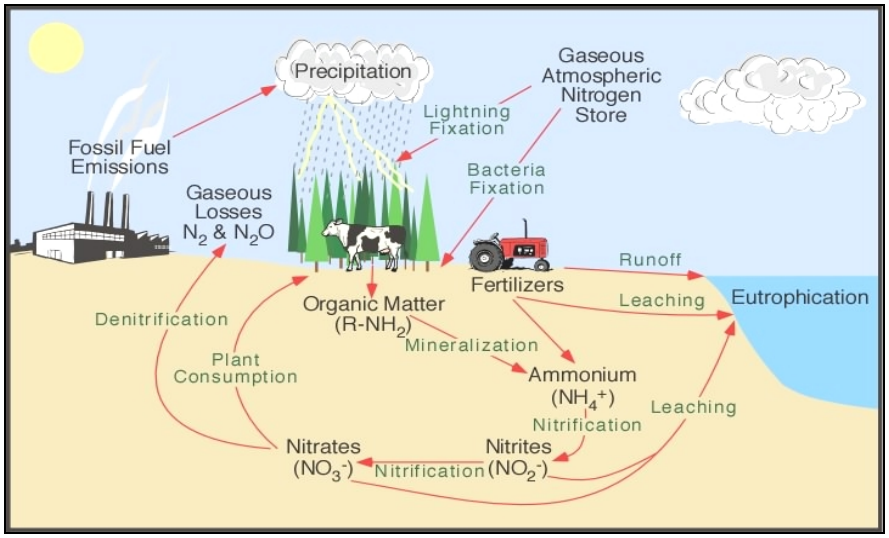


Figure 2 Nitrogen Cycle

Nitrogen assimilation means that the inorganic nitrates, nitrites or ammonia must be incorporated into organic compounds. Ammonification means that the dead organic remains of plants and animals and excreta are acted upon by bacteria, actinomycetes releasing nitrogen as ammonia. Enitrification means conversion of ammonia into nitrate by nitrosomonas, nitro coccus, in oceans and soils. Conversion of nitrite into nitrate by nitrobacter is also nitrification.

Denitrofication in conversion of nitrite and nitrate into nitrogen by Thiobacillus denitrifications, micro coccus, denitrificans, *pseudomonas aerusinosa*, etc.

SULPHUR CYCLE

Unlike carbon and oxygen cycles (gaseous cycles), sulphur and phosphorus cycles are sedimentary cycle. Sulphur is present normally as sulphates or sulphides. In sulphur springs and volcanic eruptions sulphur di-oxide is present to some extent. Sulphur is a component of 3 amino acids. Sulphur cycle is going to be important from protein synthesis point of view. Almost all proteins contain these amino acids. Sulphur is also present in the fossil fuels which emit sulphur di-oxide, in the automobile exhaust. Under anaerobic conditions sulphates are used to supply oxygen for sulphur organisms. In some of the sulphur bacteria elements of sulphur is precipitated. Hydrogen sulphide produced under anaerobic conditions can be oxidized to suplhur or sulphates. Sulphur di-oxide in the atmosphere gets converted to sulphorous and sulphuric acid causing the

acid rain problem in many urban and industrial areas. In sewers, because of anaerobic conditions, H_2S is produced. This get oxidized with oxygen present in the sewer pipe and become SO_2 which dissolves in water to form sulphuric acid. Accumulation of this inside the pipe results in 'crown corrosion' in sewers.

Sulphur cycle links soil, water (Figure 3). Sulphur also occurs in soils and rocks as sulphides (FeS, ZnS, etc.). Except a few organisms which need organic form of suplhur as amino acids and cystein, most of the organisms take sulphur as inorganic sulphates. Under aerobic conditions sulphur can be reduced to directly sulphides.

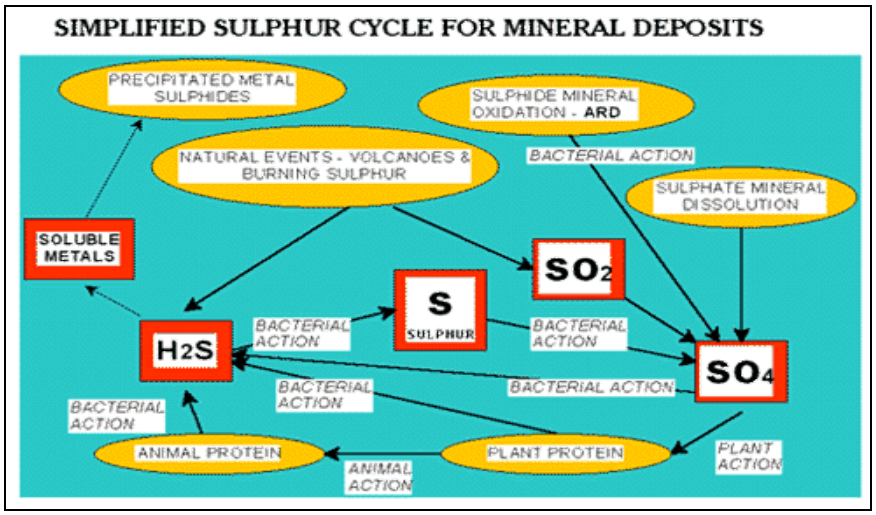


Figure 3 Sulphur Cycle

Green and purple photosynthetic bacteria use hydrogen of H_2S as oxygen acceptor in reducing carbon-di-oxide. Green bacteria are also to oxidize sulphide to elemental sulphur, whereas purple sulphur bacteria can carry oxidation of sulphate stage. In the ecosystem sulphur is transferred from autotrophs to animals, their to decomposers and finally it returns to environment through death and decay of dead organisms.

Sedimentary nature of sulphur cycling involves precipitation of sulphur in presence of iron, under anaerobic conditions. Sulphides of iron, copper, zinc, cadmium, cobalt are insoluble in neutral and alkalie waters and sulphur is bound to limit the amount of these elements.

Session – 12
Unit – VI

POPULATION GROWTH, URBANIZATION AND AUTOMOBILE POLLUTION

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%.

Population Pyramids

The age-sex distribution of population is an important feature to understand a country's demographic situation. These statistics give government the tools they need to make informed decisions that will affect our lives today and in the future. One way to illustrate the structure of a population is to plot the number of males and females for various ages. Such a horizontal bar graph with data for males on the left and females on the right is called a 'Population Growth Pyramid' (Figure 1).

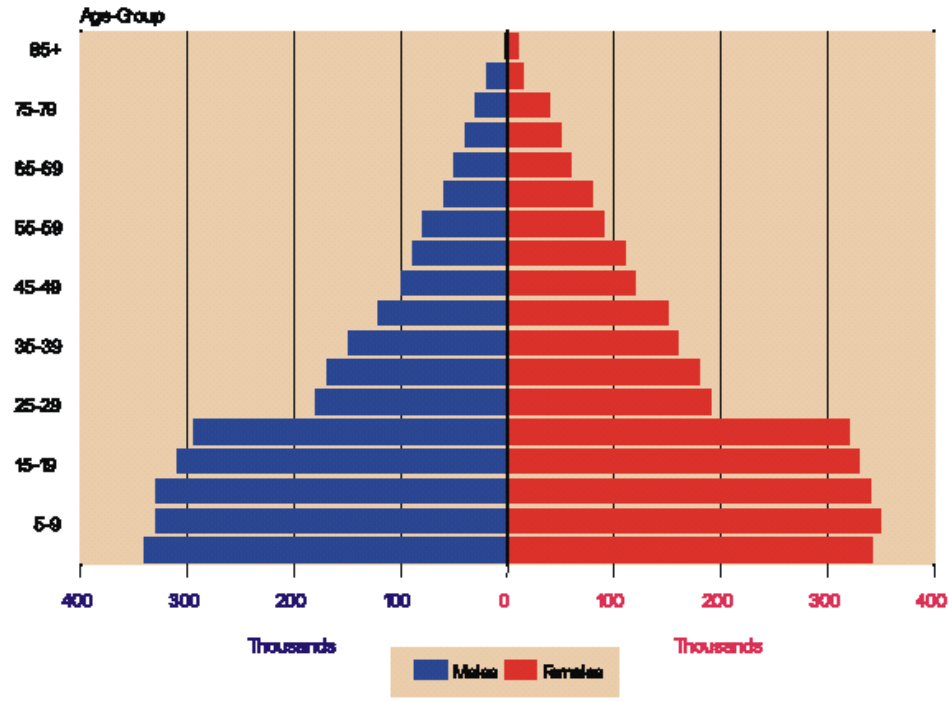


Figure 1 Population Growth Pyramid

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

Malthusian Theory

In 1978, the British economist and demographer Thomas Robert Malthus published his theory. Malthus noted that human population was growing exponentially,

while an ability to grow food was increasing arithmetically. Malthus ultimately concluded that human population would outgrow the capacity of land to produce food. Famines, plagues, natural disaster and war would then bring the population under control.

Population Prediction

Sl. No.	Country	Population (Million)	
		2004	2050
1	China	1300	1440
2	India	1075	1630
3	USA	295	420
4	Indonesia	220	310
5	Brazil	180	310
6	Pakistan	160	300

$$\text{Annual Population Growth} = \frac{(\text{Crude Birth Rate} / 1000 - \text{Crude Death Rate} / 1000)}{1000} \times 100$$

* About 40% of Indians < 15 years

* About 70% live > 55,000 villages

* India was the first country in the world to start family planning.

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

Environmental Implications of Population Growth

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

Rapid population growth will overstress the earth's natural resources and crowd out undomesticated plant and animal species. All people want to be fed, clothed, housed and have access to clean water. To meet these requirements, water, land, forest and other natural resources must be exploited to some degree. As population increases, more resources are needed to meet the basic requirements. More forest must be cut down to provide wood for housing and fuel. More cleared land is needed for agriculture and development. All of these are finite. More than 99% of the world's food supply comes from the land, while less than 1% from oceans and other aquatic habitats. The continued

production of an adequate food supply is directly depended an ample fertile land, fresh water, energy, plus the maintenance of biodiversity. As the human population grows, the requirements for these resources also grow. Even if these resources are never depleted, on a per capita basis they will decline significantly because they must be divided among more people.

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

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

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

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

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

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

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

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

URBANIZATION

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

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

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

There are a number of schemes designed to improve urban infrastructure such as centrally assisted programmes for construction of individual and community latrines. There are schemes for water supply to small towns with population less than 20,000. Initiatives create infrastructure for the urban poor include, schemes to provide drinking water, drainage and lighting to notified slums. The urban basic service schemes – 1986 promotes women and child development, low cost water supply and sanitation. A programme for environmental improvement of urban schemes was introduced in 1974.

AUTOMOBILE POLLUTION

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

When fuel like kerosene, diesel, petrol burn a lot of smoke is released into the atmosphere. These fuels are all mixture of various hydrocarbons of different molecular masses and formulae. Of these, octane constitute 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.

Session – 14
Unit – VI

CLIMATIC CHANGE AND GLOBAL WARMING

Carbon di-oxide is a natural constituent of atmosphere, but now, its concentration is increasing at an alarming rate. According to an estimate, CO_2 level is expected to be doubled by 2030 A.D.

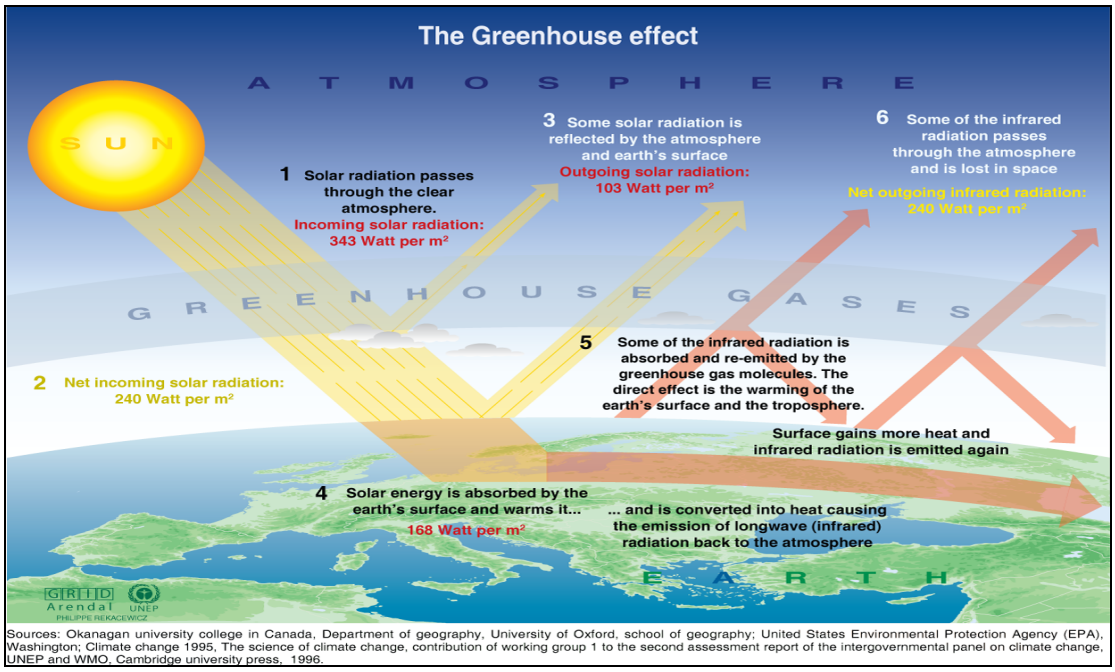
The term 'Green House Effect' is also called as 'Atmospheric Effect', 'Global Warming' or 'CO_2 Problem'.

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

Under normal concentrations of CO_2, the temperature of the earth's surface is maintained by the energy balance of the sun's rays that strike the planet and the heat is radiated back into the outer space. However, when concentration of CO_2 in the atmosphere increases, the thick envelope of this gas prevents the heat from being re-radiated out. The heated earth can radiate this absorbed energy as the radiation of longer wave length.



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Figure 1 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

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

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.

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NATURAL RESOURCES

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Resources are needed for the development of civilization. Natural resources are the materials provided by the nature that are required to sustain life and livelihood. They include air, water, land, food, timber, paper, medical plants, minerals, fuel, etc. Everything that human beings use is drawn from the nature. Due to increased standards of living results in excessive utilization of natural resources. However, the natural resources are limited. They should be properly and optimally used for a comfortable living. The entire living system will collapse when the utility exceeds the regeneration capacity.

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.

Water Resources

Precipitation is the primary source of water which may be in the form of surface water and groundwater available for our use. Much of this will be known in the subsequent lectures.

Energy Resources

The power we use is mostly hydel or thermal or nuclear origin. Alternate energy refers renewable energy sources (rather than burning the fossil fuels like petroleum and coal production) which will never exhaust viz.; wind energy, geothermal energy, biomass, solar energy, etc. The renewable energy is the need of the hour because fossil fuels are getting exhausted very fast. In India, for every year 300 million tons of agro residues produced to get biogas. The biomass programme propagates the protection of fast growing species of trees to meet fuel fodder and power requirements particularly rural areas. Wind energy produces electricity at a very lower cost with no emission and no big investment. Tidal and geothermal energy are yet to be exploited to economical scale. One of the biggest hurdles coming in the way to tap the vast sources available is the capital cost. In promoting renewable energy the people's support is very much required. Further, hydrogen will be alternative source of energy.

Food Resources

Global food supply has improved enormously since 1960's. Agricultural production has increased and world food supplies are 18% higher than 30 years ago. Food security is the ability of all people at all time to access enough food for an active and healthy life. Food insecurity is not just a problem related to food production, it is closely linked to poverty and economic stagnation.

Land Resources

Land is a declinable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface including those of the near surface climate the soil and terrain forms the surface hydrology (including shallow

lakes, river, marshes and swamps), the near surface sedimentary layers and associated groundwater resource, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.).

Natural resources in the context of land as defined above are taken to those components of land units that are direct economic use for human population living.

To a large degree, these resources can be quantified in economic terms.

Environmental resources are taken to be those components of the land that have intrinsic value. They include biodiversity of plant and animal population, science, educational / research value of landscape, protective value of the vegetation in relation to soil and water resources, water and soil condition as regulators of nutrient cycles, etc.

Environmental resources are to a large degree 'intangible' in strict economic terms.

Conservation of Natural Resources

As the human population increases, greater demands are placed upon the available resources. Large areas of earth are being converted for in exclusive use of human beings. This result in several changes do occur in various components of the biosphere such as pollution of seas, rivers and lakes, denudation of forest, degradation of land. The problem lies is what will happen to our future generation, if the natural resources are used injudiciously at a rapid rate. At present, world environment is suffering critical stress not only by our utilization of natural resources but the greater environmental change. For all these Sustainable Environmental Management System has to be adopted through individuals, value system and prevention of pollution.

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WATER RESOURCES

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Precipitation is the primary source of water which may be in the form of snowfall or rainfall. Surface water and sub-surface water are the sole sources available for utility. The total volume of water available on earth is very vast. About 97% of world's water volume is in ocean and sea as salt water. Fresh water is roughly 3%, and this major portion (about 80%) is trapped at the poles in the form of polar ice-caps. Thus less than 1% of the total hydrosphere is available to us in the form of surface and sub-surface water.

As per National Commission on Agriculture, considering average annual rainfall as 120 cm, the water wealth of India is estimated to be 400 million-hectare-m.

With increasing industrialization and consequent growth of human population, water being used in enormous quantities. Per capita consumption has increased several fold. Developed countries are using much more water than the developing countries of Asia and Africa. The per capita water utilization is USA and France are about 700 and 400 litre respectively for domestic purpose only. The Central Water Commission, Government of India is the sole National apex organization look upon the water resources management through conservation and utilization of water resources for irrigation, flood control, hydropower generation and navigation throughout the country.

In urban areas, people consume about 80-100 lpcd (litre per capita / day) for domestic use. Agriculture accounts for more than 75% of world useful water.

The major factors worsening the present water crisis are:

- Growing population
- Inefficient irrigation
- Pollution.

Water on the earth is in continuous motion through hydrological cycle (Figure 1). The global consumption of water may be doubling in the next 20 years. The world's quest for fresh water had led to widespread environmental destruction. The number of large dams built to divert water has risen from 5000 to 45000 today. The environmental impact resulting from such diversions have been devasting.

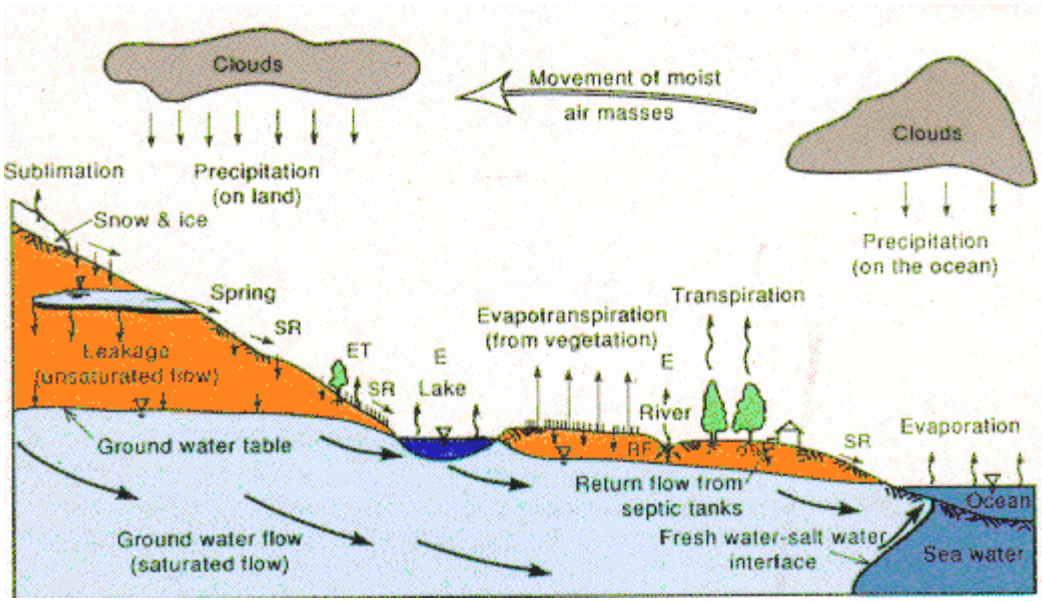

Figure 1 Hydrologic Cycle

Drought

Drought is a complex physical and social process having widespread significance. There is no universally accepted definition. However, drought, unlike floods is not a distinct event, no well defined start or end. The most commonly used definition of drought is based on meteorological, agricultural, hydrological and socioeconomic effects. Meteorological drought is often marked by a period of substantially diminished precipitation duration / intensity. Hydrological drought means lack of rain and flow. Agricultural drought occurs due to inadequate soil moisture. Socio-economic drought occurs when physical water shortage start to affect health, well being, diminished quality of life and economic loss.

Future global conflicts would arise over control of the shared river basins on which millions of people depend on water for drinking, irrigation and energy.

Water available at different places through different sources have different qualities. Some are hard, some are soft and some are saltish. However, human being are learnt to make the best use of the available quality and quantity of water for different uses. The major impurities in water are dissolved and suspended solids. These are the main sources of many water borne diseases.

Role of Dam in Water Resources Conservation

Dams have made a significant contributions to human development and the benefits derived from them have been considerable.

Dams converts available water to useful water. Water storage in the reservoir is to assured the source against uncertainty in natural water availability during climatic variation. Dams regulate water release for flood mitigation, regulate the supply of water for irrigation and drinking. They also safeguard from social and economical tragedies.

Multipurpose dams accounts for a large proportion of water for irrigation followed by flood control, hydropower, domestic and industrial use, recreation and fish farming.

In India, more than 80% of the rain occurs during monsoon and 60-80% precipitation occurs in just 6-8 intense rainfall events. Harvesting water through dam is the major concerns for all multiple usages.

Benefit of Dams

40% of the world food production comes from irrigation farming, with a direct 16% contribution from land irrigation are from dam reservoir. 19% of world energy is from hydro electrical power. It accounts more than 90% of all energy in 24 countries and more than 50% for 63 countries. 12% of large dams supply water to towns and cities. 13% of dams help in flood mitigation in nearly 75 countries. Some dams have helped to

improve the ecosystems by creating new wetland for creating fishing and recreation in the reservoirs.

Problem with Dams

Loss of biodiversity, habitat submergence, loss of forest and fertile land, water logging, salinity, human involved erosion, cumulative impacts on water quality, natural flooding and loss of species composition. All these could be resulted where a number of dams are sited in the same river.

Socio-economic Impacts

- ⇨ Poorly managed involuntarily displacement and loss of livelihood
- ⇨ Higher incidence of water borne diseases
- ⇨ Millions of people living downstream from dams suffer serious harm to their livelihood
- ⇨ Compensation provided for them are inadequate

Ethical Dilemma with Dams

- ☞ Rights of a small number of locally affected population versus gain of large number of potential beneficiaries.
- ☞ Conservation of natural resources
- ☞ Increase production of wealth to support growing needs versus fair distribution of accumulated wealth
- ☞ Sustainable development concept

Possible Solution to Improve the Acceptability of Dam Project

- ➢ Avoid and minimize ecosystem impacts
- ➢ Conduct regular monitoring and periodic review
- ➢ National water policy adaptation
- ➢ Riparian rights
- ➢ Sharing of water without disputes

Water Disputes

1947-1960: India – Pakistan

Partition leaves Indus basin divided between India and Pakistan; disputes over irrigation water ensue during which India's stems flow of water into irrigation canals in Pakistan. Indus water agreement reached in 1960 after 12 years of World Bank – led negotiations.

1991-Present: Karnataka – Tamil Nadu

Violence erupts when Karnataka rejects an interim order handed down by the Cauvery Water tribunal set up by the Indian Supreme Court. The tribunal was established in 1990 to settle two decades of dispute between Karnataka and Tamil Nadu over a irrigation rights to the Cauvery river.

Conservation of Water by the Community

To conserve water reduced utility of water to be practiced in domestic and industrial sector. At domestic level one can think of better toilet design, prevention of wastage by repairing and checking the pipes and taps. Recycling of water is another way of conservation of water. Sewage effluent can be used to grow plants and vegetables. Industries can also partially purify used water and recycle it. Better effluent treatment technologies will not only conserve water but also prevent water pollution causes by their effluent.

By rainwater harvesting one can save and utilize the water and also enhance the groundwater storage. Surface water can be conserved by temporary bunds.

It is the sole duty of every citizen to conserve each drop of water to the maximum equitable benefits.

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WATER AND HEALTH
(Water Induced Diseases)

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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 majority of people are seriously affected by or die from preventable water and sanitation related diseases are rural dwelling and the urban poor in the developing countries. Current international estimate of deaths are due to water related diseases which range from 2.2 million to 5 million annually.

Classification of Water Related Diseases

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

Classification of Water Related Diseases

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

Description of Selected Water Borne Diseases

Disease	Description
Diarrhea	It is the most common type of water related illness and is caused by drinking water contaminated with disease causing bacteria, viruses and / or tiny parasites like worms / amoebas from human excreta. People who are sick with this have to defecate more often than usual which results in problem of dehydrations and malnutrition.
Dysentery	It is a more serious form of diarrhea and occurs when contaminated water is used for eating / drinking. The persons' feces will frequently contain blood or mucus. It spreads from person to person.
Cholera	It is a highly contagious diarrhea caused by drinking / eating food of water contaminated with the feces or vomit of an infected person. It can also be spread by dirty hands / flies. Cholera outbreaks commonly occur in crowded slums and in the aftermaths of major diseases where water and sanitation facilities are non-existent / damaged / destroyed. In severe cases rapid loss of body fluids leads to dehydration and shock.
Typhoid Fever	Typhoid is a gut infective caused by food / water contaminated with bacteria found in human excreta, and often occurs in epidemics. This disease results in high fever accompanied with diarrhea or vomiting.
Trachoma (Eye Infection)	It is a chronic form of conjunctivitis (pink eye) that get progressively worse and may last for months or many years. The disease is spread by touch of flies. Trachoma is a major cause of blindness in developing countries.
Malaria	Malaria is a disease caused by the micro organisms that are passed onto people who are bitten by malaria infected mosquitoes. People who suffer from malaria suffer from recurring attacks that cause shivers, fevers and aches.
Schistosomiasis	This disease is caused by blood flukes-tiny worms that begin their lives inside fresh water snails. After being released with water as free-swimming worms they penetrate the skin who are swimming, bathing or washing in contaminated water. Once in the blood stream, the worm cause victims to suffer from fever, pain in the lower abdomen over time this results in liver damage.
Trypanosomiasis (Sleeping Sickness)	This disease is a dangerous infection spread by infected flies commonly found much in woodland especially around water holes where flies breed. People suffer from fever, ache, fatigue and progressive confusion and difficulty in walking and talking.
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

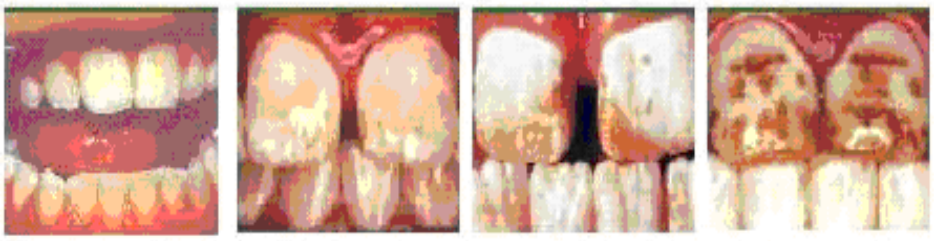
Fluoride in water is mostly of geological origin. Waters with high levels of fluoride content are mostly found at the foot of high mountains and in areas where seas has made geological deposits.

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.

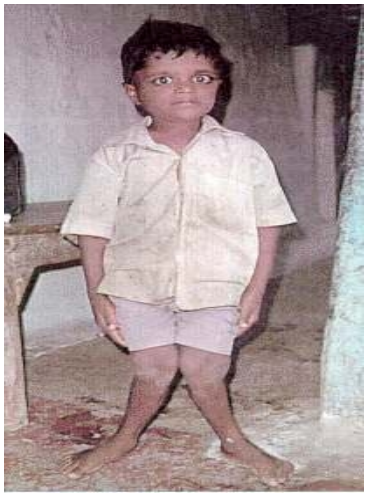
High level exposure to fluoride can lead to skeletal fluorosis (photos). Here, fluoride accumulates in the bone progressively over many years. The early symptoms of skeletal fluorosis include stiffness and pain in the joints. In severe cases the bone structure may change and ligaments may calcify resulting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

Dental Fluorosis



Very Mild	Mild	Moderate	Severe

Skeletal Fluorosis



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. A new invention on this is the modified Nalgonda Technique i.e., design of continuous flow defluoridation unit which has been developed at S.J. College of Engineering, Mysore, by this author.

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Session – 15
Unit – VIII

ENVIRONMENTAL PROTECTION ACTS, NON-GOVERNMENTAL ORGANISATIONS, ENVIRONMENTAL EDUCATION AND WOMEN EDUCATION

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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 compasion 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 property.

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

- 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.
- To advise the state government on any matter concerning the prevention, control or abatement of water pollution
- To collect and disseminate information relating to water pollution, prevention, control or abatement of water pollution.
- To encourage, conduct and participate the investigations and research relating to problems of water pollution.
- To collaborate with central board in organizing the training of persons engaged in programmes relating to water pollution, prevention, abatement and treatment.
- To inspect effluent treatment plants trade waste and domestic waste.
- To lay down, modify standard for trade and domestic wastes.
- To evolve economical and reliable methods of treatments, utilization of treated effluent for agriculture and disposal into land.
- To lay down standards of treatment of sewage and trade effluents to be discharged into a stream during dry weather flow.
- 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;

- Constructing bridge, weir, dam, sluice, dock, pier, drain or sewer or other permanent works which he has a right to construct, improve or maintain.
- 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.

- 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 Organisation

- ⇨ 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.

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06CIV-18/06 CIV 28 ENVIRONMENTAL STUDIES
(E-Notes)

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Unit-1V
ENERGY

Different types of energy are - Electro magnetic radiation, conventional and non-conventional sources, Hydro electrical, Fossil fuel based, Nuclear, solar, Bio mass and Biogas, Hydrogen as an alternative future source of energy**.**

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.

a) Jog for 6 min b) Bicycle for 10 min c) walk briskly for 10 min d) sleep for 11/2 hours e) Run a car at 80 km ph for sec s f) light a 60 w bulk for 11/2 hrs. g) Lift a sack of sugar from floor to counter 21,000 tones.

Kinds of energy

a) Kinetic energy: it is the energy of motion
b) 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

Energy resources are broadly classifies as primary and secondary .

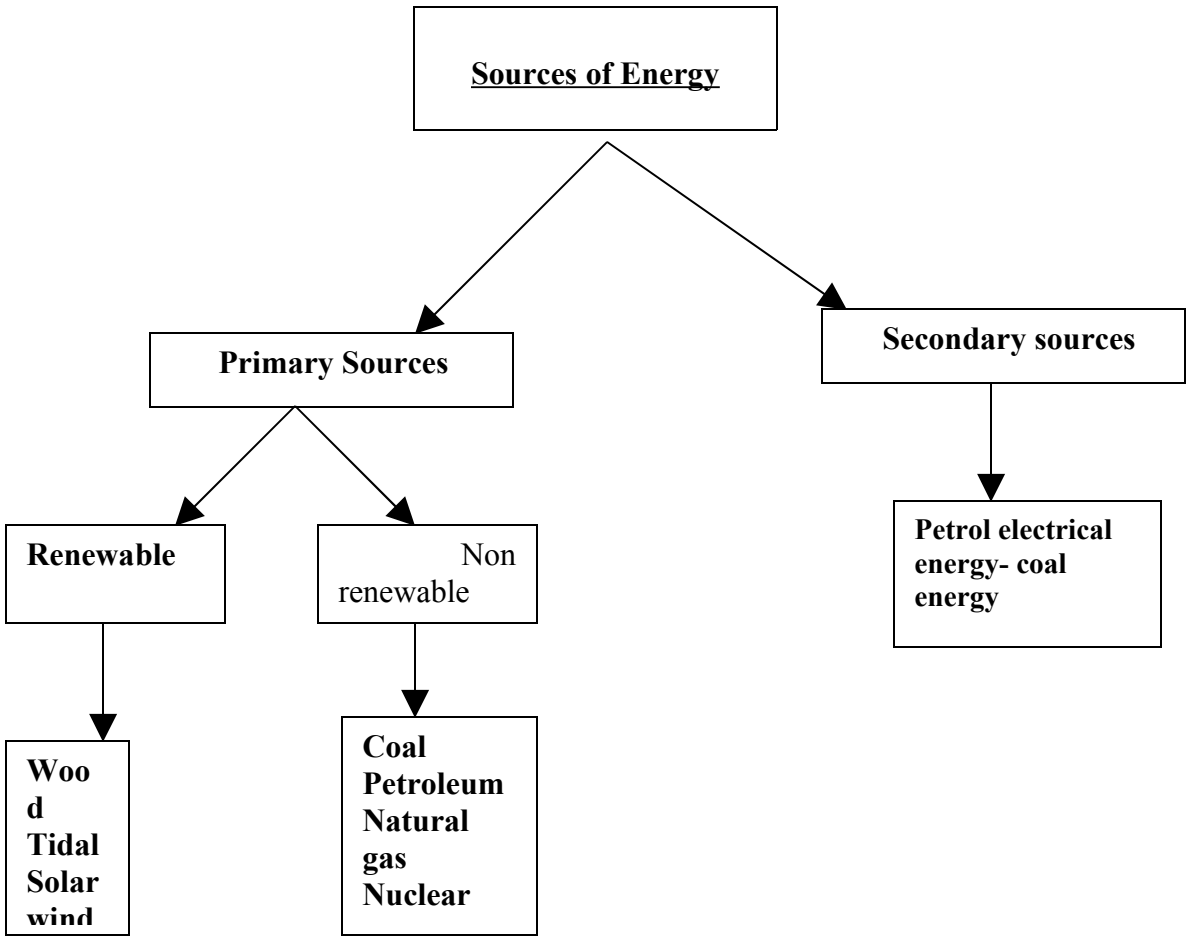


Fig 1 Sources of energy

Primary:

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.

Table 1: ***Different Sources of Energy***

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

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.

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 is 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

a) 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.

b) 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 utilisation.

Electromagnetic Radiation

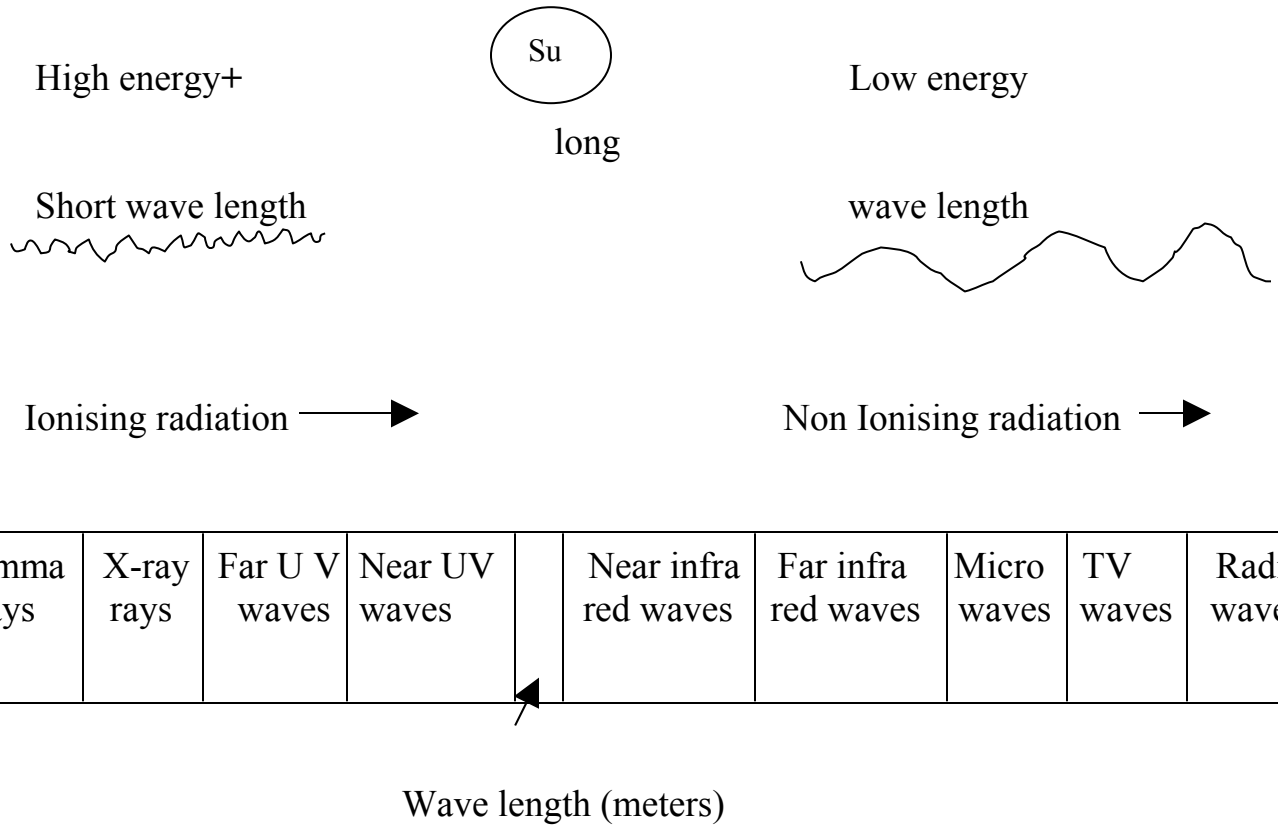
An electromagnetic radiation is energy in the form of a wave due to changing electric and magnetic fields. There are different forms of electro magnetic radiation, each with a different wavelengths (i.e. Distance between successive peaks or troughs in the wave) and energy content. Such radiation travels 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.2 given the details of Electromagnetic Spectrum.



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.

a. **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.

b. **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.

c. **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 4×10^{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 have 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.

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

Advantages	Disadvantages
* Moderate to high net energy.	* High construction cost
* High efficiency (80%)	* High environmental impact
* Low cost electricity	* High carbon dioxide emission from biomass decay in shallow tropical reservoirs.
* Long life span	* Floods natural areas.
* No carbon dioxide emission during operation	* Coverts land habitat to lake habitat.
* May provide flood control	* Danger of collapse

below dam.

* Provides water for year-round Irrigation.
* Reservoir is useful for fishing and recreation.

* Uproots People.
* Decreases fish harvest Below dam.
    - Decreases flow of natural Fertilizer (stilt) to land Below dam.

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:

a. Anthracite or hard coal (90% carbon content)
b. Bituminous or soft coal (85% carbon content)
c. 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 (Organisation 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:

a. **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.

b. **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.

c. **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 habitate for living organisams. 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 microspheres 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

a. 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
* Easily transported within and between countries
* Low land use
* Technology is well developed
* Efficient distribution system

* Air pollution when burnt
* Released carbon dioxide when when burnt
* Moderate water pollution

Heavy oils from oil shale and Tar sand

Advantages

* Moderate existing supplies
* Large potential supplies
* Easily transport within and between countries
* Efficient distribution system in place
* Technology is well developed

Disadvantages

* High costs
* Low net energy yield
* Large amount of water needed to process
* Severe land disruption
* Water pollution from mining residues
* Air pollution when burnt
* Carbon dioxide emissions when burnt

c. Conventional Natural gas

Advantages

* Ample supplies (125 years)
* High net energy yield
* Low cost (with huge subsidies)

Disadvantages

* Non renewable resources
* Releases carbon dioxide when burnt
* Methane (a green house gas) can leak from pipelines

* Less air pollution than other fossil fuels	* Shipped across ocean as highly explosive LNG
* Moderate environmental import	* Sometimes burnt off and wasted at wells because of low prices
* Easily transported by pipelines	* Requires pipelines
* Low land use	
* Food fuel for fuel cells and gas turbines	

d. Coal

Advantages	Disadvantage
* Ample supplies (225-900years)	* Very high environmental impact
* High net energy yield	* Several land disturbance air pollution and water pollution
* Low cost (with huge substitutes)	* High land use (including mining)
* Mining and combustion technology well developed	* Severe threat to human health
* Air pollution can be reduced with developed	* High carbon dioxide emissions 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

1. Solar energy is free and it is available locally in abundance.
2. Solar energy is pollution free.
3. Systems are easy to install, generate and maintain.
4. System can be specifically designed according to individual requirements.
5. Supply of hot water is instant and un interrupted
6. Recurring fuel costs are zero
7. 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 rown specially for this 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.

(d) Temperate regions: Produce wood, crop residues like straw, vegetable leaves, human and animal waste.
(e) 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.
(f) 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 inspiration for early research and development work on improved stoves. Initially, one environment concern dominated the improved stove work, saving trees. Today, this is considerably downplayed. At the same time, other environmental issues have become dominant.
Large scale combustion of biomass is only environmentally feasible if carried out on a sustainable basis. For obvious continual large-scale exploitation of biomass resources without care for its replacement and regeneration will cause environmental damage and also Jeopardize the fuel source itself.

Benefits of Biomass energy:

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

BIOGAS

Biogas is obtained by an aerobically (without air) digesting organic material to produce a combustible gas known as methane. Animal waste and municipal waste are two common feed stocks for an aerobic digestion.
At present biogas technology provides an alternative source of energy in rural India for cooking. It is particularly useful for village households that have their own cattle. Through a simple process cattle dung is used to provide the gas. The residual dung is used as manure.
India has world's largest cattle population – 400 million, thus offering tremendous potential for biogas plants. Biogas production has the capacity to provide us with about half of our energy needs either burned for electricity production or piped into current gas lines for use. It just has to be done and made a priority. Though about 3.71 million biogas plants in India up to March 2003 are successfully in operation but still it is utilizing only 31% of the total estimated potential of 12 million plants. The pay back period of the biogas plant is only 2 to 3 years. Rather in the case of community and industrial Biogas plants is even less. Therefore biogas electrification at Community Panchayat level is required to be implemented. A sixty cubic feet approx 2 m^3 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 50^0C. 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%, Crbon 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

Plants and animals that lived ages ago have returned to haunt us with a vengeance. Their incinerated remains pollute both land and sea and clog the air we breathe. Life from the past now threatens life of the present.

As the environmental destruction associated with man's whole sale consumption of fossil fuels has become globally recognized a corresponding need has grown for an alternate energy source.

Easy to produce and non-polluting hydrogen could be the ideal for the future. As a gas, hydrogen could be piped to homes and businesses for heating and cooking purposes or converted into electricity by fuel cells. As a cryogenic liquid, hydrogen electricity by fuel cells. As a cryogenic liquid, hydrogen could launch rocket or fly aircraft or locked as a solid in metal hydride storage canisters, hydrogen solid could propel ground transportation and all this could be provided with virtually no impact on the environment.

Hydrogen is a colorless, odorless gas that accounts for the 75% of the entire Unverse's, mass. Hydrogen is found on Earth only in combination with other elements such as oxygen, carbon and nitrogen. To use hydrogen, it must be separated from these elements.

Hydrogen can be made from molecules called hydro carbons by applying heat, a process known as referring hydrogen. This process makes hydrogen from natural gas. An electric current can also be used to separate water into its compound of oxygen and hydrogen is a process known as electrolysis. Some algae and bacteria using sunlight as their energy source give off hydrogen under contain conditions.

Hydrogen as a fuel is high in energy, yet a machine that burn pure hydrogen produces almost zero pollution. NASA has used liquid hydrogen since 1970's to propel rockets and now the space shuttle into orbit. Hydrogen fuel cells power the shuttle's electric systems, producing a clean by –product pure water, which the crew drink.

The bad news about hydrogen is that although hydrogen is all around us it is chemically locked up in water and organic compounds such as methane and gasoline. The good news is that we can produce it from something we have in plenty ie. water. Water can be split by electrolysis (electricity) or high temperature (thermolysis) into hydrogen and oxygen. The major problem is that if takes high to produce hydrogen. There are other ways to produce hydrogen.

One is reforming , in which high temperature and chemical process are used to separate hydrogen from carbon atoms in organic chemicals (hydro carbons) found in conventional carbon-containing fuels such as gas, gasoline or methanol. Gasification of coal or biomass can also produce it.

Hydrogen can be stored in compressed gas tanks or in the liquid form (liquid hydrogen).In 2002 scientist were also able to trap hydrogen gas in a frame work of water molecules called castrate hydrates.

Advantages and disadvantages of hydrogen

Advantages

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

Disadvantages

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

UNIT VII ACID RAIN

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

What is Acid Rain?

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

Through a variety of chemical reactions the gases form Sulphuric acid and Nitric acid, which are the two acids responsible for the acid rain.

How is acid produced?

Nitric oxide can react with oxygen O_2 to form nitrogen dioxide which can be broken down again by Sunlight(h_v)to give Nitric oxide and an oxygen radical (O).

$2NO + O_2 = 2N_2$

$NO_2 + h_v = NO+O$

The oxygen radical then enables the formation of Ozone (O_3)

$O+O_2= O_3$

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 (HNO_2) and nitrogen dioxide to give nitric acid (HNO_3). It also combines with Sulphur dioxide to produce Sulphuric acid

$HO+NH= HNO_2$

$NH_2+HO= HNO_3$

$SO_2+2HO = H_2SO_4$

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 man made 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 method 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 physicists CHARLES FABRY and HENRI BUISSON in 1913.
•Its properties were explored in detail by G.M.B.DOBSON, a British Meteorologist.
•Dobson established a world wide 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 O_2 and Ozone O_3 are involved in the ozone – oxygen cycle.
Ozone is formed in the Stratosphere when oxygen molecules dissociate after absorbing the ultraviolet photon whose wave length is shorter than 240nm.
This produces two oxygen atoms. The atomic oxygen then combines with O_2 to create ozone O_3

Ozone molecules absorb UV light between 310 and 200nm, following which ozone splits into a molecule of O_2 and O. The process O_3 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 raditions 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 (CFC's) .
- 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)

•Polar Stratospheric clouds form during winter. In the extreme cold temperatures would be around – 80^0C› without Sunlight and the 'polar vertex' trapping the chill air.
This enhances the Surfaces for chemical reactions that lead to ozone destruction.
•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.

Animal Husbandry

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

Types of Livestock

The term "livestock is vague and may be defined narrowly or broadly.
Domesticated animals such as cows, pigs, deer, goats, sheep, horses, donkeys, chickens, yaks are livestock's. Hence the definition of livestock includes mammals and birds.
On a broader view, "livestock" could incorporate the international rearing of butterflies, silk & honey bees.
Purpose of Animal husbandry

•Meat: The production of a useful form of dietry, protein & energy.
•Dairy products: Mammals can be used a source of Milk, which can be turned into various dairy products.
•Using such livestock can often yield several time the food energy of slaughtering the animal outright.
•Fiber: Livestock produce a range of fiber or textile, Example: Sheep, can make leather, etc.
•Fertilizer: Manure can be spread on fields to increase crop yields. Manure is also used to make plaster for walls and floors and can be used as fuels for fires.
•Labour: Animals such as horses, donkies, yaks can be used for transportation of men & material, Agricultural purposes & even in military.
•Land management: The grazing of livestock is used to control weeds etc.

Impacts of Animal Husbandry on Environment:

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

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

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

On global warming: Methane is a major green house gas. The annual global generation of methane from ruminants accounts for 15% of total amount released into the

atmosphere. This rate is increasing steadily at 1% per year. It is interesting to note that cattle produce methane
2 to3 times more than that from the ruminants.

On water sources: Inadequately protected wells and watering places can easily be contaminated by animal waste, which is a big health risk.
Proper care should be taken in controlling the quantity of liquid & solid fertilizers, so that the positive effects on soil fertility & soil structure are enhanced.

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

Exercise-1 (ENERGY)

1. The word energy is derived from
a) English b) Arabic c) Greek d) Latin

2.Energy means,
a) Capacity to do work b) Capacity to see
c) Capacity to hear d) None of the above

3. Energy is measured in
a) Blu b) Bhu c) Btu d) Ntu

4.James prescott Joule was a English
a) Chemist b) Physicist
c) Mathematician d) Astronomer

5. One Btu is equivalent to
a) 1000 Joules b) 10 Joules
c) 100 Joules d) 10000 Joules

6.A piece of buttered bread toast contains about
a) 200 kilo joules b) 200 Joules
c) 315 Kilojoules d) 315 Joules

7.The energy equivalent derived after consuming a piece of buttered bread toast is sufficient enough to jog for
a) 16min b) 16 secs c) 6 secs d) 6min

8. The energy equivalent of a piece of buttered bread is sufficient to light a 60W bulb for
a) 19min b) 90min c) 90secs d) 19sec

9.Energy of motion is known as
a) Heat Energy b) Potential energy
c) Kinetic energy d) None of the above

10.Energy due to position is known as
a) Heat energy b) Potential energy
c) Kinetic energy d) Wind energy

11. Renewable energy is
a) Primary source b) Secondary source
c) Tertiary source d) None of the above

12. Coal, lignite & natural gas are
a) Renewable b) Fossil fuels
c) Secondary sources d) All the above
13. Nuclear energy is obtained from
a) Barium b) Calcium
c) Platinum d) Uranium

14. Hydro energy is obtained from
a) Still water b) Falling water
c) Stored water d) None of the above

15. Electromagnetic radiation from the sun is known as
a) Nuclear energy b) Hydro energy
c) Solar energy d) Tidal energy

16. Electric energy from Coal burning is an example of
a) Secondary energy b) Primary energy
c) Solar energy d) All the above

17. The energy consumption for Global transportation is about
a) 42% b) 24% c) 4% d) 34%

18. Energy consumption for Domestic & Commercial purposes is about
a)30% b) 13% c) 3% d)50%

19. Ninety nine percent of our energy comes from
a) Moon b) Earth c) Sun d) Wind

20. The annual oil consumption of the top 20 richest countries is about
a) 35% b) 50% c) 10% d) 65%

21. For cooking and heating, about Three billion people of the third world mainly depend upon

a) Electricity b) Coal
c) Nuclear energy d) Solar energy

22. _____Percentage of the total energy represents the Non – renewable sources
a) 82 b) 28 c) 8.2 d) None of the above

23. The largest energy consumer in the world is
a) India b) USA c) UK d) Russia

24. Annual coal consumption of India is about
a) 100million tonnes b) 100 billion tons
c) 10 million tons d) 10 billion tons

25. Annual oil consumption of India is about
a) 3.25 million tons b) 325 million tons
c) 32.5 million tons d) 32.5 million tons
26. Official estimates of coal availability in India is about
a) 40 million tons b) 4 million tons
c) 4 billion tons d) 40 billion tons

27. Projected demand for coal in India till the year 2020 is
a) 2.3 billion tons b) 23 billion tons
c) 23 billion tons d) None of the above

28. Projected demand for hydroelectric power in India by 2020 is _____times more than the present installed capacity of about 15,000 Mu
a)120 b) 1.2 c) 0.12 d) 12

29. Gas reserves of India is about
a)100 million cubic meters b) 10 million cubic tons
c) 100 cubic meters d) None of the above

30. World gas reserves is estimated as
a) 6300 million cubic meters b) 630000 million cubic meters
c) 630 million cubic meters d) 63000 million cubic meters

31. Electromagnetic radiation is an energy in the form of a
a) Light b) Wave c) Heat d) All the above.

32. Electromagnetic radiation energy is due to changing of
a) Electric and magnetic fields b) Electric and Heat fields

c) Magnetic and Heat fields d) None of the above

33. Speed of Electromagnetic radiation waves is of the order of
a) 30000 km/sec b) 30000 kmph
c) 300000kmph d) 300000 km/sec

34. Electromagnetic radiation travels through space at the speed of

a) Sound b) Wind c) Light d) all the above.

35. Cosmic rays, Gamma rays, X-rays and Ultraviolet radiation are known as
a) Primary radiation b) Ionizing radiation
c) Non-Ionizing radiation d) Secondary radiation

36. Cancer and related diseases are caused due to
a) Primary radiation b) Non-Ionizing radiation
c) Ionizing radiation d) Secondary radiation.

37. The forms of electromagnetic radiation not containing enough energy to form ions are known as
a) Thermal radiation b) Primary radiation
c) Ionizing radiation d) Non-Ionizing radiation
38. The visible light that can be detected by our eyes is a form of
a) Non-Ionizing radiation b) Ionizing radiation
c) Solar radiation d) Black body radiation

39. Ionizing radiation waves have
a) Low energy & short wave length b) Low energy & long wave length
c) High energy & short wave length d) High energy & long wave length

40. The wave length range of ionizing radiation waves falls in the range of
a) 10^{+4} to 10^{+7}m b) 10^{-4} to 10^{+7}m
c) 10^{+4} to 10^{-7}m d) 10^{-4} to 10^{-6}m

41. Non ionizing radiation electro magnetic waves have
a) Low energy, short wave length b) Low energy, long wave length
c) High energy, short wave length d) High energy, long wave length

42. In the early days the energy demands were met by
a) Wind b) Muscular effort
c) Water power d) None of the above

43. Example of renewable source of energy form is
a) Uranium b) Wind c) Coal d) Oil

44. Example of non-conventional source of energy is
a) Natural gas b) Oil c) Nuclear d) Biofuels

45. Which of the following is not a fossil fuel
a) Oil b) Gas c) Coal d) Uranium

46. Which of the following is not a non-conventional energy
a) Wind energy b) Solar energy
c) Bio energy d) Hydro electric energy

47. Wind patterns and water flow is due to
a) Sun b) Moon

c) Earth d) None of the above

48. Per Capita annual electric consumption in India is about
a) 3550 KW b) 3550 MW
c) 355 KW d) 355MW

49. The annual power consumption of a computer working continuously is
a) 876 Watt hours b) 876 KWh
c) 8760 KWh d) 8760 Watt hours

50. One calorie is the amount of energy required to heat
a) One litre of water to 1^0C b) One gram of water to 1^0C
c) One cubic meter of water to 1^0C d) None of the above

Answers (exercise-1)

1.c, 2.a, 3.c, 4.b, 5.a, 6.c, 7.c, 8.b, 9.c, 10.b
11.a, 12.b, 13.d, 14.b, 15.c, 16.a, 17.b, 18.a, 19.c,
20.d, 21.b, 22.a, 23.b, 24.a, 25.c, 26.d, 27.b, 28.d
29.a, 30.d, 31.b, 32.a, 33.d, 34.c, 35.b, 36.c, 37.d,
38.a, 39.c, 40.d, 41.b, 42.b, 43.b, 44.d, 45.d, 46.d,
47.a, 48.c, 49.b, 50.b

Exercise- 2 (ENERGY)

1. Hydroelectricity is produced from
a) Stream b) Falling water
c) Ocean d) All the above

2. Hydroelectricity is generated by
a) Lifting the water by the turbine b) Lifting the water by the Generator
c) The turbine rotating the Generator d) The generator rotating the turbine

3. In 2001, Hydropower supplied about ____ percent of world's total commercial energy.
a) 7 b) 17 c) 71 d) 0.7

4. In 2001, Hydropower supplied about ____ percent of world's electricity
a) 2 b) 17 c) 71 d) 0.7

5. By the end of fourth five- year plan India was able to generate _____MW of hydropower
a) 690 b) 69 c) 6900 d) 69000

6. Due to increase in demand, the hydropower production at the end of Eighth plan fell down by about
a) 25% b) 2.5%

c) 0.25% d) None of the above

7. Hydropower potential of India is estimated to be
a) $4x10^{11}$ MW hours b) $4x10^{11}$KW hours
c) $40x10^{11}$MW hours d) $40x10^{11}$KW hours

8. World commission on_____has reported that hydropower in tropical countries is major emitter of green house gases
a) Hydraulics b) Environment
c) Atomic energy d) Dams.

9. Efficiency of hydropower is of the order of
a) 80% b) 8% c) 0.8% d) 18%

10. Major disadvantages of an Hydropower project is due to its
a) Low construction cost & High flood risk b) Low construction cost & low flood risk
c) High construction cost & low flood risk d) High construction cost & high flood risk

11. According to unit nation's report, the percentage of world's hydropower exploited is
a) 13% b) 31% c) 130% d) 1.3%

12. Much of the untapped hydropower is in
a) Europe b) USA
c) Canada d) South America

13. Fossil fuels are
a) Energy rich substance b) Less energy substances
c) No energy substances d) None of the above

14. Fossil fuels are formed from the remains of organisms that lived
a) 200 to 500 years ago b) 200 to 500 billion yrs ago
c) 2000 to 500yrs ago d) 200 to 500 million yrs ago

15. Between 1859 & 1969 total oil production of the world was
a) 2270 barrels b) 227 million barrels
c) 227 billion barrels d) 22.7 billion barrels

16. Fossil fuels largely consists of
a) Hydrocarbons b) Hydrogen Sulphide
c) Hydrochloric acid d) carbon dioxide

17. One barrel is equivalent to
a) 15ltrs b) 159ltrs
c) 1590ltrs d) 1.59ltrs

18. The coal deposits in our planet is about
a) 27350 million metric tons b) 27350 metric tons

c) 27350 billion metric tons d) 2735 billion metric tons

19. The coal available in India is
a) Not good quality b) Excellent quality
c) Very good quality d) Medium quality

20. In India coal is available in
a) Karnataka b) Tamil Nadu
c) Rajasthan d) Madhya Pradesh

21. The carbon content of Anthracite or hard coal is
a) 90% b) 9% c) 900% d) 0.9%

22. Anthracite & lignite are examples of
a) Petroleum b) Natural gas
c) Coal d) Wood

23. Present annual extraction rate of coal is about
a) 3000 million metric tons b) 3000 metric tons
c) 300 billion metric tons d) 3000 billion metric tons

24. The existing coal deposits may last for about
a) 20yrs b) 2000yrs
c) 2 years d) 200yrs

25. Energy content of petroleum when compared to coal is
a) Equal b) High
c) Low d) None of the above.

26. Lifeline of global energy is
a) Coalb) Electricity
c) Petroleum d) All the above

27. Petroleum when burnt
a) Leaves residue b) Leaves no residue
c) Emits large quantities of Sulphur d) Emits large quantities of carbon dioxide

28. OPEC is formed by a group of _____ oil rich countries
a) 13 b) 31 c) 130 d) 310

29. One of the major oil producing country in the world is
a) Japan b) Africa
c) New Zealand d) Mexico

30. _____ of the world's oil reserves are available in Saudi Arabia
a) ¼ b) ½ c) 1/3 d) 1/8

31. Total oil reserves of the world is
a) 356.2 trillion metric tons b) 356.2 million metric tons

c) 356.2 billion metric tons d) 356.2 metric tons

32. World's Annual extraction of petroleum is about
a) 2874 million tons b) 2874 billion tons
c) 287.4 million tons d) 28700 billion tons

33. Existing oil reserves could last for about
a) 5000yrs b) 500yrs c) 5yrs d) 50yrs

34. Oil bearing potential of India is about
a) One Million km^2 b) $1000km^2$
c) 10,000 km^2 d) 100,000 km^2

35. Natural gas mainly consists of
a) Carbon dioxide b) Hydrogen
c) Methane d) Oxygen

36. A good example of cleanest source of fossil fuel energy is
a) Petroleum b) Natural Gas
c) Coal d) Lignite

37. Total natural gas reserves of the world is about
a) 600,000 million $meter^3$ b) 600,00 m^3
c) 600,000 billion $meter^3$ d) 60000 million m^3

38. Natural gas reserves of Russia is about
a) 34% b) 3.4% c) 50% d) 85%

39. Annual production of natural gas is about
a) 1250 million cubic meters b) 1250 billion cubic meters
c) 125 million cubic meters d) 125 billion cubic meters

40. Natural gas reserves are expected to last for about
a) 500yrs b) 5000yrs c) 50yrs d) 5yrs

41. Burning of fossil fuels results in
a) Acid rain b) Alkali rain
c) Heavy rain d) No rain

42. Unburnt fuel particles are known as
a) Smoke b) fog
c) smog d) Ash particles

43. Example of green house gas is
a) Nitrogen b) Hydrogen
c) Carbon dioxide d) Hydrogen Sulphide

44. Between 19^{th} & 20^{th} Century the green house gas liberation from fossil fuel burning has increased by
a) 2.8% b) 28% c) 280% d) 128%

45. Disrupted weather patter & polar ice melting is due to
a) Global warming b) Global cooling
c) Heavy rains d) Deforestation

46. Nuclear energy is an example of
a) Renewable energy b) Non-renewable energy
c) Bio degradable energy d) Degradable energy

47. Reserves of Nuclear fuels is about ____times than fossil fuels
a) 10times b) 100times
c) 1000times d) million times

48. 1000 kgs of Nuclear fuel can produce energy equivalent to ____ barrels of oil
a) 12millions b) 12 billion
c) 12,000 d) 1200

49. Nuclear reactors operate at about
a) 625^0C b) 625k
c) 62.5K d) 62.5^0C

50. Nuclear fusion is the process of
a) Absorbing energy b) adsorbing energy
c) Releasing energy d) removing energy

51. Radio active waste can remain for
a) Few days only b) for months
c) For years d) for centuries

52. Chernobyl (Russia) nuclear accident occurred in the year
a)1986 b) 1976 c) 2006 d) 1876

53. Fuel for Nuclear fusing is
a)Oxygen b) Carbon dioxide
c) Hydrogen d) Helium

54. Fusion process is _____ fission
a) Same as b) Not safer than
c) Safer than d) None of the above

55. When compared to fission the pollution problems from the fusion process is
a) Same b) High
c) Nominal d) all the above.

Answers (exercise-2)
1.b, 2.c, 3.a, 4.d, 5.c, 6.a, 7.b, 8.d, 9.a, 10.a
11.a, 12.d, 13.a, 14.d, 15.a, 16.c, 17.b, 18.c, 19.a,
20.d, 21.a, 22.c, 23.a, 24.d, 25.b, 26.c, 27.b, 28.a
29.d, 30.a, 31.c, 32.a, 33.d, 34.a, 35.c, 36.b, 37.c,
38.a, 39.b, 40.c, 41.a, 42.d, 43.c, 44.b, 45.a, 46.b,
47.a, 48.a, 49.b, 50.c, 51.d, 52.a, 53.c, 54.c, 55.c

Exercise-3 (ENERGY)

1.Solar energy orginates from the
a) Thermo nuclear fusion reaction taking place in the Sun.
b) Nuclear fission taking place in the Sun.
c) Burning of oxygen on the surface of Sun.
d) None of the above.

2. Solar energy is a potential
a) Conventional energy Source b) Converted energy
c) Non conventional energy source d) Electric energy

3. 92% of the solar radiation reaching the Earth will be in the range of
a) 315 to 1400m b) 315 to 1400 m
c) 315 to 1400nM d) 315 to 1400mm

4. 45% of the Solar radiation reaching the Earth will be in the
a) Invisible range b) Dark range
c) bright range d) visible range

5. Earth emits radiations in the
a) Yellow region b) Brown region
c) Infra red region d) Black region

6. The heat equivalent of the Solar radiation reaching the estimated to be about
a) 2.68×10^{24} Joules per year b) 2.68×10^{24} kilo Joules per year
c) 2.68×10^{24} Joules per day d) 2.68×10^{24} Joules per month

7. Solar energy is
a) Non-polluting & deplete b) Non-polluting & non-deplete
c) Polluting & non – deplete d) Polluting & deplete

8. In India, Solar volatile systems are being installed by the Department of

a) Space b) Atomic energy
c) Geology d) Non – conventional energy resources

9. The maintenance free life of solar cells is
a) Ten or more years b) One hundred years
c) Ten months d) One thousand yrs

10. The Earth's surface area required for producing 1000MW of electricity is
a) $120km^2$ b) $1.2km^2$ c) $12km^2$ d) $1200km^2$

11. The electricity saved in heating about 100 litres of water daily to 60^0C using solar energy results in saving
a) 1200 – 1500 units per month b) 1200-1500 units per day
c) 1200-1500 units per year d) 12000-1500 units per hour

12. Solar energy collection process can damage the fragile ecosystem of the
a) Oceans b) Mountains c) Rivers d) Deserts

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13. Active & Passive systems are the terms using in
a) Air conditioning b) Nuclear reactors
c) Solar heating systems d) None of the above

14. Passive solar heating system depends upon
a) Pumps b) Natural convection currents
c) Turbines d) Blowers

15. Passive solar energy needs access to the sun ____ percent of the time
a) 5 b) 0.5 c) 60 d) 600

16. Solar cell contains
a) Semi conductor material b) Thermo couple
c) Batteries d) Capacitors

17. Sunlight energizes and causes ___ in the semi conductor to flow, creating an electric current
a)Protons b) Neutrons
c) Electrons d) All the above

18. Solar cells reduces dependence on
a) Nuclear power b) Fossil fuels
c) Hydrogen d) Biomass

19. Solar energy is an ideal energy source because of
a) Unlimited supply b) No air & water pollution
c) Free of by-products d) All the above

20. A Solar cell generates electricity from Sunlight by
a)Flow of charge carriers b) Flow of heat
c) Flow of energy d) Flow of electrolyte

21) Biomass is a ____energy source
a) Non renewable b) Renewable
c) Alternative d) None of the above

22. Biomass is the term for all organic matter produced by
a) Photography b) Photo electric effect
c) Photosynthesis d) Combustion

23. The source of all energy is biomass is the
a) Moon b) Earth c) Jupiter d) Sun

24. Extraction of energy from biomass is split into
a) Solid biomass, Biogas & liquid bio fuels b) Petrol, Coal & Peat
c) Solar energy, nuclear energy & Hydro energy. d) None of the above

25. Heat from Solid biomass is derived from
a) Conduction b) Combustion
c) Convection d) Digestion

26. Biogas is the result of _____ organic materials
a) Anaerobic digestion b) Aerobic digestion
c) Combustion d) Compression

27. Many of the World's poorer countries with wood supplies, crop residues & animal wastes are in
a) Temperature regions b) Humid tropic regions
c) Arid regions d) Polar regions

28. Bagasse is a left over of
a) Paddy b) Wheat c) Vegetables d) Sugarcane

29. In India the estimates of electricity generation from bagasse is about
a) 350MW b) 3500KW c) 3500MW d) 35000MW

30. In India, around ____ of power from biomass has already bee commissioned

a) 270KW b) 270MW c) 2700KW d) 2700MW

31. Production of biomass energy mainly involved
a) Water damage b) Sulphur dioxide
c) Release of Methane d) Soil damage

32. Biogas is obtained by _____ organic material
a) Photosynthesis b) Anaerobic digestion
c) Aerobic digestion d) All the above

33. The cattle population of India is about
a) 4 million b) 400 million
c) 400 billion d) 40 billion

34. Biogas production has the capacity to provide about ___ of our energy needs
a) ¼ b) 1/3 c) ½ d) ¾

35. By the end of 2003 the number of biogas plants in India was
a) 37.1 million b) 3.71 million
c) 371 million d) 0.371 million

36. Only ____ percent of the total estimated 12 million biogas plants are being utilized world over
a) 3.1 b) 13 c) 0.31 d) 31

37. The pay back period of biogas plants is only
a) 2 to 3 years b) 2 to 3 months
c) 20 to 30 years d) 200 to 300 years

38. The biogas needs of an average family size can be met by a biogas plant with a capacity of about
a) 200m^3 b) 20m^3 c) 2m^3 d) 0.2m^3

39. Fermentation in the biogas plant is carried out between
a) 350 to 500^{0}C b) 35 to 50^{0}C
c) 85 to 150^{0}C d) None of the above

40. One kilogram weight of cowdung produces about ___ liters of biogas
a) 1600 b) 16 c) 1.6 d) 160

41. Percentage Methane, content of Biogas is
a) 5.5 b) 85 c) 55 d) 0.55

42. The average gross calorific value of biogas is
a) 530 kilo cal/m^3 b) 53 kilo Cal/m^3
c) 5300 kilo Cal/m^3 d) 5.3 kilo Cal/m^3

43. Hydrogen is colourless, odourless gas that accounts for the ____ percent of the entire Universe's mass
a) 25 b) 50 c) 5 d) 75

44. Hydrogen as an energy source is
a) Alternative b) renewable
c) non renewable d) all the above

45. Hydrogen is found on Earth in combination with
a) Sulphur b) Helium c) Copper d) Oxygen

46. Reforming hydrogen means producing hydrogen from molecules of hydro carbon by
a) Cooling b) melting c) freezing d) heating

47. Electrolysis is the process used to separate water into
a) Oxygen & Nitrogen b) Oxygen & Hydrogen
c) Nitrogen & Hydrogen d) Hydrogen & Carbon

48. Hydrogen as a fuel has
a) No energy b) Low energy
c) High energy d) None of the above

49. A machine that burns pure hydrogen produces
a)High pollution b) Medium pollution
c) Smoke d) Almost zero pollution

50. NASA has used liquid hydrogen for propelling rockets & space shuttles since.
a) 1870 b) 2000 c) 1920 d) 1970

51. The pure water which the space shuttle crew drink is the by product of
a) Oxygen b) Hydrogen c) Nitrogen d) Carbon

52. Hydrogen can be stored in
a) Compressed gas tanks b) Air tight tanks
c) Petrol tanks d) None of the above

53.In 2002 scientists were able to trap hydrogen in a frame- work of water molecules known as
a) Clathrate Hydrates b) Clathrate Hydrogen
c) Clear hydrates d) Clear Hydrogen

54. Hydrogen contained in the form of metal hydrides in a vehicle's tank____ even if the tank is ruptured in an accident
a) Melt b) Freeze c) Explode d) Expand

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a) Clathrate Hydrates b) Clathrate Hydrogen

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55. The disadvantage of hydrogen energy source is
a) Energy is needed to produce it b) Causes air & water pollution
c) Hazardness effect due to risk of leakage d) Releases toxic by –products

56. Excessive hydrogen leaks results in
a) Production of ozone b) Increasing ozone
c) Depletion ozone d) None of the above

57. Sequence of production of electricity from hydrogen is
a) Electrolysis of water, fuel cell reaction, storage of hydrogen.
b) Production of Hydrogen, Electrolysis of water, fuel cell reaction
c) Electrolysis of water, Storage of hydrogen, fuel cell reaction
d) Fuel cell reaction, Electrolysis of water, Storage of hydrogen at present

58. The performance coefficient of Solar cells at present stands between
a) 10 to 16% b) 25 to 35%
c) 45 to 55% d) 80 to 90%

59. The solar flux reaching the earth's upper atmosphere is estimated to be about
a) 1400 kilowatts/m^2/min b) 1400 watts/m^2/min
c) 1400 kilowatts/m^2/sec d) 1400 watts/m^2/sec

60. Soil erosion, water pollution and loss of wild life habitat is a major disadvantage of
a) Solid biomass b) Hydrogen
c) Ethanol fuel d) Solar energy

Answers (Exercise-3)

1. a, 2.b, 3.c, 4.a, 5.c, 6.a, 7.b, 8.d, 9.a, 10.c, 11.c, 12.d, 13.c, 14.b, 15.c, 16.a, 17.c, 18.b, 19.d, 20.a, 21.b, 22.c, 23.d, 24.a, 25.b, 26.a, 27.b, 28.d, 29.c, 30.b, 31.c, 32.b, 33.b, 34.c, 35.b, 36.d, 37.a, 38.c, 39.b, 40.d, 41.c, 42.b, 43.d, 44.a, 45.d, 46.d, 47.b, 48.c, 49.d, 50.d, 51.b, 52.a, 53.a, 54.c, 55.a, 56.c, 57.c, 58.a, 59.b, 60.a.

Exercise-4 (Acid Rain, Ozone depletion, Animal Husbandry)

1. The term Acid Rain was coined in the year.

a) 1952 b) 1852 c) 1652, d) 1752

2. The Term Acid Rain was coined by
   a) ROBERT ANGUS WHALES
   b) CHARLES ANGUS SMITH
   c) ROBERT ANGUS SMITH
   d) NONE OF THE ABOVE

3. Acid Rain is a form of
a. Soil Pollution b) Water Pollution
c. Solar pollution d) Air pollution

4. The major contributors to acid rain are known as
a. Precursors b) Processors
c. Protons d) Pollutants

5. Two acids responsible for acid rain are
- Nitric acid & Sulphuric acid
- Nitric acid & Hydrochloric acid
- Sulphuric acid & phosphoric acid
- Sulphuric acid & Acitic acid

6. Precursors mainly come from
   a. Chemical & physical sources
   b. Biogenic and anthropogenic sources
   c. Biotic & abiotic sources
   d. Arctic & Antarctic sources

7. Anthropogenic or Man made sources of air pollution are:
   a. Spread over large areas.
   b. Concentrated around the source
   c. Spread all over the Earth
   d. None of the above.

8. Volcanic eruptions and Decay of organic matter are good examples of
   a) Volcanic source
   b) Natural resources
   c) Biogenic source
   d) Anthropogenic source

9. Example of Anthropogenic sources is
   a) Bush fire b) Burning of fossil fuels
   c) Microbial process d) lighting discharges.

10. Particulates falling directly from the atmosphere to the ground are known as
a) Wet forms b) solid forms
c) Dry deposition d) None of the above.

11. Catalytic reduction is a process adopted to

a) Increase the levels of Sulphur dioxide
b) Decrease the levels of Sulphur dioxide
c) Increase the levels of Nitrogen oxides
d) Decrease the levels of Nitrogen oxides

12. Catalytic converter in a vehicle will convert engine gases into
a) Nitrogen & oxygen
b) Hydrogen & Oxygen
c) Hydrogen & Nitrogen
d) None of the above.

13. Using less air for combustion can
a) Increase nitrogen oxides
b) Increase Sulphur oxides
c) Decrease Sulphur oxides
d) Decrease Nitrogen oxides.

14. Lower the temperature of combustion, lower will be the production of
a) Nitrogen b) Hydrogen
c) Nitrogen oxides d) Water

15. Two stage combustion and flue gas recirculation results in
a) Reduction in temperature
b) Increase in temperature
c) Reduction in emissions
d) None of the above.

16. Fluidized bed combustion is a complex process of reducing.
a) Nitrogen b) Oxygen
c) Hydrogen d) Sulphur dioxide

17. Flue gas desulphurization is achieved by using
(iii) Lime stone b) Coal
c) Sand stone d) Diesel

18. Fluidized bed combustion produces
a) Liquid waste b) Air pollution
c) Solid waste d) none of the above

19. Acids are corrosive chemicals that react with other chemical by giving
a) Oxygen atom b) Hydrogen atom
c) Nitrogen atom d) Chlorine atom

20. Acid rain on trees results in
(iv) Brown dead spots b) Photosynthesis
c) White patches d) Plasma

21. In Black forests of South Western Germany, half of the trees are damaged from
(iv) Snow b) Water pollution
c) Air pollution d) Acid rain.
22. Most farm crops are _____affected by Acid Rain.
a) Most b) Very little
c) Not at all d) Less.

23. Parthenon in Greece and Taj mahal in India are deteriorating due to
a) Alkali deposition b) Snow fall
c) Acid rain d) All the above

24. It is _____ to swim in even the most acidified lakes.
a) Safe b) Unsafe
c) Not advisable d) None of the above
.
25. Acid rain tends to _____ global warming
a) Increase b) No effect on
c) Slow down d) All the above

26. Acid Rain can be controlled by
a) Reducing CO2 and Hydrocarbon emission
b) Reducing SO2 and NO2 emissions
c) Increasing number of vehicles
d) Increasing number of lakes.

27. Ozone layer was discovered by
a) Charles Fabry b) Charles Darwin
c) Henry Charles d) Henry Darwin

28. Ozone layer was discovered in the year
a) 1613 b) 1713 c) 1913 d) 1813

29. Properties of ozone layer were explored by
a) Johnson b) Kingston c) Polson d) Dobson.

30. The equivalent of one Dobson Unit (DU) is
a) 0.1mm b) 0.01mm c) 0.1m d) 0.01m

31. Ozone layer is at a height of ____ above the Earth's Surface
a) 19 to 48m b) 19 to 480m
c) 19 to 48km d) 190 to 148km

32. Ozone layer is very important because it absorbs Ultra violet radiation emissions from
a) Sun b) Moon c) Stars d) Jupiter

33. UV radiation is divided into three categories based on its

(g) Frequency b) Intensity
c) Wave length d) None of the above

34. The wave length range of UV-A is in the range of
(k) 315 to 400nm b) 315 to 400nm
c) 315 to 400cm d) 315 to 400m.

35. Excessive exposure to UV-B radiation can cause
a) Kidney failure b) Skin cancer
c) Blood cancer d) None of the above.

36. UV-C rapidly damages all types of
a) Biota b) Buildings
c) Water bodies d) All the above.

37. Ozone is formed in the
a) Lithosphere b) Atmosphere
c) Hydrosphere d) Stratosphere

38. Ozone molecules absorb UV light between
⇨ 310 to 200nm b) 310 and 200m
c) 310 and 200mm d) 310 and 200nm

39. The average thickness of ozone layer in the stratosphere is approximately
(iii) 3000Du b) 30DU
c) 30,000DU d) 300DU

40. Ozone holes is due to
a) Increase in oxygen level
b) Increase in ozone level
c) Decrease in oxygen level
d) Decrease in ozone level

41. Ozone hole is said to occur when the ozone level decreases below
a) 200DU b) 2000DU c) 20DU d) 2 DU

42. Hydroxyl, Nitric oxide, atomic chlorine and Bromine can result in _____ of ozone.
- Increase
- Balancing
- Decreasing
- Neutralizises

43. UV-C radiation lies in the region
a) <280nm b) >280nm
c) 315 to 400nm d) 280 to 315nm.

44. Many thousands of ozone molecules are removed from the stratosphere due atoms of

a) Sulphur b) Oxygen
c) Hydrogen d) Chlorine

45. CFC molecules can stay in the atmosphere for about
(h) 1 year b) 10 yrs c) 100yrs d) 1000yrs

46. In the Antarctic zone, ozone layer occurs during the period
- Sept to Dec b) Jan to Mar
c) April to June d) July to Sep

47. The decrease in the ozone layer was predicted in the early
a) 1960 b) 1970 c) 1980 d) 1880.

48. The Antarctic stratosphere is _____ than the Arctic, hence the reason for ozone hole.
a) Colder b) Warmer
c) Brighter d) None of the above

49. One percent decrease in Stratospheric ozone would increase the incidence of skin cancer by
a) 0.2% b) 20% c) 2% d) 0.02%

50. Ozone at ground level is health risky due to its strong ____ property
a) Acid b) Alkaline
c) Oxidant d) Hydroscopic.

51. World ozone day is celebrated on
a) 16th Sep b) 18th Sep c) 16th Mar d) 15th Aug

52. The Antarctic ozone hole reached its largest ever size
(vii) Sep 2000 b) Jan 2000
c) Jan 2005 d) Sep 2005

53. The largest ozone hole size on Antarctic region is reported as
- 11.5 thousand square miles
- 11.5 million square miles
- 11,500 square miles
- 1,15,000 square miles

54. Breeding, feeding and managing animals for the production of food, fiber, work and pleasure is termed as
a)Cattle feeding b) Poultry
c) Animal building d) Animal husbandry

55. Animals furnish about ___ percent of world's total value of agricultural products.
4) 2.8 b) 0.28 c) 28 d) 58

56. Good example of domesticated animals is
a) Cow b) Tiger c) Elephant d) Snake

57. The purpose of animal husbandry is
(e) Conservation of biodiversity
b) production of meat.
c) Conservation of wild life
d) None of the above.

58. Live stock does not include
a) Sericulture b) Honey bees
c) Horticulture d) None of the above

59. The annual global generation of methane from ruminants accounts for _____ percent of the total amount released into the atmosphere
a) 15% b) 1.5% c) 0.15 d) 150

60. Methane produced form cattle is ____ that from the ruminants.
a) Less than b) Equal to
c) More than d) None of the above

61. Over fishing is
a) Desirable
b) Necessary
c) Undesirable
d) None of the above

62. Animal husbandry may result in
- Acid rain b) Ozone depletion

c) Global warming d) Snow fall

ANSWERS (Exercise-4)

1. b, 2.c, 3.d, 4.a, 5.a, 6.b, 7.b, 8.c, 9.b, 10.c,
11. d, 12.a, 13.d, 14.c, 15.a, 16.d, 17.a, 18.c
19. b, 20.a, 21.d, 22.d, 23.c, 24.a, 25.c, 26.b
27. a, 28.c, 29.d, 30.b, 31.c, 32.a, 33.c, 34.a,
35. b, 36.a, 37.d, 38.a, 39.d, 40.d, 41.a, 42.c,
43. a, 44.d, 45.c, 46.a, 47.c, 48.a, 49.c, 50.c,
51 .b, 52.a, 53.b, 54.d, 55.c, 56.a, 57.b, 58.c,
59. a, 60.c, 61.c, 62.c.

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