P.G. DIPLOMA IN ENVIRONMENTAL STUDIES

COURSE-1

ECOLOGY, ENVIRONMENT AND DEVELOPMENT

BLOCK-1 : ECOLOGY AND ECOSYSTEMS
BLOCK-2 : INDUSTRY AND AGRICULTURE
BLOCK-3 : ENERGY FUTURES
BLOCK-4 : HUMAN ACTIVITY AND POLLUTION
BLOCK-5 : ENVIRONMENTAL PROTECTION LAWS

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PREFACE

This book deals with Ecology, Environment and Development included in the one year duration P. G. Diploma Programme in Environmental studies offered by Dr. B.R. Ambedkar open University. The topics included in this course generally cover the "core area" of the Programme. The syllabus for the sake of convenience is divided into blocks each of which comprises a number of units. Each block generally covers a specific area of the subject. The Units are written by the specialists in accordance with a format specially designed as to enable the student to read and understand them without much difficulty. Each unit begins with a statement of its contents followed by objectives. Each unit has at its end summary, model answers for the questions given in check your progress and also model examination question. Three assignments are given at the end of the book and the student is expected to submit at least one to the Coordinator/Asst. Director/Deputy Director of the concerned study centre.

This book deals with different aspects of ecology and ecosystems, industry and agriculture, energy futures, pollution caused due to human activity in addition to toxic chemical wastes, Environmental protection laws in India and abroad etc.

The University hopes that this material will help the student to get acquainted with principal issues of Envirnoment. Critical suggestions for improving the material are most welcome and they will be incorporated in the future edition.

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CONTENTS

BLOCK - 1

ECOLOGY AND ECOSYSTEMS

UNIT-1: INTRODUCTION TO ECOLOGY

Contents

1.1. OBJECTIVES

After completing this unit, you will be able to :

* explain how earth is a suitable and ideal habitat for humans,
* define and describe the term biosphere, atmosphere, hydrosphere and lithosphere,
* describe the geological and water cycles, and
* differentiate wind forms and iceland forms

1.2. INTRODUCTION

In the Solar System, the planet Earth has all the conditions for existence of life that are most favourable on it, especially it has an atmosphere with 21% Oxygen, the vital gas required for the operation of life, hence earth has become the suitable habitat for humans. Environment is a physico-chemical system required by the organisms, whereas an organism is a living body and an integral part of the Environment. The study of inter-relationships between organism and its environment constitute Ecology.

Biosphere is that part of the earth in which life exists. It extends down to the greatest depths of the sea and on land. The upper boundary of the Biosphere reaches the Ozone screen from surface of earth to ozone in Atmosphere, the lower boundary goes down to sea sediments on the ocean floor constitute, Hydrosphere and the deep lying deposits of a biozene origin in the bowels (crust) of the earth is called lithosphere. Earth contains an array of elements which undergo a cyclic change through both geological and biological world that is between Environment and organism, are called biogeochemical cycles. Nitrogen cycle is a good example for geological cycle where the cycle is maintained through atmosphere, organisms and soil through specialized microorganisms like bacteria. The water cycle represents the hydrological cycle which consists of the varied events happening to a particle of water from the time it is a bit of vapour in the atmosphere until it is again evaporated. Water cycle can change weather and climate. Wind is an important environmental factor with tremendous influence on the ecology of organisms and it can also produce energy in the form of wind power. Icelands are

also called as ice caps and glaciers which are found when temperature goes zero and below zero degrees centigrade, Vast icelands exists in the Greenland and Antarctic regions. Glaciers can increase the level of oceans and seas due to global warming.

1.3. EARTH AS SUITABLE HABITAT FOR HUMANS

Life is sustained on the surface of the totally inert Earth by the Solar radiation. In the entire Solar system, the Earth is the only planet with an atmosphere containing free oxygen and water. Our atmosphere shields us from the lethal ultraviolet rays and high energy particles from sun that are highly destructive to human life. Earth has provided a favourable and suitable temperature from 0 to 40°C, the biokinetic zone where normally all biological activities of man will be performed at best at the optimum temperature. Earth has an ideal pressure of 760 mm. of mercury at sea level where man can move, walk, run, feed and sleep without any difficulty. Sun provides sufficient light which is the greatest source of energy for human activities. It is essential for photosynthesis, development of pigments in plants and animals including humans, especially in the development of vision. Perhaps, light is the single determining factor in the creation of life on earth.

Man is the climax and culmination of organism evolution and he is endowed with power of thinking and faculty of talking. The terrestrial environment on the living planet Earth has offered many favourable conditions and many advantages where man could adjust and adapt easily to a terrestrial environment. The most important and vital requirement for the existence of man offered by the earth is, copious supply of Oxygen. In that Oxygen is 5% in sea water, 7% in fresh waters and 21% on land habitat. Secondly because of very less density of air man can perform very rapid locomotion on land. Thirdly, Earth provides abundance of vegetation for food and shelter which the man can utilize for the production of energy to perform his biological activities for the maintenance of life. Thus, Earth has become a suitable and ideal habitat for the operation of any life, particularly human life.

Check Your Progress - 1

How many planets are there with life on them ?

Note: (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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1.4. BIOSPHERE AND ITS COMPARTMENTS

The external envelop of the earth is inhabited by living things. It comprises all the living organisms of our globe and the elements of inorganic nature providing the medium for their habitat. For instance, Oxygen which is a product of photosynthesis of green plants belongs to the biosphere. Hence, biosphere is the term used to denote the collective eco-systems of the world, and biosphere is also called as ecosphere.

The biosphere is a relatively thin shell over the Earth. It extends down to the depths of sea and on land; bacterias have been reported from corals at depths of upto 1089 meters. We can conveniently divide the biosphere into three elements. (1) The total amount of living organisms (living cover of the planet earth) (2) Mineral substances involved in the biotic circulation (elements) and (3) The by-products of organisms activities, e.g., oxygen, carbondioxide etc.

If the Earth were reduced to the size of an apple, the biosphere would be no thicker than the apple's skin. About 21 km. thick, it extends from the ocean floor to high in the atmosphere. At an altitude of about 9,000 meters, the parabiosphere ozone represents altitude where only dormant forms of life such as bacterial and fungal spores exist. The emphatic zone upto a depth of 100 meters in aquatic environment is the zone of active photosynthesis. In the biosphere, there are minientities, known as ecosystems, each has an autotroph, a heterotroph and decomposers and the biogeocoenoses may differ essentially depending on the features of the substrature, climate and historical factors involved in the formation of life. Thus, the upper boundaries of the biosphere reaches the ozone screen from surface of earth to ozone, constitute an Atmosphere, the lower one goes down to sea sediments on the ocean floor known as Hydrosphere and the deep lying deposits of a biogene origin in the bowels of the earth is called lithosphere.

1.4.1. Atmosphere

In the entire solar system, the earth is the only planet with an atmosphere containing free oxygen. Nearly 75% of the atmosphere on the Earth lies within 11.5 km. above the mean sea level surface. Our atmosphere filters the Solar radiation and cosmic rays, serves as a barrier for meteores, regulates temperatures and provides the engine for weather making. The primordial atmosphere (three billion years ago) has nitrogen, ammonia, hydrogen, carbon monoxide, methane and water vapour, but no free oxygen. The non-biological oxygen produced by U.V. dissociations of water vapour might have provided enough ozone which in turn absorbs U.V.radiation. Only after the evolution of blue-green algae, the photosynthetic activity came into being and thus the gradual build up of oxygen biologically produced in waters and its diffusion into the atmosphere brought about the present day oxygen rich atmosphere. Thus the primordial anoxic (without oxygen) atmosphere converted into oxygenic (with oxygen) atmosphere for the operation of life activities.

Table 1.1. The atmospheric gases at 100 Vol percent at 760 mm. pressure.

Gases		Volume %
Nitrogen	—	78.03% (780 cc/litre)
Oxygen	—	20.99%
Argon	—	0.9223%
Carbondioxide	—	0.03%
Hydrogen	—	0.01%
Neon	—	0.0018%
Helium	—	0.0005%
Krypton	—	0.0001%
Ozone	—	0.00006%
Xenon	—	0.000009%

In the structure of the atmosphere, the position nearest the Earth is called troposphere. It extends some 6 or 7 miles above sea level in temperate latitudes and usually goes up 8 or 10 miles in the tropics. In this region the air is mixed by convention currents and in which temperature decreases with increasing height. Above the troposphere, is the stratosphere in which convection currents are lacking and in which temperature, when not independent of altitude, becomes higher with increasing distance above the earth. Above the stratosphere, at an altitude of about 50 miles, is the extremely tenuous ionosphere region where the cyclonic storms may occur.

1.4.2. Hydrosphere

The water part of the earth surface is known as hydrosphere. Nearly 3/4 of the surface of the earth is covered with water.

Total water on Earth	—	14,60,000	(Vol in thousands cu.km.)
Total Water in Oceans	—	13,70,000	(,, ,,)
Total Water in Earth Crust (upto 5km)	—	60,000	(,, ,,)
Glaciers & Permanent Snow	—	29,000	(,, ,,)
Lakes	—	750	(,, ,,)
Atmospheric moisture	—	14	(,, ,,)
River Waters	—	1.2	(,, ,,)

Of the total amount of water on earth

93%	—	Oceans
4.1%	—	Earth crust
2.0%	—	Glaciers & Polar ice caps
0.052%	—	Fresh Water Lakes, Rivers, Atmospheric moisture.

The oceans occupy nearly four-fifths of the surface of the Earth; the seas and oceans are thus almost two and a half times as extensive as the dryland surface. The mean depth of ocean is about 4,000 m. (2,180 fathoms; 1 fathom = 6 ft. (or) 1.828 meters). All the oceans of the world are physically connected together but nevertheless the ecological conditions differ in different regions. The sea water contains on an average about 35 parts of salts in 1,000 parts of water. The temperature of the sea is on the whole far more uniform than on the land. The freezing point of sea water is lower than that of pure water. The highest temperature of the sea water so far recorded in the world is 35.5°C in the Persian Gulf and the lowest surface temperature is - 3.5°C in the Polar seas. Nearly all over the world, the temperature at sea bottom is constant at about 1°C. Sunlight does not penetrate below depths of 500 m.

Fresh Waters belong to inland waters like lakes, tanks, ponds, wells, springs, rivers, streams etc. Compared to the seas fresh waters occupy hardly 1% of the land surface. Fresh water bodies often completely dry up during summer or during periods of drought. In marked contrast to the seas, fresh water has very low salinity, lower density and buoyancy than sea water. Fresh water bodies are generally grouped as stagnant (Lentic) waters like lakes, ponds, swamps, bogs and marshes and running (Lytic) waters like rivers, springs, streams and brooks.

1.4.3. Lithosphere

The Earth crust is known as lithosphere. It ranges from 6 to 22 miles down into the earth bowels. It has soil organisms. For e.g., bacteria can be obtained in the coal deposits at a depth of 1,089 meters. The area of lithosphere is 1.408×10^8 sq.km. Lithosphere occupies roughly 29.2% of earth's surface. Experiments have proved that 98% of the crust is composed of 8 elements like Oxygen, Silicon, Aluminium, Iron, Calcium, Sodium, Potassium and Magnesium, and the rest of 90 elements compose the remaining 2% of the crust. These elements are not found in their elemental forms, but combine with others to make various substances with specific physical and chemical properties called, minerals. The substance formed of one or more minerals and a part of the Earth's crust is called rock.

In the lithosphere that is in the bowels of the Earth 3 types of rocks are available. 1) Igneous rocks, these are formed in the early stages when the Earth was in the molten state. 2) Sedimentary rocks, in these the weight of upper layers on the lower layers hardens the latter, these layers hardened, stratified and consolidated are known as sedimentary rocks and 3) Metamorphic rocks which are formed of Igneous as well as of sedimentary rocks. Lithosphere has a temperature gradient in that on the surface of Earth the temperature would be 42.50 and the temperature increases as depth increases.

Check Your Progress - 2

Define the terms biosphere, hydrosphere, atmosphere and lithosphere

Note: a) Write the answer in the space provided below

b) Compare your answer with the one given at the end of this unit.

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1.5. WATER CYCLE

It is otherwise called as hydrological cycle which can advertently and inadvertently change weather and climate. The water cycle consists of the varied events happening to a particle of water from the time it is a bit of vapour in the atmosphere until it is again evaporated (Fig.1.1).

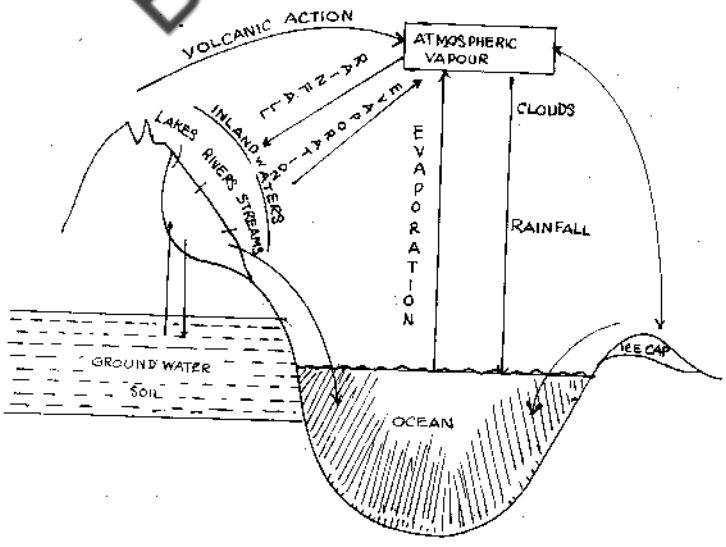

Fig. 1.1 Water Cycle

Water enters the atmosphere from the surface of bodies of water and from the soil from plants in transpiration or in drying and in small amounts from animals. It is disseminated through the atmosphere by winds, precipitated as liquid or frozen rain or as snow. Once precipitated there may be immediate evaporation. The water may be stored in soil, swamps, lakes, or oceans before evaporation takes it back to the beginning of the cycle. Plants and animals take water out of the inorganic hydrological cycle and make an organic one from which the water returns sooner or later by diffusion, excretion or as a result of organic decomposition and due to evaporation, the water accumulates in atmosphere in the form of vapour. If all moisture in the air were precipitated and collected in the ocean, the sea level would be raised only 3.5 cm. The amount of fresh water is about 33 times to that in the atmosphere.

More water evaporates from the sea than returns via rainfall, and vice versa for the land. 0.25 geograms (1 geogram = 10^{20} gms) of water are in fresh water lakes and rivers and 0.2 geograms run off each year, the turn over time is about a year. The difference between the annual rainfall (1.0 geogram) and the run off (0.2 gms) in 0.8 is an estimate of the annual recharge rate of ground waters. Man's tendency to increase the rate of run off may soon reduce the very important ground water compartment, we should be putting more water back into the 'aquifers' instead of trying to store it all in lakes, where evaporation is high.

1.6. GEOLOGICAL CYCLE

In nature, elements or chemicals undergo a cyclic change between organisms and environment (earth) and these changes are called geological or biogeochemical cycles. Bio refers to living organisms and geo to the rocks, soil, air and water of the Earth. Nitrogen cycle is a typical example for geological cycle.

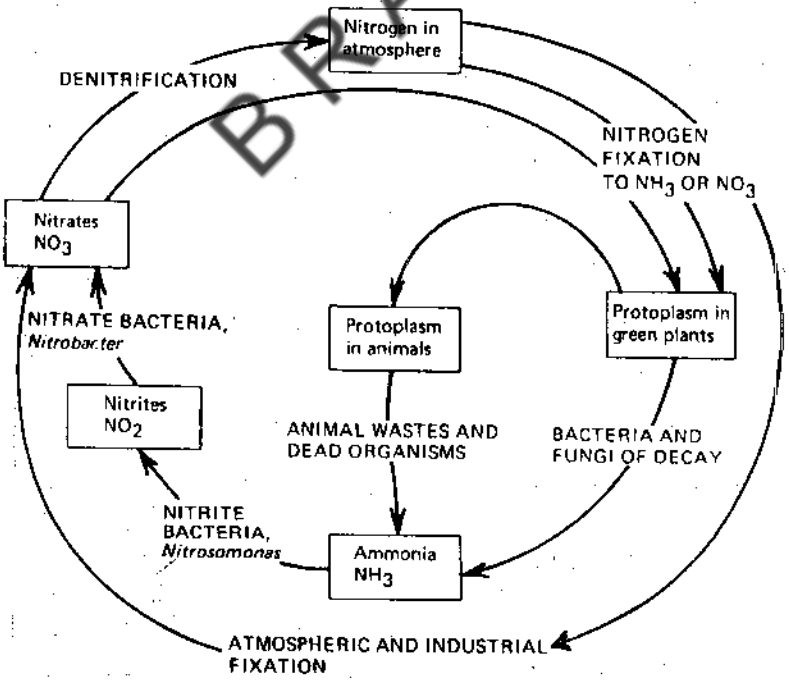

Fig 1.2. Nitrogen Cycle

In the nitrogen cycle, atmosphere is the main reservoir and nitrogen is continually feeding into and out of this great reservoir from the rapidly cycling pool associated with organisms. Nitrogen is present in about 79% in the atmosphere which serves as the Nitrogen reservoir. This free nitrogen is converted into nitrates by a specific kind of micro-organisms called as nitrogen fixing bacteria and also by algae. The nitrogen in the form of nitrates is available to the plants for construction of proteins. These plant proteins enter into the body of animals through food chains. Due to the metabolic activity, the nitrogen is excreted outside the animal in the form of ammonia, on the other hand ammonia is also formed and added onto the stock from igneous rocks through volcanic action. Thus, the ammonia which has accumulated is converted into nitrites through nitrite bacteria in the soil and later, the nitrites are converted into nitrates through nitrate bacteria. Thus nitrates are going on added to the nitrate stock. Nitrates are also added on through the marine birds and fish. The excess nitrates are lost to the deep sediments through shallow marine sediments. And, if the nitrogen content decreases in atmosphere, it can be regained by the formation of nitrogen from nitrates through denitrifying bacteria. Thus the nitrogen cycle is maintained through specialized micro-organisms like bacteria and blue-green algae and any increase or decrease of nitrogen along one path is quickly compensated for by adjustments along other paths.

Check Your Progress - 3

What are biogeochemical cycles ?

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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1.7. WIND FORMS

Wind is important environmental factor capable of creating currents and cyclones in terrestrial as well as in aquatic ecosystems. Air-temperature differences between poles and equator set up strong winds which together with rotation of earth produces water currents. The warm winds from the equator cools as it makes toward the poles and descends at about 30^0 latitude. The cold wind flowing along the surface from the poles warms and ascends at about 60^0 latitude.

Winds are relatively calm at the surface near the equator and are called the doldrums. The winds which flow from high pressure to low pressure are called geotropic winds which tend to follow the lines of constant air pressure (isobars).

Stormy winds occur with greater wind velocities. Closer to the Earth surface, stormy weather is associated with jet maximums (wind with extremely higher speeds). Sharp temperature differences between air masses tend to induce a cyclonic circulation pattern around the low-pressure areas. The jet maximums accelerate this tendency and thunder storms and tornadoes may develop. A hurricane otherwise known as a typhoon, is an intense cyclone that develops over tropical oceans. Hurricanes can reach 800 km. in diameter with winds over 120 km per hour . Interaction between the wind and water can produce waves 6 to 10 meters high as well as cause water to rap up on shores, flooding coastal areas. When hurricanes move over land, the moist air is not readily available to supply energy, so winds dissipate and the hurricane dies out in rain storms. Tornado is another type of cyclone, but is much smaller in diameter than a hurricane. Tornadoes are about 100 meters to 1 km. in diameter with wind speeds exceeding 200 meters per second. Tornadoes usually form over land when cooler drier air moves rapidly over warm moist air.

Wind energy (Power) can be generated through the operation of windmills. The blades of the windmill rotate when wind strikes their feathered surfaces which are directly attached to an electric generator. Wind power is a potential source of energy along the plains, mountains and coastal areas. A wind of 32 km. per hour blowing through a rectangle of 16 km. long and 46 meters high produces about 350,000 kw of energy. In rural areas wind energy has been utilized for pumping water.

Check Your Progress - 4

What are the uses of wind?

Note : (a) Write your answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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1.8. ICELAND FORMS

Water freezes during excessive cooling at zero and sub-zero temperatures near the poles and forms into icelands like glaciers ice caps and snow packs. During summer when snowfall does not melt, a snow pack accumulates, over a period of years the snow pack will build up with increasing pressure exerted on the bottom layers and slowly the packed snow and ice is converted in their name as glaciers. Glaciers also move so slowly like a stream. Glaciers moving down mountain slopes carry along rocks and grind away the rock beneath. For e.g., more massive accumulations form continental sheets of ice as in Greenland and Antarctica, but Alpine glaciers represent small volume of the World's glaciers.

Glaciers seem to occur with a cyclic regularity. Twenty per cent of the Earth's land area was covered with glaciers and in recent times it is reduced to 10%. 96% of that is in the Antarctic and most of the remainder in Greenland. During the melting of these icelands, the sea level increases, therefore, the last glacial epoch, the sea level was about 137 meters lower than now. This process of melting of glaciers due to global warming cause the sea level to rise and flood the edges of the continents and mouths of rivers. The sea level rose at the rate of 8.75 centimeters per century prior to 1920 s. If all glaciers melted, the sea level would rise to 60 meters and flood seaports and coastal areas around the world. If global warming continues, the small islands in the sea like Maldives, Nicobar and Andamans will be drowned completely. Once the glaciers melt a great weight is removed from the land and the land rises like a ship that has been unloaded .

1.9. SUMMARY

Planet Earth is a suitable and ideal habitat for the living of Man, since it has an atmosphere with oxygen. The part of the Earth having life constitutes biosphere. The atmosphere forms the outer envelop of the Earth and filters solar radiation, regulates temperatures and makes weather. The water part of the biosphere constitute hydrosphere and the Earth crust (bowels) is called as lithosphere. The study of inter-relationship between organisms and environment is called Ecology.

In nature movements of elements take place between living and nonliving substances in the form of cycles. Nitrogen cycle represents an important gaseous geological cycle regulating the fertility of the soils and water cycle represents the hydrological cycle, regulating water content, can change

the weather and climate of particular area. Air temperature differences between the poles together with the rotation of Earth bring wind forms which can also generate energy. Excessive cooling of the Earth near the poles induces formation of icelands in the form of glaciers and the ice caps which could be melted due to global warming and thereby raising the level of sea.

1.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The only planet with life is Earth and it is a suitable habitat for the survival of man.
2. A very small portion of the Earth having life is called biosphere. The water part of the Earth is hydrosphere and the vertical extension of the portion from Earth is atmosphere which protects us from harmful radiation. The raised portion of the crust of Earth is called lithosphere.
3. The more or less circular paths of the chemical elements passing back and forth between organisms and environment are known as biogeochemical cycles.
4. Wind is an important environmental factor that can create water currents, cyclones etc., and also generate wind power, whereas icelands are called as glaciers which will be melted due to global warming.

1.11. MODEL EXAMINATION QUESTIONS

I Answer the following questions in about 30 lines each.

1. Give a detailed account on the structure of atmosphere.
2. What is geological cycle and describe the same with nitrogen cycle ?
3. How do wind and Iceland forms influence the environment ?

II Answer the following questions in about 10 lines each.

1. Write about Hydrosphere briefly.
2. How is water cycle operated?
3. Give a brief account on glaciers.

Prof. Md. Basha Mohiuddin

UNIT- 2 : BIOLOGICAL PROCESSES

Contents

2.1. OBJECTIVES

After going through this unit, you will be able to :

* list out and describe different concepts on origin of life,
* define evolution and describe the theories of evolution,
* describe the impact of evolution on bio-geochemical cycles,
* define species and to explain the richness of species,
* define population and to describe the density and distribution of different populations, and
* explain the factors affecting the density and distribution of population.

2.2. INTRODUCTION

For centuries together, the origin of life is a subject of curiosity for makind. Till the middle of the nincteenth century, life was thought to be created by 'God' or by an unknown supernatural power. Later to this also, several scientific and non scientific theories were putforth to explain the origin of life, but by the turn of this century all of them were abandoned and the concept of bio-chemical origin of life was widely accepted.

2.3. ORIGIN OF LIFE

In the ancient past, it is believed that life originated *de novo*. Several theories based on different observations/ideas were proposed but by the turn of this century, all these theories were ruled out and the widely accepted biochemical origin of life was proposed. The different theories known on the origin of life are as follows :

2.3.1. Theory of Special Creation

This theory states that life was created by an unkown power either once or at successive intervals. In the 'Bible' it was written that the world was created within six days. According to Hindu mythology, the world was created by God 'Brahma'. God's men and devils were formed from his head, birds from his chest, goats from his mouth and plants from the hairs of his body.

2.3.2. Theory of Spontaneous Generation or Abiogenesis

Till 17th century, people believed in abiogenesis or spontaneous generation of living beings from non living substances. Epicurus, an ancient greek philosopher stated that worms and numerous other animals were generated from the wet soil or manure by the action of sun and air. 'Aristotle' also believed that living creatures are born from like species but they also arose spontaneously. The common worms, bee larvae, wasps, ticks, glow worms etc. are born from dew, rotten slime, manure, dry wood, sweet, meat, etc. Eels develop from sea mud; frogs and salamanders from coagulated slime and butterflies from cheese. The theory of abiogenesis was also supported by Thales, Anaxemander, 'Newton' and Descartes.

2.3.3. Theory of Biogenesis

Franscesco Redi (1621-1697) showed that Abiogenesis cannot exist. In his simple experiment, Redi cooked few meat pieces and placed them in three jars. Jar A was covered with parchment paper, jar B was covered with muslin cloth or gauge and jar C was left uncovered. After a few days maggots appeared in jar C but not in A and B. Plenty of flies were seen sitting and laying their eggs on muslin cloth covering the jar B. But no maggots appeard in the meat. In the jar A, the flies could not enter inside and no flies or maggots appeared inside the jar A even for days together. From these observations, Redi demonstrated that the flies arose from the eggs laid down by the parent flies and that the maggots cannot appear spontaneously. 'Abbe Spallonzani' (1929-1799) and Louis Pasteur also proved that Abiogenesis cannot exist in nature.

2.3.4. Theory of Panspermia or Cosmozoic Theory

This theory states that life was distributed throughout the cosmos in the form of resistant spores or cosmozoa. These spores reached the earth from other planets through meteriorites or celestial bodies. In presence of favourable conditions, these developed into organisms.

2.3.5. Bio-chemical Origin of Life or Modern Hypothesis of Origin of Life

'Haeckel' propounded the modern hypothesis of origin of life. He stated that the most primitive organism would have been generated spontaneously, at some time, from some inorganic matter as a result of formative action of some special external physical forces such as electrical charges, ultraviolet light and corpuscular radiation of radioactive elements. This hypothesis was refined by the explanation and experimental support of the scientists 'Haldane', 'A.I.Oparin', Stanley Miller and H.Curey. The Russian Biochemist A.I.Oparin schematically presented the biochemical origin of life as follows.

The earth is believed to be formed about 5 to 6 billion years ago. Initially, it was a mass of hot gases and vapours of various elements. These gases condensed into a molten core and the heavy elements like iron and nickel occupies the centre, the lighter elements like silicon and aluminium occupied the middle zone whereas the lightest elements like Helium, Hydrogen, Nitrogen and Carbon occupied the surface and formed the gaseous atmosphere. At that time, the temperature was roughly about 900°c and the elements like Hydrogen, Oxygen, Carbon and Nitrogen could not exist in free state. They combined among themselves or with metals forming oxides, carbides and nitrites. These compounds at higher temperature turned into gaseous state and water in the form of water vapour and formed the atmosphere of the primitive earth. Thus, the atmosphere of the primitive earth was composed of Ammonia (NH_3), Methane (CH_4), water vapour, cyanide, carbon-monoxide (CO) and free Hydrogen, but without free oxygen. The earth got cooled gradually and the gases which constituted the atmosphere of it got liquified. Some of the liquids got transformed into solids. The water vapour in the process of cooling got condensed and resulted in the form of rain. Such rains cooled the earth's surface. As a consequence, larger water bodies (oceans) came into being. These larger water bodies or oceans bear Ammonia and Methane of the atmosphere. They also contain the minerals and salts and they are basically alkaline in nature. Thus, three billion years ago, the earth developed a solid crust with eruptions of molten rocks and places filled with boiling sea water. The sea water contained dissolved Ammonia, Methane, minerals and salts. Its atmosphere is having Ammonia, Methane, and Hydrogen but without free Oxygen. The earth at that time also experienced the high energy radiation.

2.3.6. Origin of Organic Compounds

When the temperature of the earth got cooled down to below 100° C a variety of saturated and unsatuarated simple hydrocarbons were formed. They are Acetylene, Ethylene, Methane, etc. The formation of oxy and hydroxy derivatives such as aldehydes, ketones and acids are formed when the unsatuarated and saturated hydrocarbons reacted with the water vapour. Further, from the hydroxy derivatives, small chain compounds like glucose and fructose are derived. Their condensation formed the disaccharides and polysaccharides. Condensation and the polymerization of the oxy and hydroxy derivatives such as aldehydes and ketones and their oxidation had resulted in the formation of fatty acids. The combination of glycerol and fatty acids might have resulted in the formation of fats. Under the influence of the freely available force of energy, the hydrocarbons formed the amino acids. The polymerization of amino acids lead to the formation of protein molecules.

2.3.7. Formation of Macro-molecules or Complex Organic Molecules

The molecules of simple organic substances had aggregated, reacted and formed new complex molecules. Thus, the polysaccharides, fats, proteins, purines, pyremidines, nucleosides and nucleotides got originated. The formation of protein molecules is a significant event in the origin of life. Another important event in the origin of life is the formation of nucleic acids by the polymerization of nucleotides. Due to the union of nucleic acids and protein molecules, giant molecules of nucleoproteins were formed. It is presumed that such giant nucleoprotein molecules had the characters of a feee living gene. A number of such genes might have come together to form a single large unit comparable to that of a virus and this unit was referred to as **Protovirus**. All these events led to the formation of nucleoproteins and other complex macromolecules are referred to as the **chemical evolution** of life. The events succeeding to these are described under **biological evolution** of life.

2.3.8. Biological Evolution

The giant organic molecules formed through chemical evolution of life aggregated in different combinations and formed the large colloidal particles. These were named as **coacervates**. These coacervates contain more than one type of proteins, nucleoproteins and other organic and inorganic molecules in various combinations. They appear as distinct bodies suspended in the water media.

These coacervates, according to A.I.Oparin, can grow and reproduce by taking molecules of other substances. Such forms have formed the surface membranes around them. These membranes are formed from lecithin, cephalin, etc. The formation of surface membrane resulted in the accumulation of various substances in coacervates. The internal reactions like catalyses and absorption also occurred within them and some of the proteins in coacervates got differentiated into enzymes. These enzymes were able to complete some reactions which otherwise require huge amount of energy and high temperatures. All these changes ultimately resulted in the formation of the first living cell. The coacervates in due course with nucleoprotein molecules surrounded by the surface membrane have accumulated nutrient shells and became the first living cell.

Among the various cell types derived from the coacervates the moneron type of cells and protestan type of cells are significant. In moneron type, the nucleoproteins aggregate together loosely and directly in the cell substance (Examples : Bacteria, Blue green algae), where as in protestan type, the nucleoproteins were accumulated into a central mass covered by a fine membrane. In this type, the nucleoproteins got separated from the cell substance. The early living organisms, ancestors of monerons and protesta evolved different mothods for obtaining food. Thus, they are distinguished into 1) parasites (living on other living cells for food), 2. Saprophytes (Deriving food from the dead and decaying cells), 3. Predators (Organisms eating another in whole or part for its food), 4. Chemosynthesisers (utilising energy from the inorganic molecules like sulphur, Iron, Nitrogen etc.), 5. Photosynthesisers (The sun light is trapped by the living cells by a substance named chlorophyll).

2.4. EVOLUTION

The term evolution denotes the unfolding of life. Evolution is a process in which the complex organisms are formed from the simple organisms. Evolution is due to descent with modification. The idea of organic evolution was rightly emphasised by **Charles Darwin** in 1859, in his book the **Origin of Species.**

2.4.1. Theories

Prior to Darwin a number of philosophers and scientists thought about evolution. **Empedocles** (495 to 435 B.C.), the Greek philosopher opined that life was spontaneously formed but it was gradual and evolution occurred due to the interaction of forces.

Aristotle porposed the **scale of beings.** He said that organisms could be arranged in a graded series showing there by a gradual evolution of living organisms occurred in nature.

The discovery of organic remains of certain animals and plants which were not existing at present has led to the idea that life existed in the past has become extinct due to catastrophic changes and this idea has formulated the **theory of catastrophism** by **Cuvier** (1769-1832).

James Hutton (1785) and ***Charless Lyell*** (1932) established the concept of ***uniformatarianism***. It states that the slowly acting geological forces such as erosion, sedimentation, disruption, etc. resulted in the formation of fossil bearing rock strata.

Carolus Linnaeus (1707 to 1788) believed in ***special creation***. He classified the animals and plants and presumed that species of different organisms are immutable and fixed entities.

To explain the concept of organic evolution, ***Lamarck*** (1744-1829) has proposed the ***Theory of inheritance of acquired characters.*** The salient features of Lamarck theory are as follows :

Lamarck Theory : The organisms acquire changes or variations in the body due to the changes in the environment. The changes thus acquired by the organisms are inherited to the next generation. The theory of Lamarckism is supported by Lysenko (1930).

Theory of Natural Selection (1830-1882) : Darwin formulated the most accepted ***Theory of Natural Selection,*** in his book the **Origin of species.** This theory states that variations occur in populations and these variations are generally caused by the recombinations in sexual reproductions. Some times these variations may occur due to mutations which are referred to by Darwin as **sports.** Darwin states that nature favours only those individuals of species having variations to suit to the environment or nature. The unsuccessful individuals are eliminated by nature. Thus nature selects and favours certain individuals and eliminates others. This process is called ***Natural selection.*** Thus natural selection leads to ***speciation or evolution.***

Devries Theory of Mutations : Devries (1848-1935) theory states that large and significant variations in organisms occur all of a sudden due to *mutations* or *saltations.* Such mutations favoured by nature would lead to the *organic evolution.*

Modern Synthetic Theory : The modern concept of evolution is a synthesis of Darwin's theory of natural selection and Devries theory of mutations backed by the knowledge in genetics. It is the outcome of the views expressed by scientists such as Fisher, Haldane, Huxley, Sewell, Wright, Chetverikov, Dobzhansky, Muller, Mayer, Stebbens, etc.

The synthetic theory of evolution recognises 5 basic processes, namely

1. Gene mutations
2. Changes in chromosome number
3. Genetic recombination
4. Natural selection
5. Reproductive isolation

The 3 accessory processes also affect the working processes of evolution. They are :

1. Migration
2. Hybridization
3. Chance

Check Your Progress - 1

What is evolution ? What are the different theories on evolution ?

Note : a) Write your answer in the space given below.

b) Compare your answer with the one given at the end of this unit.

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2.4.2. Effect on Bio-geochemical Cycles

The formation of primary organisms has led to the changes in the atmosphere. The oxygen released by the photosynthetic organisms reacted with the gases like Methane (CH_4) and Ammonia (NH_3) present in the primitive atmosphere forming CO_2 and free N_2

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

$$NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$$

Thus, the atmosphere in presence of photosynthetic organisms had evolved into an oxidising atmosphere with plenty of free oxygen and got rid of Methane and Ammonia. But, it contains water vapours, carbondioxide, molecular Nitrogen, Hydrogen and large quantities of free molecular oxygen. The earlier forms exhibiting anaerobic respiration or fermentation, in presence of the oxygen abundant modern atmosphere have evolved into aerobic respirators. Thus, in the process of evolution the physico-chemical features of the environment are influenced by the evolving organisms. The changing atmosphere in turn acted on the biota and favour the organisms to adapt to the ever changing new environment.

2.5. SPECIES RICHNESS

Species are considered as fundamental biological units of Taxonomy as well as of evolution. Up to 19th century, species were regarded as man made categories of thought with no stability of characters. But Linnaeus for the first time said that species have constant characteristics and sharply delimited against each other.

2.5.1. Species Concept

To recognise species, different concepts were proposed . They are as follows :

Morphological species concept : According to this definition, a population consisting of morphologically distinct organisms would constitute a species. In elaboration, a morphological or taxonomic species is defined as a group of individuals that resemble each other in most of their visible or morphological characters. But morphological species concept is not applicable in all cases and very often morphological differences are seen among individuals of a single population or between non specific populations than between related species. Example : seasonal polymorphic forms of *Daphnia*.

Genetic species concept : Some genetists like Losty (1918) defined species purely on the basis of genetics. The concept states that species is a group of genetically identical individuals. This definition is ruled out for the reason that no two individuals are genetically similar.

Biological species concept : The biological species concept was put forth by Dobzhansky in 1937 and Mayer in 1942. The Mayer's 1942 concept is most complete and practical definition on biological species. It states that species are the group of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups.

Check Your Progress - 2

Describe the biological species concept.

Note :a) Write your answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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2.5.2. Species Richness

There are innumerable number of biological species existing in this world. These species are the end products of evolution of about 3.5 billion years. According to an estimate, about 1 million species of animals and half a million species of plants have already been described. The number of

still undescribed living species may range from 3 to 10 million. The extinct species as per a moderate estimate may come to a tune of half a billion. The existing species in their turn would appear in numerous different forms such as sex, age, classes, seasonal forms, morphs etc,. It is difficult to deal with this enormous diversity if it were not ordered and classified. Linnaeus classified the enormous number of biological species in two large kingdoms, namely a) Plant Kingdom and b) Animal Kingdom

Three Kingdom Approach : Haeckel (1894) proposed three kingdom system, which includes **Protista kingdom, animal kingdom** and **plant kingdom.** The Protista includes the prokaryotes (Bacteria and blue-green algae), Algae, Fungi, slime moulds and Protozoa. Protista is further divided into lower protista or Monera and higher protista. Lower protista includes only prokaryotes and higher protista includes other algae, fungi, slime moulds and Protozoa.

Five Kingdom Approach : Whittaker (1969) proposed 5 kingdom arrangement. In this approach the species were separated into 5 kingdoms on the following criteria. They are :

1. Complexity of cell structure
2. Complexity of the body
3. Mode of nutrition.

The five kingdoms are **Monera, Protista, Plantae, Fungi,** and **Animalia.**

1. Kingdom Monera	:	This is the kingdom of prokaryotes (Bacteria, Actinomycetes and Cyanobacteria)
2. Kingdom Protista	:	This is the kingdom of unicellular eukaryotes which are primarily aquatic (Protozoa, Algae)
3. Kingdom Plantae	:	This is the kingdom of multicellular producers with a complex body organisation (Algae, Bryophytes and Trachacophytes).
4. Kingdom Fungi	:	This is the kingdom of muticelluar decomposers.
5. Kingdom Animalia	:	This is the kingdom of multicellular consumers (Metazoa).

2.6. DENSITY AND DISTRIBUTION OF POPULATIONS

The word **population** is derived from **populas**, meaning people. In terms of biology, population is defined as the organisms, collectively, inhabiting an area or region. Pearl(1937) defined population as a group of living individuals set in a frame that is limited and defined in respect of both time and space.

A population exhibit characteristics that it shares with an organism as well as characteristics that are its own unique possession. The former might be called biological attributes and the later unique attributes. At least 5 general attributes are exhibited by population and organism alike. They are:

1. A definite structure and composition is constant for any moment of time, but fluctuates with age.
2. The population is ontogenetic. It exhibits growth, differentiation and division of labour, maintenance,scenescence and death.
3. The population has a heredity.

4. The population is integrated by both genetic and ecological factors that operate an independent mechanism.

5. Like the organism, the population is a unit that needs the impact of its environment. This is reciprocal phenomenon, since the population is altered as a consequence of this impact, and intime, it alters its environment. Population can be recognized as space relative and time relative population.

Check Your Progress - 3 & 4

3. Define population?
4. What are the characteristics of population?

Note : a) Write your answers in the space given below.

b) Compare your answers with these given at the end of this unit.

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2.6.1. Populations

Space relative populations: This is the number of organisms for unit of space they occupy. This is commonly called density of population. The special unit varies both with the organism study and the judgement of the investigator. Thus, in human populations meets such units as square miles, meters, cubic feet, beds, etc. The generalized definition of a space relative population is d= T/a or density = Absolute no. of organisms in an area/no. of special units in that area.

Time relative population: This can be defined in one form as the difference between the number of a population at a particular day T_2 and an earlier day T_1, relative to the absolute no. at the earlier date, T_1 and average to some appropriate figure of time.

2.6.2. Density of Population

Population density is a group phenomenon. Density is a numerical concept and a population product. The factors affecting population can be distinguished based on the density factor.

Factors affecting density of population : Thompson (1928) distinguished the factors, affecting population into two categories.

1. Catastrophe "General or independent" : Largely comprised by the physico-chemical aspects of the environment.

2. Facultative "Individualised dependent": The credacious and parasitic organisms.

In 1935 Smith reconsidered this classification and proposed the terms 1. Density independent mortality factors and 2) Density dependent mortality factors.

The density independent mortality factors destroy a constant percentage of organisms in sparse, intermediate or dense population. These factors are analogous to the catastrophic or general of Thomson.

The density dependent factors destroy a percentage that increases with density. These factors are analogous to the facultative and individualised factors of Thomson.

Allee (1949) states that mortality can decrease as well as increase with density. Accordingly, he proposed that density dependent factors be split into direct and inverse categories. Direct density dependent factors are the factors wherein mortality increases with density. Inverse density independent factors are those 'Eliminating influences which take a decrease in percentage of the individuals present as the population increases. Thus the following classification holds good as for the above explanation.

1. Density independent mortality factors

2. Density dependent mortality factors : a) Directive, b) Indirective

The physical or climatic factors that affect the population densities are summarised by Urarov and they are as follows :

1. **Temperature as a controlling factor**
   a) Direct injury by high and medium temperatures.
   b) Effective of high temperature on the reporduction.
   c) Winter mortality and general effects of low temperatures.
   d) Favourable effects of temperature.
2. **Precipitation**
   a) Excess precipitation
   b) Deficient precipitation (drought)
   c) Winter precipitation
   d) Effects of rain fall in tropical climates
   e) Rain storms and hail storms
3. **Wind**
4. **Atmospheric pressure**
5. **Thunder storms**
6. **Temperature and rain fall**
7. **Temperature and Humidity**
8. **Temperature and light**
9. **Food quality and quantity as related to climate.**

The chemical factors that effect the population in a density independent fashion are classifiable as chemical factors of the environment. These are of particular significance in aquatic groups. But, examples can also be found among studies of laboratory and natural terrestrial populations. These factors include :

1. Hydrogen ion concentration 2. Salinity 3. Oxygen 4. Carbondioxide
5. Calcium and other macronutrients 6. Pollution 7. Food

Density independent factors : The density independent factors include the biological factors such as

1. Parasitism

2. Predators

3. Competition

2.6.3. Types of Distribution of Populations

The distribution of the organisms can be classified as (1) Distribution in space and (2) Distribution in time.

Distribution in space : The terrestrial and aquatic organisms can be distributed in space in the horizontal direction. Such distribution is governed by the physicochemical and biological parameters. The horizontal distribution of the populations is distinguished as random and non-random distribution.

The random distribution is primarily governed by the mechanical factors such as wind, water currents, inflowing and outflowing waters, etc. in aquatic environment. The other physico-chemical parameters such as light, temperature, dissolved gases, nutrients are responsible for the random distribution. The biological parameters such as behavioural aspects, distribution of the plants, predators, etc. also govern the random distribution. The random distribution is also referred to as **patchiness.**

The non-random distribution is a rare phenomenon. However, it is realized in aquatic environment in situations wherein competition and over growth of the populations are met within the environment.

The populations in aquatic environment can also be distributed vertically. The organisms having wide range of tolerance to the environmental conditions are called eurytopic organisms. The organisms having narrow range of tolerance to the environmental conditions are said to be the stenotopic organisms. The eurytopic organisms get themselves distributed vertically all through the water column whereas the stenotopic organisms distribute either in the surface layers or in the middle depths or nearer to the bottom in a water body depending on the optimal environmental conditions suitable to them. The factors such as density, water currents, temperature, light, nutrients, parasites, predators, prey populations, etc. govern the vertical distribution. In aquatic environment the migratory behaviour of the organisms in the vertical column of water during 24 hours of the day is referred to as **diel vertical migration.**

Distribution in time : Population distribution with reference to time is known as **temporal distribution.** The temporal distribution of populations is generally studied over a period of an year. Hence it is also been referred to as annual distribution. The distribution pattern of the populations over a period of an year varies significantly. The peak periodicity of the populations are realized when environmental factors are favourable for the growth and reproduction of the populations. The lowest ebb of the populations are known when the environmental parameters are antagonistic to the growth and reproduction of the populations. Generally, the factors such as turbidity, temperature, light, nutrients, competition, parasitism, predation, etc. will govern the temporal distribution of populations.

The geographical distribution of the populations in an area can be distinguished as sympatric and allopatric populations. The sympatric populations are the overlapping populations in a geographical region. The allopatric populations are the isolated populations.

2.7. SUMMARY

Life originated through bio-chemical processes on earth manifests different species of plants and animals. All the species ranging from simpler to the complex forms are formed due to organic evolution, the process of continuity of life with constant modifications. The changes in the life forms are with the changing environmental conditions. This is called adaptability. This ultimately leads to the formation of new species. The great-array of species existing today have a common ancestor at some time of their evolution. This is called monophyletic geneology. The individual of species migrate from their place of origin to varied geographical regions and gradually adapt to different sets of environmental conditions. This results in the formation of several new species from one ancestral

species (divergent evolution). Thus, the species are the end products of evolution. An innumerable number of species are existing in this world. This speaks about their richness. These species depending on their diversity are assigned to different kingdoms which are further classified based on phylogeny and diversity of species. Biological species forms populations. The population densities are governed by density dependent and density independent factors which include physical chemical and biological factors. The distribution of populations is governed by geographical, physical, chemical and biological conditions in space and time.

2.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Evolution is a process in which complex organisms are formed from the simple organisms.
   The different theories on evolution are : 1) Lamarck theory, 2) Darwins theory of natural selection, 3) Devries theory of mutations and 4) Modern synthetic theory.
2. The biological species concept states that species are the group of potentially interbreeding natural populations that are reproductively isolated.
3. The population is defined as the organisms collectively inhabiting an area or region. Population can also be defined as a group of living individuals set in the frame that is limited and defined in respect of both time and space.
4. The characteristics of a population are a) A definite structure and composition is constant for any moment of time but fluctuates with age b)The population is ontogenetic. It exhibits growth, differentiation and division of labour, maintenance, scenescence and death. c) The population has a heridity. d) The population is integrated by both genetic and ecological factors that operate an independent mechanism. e) Like the organism, the population is a unit that needs the impact of its environment. This is altered as a consequence of this impact, and intime, it alters its effective environment. Population can be recognised as space relative and time relative population.

2.9. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Give an account of the origin of species.
2. What are the various theories on Evolution ? Explain them.
3. Give an account of the species concept and add a note on the richness of species.
4. What is population ? Explain in detail the factors influencing the density and distribution of populations.

II. Answer the following questions in about 10 lines each.

1. Give an account of the Modern Synthetic Theory on evolution.
2. Explain in detail the species richness in the world.
3. Describe in detail the factors affecting populations.

Prof. M. K. Durga Prasad

UNIT - 3 : ECOSYSTEMS

Contents

3.1. OBJECTIVES

After completing this unit, your will be able to :

* define ecology and describe its scope and history,
* delineate the structure and function of an ecosystem,

* define various processes like energy transfer, material cycling, and factors limiting these processes,
* describe and analyse population and community,
* describe how a marine system is organised, and
* list out various 'commons' of the world, and describe how they are threatened.

3.2. INTRODUCTION

Ecology encompasses so many complexly inter-related concepts and phenomena involving several levels of organisation. Also there is no "ideal outline or perfect sequential order for presentation of the subject. Thus, the order best suited to the syllabus of unit-3: ecosystems; of block-1: ecology and ecosystems, is chosen to present here.

As man's power to alter the environment has expanded, the need to have an intelligent knowledge of the ecology and environment has become more essential than ever before. The subject treated in this unit provides a good insight into the field to any graduate learner, or a beginner of ecology course. For a detailed study, those interested in it, are advised to refer Fundamentals of Ecology" authored by Eugene P.Odum (1971) and published by W.B.Saunders Company, London, which forms the primary source for the subject presented here.

3.3. SCOPE AND HISTORY OF ECOLOGY

'Ecology' and 'Environment' are words frequently encountered, usually in association with humanity and development. More often than not, they are misused and misquoted. However, these two words have assumed increasing importance in the recent times than ever before. The word 'ecology' was first proposed by the German biologist, Earnest Haeckel in 1869, and has its origin in Greek *Oikos*, meaning "place to live". Literally, ecology is the study of organisms "at home". The term has been variously defined from time to time before it attained the status of a recognised distinct field of science. One of the best and widely used definitions describe ecology as the study of the relations between organisms and the totality of the physical and biological factors affecting them or influenced by them (Pianka,1983). In brief, it is the study of interrelationships between organisms and their environment.

Environment includes everything from sunlight, air, soils, water and rain to other organisms. For example, the environment of a tiger consists not only of other plants and animals encountered directly or utilised for food, shelter and range, but also of purely physical processes and inorganic substances, such as fluctuations in the weather conditions, terrain type, ability to explore and exploit the resources and so on. Thus, environment of most organisms is extremely complex and consequently, ecology takes in aspects of many other fields, including mathematics, physical sciences, geosciences, social sciences, economics, anthropology and many other fields besides various subdisciplines of biology.

Although the label "Ecology" was in use from about 1900, studies which were clearly ecological in nature appeared from the times of Hippocrates and Aristotle (see Odum, 1971). the concepts of 'Abhayaranyas' and thier role in the nation's economy as related by Kautilya, are classic examples for the theme during the medieval periods. The famous microscopist, Anton van Leeuwenhoek of the early 1700s pioneered the study of food chains and population regulation which are two important aspects and areas of modern ecology.

ECOLOGY IS DEFINED AS :

* Study of the relations of organisms or groups of organisms to their environment.
* The science of interrelations between living organisms and their environment.

* The study of the structure and function of Nature.
* The study of distribution and abundance of organisms.
* Scientific natural history.
* The study of the relations between organisms and the totality of the physical and biological factors affecting them or influenced by them.
* The totality of Man and Environment.

Modern ecology has become more mathematical when compared to early ecology, which was basically descriptive and the pioneers of the field spent most of their time describing, itemising and classifying various ecological elements. During this time, ecology primarily dealt with the biology of groups of organisms and with their functional processes in their environment. Modern ecologists want to understand and to explain, in general terms, the origin and mechanisms of interactions of organisms with one another and with their nonliving world. In this process, ecologists construct "models" which closely resemble the reality and enable the capacity for testable predictions.

Until 1970s, ecologists mostly restricted themselves to the natural systems. They began to study man-made ecosystems or altered ecosystems, such as agro ecosystems, urban ecosystems and so on. By the close of century, ecology has become one of the important sciences, the knowledge of which is highly essential in planning processes from microlevel to macrolevel. With this development, ecology is now defined as the study of "the totality of man and environment". Consequently, ecology is rapidly becoming most relevant to the everyday life of every man, woman and child.

3.4. ECOLOGICAL PRINCIPLES

Ecology is a young science. Bric Pianka, an American professor of Ecology, characterized ecology as a 'Soft 'science, as it is not so precise as older and better established 'hard sciences such as chemistry and physics. Presently, ecology has few firm laws, but many hypotheses are to be tested.

3.4.1. Ecosystem Concepts

Ecology being an exceedingly broad subject with great complexity and multifaceted physical environment, students of ecology attempt to interweave and correlate various of its subdisciplines. Since ecology baiscally deals with the living organisms and their environment, the simple and fundmental approach is to proceed from inorganic to organismic levels. This is called Ecosystem approach. An ecosystem is a system wherein the biotic community and the abiotic components in their environment interact with each other so as to function as a unified 'whole'. The term 'ecosystem' was first proposed by A.G. Tansley in 1935.

3.4.2. Structure and Function of Ecosystems

The various components of an ecosystem can be conveniently classified into two major categories: 1) Abiotic components and 2) Biotic components. All the non-living elements in all their states constitute the abiotic category, while all living organisms ranging from micro-organisms in the soil, water and air to large plants and animals form the biotic category.

Abiotic Components

Abiotic components can be recognised under three major classes:

i) Inorganic substances (like C, N. CO_2, H_2O etc.) involved in material cycles;

ii) Organic compounds (proteins, carbohydrates, lipids, humic substances etc.,) that link abiotic and biotic;

iii) Climate Regime, which includes temperature, light, humidity, precipitation and all other physical processes.

All these three classes of abiotic components will influence, and be influenced by most of the other abiotic factors and also by the biotic factors as well. However, their relationship and the importance will vary with the type of ecosystem and organism at the macrolevel and microlevel respectively.

Light, temperature and water (rainfall) are ecologically important factors on land; light, temperature and salinity are important in seas; oxygen is of major importance in freshwater systems. Some of these abiotic factors may act as 'limiting factors' and also as regulatory factors, as will be explained at a latter section of this unit.

Biotic Components

All living orgainsms form the biotic component of an ecosystem. This component also can be divided into three major classes:

i) **Producers**: Organisms which are able to manufacture food from simple inorganic substances are called 'autotrophs',

ii) **Macroconsumers**: Organisms, chiefly animals, which ingest other organisms or particulate organic matter are called 'phagotrophs'.

iii) **Microconsumers:** Organisms, mostly bacteria and fungi, which break down the complex compounds of dead protoplasms, and release inorganic nutrients that are usable by producers; and influence other biotic components of the ecosystem, are called 'saprotrophs' or 'osmotrophs'.

Apart from visualising the structure of an ecosystem into different components, the structure of an ecosystem needs to be considered from various angles if we are to understand the interplay of structure and function. The producer-consumer arrangement is another kind of structure called '**trophic structure'**, and each "food"level is known as a **trophic level.**

From the functional stand point, an ecosystem may be analysed in terms of various mechanisms of the processes. These include:

a) **Energy Circuits**: explains how energy is trapped initially by the system, and transfer among different hierarchial levels of the biotic community.

b) **Food Chains:** The linkages between 'to eat' and 'to be eaten' processes within the biotic community.

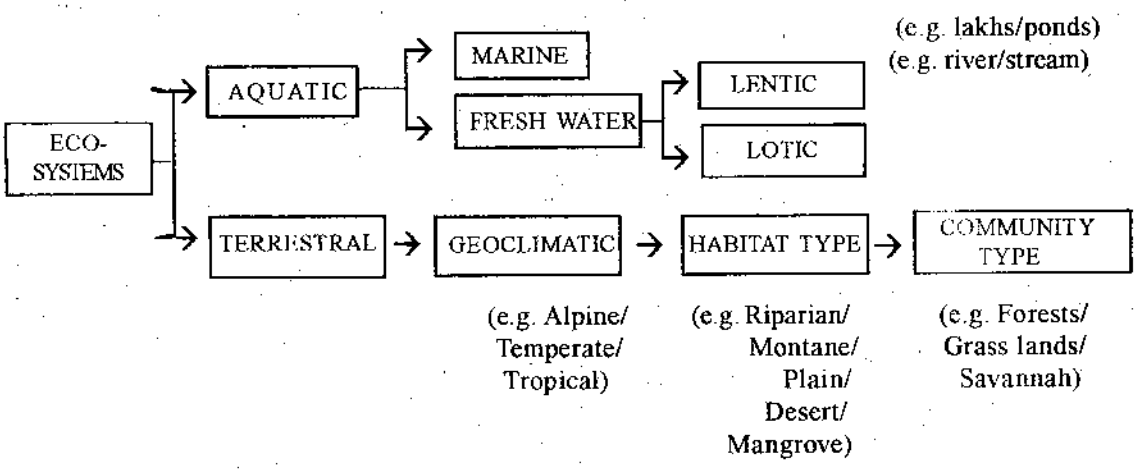
c) **Nutrient Cycles:** The behaviour of various nutrient elements, mostly inorganic, with regard to their cyclic movement within and among the different components of the ecosystem.

d) **Diversity Patterns in Time and Space**: How the composition of the biotic community and its complexity is changing in time and space.

e) **Development and Evolution**: How the ecosystem (with both the abiotic and biotic components) is developing and evolving to attain a steady state or to take a new course.

f) **Controls:** All factors, mostly belonging to abiotic, that either limit or regulate various processes and actions that take place in the ecosystem to ensure its stability.

The structure and function of an ecosystem can be better understood by examining a typical ecosystem. Major ecosystems of the world can be classified in different ways. The one which is more convenient and basic is given in next page :



3.4.3. Pond Ecosystem

Consider a pond ecosystem to examine its structure and function broadly. Since the major medium of this system is water, this ecosystem can be called as an aquatic ecosystem of lentic type.

Various physico-chemical conditions of water, such as pH, temperature, salinity, turbidity, hardness, dissolved oxygen, demands for biological and chemical oxygens etc., along with bathymetric conditions and climatic conditions, form the abiotic compartment of the ecosystem.

Phytoplankton and all other aquatic plants of the pond constitute the producers stratum. Zooplankton, and all other animals like aquatic insects, molluscs, fish, frogs, snakes etc., will form the macroconsumers stratum while, microorganisms like bacteria, fungi and of other groups which are of saprophytic type will form the microconsumers strata.

Producers, by photosynthesis, bring energy into the biotic community and initiate the energy flow and circuits. From producers, the energy flows through different food chains, while some is lost at each of the trophic level by way of consumption for respiration, metabolic and physical activities. Also some energy reaches the microconsumers from each of the trophic level through deaths at that level. Energy flow in an ecosystem is unidirectional and resemble with the food chain and ultimately with the food web.

Energy flow in an ecosystem has assumed increasing importance in the recent years and a separate branch, ecological energetics is now drawing the attention of the applied ecologists. A more detailed discussion on the energy transfer will be presented in a latter section of this unit.

3.4.4. Biogeochemical Cycles

Unlike the energy flow, which is unidirectional, all other transfers that take place between different compartments of the ecosystem are cyclic. These include, material flows of both organic and inorganic substances. The more or less circular paths of the chemical elements passing back and forth between organisms and environment are known as Biogeochemical cycles. For each cycle, at least two compartments or pools are recognised:

a) Reservoir Pool : the large, slow moving, generally in the abiotic state;

b) Cycling Pool: a smaller, but more active portion that is exchanging between organisms and their environment.

Biogeochemical cycles, generally fall into two types: Gaseous types, and sedimentary types. The former is the type in which the reservoir is in the atmosphere or hydrosphere. Sedimentary type is the one in which the reservoir is in the Earth's crust.

Two examples will suffice to illustrate the principle of cycling. The nitrogen cycle (Fig.3.1) is an example of a complex gaseous type cycle; and the phosphorus cycle (Fig.3.2) is an example for a simple sedimentary type.

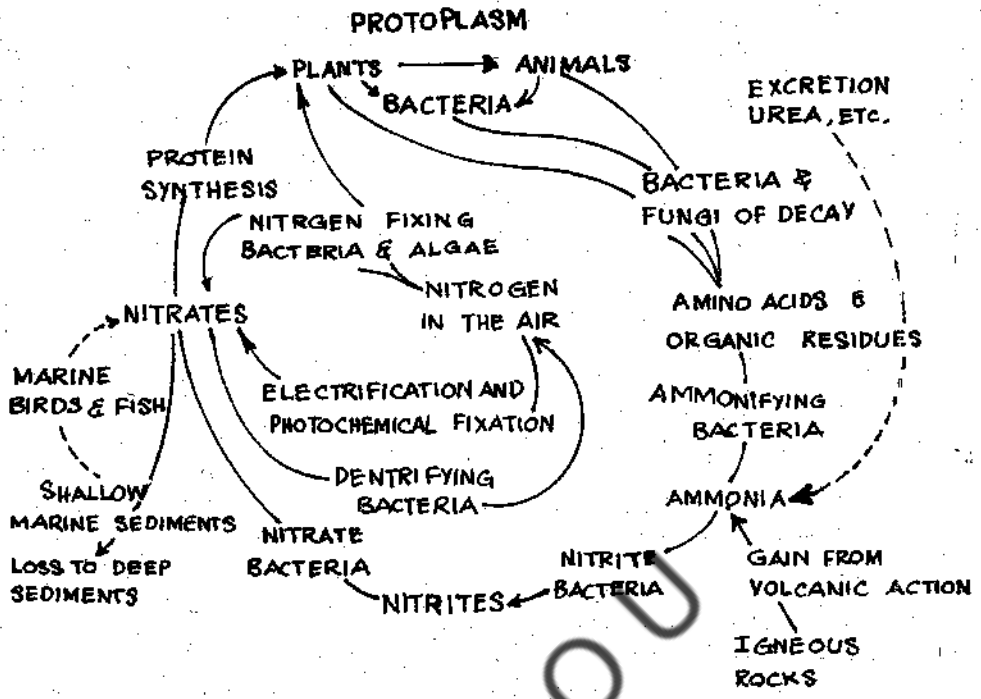


Fig. 3.1. Nitrogen Cycle

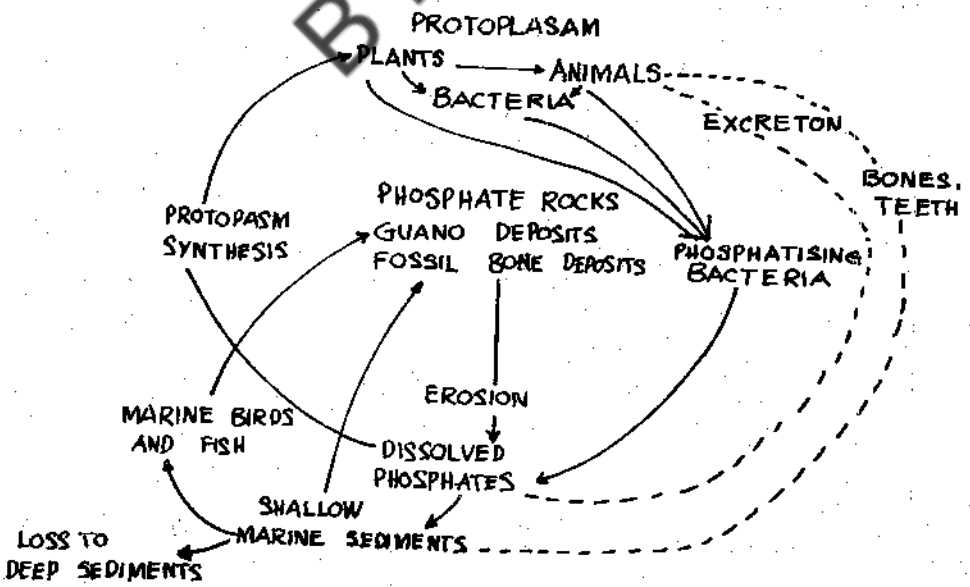


Fig. 3.2. Phosphorus Cycle

3.4.5. Limiting Factors

All interactions between different individuals and groups of organisms in the biotic compartment, and the flows of energy and material that occurs in an ecosystem are regulated or influenced by various environmental factors such as temperature. These factors, though are not directly involved in biological energy, or material transformations, but determine the "conditions" of existence for living organisms. Any such factor or condition that tends to slow down potential growth in an ecosystem is called a 'limiting factor'. In other words, any condition that approaches or exceeds the limit of tolerance for the organism or group in question, may be called a 'limiting factor'. For instance, milk that is stored in refrigerator cannot become curds, as the microbes responsible for the transformation have been limited by the temperature. Thus, temperature acts as a limiting factor in this example. This principle has became known as Liebig's "Law of the minimum". Similarly, if any nutrient required by a plant is in short supply or is not available for the plant, the nutrient may regulate the plant activities such as growth, reproduction, photosynthesis etc., inspite of the fact that all other resources are present in adequate quantities.

A closely related concept known as Shelford's "Law of Tolerance", extends the concept of limiting factors to limits of tolerance where the organism or group conditioned within a definite range of environmental factors. These factors will have both the upper and lower limits. If the performance of the organism or group is plotted against these important environmental variables, bell shaped curves usually result (Fig.3.3).

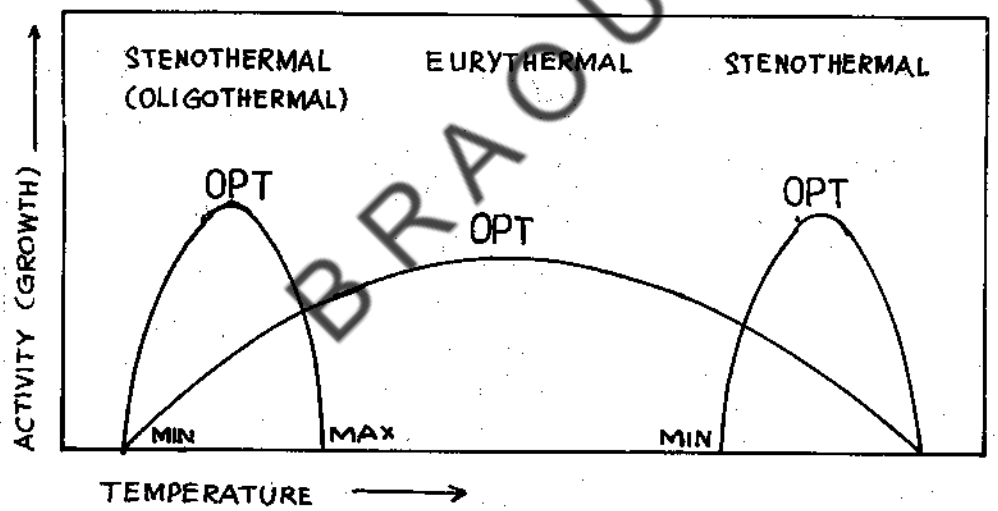


Fig. 3.3. Tolerance Curves

Check Your Progress-I

Define Ecology and Ecosystem.

Note : (A) Write your answer in the space given below.

(B) Compare your answer with the one given at the end of this unit.

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3.5. ENERGY TRANSPORT IN ECOSYSTEMS

The overall energy relations of an ecosystem are in accord with the first and second laws of thermodynamics. The first law of thermodynamics states that energy may be transformed from one type to another but is never created or destroyed. Energy is brought into the ecosystem by the producers (autotrophs) which receive the same from sun light and through a wonderful phenomenon called photosynthesis convert the solar energy into food energy.

The transfer of food energy from plants to other organisms in the ecosystem occurs through a series of stages of eating and being eaten, which is known as food chain. For example, in a grassland ecosystem we find one of the typical food chains as shown in Figure 3.4.

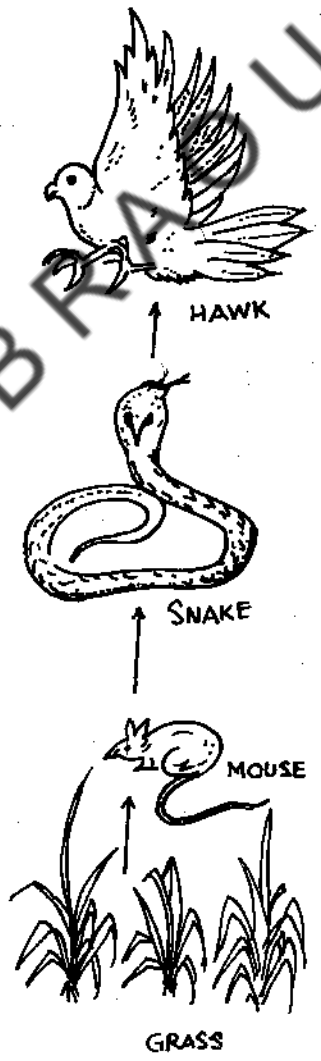

Fig. 3.4. A typical food chain (a grassland ecosystem)

In a complex natural community, all organisms whose food is obtained from plants by the same number of steps are considered to belong to the same trophic level. The food energy, that has been converted by plants from the solar energy is transferred from one trophic level to another in the same direction as in the food chain; from the first trophic level (the producers level) to the second trophic level (plant eaters or herbivores), to carnivores that eat the herbivores, the third trophic level (secondary consumers), and perhaps even to the fourth trophic level (tertiary consumers).

The second law of thermodynamics may be stated as "all processes of energy transformations will spontaneously involve degradation of the energy from a concentrated form into a dispersed form". So is the case with the energy transfer in the ecosystem. At each transfer of energy from one trophic level to another, a large part of the energy is degraded into heat. As shown in Fig.3.5 the energy flows are greatly reduced with each successive trophic level.

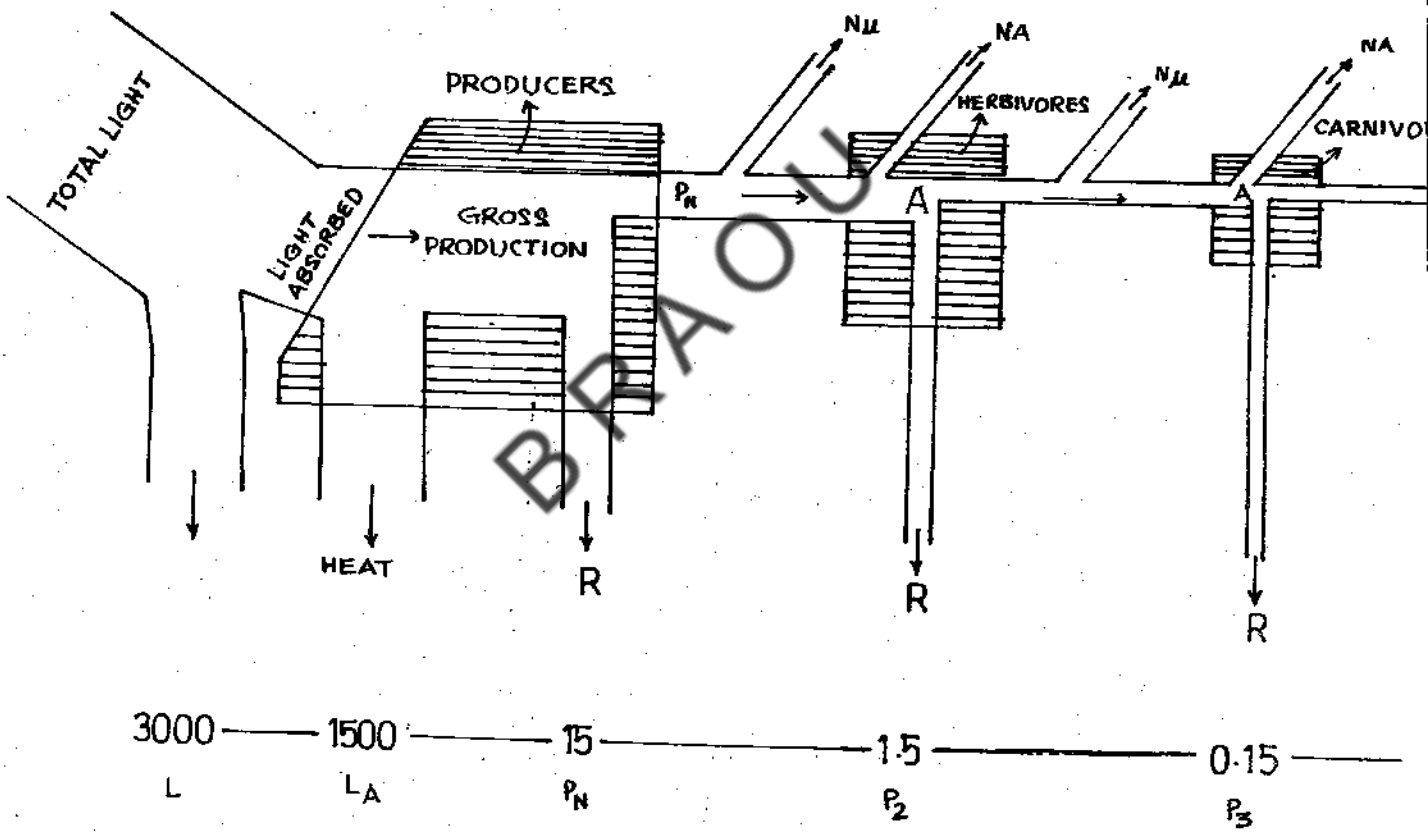

Fig. 3.5. Energy flow in an ecosystem

(figures in the lower margin indicates the order of magnitude expected at each sucessive transfer). L. Total light. LA. Light absorbed. R. Respiratory loss. Pn. Net production. A. Assimilated energy. NA. Nonassimated energy. Nu. Unused energy (export)

Because energy transfers are never 100% efficient; some is lost in converting prey tissue into predator tissue; some pass onto decomposers and reducers; some is expended on the activities of the self. Thus, the rate of energy flow through a given trophic level decreases with increasing trophic level. However, at equilibrium, all energy entered into the ecosystem, through primary producers, must exactly balance that leaving the entire system, and must be expended and dissipated back into space as heat.

A convenient means of expressing the energetic structure of a community is the pyramid of energy, which consists simply of the rate of energy flow between various trophic levels (Fig.3.6).

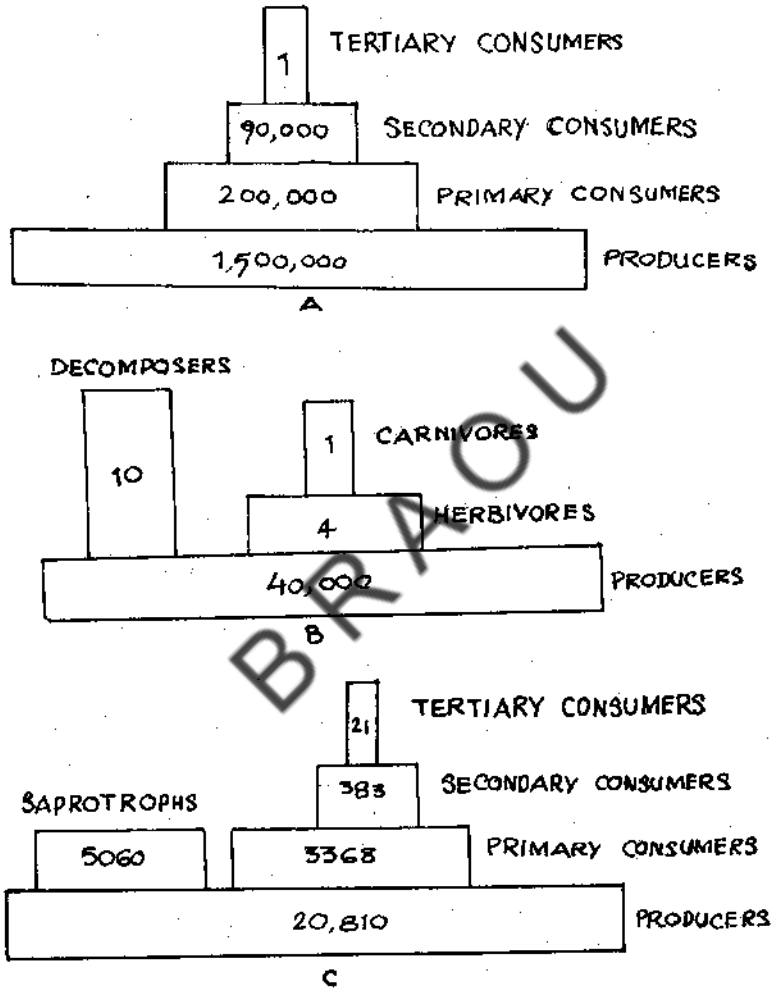

Fig. 3.6. Ecological Pyramids.

A. Pyramid of numbers. e.g., Temporate forests (individuals per 0.1 hectare). B. Pyramid of Biomass e.g., Tropical forests (grass dry weight per square meter) C. Pyramid of Energy. e.g., Silver springs (Energy flow ; K. Cal/M^2/year).

The other types of ecological pyramids are the "pyramid of numbers" and the "pyramid of biomass" The former consists of a set of the densities of individuals in each trophic level; while the latter, is the biomass (usually measured in grams dry weight) per unit area in each trophic level.

Check Your Progress-2

Describe how energy transfer in an ecosystem is in accord with the second law of thermodynamics.

Note: (A) Write your answer in the space given below.

(B) Compare your answer with the one given at the end of this unit.

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3.6. POPULATION ECOLOGY

The word 'population' has its origin in Latin, where populus means people, and is usually referred in conjunction with man. However, the term is now extensively used in ecology to refer any "group of individuals of the same species living in a particular time and space". Here, the same species is attributed to those which can transmit their genetic material to their offspring through sexual reproduction. Alternatively, a population may be defined as a cluster or individuals with a high probability of mating with each other and are potentially able to interbreed.

Population is often described as a self regulating system with a definite set of characteristics, irrespective of the species, habitat, ecosystem and its size. Some of these characteristics are to be studied in detail if one has to understand the status of the organism in its ecosystem.

All populations will have various characteristics which are unique possession of the group and are not characteristic of the individuals in the group. Some of the properties are: 1. Size, 2.Density, 3. Natality (birth rate), 4. Mortality (death rate), 5. Age distribution, 6. Biotic Potential, 7. Dispersal, 8. Growth form.

Apart from these, populations possess genetic characteristics also which are directly related to their ecology, namely adaptiveness, reproductive fitness and persistence. On the whole, population attributes can be considered in two categories: (1) those dealing with numerical relationships and structure; and (2) the general genetic properties.

3.6.1. Population Size and Density

Population size is generally expressed as the total number of individuals occupied a particular space. On the other hand, population density is described as the population size in relation to some unit space. Density is a useful measure to understand the magnitude of the population size.

For example, consider two farmyards, A and B, infested by an insect pest, the populations of which are almost similar in size at the two farmyards (A:4350 and B:4670). However, their densities have varied significantly. 'A' had a density of 435/ha while 'B' was with 47/ha. Although the population sizes are similar (nearly) at the two farms, the pest problem at 'A' was more intense as the density was nearly 10 times to that of 'B'. Thus, in a unit area, the damage caused by the insect pest was 10

times more at 'A' than in 'B' Thus, density is a useful measure to obtain a fairly good picture of the population.

3.6.2. Natality and Mortality

'Natality' is the inherent ability of a population to increase through births. On the other hand, 'Mortality' is more or less the antithesis of natality, and refers to the decrease in the population due to deaths. Natality rate is equivalent to birth rate, and mortality rate is equivalent to death rate.

Natality is generally expressed as a rate determined by dividing the number of new individuals produced by time:

$N_n/t = B$ (Absolute Natality).....(1)

in this, the rate is not related with the population size and will be of little scope. In the other way, natality is expressed as the number of individuals born per unit of time or unit of population:

$N_n/N\ t = b$ (Specific Natility).....(2)

Wherein N_n is production of new individuals in the population, N is the total population or only the reproductive part of the population; t is time.

Similarly, mortality also is expressed as a rate determined by dividing the number of deaths occurred during a particular period of time:

$N_m/t = M$ (Absolute Mortality)

or

$N_m/N\ t = m$ (Specific mortality)

This can be measured in the same way as natality is measured.

3.6.3. Age Distribution

The individual members of a population can be distributed into different age-classes. The size of the classes usually vary from one another and with time, sometimes even without any change in the population size. The distribution of individuals into different age-classes is called 'Age distribution' which influences both natality and mortality. The ratio of various age-groups in the population reflects the current reproductive status of the population. Usually, an expanding population will contain a large portion of young individuals; a declining population with a large proportion of old individuals and stationary population will have a more even distribution of age-classes.

3.6.4. Biotic Potential

When the environment is not exerting a limiting effect, the population grows exponentially. The rate of growth becomes constant and maximum. If the growth rate is expressed per individual, it is called specific growth rate. When a population has a stationary and stable age-distribution, the specific growth rate is called the "intrinsic rate of natural increase" or r_{max}. The maximum value of r is called 'Biotic Potential' or 'Reproductive Potential', which is defined as "the inherent property of an organism to reproduce, to survive, and to increase in numbers". This if more or less a theoritical concept based on the assumption, that if all factors in the environment supports (which is most unlikely), the reproductive power of the population will be maximal, and much greater than under natural conditions. The difference between the biotic potential and the actual rate of increase occured, is often taken as a measure of Environmental Resistance which is the sum total of environmental limiting factors' effects.

3.6.5. Growth Forms

If the size of a growing population is plotted against time, some characteristic patterns of increase can be recognised which are called population growth forms. Of these, two growth patterns are important which include J-shaped growth form, and the S-shaped or Sigmoid growth form.

In the J-shaped form, density increases rapidly in exponential or compound interest fashion, and then stops abruptly as environmental resistance or some other limiting factor becomes operative suddenly (Fig.3.6 A). In the sigmoid form, the population increases in three phases: In the first phase, positive acceleration phase, the increase will be slow; during the second phase, logarthmic phase, the increase will be rapid; and in the third phase, negative accelerating level is reached and maintained. The upper level beyond which no major increase can occur is called "carrying capacity" which is determined by the environment (Fig. 3.6.B).

3.6.6. Population Dispersal

Population dispersal is the movement of the individuals or their reproductive products into or out of the population or population area. Dispersal supplements natality and mortality in shaping the population growth form and density. Further, dispersal is the means by which new or depopulated areas are colonised and equilibrium diversity is established. It is also an important component in the gene flow and the process speciation.

Three basic forms of dispersal are recoginsed: Emigration, a one-way outward movement, wherein some individuals of the population will leave the population area; Immigration, a one-way inward movement, wherein some individuals of a different population will enter into the population area; Migration, periodic departure and return of some or all individuals of a population.

Population ecology has assumed increasing importance in the management of wildlife and also in the pest control operations. Modern ecologists are now developing population models to predict the behaviour or various populations in response to various changes in their environment.

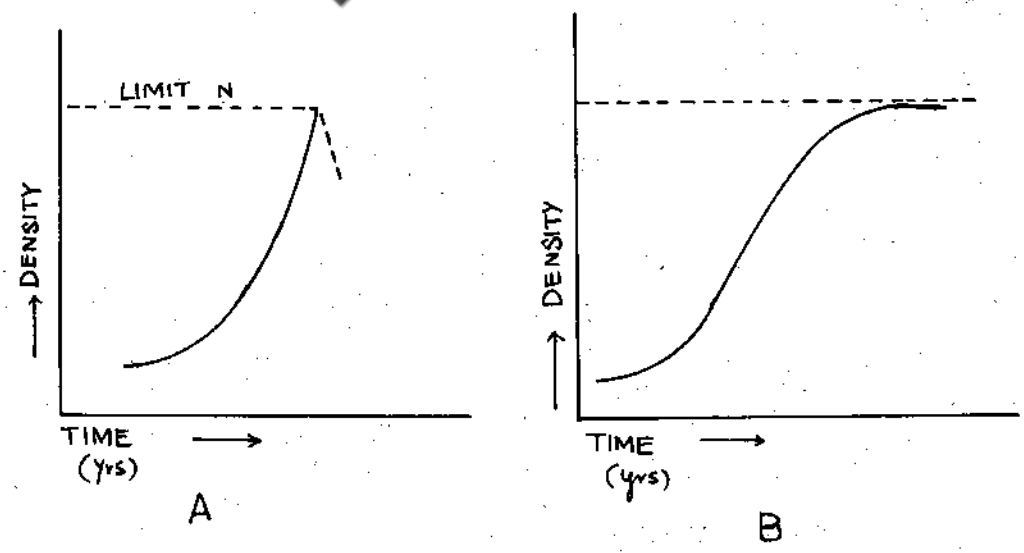

Fig. 3.7. Population growth curves

Check Your Progress - 3

Distinguish between 'J' and 'S' shaped population growth forms.

Note: (A) Write your answer in the space given below.

(B) Compare your answer with the one given at the end of this unit.

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3.7. COMMUNITY ECOLOGY

Several interacting populations of an ecosystem will make a **community** which is an organised unit to the extent that it has characteristics additional to its individuals and population components. The community concept is very important to environmentalists because, often the best way to "**control**" a particular organism, whether positively or negatively, is to modify its community, rather than to make a direct "attack" on the organism. Man's welfare, like that of any species, depends ultimately on the nature of the communities and ecosystems.

A **"biotic community"** is any assemblage of populations living in a prescribed area or physical habitat, and the term may be used to designate natural assemblages of various sizes ranging from the biota of a small ditch to that of a vast ocean. However, two types of natural communities are recognised based on their organisation:

1. **Major Communities** : Those communities which are sufficiently large in size and completeness of organisation, and are relatively independent of inputs and outputs from adjacent communities.

2. **Minor Communities** : Those communities which are more or less dependent on neighbouring assemblages, yet differentiated from the major community in one or more ways.

3.7.1. Ecological Dominance

All organisms in the community differ widely in their importance in determining the nature and function of the whole community. Relatively few species, or species groups are capable of exercising the major controlling influence by virtue of their numbers, size, production, or other activities. Species or species groups which largely control the energy flow and strongly affect the environment of all other species are known as **"ecological dominants".**

3.7.2. Community Analysis

No specific rules exist for naming the communities. But community names, like names of anything else, should be meaningful and convey a clear picture of it. The important practices in naming and

classifying the communities accord to

1) major structural features such as dominant species, life forms or indicators (e.g., Sal forest; Coral reeves etc.);
2) the physical habitat of the community (e.g., Tropical Rain Forest; pond community etc.,);
3) functional attributes, such as the type of community metabolism, or trophic level etc. (eg. Herbivore community; Parasitic community).

Community analysis deals with understanding the structure, function and development of a community with special reference to space and time. Within a given geographical region, two basic approaches are followed in analysing the communities:

1) Zonal approach — In this approach, discrete (non-overlapping) communities are recognised, classified and listed in a sort of check-list of community types.

2) Gradient Analysis Approach : In this approach, the arrangement of populations along a uni- or multi-dimensional environmental gradient or axis are studied along with recognising the communities based on their frequency distribution, similarity coeffecients and other statistical comparisons.

3.7.3. Species Diversity

Since complex communities, such as tropical rain forests, consists of many thousands of plant and animal species, where as other communities, such as tundra communities, supports perhaps only a few hundred species, it is important to understand why some communities have more and some with few. The number of species often varies greatly even at a local level. The number of species in a community is referred to as **"species richness"** or **"species density"**.

Community with similar species richness often differ in yet another way; the relative importance of their member species may vary. Species richness and relative importance have been combined in the concept of species diversity. Ratios between the number of species and importance values of individuals are called species diversity indices. The two major components of species diversity are (1) species richness, and (2) equitability. If the first one indicates the variety component, the second one delineates as to how equitably or evenly the species are distributed in the community.

3.7.4. Pattern in Community

The structure of a community that results from the distribution of organisms, and their interaction with environment is called **community pattern**. Many types of arrangements are known to contribute to pattern, of which the most important are:

1) Stratification Patterns: Patterns organised vertically;
2) Zonation Patterns: Patterns organised with horizontal seggregation;
3) Activity Patterns: Those differentiated by time of activity;
4) Food web Pattern: Those with net-work organisation in food chains;
5) Reproduction Pattern: Parent-offspring associations, plant clones etc.;
6) Social Patterns: Those organised in flocks and herds;
7) Coactive Patterns: Those resulted from competition, antibiosis etc.;
8) Stochastic Patterns: Those resulted from random forces.

To understand the functional aspects and various factors that govern the community organisation, Community pattern is to be understood and thus, it has a vital role in the management of the ecological communities.

Check Your Progress- 4

What is species diversity and what does it indicate?

Note: (A) Write your answer in the space given below.

(B) Compare your answer with the one given at the end of this unit.

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3.8. MARINE ECOLOGY

Life has first originated in sea. Inspite of the explorative technological advancements of man, a great bulk of the seas and oceans still remained largely mysterious. However, because of the key role of the seas and oceans in controlling the world's climates, the atmosphere, the functioning of major mineral cycles, and the mounting evidences in ecology, the study of seas has become a major concern for the ecologists.

Biologists have long been fascinated by the amazing variety of life to be found along the shores and among coral reeves. Yet, much of the sea is considered to be a semi-desert with entirely a different set of ecological conditions. The term 'marine ecology' emphasises the "totality or pattern of interrelationships between organisms and the marine environment".

3.8.1. Marine Environment

Seas and oceans occupy roughly 70% of the total surface of the Earth. Owing to its size and area, the ocean environment support various organisms while Life is much denser around the margins of the continents and islands. Unlike the terrestrial environment, ocean environment is continuous, not separated as land and fresh water habitats. Temperature, salinity and depth are the chief barriers to free movements of marine organisms. The important characteristics of the marine environment are given below.

Currents: The sea is in continuous circulation. Air temperature differences between poles and equator, set up strong winds, which together with the rotation of the Earth, create definite currents. Among the major surface currents of the world, noteworthy are the equatorial currents running east and west, and coastal currents running north and south.

Upwelling: An important process called **"upwelling"** occurs where winds consistently move surface waters away from precipitous coastal slopes, bringing to the surface cold water rich in nutrients which have been accumulating in the depths, Thus, the most productive marine areas are located in regions of upwelling which occur largely on western coasts, as was evident from the large fisheries, and large populations of sea birds in such regions.

Salinity: Salinity is another important parameter in marine ecology. The average salinity or salt content is 35 parts of salts by weight per 1000 parts of water. About 27% is sodium chloride and most of the rest consists of magnesium, calcium and potassium salts. Since the salts dissociates into

ions, the best way to picture the chemistry of the sea is as follows:

Positive ions		Negative ions	
(parts/thousand or grams/kilogram)			
Sodium	10.7	Chloride	19.3
Magnesium	1.3	Sulphate	2.7
Calcium	0.4	Bicarbonate	0.1
Potassium	0.4	Carbonate	0.007
		Bromide	0.07

Organisms of the open ocean are usually 'Stenohaline' (i.e. have narrow limits of tolerance to change in salinity)., whereas organisms of inshore brackish waters are generally 'Euryhaline'. Most marine organisms have an internal salt content, isotonic with sea water, and hence osmoregulation poses no problem except where salinity is subject to change.

Concentration of Dissolved Nutrients: The concentration of dissolved nutrients is low and constitutes an important limiting factor in determining the size of marine populations. Whereas the concentration of sodium chloride and other salts are measured in parts per thousand, nitrates, phosphates and other nutrients are so diluted that they are measured in parts per billion.

3.8.2. Marine Biota

The marine biota is so varied, coelenterates, sponges, echinoderms, annelids and various minor phyla are very important in the ecology of the sea. The bacteria, algae, crustacea and fish play a dominant role in aquatic environments, with diatoms, green flagellates and copepods being equally prominant. The variety of algae (Brown and Red algae being chiefly marine), crustacea, molluscs and fish is greater in sea. On the other hand, seed plants (spermatophytes) are of little importance in the sea, except for eel grass and a few other species in coastal waters. Insects are nearly absent, except in brackish water, and as such the crustaceans are called" 'insects of the sea".

Life in the sea environment can be divided into various components namely, plankton, nekton and the bethos. Plankton are the floating organisms whose movements are more or less dependent on currents; swimming organisms able to navigate at will are called nekton; an organisms attached or resting on the bottom, or living in the bottom sediments are called Benthos. An additional term 'pelagic' is widely used to include the plankton plus the nekton and the neuston (organisms resting or swimming on the surface), or all of the life in the open water.

3.8.3. Zonation

Two types of zonation classification are in wide use in marine ecology. The first one is based on the bathymetry of the sea, while the second one is determined by light penetration.

Generally a continental shelf extends for a distance offshore, beyond which the bottom drops off steeply as the continental slope then levels off before dropping down to a deeper plain. The shallow water zone on the continental shelf is **neretic zone**; the region of the continental slope and rise is the **bathyal zone;** and the region of the ocean deep plains is called **'abyssal zone'**, the world's largest ecological unit but an incomplete ecosystem.

The important vertical zonation is determined by light penetration into the sea. In this type also, three distinct zones are recognised. The upper thin 'Euphotic' zone (i.e. the producing zone) where light penetration is effective; the middle' compensation 'zone where photosynthesis just balances the respiration; and a lower, and vastly thicker 'Aphotic' zone where light penetration is meagre and respiration far exceeds the photosynthesis which is nearly absent with incresing depths (Fig 3.8).

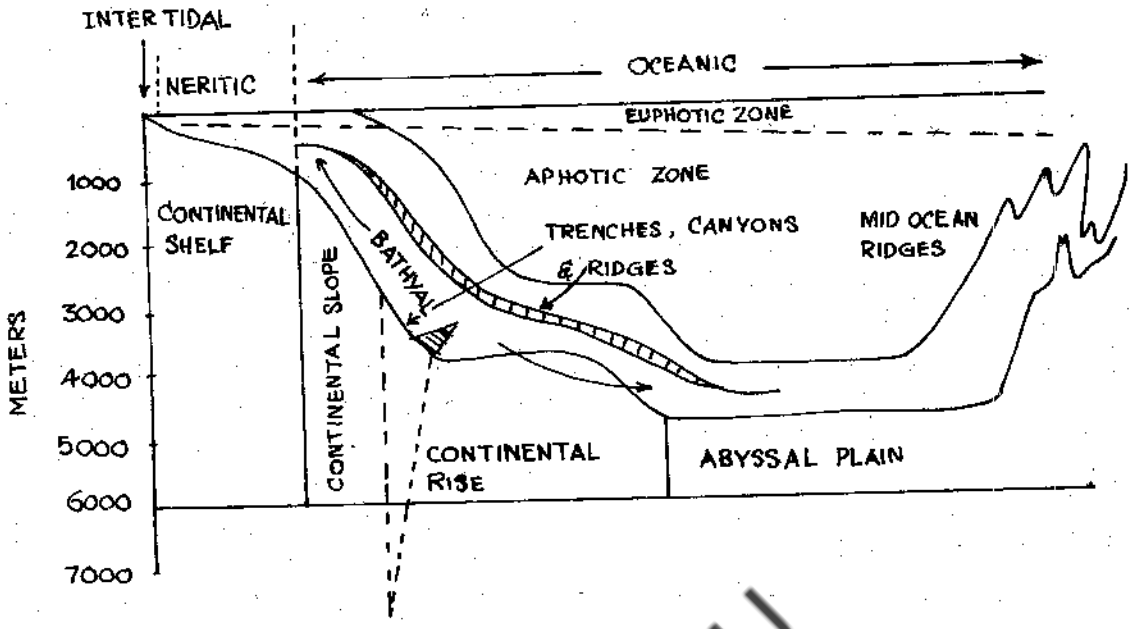

Fig. 3.8 Zonation in Marine Systems

Within these primary zones, well marked secondary zonation of both horizontal and vertical types is generally evident from the distribution of communities. Producer plants of the sea come in small packages, i.e., the microscopic phytoplankton, although large sea weeds are important in some coastal regions. High density of predators is a seemingly inconsistent feature of many ocean bottom communities. The highest primary productivity occurs in regions of cold-water upwelling and the great commercial fisheries of the world are almost entirely located in and around the continental shelf.

Check Your Progress - 5

How can ecological zonation be made in marine ecosystems ?

Note : (a) Write your answer in the space given below.

(b) Compare your answer with the one given at the end of this unit.

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3.9. GLOBAL COMMONS

Resources which are open to exploitation to all without restriction, and are held commonly are called "**commons**". The grazing lands around a village is a common to the herdsmen of the village and to those of the neighbouring villages. Similarly, a fishery, forest, or pond are all commons. We have such common resources at local, regional and global levels.

Garrett Hardin was among the first to articulate the alarming states of the global commons. He contended that the "commons" today is nothing less than the earth itself. Now, the world has variously recognised several commons for the entire planet, which are called 'Global Commons' and includes the earth's atmosphere, water, outer space, oceans and biological cycles.

Hardin points out that "freedom in commons brings ruin to us all". The present state of deteriorated grazing lands in the Indian countryside can be taken as the best example for this. Village grazing lands are open to exploitation to all herdsmen irrespective of the number of cattle they own. As long as the number of cattle did not overburden the regenerating capacity of the pasture, the resource contained its produce. However, the economy of the individual herdsmen depended upon the number of cattle they rear and market. Thus, most of the herdsmen tend to increase the size of their herds, and ultimately the total number of cattle using the pasture is prone to exceed beyond the carrying capacity of the land which results in the decimation of the resource. This forces the herdsmen to buy fodder for their cattle, or migrate, or to choose another profession.

The notion that 'commons' which are open to all without restriction, will ultimately be devastated in the stampede to exploit it in one's own interest, without regard to the common good, has been called "**The Tragedy of Commons**".

The Tragedy of Commons : Local tragedies of the commons can have global consequences. The world is now facing the challenge of devising international rules to govern the global commons. One of the difficult tasks is defining what parts of the planet fall into this category, and will be acceptable to all the nations. Some of the important global commons include Oceanic environment, Biodiversity, stratospheric Ozone layer and the land itself.

In oceans, overfishing has led to shrinking stocks and declining catches. Many developed and developing nations are discharging several types of wastes into the oceans and thereby contaminating them to the extent that they are no longer productive.

Deforestation threatens all ecological systems and undermines the fertility and stability of soils. Over the past 50 years, deforestation in the Indian subcontinent has resulted in :

a) the loss of soil's ability to absorb and hold water;
b) more frequent and more severe flooding;
c) decline in the precipitation; and
d) loss of biodiversity.

These in turn have contributed to serious inflation because of :

i) high use of fertilizers and pesticides;
ii) heavy investments on flood controls or drought relief;
iii) large imports of paper, and so on.

In the early eighties, strong evidence for Ozone depletion at the stratosphere was found. The environment and life of the earth is protected from the harmful ultraviolet (UV) radiation, by a thin gaseous layer made of Ozone and formed at the stratosphere. The existence of this delicate layer is now threatened with harmful aerosols released by man. The gaseous emissions involving chlorine- and bromine- containing industrial chemicals such as chlorofluorocarbons (CFCs) and halons, with their reactions have depleted the ozone causing holes in the layer through which UV radiation can

reach the earth.

The UV radiation can cause skin cancer, damage marine life, lower agricultural production, and damage the genetic quality and vigour. The use of these CFCs and other harmful aerosols though varies significantly from one continent to another, the impact on environment and mankind alike at all places.

Thus, the common use of common resources, is often associated with some inherent tragedies. The solution to the tragedy of commons is to limit the collective claim on common resources to sustainable level, and to find a just and enforceable way to judge claims.

3.10. SUMMARY

The term ecology was coined by Earnest Haeckel in 1869, and is defined as "the study of the relations between organisms and the totality of the physical and biological factors affecting them or being influenced by them'. As a subject, ecology has a history of around 100 years and evolved from the 'descriptive' natural history phase to an analytical and mathematical modelling phase.

Tansley, in 1935 has proposed the term 'Ecosystem' to refer the system wherein the living organisms and their abiotic environmental components interact so as to function as a unified 'whole'.

The structure of an ecosystem can be analysed by classifying and itemising the system's components. Fundamentally, all the components of an ecosystem can be recognised under two major categories; abiotic components and biotic components.

The major functional processes in the ecosystem include energy transfer, material cycling, control mechanisms and various changes that take place in the structure.

The overall energy relations of an ecosystem are in accord with the first and second Laws of thermodynamics. Energy enters into the system in the form of radiation energy, which is converted into food energy by the producers (plants). The food energy passes through different levels of the trophic, and at each stage significant amount of energy is expended or lost. At equilibrium all energy entered into the ecosystem must exactly balance with that of leaving the system.

A group of individuals with a high probability of reproductive potential, occupying a particular space in time is called "population". All populations will have various characteristics which are unique to the group and are not found with the individuals in the group. These group properties are called population attributes which reflect the state and function of a population in its ecosystem. The total number of individuals in a population is referred to as population `size' and if this number is expressed in relation to a unit area, it is called `density'. The birth rates and death rates are called natality and mortality, respectively. The way in which the individuals of a population are distributed into different age-classes is called `age distribution'.

The population is a dynamic system which changes with time depending upon various conditions in which it exists. Usually, an exponential form called 'J'-type and, a logistic called 'S'-type growth forms are prominent. The population growth rate through new births without any environmental resistance is called 'biotic potential'.

A group of interacting populations of an ecosystem is called a 'community'. Communities, large in size and independent of inputs and outputs are called major communities while those that are partly dependent on the neighbouring communities are called 'minor communities'. The species which largely control and contribute to the energy flow and state of environment, are known as ecological dominants. A community may be analysed following two major approaches :Zonal approach and Gradient Analysis approach. The ratios between the species densities and their relative importance indicate the diversity of the species in the community, while the structure of a community that results from the distribution of organisms in relation to environment is called community 'pattern'.

The study of marine ecosystem is called 'marine ecology'. The important characteristics of marine environment include, the physical processes like currents, upwelling of materials and nutrients, and chemical properties such as, salinity, concentration of dissolved nutrients etc. Marine organisms can be conveniently divided into plankton, nekton and the benthos, while the communities can be recognised based on the habitat zones which they occupy. Zonation in marine ecosystem is usually made based on either the biometry or the light penetration.

Resources which are open to exploitation to all without restriction, and are held commonly are called 'commons'. The world has recognised several commons for the entire planet which are called 'global commons'. The notion that commons which are open to all without restriction, will ultimately be devastated in the stampede to exploit it in one's own interest, without regard to the common good, has been called the 'tragedy of commons'. The solution to the tragedy of commons is to limit the collective claim on the common use of common resources to a sustainable level and to find a just and enforceable way to judge claims.

3.11. CHECK YOUR PROGRESS - MODEL ANSWERS

1. Ecology may be defined as "the study of the relationship between organisms and the totality of the physical and biological factors affecting them or influenced by them". An ecosystem can be defined as " a system wherein the biotic community and the abiotic components in their environment interact with each other so as to function as a unified 'whole'.
2. The second law of thermodynamics may be stated as "all processes of energy transformations will spontaneously involve degradation of the energy from a concentrated form into a dispersed form". So is the case with the energy transfer in the ecosystem. At each transfer of energy from one trophic level to another, a large part of the energy is expended or lost. The energy flow rate through a given trophic level decreases with increasing trophic level.
3. In the 'J'-shaped population growth form, population increases rapidly in exponential fashion and then stops abruptly. In the Sigmoid or 'S'-shaped population growth form, the population increases in three phases :1) Positive acceleration phase, in which the increase will be slow; 2)
4. Species richness and relative importance have been combined in the concept of species diversity. The two major components of the species diversity are species richness and equitability distribution of the species. If the first one indicates the variety component, the second one delineates as to how equitably or evenly the species are distributed in the community.
5. Based on the bathymetry, the sea can be divided into three zones ;

   The shallow water zone on the continental shelf is 'neretic zone'; the region of continental slope and rise is bathyal zone; and the region of ocean deep plains is called 'abyssal zone'.

   Based on the light penetration into the sea, three distinct zones are recognised. The upper 'Euphotic' zone, (i.e., producing zone), where the light penetration is effective; The middle 'compensation' zone where photosynthesis just balances the respiration; and a lower vastly thicker 'aphotic' zone, where the light penetration is meagre and respiration far exceeds the photosynthesis which is nearly absent.

3.12. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Define Ecosystem and delineate its structure and function.
2. Describe various population atributes and their role.
3. Give an account of energy transfer in ecosystems.

II. Answer the following questions in about 10 lines each

1. List out the abiotic components of an ecosystem you have studied.
2. Write briefly about Shelford's Law of Tolerance.
3. Write briefly about Pattern in communities.
4. Broadly classify the marine biota.
5. What is the "Tragedy of Commons" ?

Dr. K. Kameswara Rao

UNIT 4 : DEVELOPMENT AND ENVIRONMENT : INDIAN SCENARIO

Contents

4.1. OBJECTIVES

After completing this unit you will be able to :

* define development and list out various kinds of social and economic developments,
* explain how development is associated and influenced by the wealth of natural resources,
* list out various environmental issues that may arise from ill-planned use of resources, and
* describe sustainable development and how it resolves the conflicts between developmentalists and environmentalists.

4.2. INTRODUCTION

'Development' is the key word, more frequently used by every man, women and child, ranging from a school going kid to a head of the nation. We divide the world nations into groups based on their development-the developed, developing and underdeveloped countries. India, in spite of its long history, wisdom and resources, is still considered a developing country. On the other hand, the United States of America, which has a history of few hundred years, is one of the most developed countries, ruling the order of the day. The rational behind the classification of development is mostly based on (i) Productivity (ii) Per capita income and (iii) Standards of living, which in turn depend upon the technology, resources, population and several other factors.

However, for centuries the policy makers, economists and all others concerned with the processes of development have never tried to look at the other side of the coin of the development. For example, development in the field of health and medicine could effectively reduce the death rate by more than a half in less than 40 years, but could not reduce the population growth because of which all efforts in poverty alleviation have become insignificant. Development resulted from the discovery of nuclear energy has brought many evils of radiation, which effects even the future generations. Thus, it is high time that we review our concepts of development and discuss the challenges before us.

4.3. DEVELOPMENT

Development can be defined as the process that transforms a state of a body or a group or a system to a more advanced state-from good to better, and better to best. It could be the development of an individual of a community or a resource or anything that concerns with man and his environment are resources. For example, man has developed from a hunterer-food gatherer state to sophisticated agricultural state. A petty shopkeeper developed his business to a multimillion company. Likewise in every sphere we can envisage development. However, the process of development, if not cared for, will have devastating effects as we could realise from our recent experiences.

Till recently, development planners assumed that with rapid growth everyone would be better off-that more growth meant more for all. This approach to development has not only failed, but widened the gap between the rich and poor; the developed and the developing. This is mainly because of the neglect of distribution strategies. The remarkable achievements in production on one hand not been matched by improvements and distribution and on the other, threatening the continuity of using the resources base.

Technology and development are intimately related. From the age of Exploration until quite recently those countries that controlled technology have developed fast. The one who has the faster vehicle will move fast. The development in the transport system from a bullock cart to a super sonic jet plane can be cited as a best example. The irony of this development is, higher the mode of transport, greater our dependency on several resources.

The ultimate measures of development are : (i) Standards of living and (ii) Economic independence. Unfortunately, man with all his scientific and technological advancements, was indiscriminate in steering the development. Processes could not meet the human needs. In our world of more than 5 billion people :

* One in three children is malnourished.
* Some 1.2 billion people lack water safe to drink
* Nearly 3 million children die annually from diseases that could be averted by immunization.
* About 1 billion adults cannot read or write.
* More than 100 million children of primary school age are not in school.

This indicate that the actual development that has taken place in the world did not reach at least to two thirds of the people while a few privileged, are consuming a greater part of the production. It is reported that 20% of the population is responsible for consumption of 80% of the resources utilized. This failure in the equitable distribution exists - among different countries of the world; with in a country, among different people.

The second major evil of the so called development is the side effects of the over exploitation in the name of development. For example, it took many years of research and thousands of crores of rupees to bring on the 'green revolution', to meet the demands of ever growing population. After few years since then, now we realised the price we are paying today. The grain we eat may get poisoned with pesticides; the milk, contaminated; the soil, is turning barren as chemical fertilizers ravage the land; the genetic quality of the native varieties is eroded; and many others, of which we are still ignorant and yet to realise. Similarly the industrial revolution has polluted the atmosphere, the hydrosphere, land and soil; initiated rapid consumption of resources to exhaust or endanger them and so on. A glimpse of the environmental trends underway;

* The protective ozone shield in heavily populated latitudes of the northern hemisphere is thinning twice as fast as scientists thought a few years ago;
* A minimum of 140 plant and animal species are condemned to extinction each day;
* Atmospheric levels of heat trapping carbon dioxide are now 26% higher than the preindustrial

concentration, and continue to climb;

* The earth's surface was warmer in 1990s than in any other decade since record-keeping began in the mid-nineteenth century;
* Seventeen million hectares of forests are vanishing every year, an area equallant to the size of Bihar State.
* World population is growing by 92 million people annually, roughly equal to adding another Bihar population every year.

Eliminating these threats to our future requires a fundemental restructuring of many elements of society and practice of conservational strategies on war footing.

Check Your Progress -1

Define development and state the ultimate measures of development.

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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4.4. DEVELOPMENT VERSUS CONSERVATION

The earth's biological system form the foundations of the global economic system. In addition to food, biological systems provide virtually all the raw materials for industry, except mineral and petroleum-derived synthetics. A carefull reading of the signals indicates that pressures on the earth's principal biological systems and energy resources are mounting seriously. Stress is evident in each of the four principal biological systems - oceanic fisheries, grasslands, forests, and crop lands. Except for croplands, all are essentially natural systems little modified by men.

The rising aspirations of five billion people exert great pressure on these biological systems, often exceeding nature's long-term carrying capacity. The productivity of scores of oceanic fisheries is falling as the catch exceeds their regenerative capacity. Forests are shrinking before the onslaught of the firewood gatherer, the land hungry farmer, and international timber interests. As the number of cattle, water buffalo, sheep, goats and camels increase apace with human populations, the earth's grasslands are being over taxed. Denudation, soil erosion, and desert encroachment result. Fallow cycles in crop lands everywhere are shortening and farmers seeking land are being forced to occupy steeply sloping hillsides and onto less fertile soils.

The deterioration of biological systems and their ecology, through human abuse is not new. What is new today is the scale and speed at which the resources are being impaired and destroyed. The adjustments we must now make in consumption patterns, in population policy, and in the economic system through adequate conservational strategies.

Conservation can be defined as wise use. Dr. Sarvepalli Radhakrishnan the former philospher - President of India, once remarked that 'man had learnt to fly in air, to swim in the water but had not

yet learnt to live on the earth. This essentially means to live in harmony with nature, to pass on the natural heritage to the future generations. These are the fundemental principles of conservation. Unfortunately, our approach to conservation is different and can be best illustrated by our approach to forest conservation. We speak of afforestation. But, ironically, while large scale deforestation continues unabated in the forests, we celebrate afforestation programmes in towns and cities, in school and office campuses.

In the year 1973, American housewives have boycotted beef protesting the high beef prices. A TV interviewer made a survey and asked the housewives to explain who caused the high beef prices that they were protesting. They didn't have a clear idea, and what never occurred to these protesters was that they might somehow be responsible. As parents, they had contributed to 63% increase in the country's population since 1940. As consumers, they had more than doubled their per-capita consumption of beef from 25 kg/year in 1940 to 52 kg/year in 1972. Together, these two factors increased national beef consumption by 342 percent in a generation. So is the case with every item and resource. The consumption patterns of the individuals, the growth pattern of their numbers and the policies of the governments will govern the state and development of the resources and environment.

Thus, the first step in the conservation programmes should be to stabilise the population. This helps in setting the limits for the utilisation of the resources within their carrying capacities. All development should be planned according to the set limits for utilisation, and strategies developed for equitable distribution of what is avilable.

Thus, development and conservation should go hand in hand with careful planning by optimising the needs that are just. Many developmental activities which have ignored the aspects of conservation are now creating ecological stresses and resource scarcities.

Check Your Progress - 2

What are the earth's principal biological systems ?

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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4.5. ENVIRONMENTALISTS VERSUS DEVELOPMENTALISTS

The above title sounds as if environmentalists are against development. This misconception is a result of the fact that environmentalists oppose overzealous and shortsighted over exploitation of resources in the name of development. Overexploitation is "unplanned utilisation of resources beyond their regenerative capacities". For example, consider two persons A and B, provided with a definite quantum of money (resource). The same resource can be utilised in atleast two different ways. One person, say A, may bring comforts and pleasure to him by utilising the entire quantity, with no or little concern for the next generation, making their sustainance difficult. On the other hand, the other person, B, may use a part of the money for his generation and pass on a sufficient part to the next generation to ensure it's sustainance. The former is a typical example of overexploitation where a generation enjoys comforts at the cost of future generations. Such exploitation of natural resources

debilitates the life sustaining environment. Environmentalists welcome judicious use of resources, as in the later case, where the benefits of development pass on to future generations. Such planned use of resources, within the limits of regenerative capacity, is known as sustainable developement. Environmentalists advocate the need for prudent utilisation and conservation of the Earth's and its environments natural wealth.

Controversy has surrounded several major developmental and infrastructure projects - whether they be dams, roads or railway lines. Environmentalists have opposed such plans, not because they are against development, but due to the absence of environmental consciousness in the decision-making processes in the plans. Another kind of environmental controversy centres around the misuse of ecologically fragile areas like wetlands and mangrove swamps. A retrospection of the perceived conflict between environmentalists and development will indicate they are not against development but oppose only the inherent high environmental and social costs.

4.6. DEVELOPMENT AND ENVIRONMENTAL ISSUES

Development is essential. But not at the cost of the survival. True development is that which ensures the fruits to an infinite number of generations to come. Thus, it is essential that we review some of the major developmental activities and the environmental issues associated with them.

4.6.1. Sprawling Urbanisation

Urbanisation is said to be a quiet revolution taking place in developing countries like India. It is estimated that by 2015A.D. 50% of India's population would be living in urban areas compared to the 27% at present. Urbanisation while having a positive impact on income levels, employment and production economics has brought with it many problems including shortage of housing, inadequate water supply, sanitation and waste disposal facilities as well as unsafe social environment. Over crowding, pollution and disease stretched to breaking point - the classic urban nightmare is already staring in the face of millions living in Indian cities. Plans to divert the inevitable flow of rural migrants from these overstrained industries has resulted in the haphazard development is because the cities have reached saturation points and are unable to cope with the increasing pressure on their infrastructure. Environmentalists critisize the lack of foresight and will to usher in changes in plans which could have obviated the present crisis. They advocate that it is imperative to take up city planning with a rigorous analysis of the assimilative and supportive capacities of the environment.

4.6.2 Controversial Dams

(a) **Sardar Sarovar Project (SSP)** : The entire project envisages 30 major, 135 medium and 3000 minor dams on the Narmada river which flows through Maharastra, Madhya Pradesh and Gujarat. It envisages an irrigation component for 187 lakh ha and 1450 MW power. The project has been opposed by environmentalists like the Narmada Bachao Andolan (NBA) because it will result in the submergence of 39,134 ha of land of which 13,744 ha is forest and 11,318 ha is agricultural land. It will also displace 1,50,000 people. At the centre of dispute from the inception of the project are the lack of master plan for the resettlement and rehabilitation of the environmental refugees and potential detrimental impacts on the environment. The inadequacy of planning in the project was evident from the critical comments made by Morse committee which found the project to be lacking in meeting the environmental considerations.

(b) **Tehri dam** : The proposed dam construction across the river Bhagirathi, popular as 'Tehri Dam' envisages to produce 6000 million units of power and to irrigate 2,70,000 ha of land. Environmentalists have opposed the construction because of the high social and environmental costs inherent in the project, which once completed would repeatedly displace about 80,000 people and submerge 4,000 ha of land; may cause earthquakes in the Tehri region in particular

and in North India in general. Some environmentalists suggest that, an effective alternative to this major dam is to have a number of miniature dams at various strategic sites, thus, the impact could be reduced to the minimal levels.

4.6.3. Transport Sector

(a) **Konkan Railway :** The Konkan railway project (KRP) has been mired in controversy for the past few years. The project is a rail line along the West coast covering 760 km strech from Roha in Maharastra to Mangalore in Karnataka running through Goa. The main dispute is over the route the track takes between Mayem and Bali, a distance of 54 km. The rail line is to pass through the Mandovi - Zuari Estuaries Ecosystem, Khazan lands, the Carambolin lake - which is a notified wetland - and the archaeological and heritage sites like old Goa. Environmentalists, taking from the experience of the West coast highway, which also passes through these tracts, suggested the realignment of the railway track. The reasons were simple and straight. When the west coast highway as laid over a decade ago, there was little awareness of the possible consequences of development. Now it is realised that the disruption in the tidal circulation, the water stagnation and the outbreak of Japanese encephalitis in the region are all irrevokable damages done to the system. Thus, the environmentalists suggest that by laying the railway track along the same route is not justified and will further deteriorate the fragile ecosystems of the region.

(b) **Vehicular Pollution :** With the increasing urbanisation and commercial activities in the urban areas, the transport demand has also consequently increased. the vehicular population in India has increased from 11 million in 1986 to more than 21 million in 1991. Seventy percent of these were two and three-wheelers. the consumption of gasoline and diesel by the road transport sector has increased from 1.5 and 7.2 million tonnes, respectively in 1980-81 to 3.5 and 14.8 million tones in 1994. Because of the relatively low quality of fuel, types of engines used, age of vehicles, congested traffic, poor road conditions and outdated automotive technology, in majority of the cities, the transport sector contribute to the air pollution, even at levels higher than the industrial sector. Thus, the side effects yielded by the transport sector development are serious air pollution and the consequent health problems. At Visakhapatnam, one in seven suffers from some degree of respiratory problem.

Check Your Progress - 3

List out various environmental problems associated with urban development.

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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4.7. ENVIRONMENTAL MOVEMENTS IN INDIA

The environmental implications associated with the developmental activities, very often are not recognised when the activity is started. But once the possible consequences are experienced by the people, they become more aware and protest. If the planners and proposers of the activity lend a deaf ear, the protest will gradually evolve into a movement.

One of the biologically richest tropical trainforests of the world, existing in Kerala in the name of Silent Valley, was threatened by a Hydel reservoir and power project. At the intial stages, both the State and the Central governments have ignored seriously to consider the protests of the people opposing the activity. Later, scientists from many parts of the country and abroad, have participated in the postal campaign, to convince the governments. The movement has received wide support from all quarters. The world's renowned ornithoogist, Padmabushan Dr. Salim Ali, has personally written to the then Prime Minister, Smt. Indira Gandi opposing the activity in silent valley, Finally, the project was discontinued by the governments, honouring the public opinion and the movement.

Another movement which India can boast of is'Chipko Andolan" about which the following was written at one of the exhibitings organised in conjuction with the World Environment Day at Stockholm. "A powerful environmental movement has grown up on the slopes of mountians of Himalayas. Villagers have created an efective non - violent way to stop the devastation by forest industries when the axe-man comes, the people from ring (circle) around the trees they embrace the trees. This has given the movement its name Chipko Andolan - the tree hugging movement.

Experienced by the sufferings from land slides, eroded soil, high floods and other adversaries resulted from destruction of the forests, the illiterate tribal women commenced to unitedly protest the tree-felling in December, 1972, at Advani village, Tehri - gharwal district of Uttar Pradesh. The women faced police firing in the year 1978, from when the movement was intensified under the leadershop of Shri Sunderlal Bahuguna, who says that the movement is for protection of soil and water through ban on tree-felling in the Himalayas. The chipko's plan is to plan five Fs *viz.*,Food, fodder, fuel, fibre and fertilizer producing trees that make the communities self-sufficient in all their basic needs.

As part of this movement a 3000 km march from Srinagar (Kashmir) to Siliguri was organised to bringout awareness among the people and the government. Finally, the movement was successful in protecting the tree cover of this region.

Infected by the success of Chipko-Andolan at Himalayan region, village belt of salkam, of Sirsi taluk in North Kanara district of Karnataka have initiated "appiko" movement in September, 1983. Several Yuvak Mardalis of the region earned sucessfully drew the attention and support from all quarters and stopped tree felling in the region. Among other important Environmental movements which are still alive and yet to succeed 'Narmada Bachao Andolan' aganist the Sardar Sarovar Project, and the one against the Tehri Dam, again initiated by Shri Sunderlal Bahuguna.

4.8. SUSTAINABLE DEVELOPMENT

The need for development is never disputed by environmentalists, they have emphasised that all developmental projects should incorporate environmental and social concerns in the process of planning and design. Carefully guided development can sustain for a long time than the conventional approaches which often resulted negative effects on other fronts.

Development by building an environmentally sustainable future is called 'sustainable development'. It is seeing ourselves as a part of nature rather than apart from nature. It is to ensure the future habitability of the planet by regulating the current distribution of wealth. Above all it is development without destruction- an economy in which future growth is not compromised by that of the present.

Sustainable development primarily deals with the interaction of economic policies, growth and environment, besides a plethora of other considerations which include equity, gender, education, civil rights, culture and other aspects of human development.

Until recently, economists and development planners were in the view that growth and sustainability can never go hand in hand. The relationship assumed why "more growth means more pollution and antipollution objectives imply that growth should be restricted. However, Grossman (1994) found that economic growth does not always contribute to degradation of the environment and argued that changes in the composition of output towards more environment friendly methods of productions can more than compensate for the levels of economic activity.

The traditional schemes of economic analysis of environmental impacts were principally associated with the adoption of cost-benefit analysis, which captures direct effects of investments on a defined population. The concept of sustainable development advocates that the cost-benefit analysis may be extended to account for environmental externalities by the imaginative integration of non-market impacts.

The concept of sustainable development point out the failure of current estimates of net nation product (NNP) to measure and deduct and depreciation of environmental resources and suggests the development of methodology for the purpose. The recent experiences indicates that the private profits attributed to activities that degrade the environment the higher than the social profits they generate.

Economist and environmentalist all over the world are now carry out different kinds of research and investigations to bringout a compromise between growth and sustainability. However, careful use of resources by the people and the governments is a prerequisite, before the sustainable development bringout another revolution, compared to that of Green revolution and industrial revolution. The pace of this revolution will be for faster than that of its predecessors. The Agricultural Revolution began some 10,000 years ago and there industrial revolution has been underway for two centuries. But if the sustainability revolution is to be a success, it must be compressed into a few decades.

Check Your Progress - 4

What is sustainable development ?

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with an one given at the end of this unit.

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4.9. SUMMARY

The world nations were divided into three groups, *viz.*, developed, developing and underdeveloped, based on their productivity, percapita income and standards of living. Development is a process that transforms a system to a more advanced state- from good to better, and better to best. Earlier, planners assumed that with rapid growth (development) everyone would be better off. This approach has failed and widened the gap between the rich and the poor; the developed and the developing. A plethora of facts indicate that the benefits of development did not reach to at least a two thirds of the world population. It has brought with it major evils like inequitable distribution of resources and

several side effects such as environmental pollution, deforestation etc.

The pressures on the earth's principal biological systems- Oceanic fisheries, grass lands, forests and croplands are mounting.

To eliminate these threats a fundamental restructuring of society and practice of conservational strategies are essential. Conservation is defined as wise use. The fundamental principle in conservation is to live in harmony with nature and to pass on the natural heritage to future generations. Stabilisation of population, and developing strategies for equitable distribution of what is available are the two important steps in conservation programmes.

Environmentalists advocate planned use of resources within the regenerating capacities, which ensures sustainable development. Urbanisation beyond supportive and assimilative capacities, has resulted in shortage of housing, inadequate water supply, air pollution and waste disposal problems.

Multipurpose dams like the Tehri and Sardar Sarovar projects have submerged large areas of forests and cultivable lands and have created several thousands of development refugees, KONKAN railway project which runs through ecologically fragile areas like Mandovi-Zuari estuary will deteriorate a chain of ecosystems in the region.

4.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Development can be defined as "the process that transforms a state of a body, or a group, or a system to a more advanced state - from good to better, and better to best".
2. The four principal biological systems of the earth includes : (i) Oceanic fisheries, (ii) grass lands, (iii) forests and (iv) croplands. Except croplands all are essentially natural systems little modified by man.
3. Unplanned urbanisation has attracted immigration and resulted in overcrowding of the centres. This has led to several problems like scracity of water, over burdening of sanitary facilities, lack of proper waste disposal mechanisms and other shortage of infrastructural facilities. The increase in the vehicular population and industrialisation have contaminated the air, waters and soils of the urban system.
4. Sustainable development can be defined as the "development through building environmentally sustainable future". It is to ensure the future habitability of the planet by regulating the current distribution of wealth.

4.11. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Define sustainable development and discuss how the traditional schemes of economic analysis have failed in measuring the environmental impacts.
2. Describe the importance of the earth's biological systems in global economy and discuss why conservation of natural resources is essential .

II. Answer the following questions in about 10 lines each.

1. What is the main stand of environmentalists on development ?
2. Describe 'Chipko Movement '
3. Provide evidences to prove that the present development has not reached majority.

Dr. K. Kameswara Rao

UNIT - 5 :DEVELOPMENT AND ENVIRONMENT : GLOBAL SCENARIO

Contents

5.1. OBJECTIVES

After completing this unit, you will be able to:

* describe the global environmental issues,
* explain the economic and resource divide between the northern and southern hemisphere,
* describe and how the politics of developed nations play a dictating role in the developing and underdeveloping countries and also the impact of developed nations to do so, and
* describe the different international agreements made to deal with the environmental problems on a global basis.

5.2. INTRODUCTION

Throughout human history struggles over access to and control over natural resources like land, water, energy and minerals have been the root cause of tensions and armed conflict. Such disputes further resulted in destruction and degradation of precious natural reousrces. The recent conflict between Iraq and Iran and the Gulf War, are contemporary examples of vast destruction and degradation of the earth's atmosphere with wide ranging ramifications elsewhere in the world. Such a scenario should spur instant concern in the minds of the environmentalists across the world towards creating a global scenario that precludes the recurrence of similar holocausts in future.

5.3. GLOBAL ENVIRONMENTAL ISSUES

The oceans, the forests especially the tropical forests and the atmosphere do not belong to any single nation or territory. The sum total of these factors are termed the environment which rightly belong to the whole world. Any depletion or imbalance of these components that make up the global environment in one part of the world is bound to affect the rest of the world in the long run. Hence, environmental issues are viewed as global rather than national and regional. Though such a realisation has dawned on the world community quite late, it is heartening that efforts are being made in the right direction through global cooperation to protect, preserve and augment the natural resources of the earth of late. The World Environment Summit held at Stockholm in 1972 was the first among such efforts.

Today the depleting ozone layer, the green house effect resulting in sharp rise in temperatures, oceanic pollution due to frequent fires in oil tankers and oilwell blowouts cannot be controlled at the national or regional level. Even the rich and advanced industrialised nations are also depending on international cooperation in so far as the environmental issues are concerned. Hence, the necessity to have a global vision on environment. Just as it will be difficult for a house owner to keep his premises clean without developing an awareness about the importance of clean surroundings among the entire community. On the same analogy the rich nations are totally dependent on the rest for a sustainable earth and the cooperation of every country is a sine qua non for such a state of affairs.

The global perspective is also relevant in finding solutions in one part of the world based on the perceptions and experiences of those in other parts. Still another aspect of the global nature of environment is the sharing of resources which requires all the parties concerned to understand and follow sustainable ways of utilising common resources. For example, the river Ganges is shared by India and Bangladesh, while the Meong river flows through four States : Kampuchia, Laos, Thailand and Vietnam. Famous Rivers Euphrates and Tigris are shared by Iraq, Iran, Syria, and Turkey. Similarly, France, the Netherlands, Switzerland and Germany have a claim on the river Rhine. Throughout the world there are so many resources that have common users. The space-age science explorations also have a multinational cooperation, as we often see, space scientists belonging to different nations participating in a single exploration. Such a partnership extending over several nations needs a global vision if amicable solutions are to be found to the larger environmental issues.

Check your progress - 1

Why should we deal with environmental issues globally.

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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5.4. THE NORTH-SOUTH DIVIDE

The north of globe comprises more prosperous nations of the world incidentally or accidentally as against the sourthern hemisphere which houses the less fortunate part of humanity in general. The northern countries have in general had set their houses in order in terms of literacy and durable living standards as well as sustainable life styles. The high literacy, low population density and the resultant favourable ratio between people and resources put these countries in a comfortable position. Density and low personal incomes exposes the south to economic and environmental degradation. This economic and resources divide between the North and the South has been the major irritant in International efforts at achieving sustainablility of global resources. While entering into economic and commercial agreements the North with their inherent advantages tend to force the nations in South to agree to terms that are detrimental to their own interests at times. Waste materials and hazardous chemicals that are proved to be injurious in their own countries are also being exported to

poorer south-nations which lag much behind in technology and science.

Check Your Progress - 2

What are the differences between Northern and Southern hemisphere ?

Note : a) write the answer in the space provided below.

b) compare your answer with the one given at the end of this unit.

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5.5. POLITICS OF DEVELOPMENT

On the basis of development, the world nations are again classified into the developed, developing and the underdeveloped countries. The last category of nations are also termed the third world nations. The developed and industrial nations constitute the bulk consumers of world resources like power, foods and fuel. While in terms of populations they form a fourth of the one inhabiting the globe, they consume as much as 75% of the global resources putting the teeming milions in the other part of the world in jeopardy. Due to their superior military power, these powerful countries are in a position to dictate their terms to the less fortunate ones. The United Nations Organisation (UNO) has been making many efforts through the world fora to have an equitable distribution of the world resources to the extent possible. But such a situation is easier said than created, given the imbalances and tensions plaguing the smaller nations.

The culture of the Multinational Corporations goes against the less developed countries since these corporations in short called MNCs have started opening their manufacturing sites in under-developed countries that might pollute and aggravate the environmental imbalance in the surroundings, leaving the richer countries intact. The trade in timber, pump and newsprint also is heavily loaded against the interests of the less developed countries due to their economic necessity of procuring precious Dollars through export of such commodities that deplete their biodiversity and forest cover. Export of petroleum and the exploration of oil are also subjects that often put the underdeveloped countries in a loosing bargain due to lack of advanced technology and personnel.

Check Your Progress - 3

What is the reason for the developed countries politicising a relatioship with developing and underdeveloped countries.

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end.

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5.6. DEVELOPING COUNTRIES

Most of the nations coming under this classification have a disproportionate resource base as compared to the populations they are required to support. Added to this malady are the lack of literacy and social awareness that impinge badly on the capacity of people to nurture and protect the existing resoource base. Thus the developing countries have a dual disadvantage of depletion of existing natural resources on one hand and the destruction of long term resources like water bodies, pastures and mountains which are required to be nurtured with care taking into consideration the requirement of the future generations. Every nation including the developing ones are in desperate need of growth in order to meet the basic needs essential for life of the teeming millions. Such growth when resorted without proper care for the long term effects on the resource base would naturally result in alternation of the environmental fabric profoundly with harmful side effects on the ecosystem, unless the strategy is aimed at protecting the resource base with an eye on sustainability.

As it is often said, beggars are no choosers; a country that is in dire need of employment and foreign exchange to equip its industry and modernising its agriculture and the tertiary sector will have to sell or export whatever it has in plenty irrespective of its impact on the ecosystem. History is replete with such examples of the mismanagement of environmental resources, be it a forest, land or coast. Another feature that is peculiar to many developing countries is the proportion of landmass to people making land the most misused resource. To cater to the urban and rural dwellings, growing industry, commerce and entertainment, vast tracts of natural forests are cleared due to pressure of population. While governments in these countries continue to encroach more and more on forest land for commercial and agricultural purposes the illiterate masses destroy the remaining forest cover through indiscriminate felling and careless handling resulting in frequent fires decimating thousands of hectares of the forest. The poaching by the illiterate and the unscrupulous like-wise result in destruction of wild life. Lack of adequate energy resources leads the people to depend entirely on plants for energy. The national and individual greed are at the root of environmental mismanagement in developing countries. Thus, it is of utmost importance to assess the potential of the environement for supporting life processes and for providing resources and development. In other words exploitation of resources beyond this point would mean depletion and subsequent ecological imbalance. In essence, it is the quality of life that people aspire to which may beset the environmental goals. It is of utmost importance to the governments of developing nations to ensure watching of populations and their developmental aspirations to the environmental resources without stretching them too far, to spell disaster.

Check Your Progress - 4

Why are the natural resources depleted in developing Countries ? How do you rectify ?

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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5.7. INTERNATIONAL AGREEMENTS

The environmental era that has dawned for quite some time is distinguished by problems truly global in scale. Even while countries grapple with the more localised problems of acid rain, toxic wastes and soil erosion, global threats of unprecedented proportions throw a challenge to translate a common vision of a world at risk into the international alliances and bold actions.

The atmospheric ozone layer that protects the earthly life from harmful ultraviolet radiation had begun to thin globally and weather conditions in some parts of the world are worsening due to the green house effect raising the temperatures in parts of China soaring high to lethal levels. Crops in USA and elsewhere are getting affected adversely due to excessive heat and drought changing whole economies from export surplus to deficit economies.

Such global crises are bound to create a king of awareness and bring new perceptions the world over on environmental issues. As a result, a number of resolutions and covenants have been created in the international fora like the UN and Conferences Environment and Development. Such threats that are becoming common to the world-community of nations rather than to individual nations are bringing the East and West closer culturally, scientifically and economically. The cold war between big powers is giving way to cooperation on many fronts.

Most notable among many symbols of international cooperation is the International Geosphere Biosphere Program established in 1986 intended to deepen understanding of the physical, chemical and biological forces that affect the biosphere suing more extensive national monitoring, satellite reconnaissance and advanced computer modelling. Similarly, the European Economic Community also have an environmental cooperation in Europe for monitoring their waterways. The economic barriers are thus torn down giving way to environmental cooperation. Slowly but surely the world comunity is moving forward in protecting the atmosphere.

In 1979, a UN sponsored Convention on long-range transboundary Air Pollution was greed to by 3 countries of Europe and North America. This was followed by the Protocol on the Reduction of Sulfur Emissions signed in 1985 by 21 countries. A similar agreement on the reduction in nitrogen oxide emissions was signed in 1988 by 24 nations. The Montreal Protocol established in 1987 freezed production of Chlorofluorocarbons which are harmful to the ozone layer to 1986 levels and a gradual cut up to 50% by 1998 in so far as the industrialised countries are concerned.

The world's oceans are another global commons needing international protection, since the activities of one country can endanger the coastal ecosystem of other nations. Water pollution and ocean dumping of waste materials and overfishing are among the major threats. As a result of ceaseless efforts of the United Nations, International Maritime Organisation and the UNEP spanning over ten years, the Convention on the Law of the seas was sigged on April 30, 1982 by 119 nations declaring oceans as the common heritage of humankind and limiting actions that despoil the seas. It also provides a framework for future international agreements to protect this global resource. A 200-mile exclusive economic zone is created under this Law around each coastal nation with an international obligation on managing their respective coastal regions and resources effectively.

In addition to the efforts made by the UN Environment Programme, the International Council of Scientific Unions and the World Meteorological Organisation are also coordinating international research on climate change. The World Conference on the Changing Atmosphere : Implications for Global Security held in Toronto in 1988 recommended a 20% reduction in the emission of carbon by 2005. Now, in the recent Earth Summit held in Rio-dejenario in 1992 the accent was on global warming and funding the host of programmes on environmental protection in the developing countries through a Global Environmental facility. Students are advised to lay their hands on the proceedings of the conference at Rio-degenario for a realistic appreciation of the pivotal role the environmental issues have to play of late in international development.

All said and done, a strengthening of the UN System providing it with more reliable resources and clearer line of authority will be essential in times to come if the Globe has to be protected from the greed of man.

Check Your Progress - 5

What is the result of International Conference and Summits on Environmental issues ?

Note : a) Write the answer in the space provided below.

b) Compare your answe with the one given at the end of this unit.

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5.8. SUMMARY

The oceans and forests characterising the global environment belong to the whole world. Any degradation of forest cover and alternation of oceanic environment in a region are bound to affect the environment of the rest of the world. The environmental issues have to be tackled by world community drawn from different countries.

The northern part of the globe is more prosperous than the sourthern hemisphere. Because, high literarcy and low population density put less pressure on resources in the northern hemisphere while the low literacy and high population density put high pressure on the available natural resources in the southern hemisphere.

The developed countries constitute the bulk consumers of the world resources, although they inhabit 1/4 of the globe. These countries have established the industries which pollute and aggravate the environmental imbalance locally in underdeveloped countries. The underdeveloped countries having been attracted to foreign dollars out of economic necessity, export timber and forest products heavily by degrading the biodiversity and forest cover.

In developing countries, there is a shortage of natural resources against high population density. The shortage of resources has arisen mainly due to misuse and mismanagement and large family size. This is as a consequence of lack of high literacy and social awareness against nurturing and protecting the existing resource base.

There are several environmental issues that have to be tackled on a global basis. Many countries have realised these global issues and have entered into treaties and agreements and also made certain common laws for the sustainable earth and its environment.

5.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The oceans and forests belong to the whole world. Any imbalance or depletion in these components in one region is bound to affect the environment of the rest of the world. In view of this, it is realised that all environmental issues should be dealt with globally.
2. The northern hemisphere is more prosperous than the southern one in all aspects. Because,

high literacy and low population density have put the people in a very poor state in the south.

3. The developed nations having riches in their hands, have politicised the issue of relationships with developing and underdeveloped nations. Certain natural resources which are very much needed by the developed are being exported by the developing and underdeveloped countries out of economic necessity for precious foreign dollars.
4. In developing countries, the natural resources are being depleted because of misuse and mismanagement. This issue can be set right by developing high literacy rate and creating social awareness against non-renewable natural resources.
5. The environmental issues have been discussed at length at several international conferences and summits. As a result, certain international agreements, treaties, laws and statutes applicable to the whole world have come up to deal with the environmental problems.

5.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write an essay on global environmental issues ?
2. Describe the factors involved in the north-south divide.
3. Delineate the different international agreements made on global environmental issues.

II Answer the following questions in about 10 lines Each

1. Write briefly the use and misuse of resources in the developed, developing and underdeveloped countries.
2. What are the international agreements made to deal with the pollution of the seas and oceans.

Sri. G. Nageshwar Sharma

BLOCK - 2
INDUSTRY AND AGRICULTURE

UNIT-6 : INDIAN PHILOSOPHY

Contents

6.1. OBJECTIVES

After completing this unit you will be able to :

* explain the essence of Indian Philosophy,
* differentiate historical heritage from cultural heritage,
* describe the natural resources like land, water, forests, wild life and fisheries and how to preserve and protect them,
* define traditionalism and modernism and explain the conflict between two in protecting natural resources.

6.2. INTRODUCTION

Each country has its own philosophy and thinking for its progress and development and the type and extent of a country will countribute to its development and culture significantly. The Indian philosophy right from vedic times believes in the existence of God, Dharma and Ahimsa. India is a multi-religious, multi-lingual and multi-cultural country, its culture aims at unity in deversity. Our performance in protecting our environment and natural resources is governed and influenced by our historical and cultural heritage.

Of the different natural resources, the land, water, forests, wildlife and fisheries play an important role in shaping progress, development and destiny of any country, in that India is very richly prossessed by all these major resources. The traditional methods are as important as the modern methods because they are based on scientific thinking. The rapid depletion of the country's forests is a matter of great concern as other Natural sources are dependent upon the extent of forests and 1/3 of land area of any country must be a forest so as to have rain, wildlife and other vital gases like oxygen in their normal

amounts. Sometimes a conflict occurs between traditions and modernism in tackling the environmental issues; the best example for this is the river Ganga and its pullution. In recent times it is better to seek for naturally occuring pesticides like products of Neem tree for eliminating the harmful insects and their pests. Neem is a symbol for traditionalism and modernism as it is required in curing number of diseases.

6.3. INDIAN PHILOSOPHY

India being a sub-continent is a great country with rich historical and cultural heritege. It is a land ruled by invaders, emperors and Kings from different foreign countries and a birth place for many of the great saints, seers, sages, thinkers, scholars and philosophers. The Indian Philosophy mainly concentrates on the existence of God, Dharma and Ahimsa whereas the cultural interest aims at Unity in Diversity and India is a multi-cultural, multi-lingual, multi-ethnic and multi-religious country.

6.3.1. Historical Heritage

From the time immemorial, India has been called Bharatavarsha or Bharatakhanda. The name was derived from Bharata, the famous King. The persians pronounced Sindu as Hindu. After the advent of the Muslims, the term 'Hindu' came into vogue. The same is true with the Greek invaders to India. They used to call the country 'India'. Afterwards the Europeans popularised the word India. Thus today, both the terms India and Bharat are used to denote our mighty motherland. India being a sub-continent is separated from the rest of the world by the Himalayas in the North, the Bay of Bengal in the East and the Indian Ocean in the South and the Arabian sea in the West. Since it is separated from the rest of the world by well defined boundaries, there appears geographical unity.

India has very old historical background i.e., being ruled by kings. The terms Chakravarti, Samrat and Sarvabhouma signify the importance attached to the political unity and political head in the olden days. In order to declare their paramount sovereignity over Bharatavarsha, Kings used to perform sacrifices such as Aswamedha and Rajasuyam. Chandra Gupta Maurya was the first Indian Emperor who almost unified India. Thereafter Allauddin, Akbar the Great, Aurangazeb and Britishers succeeded in unifying India. There was an element of protection of Environment even during the regime of Shersha, Akbar and other emperors. Trees were planted on both sides of the road, beautiful gardens were maintained, trees and animals were protected.

6.3.2. Cultural Heritage

India possesses very rich cultural heritage ever from the Vedic ages. The Indus valley people worshipped mother earth as Goddess and believed in a female energy as the source of creation. Horses unknown to the people of the Indus valley, whereas they were domesticated in the vedic period. The Indus Valley Civilization was an urban civilisation with trade and commerce as the main occupation. The vedic civilization was rural civlization with agriculture as the mainstay. While the Indus Valley people were idol worshippers, the Aryans were nature worshippers, i.e., environment protection people. In spite of these differences, the synthesis of the two cultures forms the basis of the present Indian culture whose cynosure is "Unity in Diversity". India is a multi-cultural country and 'the epitome of the world'. Common history and nationalism are the agencies which fostered the fundamental unity of India and Indian culture.

Indian culture aims at the worship and protection of Nature and Environment. Indians worship earth, moon, oceans, rivers, plants and animals. As per Indian philosophy cutting of a tree and killing of animals like cow are actions of sin, hence plants and animals are protected from the Vedic times, this type of faith is useful in protecting and preserving the natural resources. The process of sedimentation has been observed right from Vedic times for the purification of water, which is one of

the ways and means of purifying polluted water even in the present times. In India Neem tree has been given much importance because of its medicinal and environmental value in providing shade and greenary to our surroundings. Thus, the colour, green appeared through the trees is considered an important environmental simulus because it is thought to create a relexed mood. Thus our performance in protecting our environment and natural resources is governed by our cultural and biological past, the environment in which we lived and we are.

6.4. PRESERVATION AND PROTECTION OF NATURAL RESOURCES

Resources are the result of human culture; the materials of the physical environment become resources only when they fulfil a human need. Natural resources, therefore, exist only in conjunction with human culture. We know that cultural system and environmental perception have much to do with the definition of a resource.

The two basic types of resources are renewable and non-renewable resources. A forest is a renewable resource because most varieties of trees grow rapidly. Fossil fuel and minerals such as gold, silver or copper, obviously do not renew themselves, thus once extracted from the earth and consumed, they are not replaced. The following are the Natural resources that have to be preserved and protected for the future of man.

6.4.1. Land

The basic determinants of what makes land a resource are found in composition of soil and in environmental conditions. Soils provide the home for bacteria, fungi, they are comprised of organic materials and inorganic components, such as weathered rock particles along with water and gases, mainly oxygen and nitrogen. The organic and inorganic elements are acted upon by sunlight, water, plant and animal communities and human activities, with this the land becomes rich in manure and becomes fertile.

For preservation and protection of land, the sanitary land fills are the best solution. In contrast to open dumping and ocean disposal, where waste materials can contribute to further pollution, sanitary land fills provide a way of burying waste materials daily, so that they untimately decompose without causing pollution. In a sanitary land fill operation, waste is compacted and mixed with soil to facilitate biodegradation. Well managed sanitary land fills can often be converted into parks, gardens and thus land may be preserved and protected.

6.4.2. Water

Water is a renewable resource. Water is principally used by people for industrial activity, irrigation municipal uses and domestic needs. Every water based city in history describe waste materials being dumped into water systems. Water is inexpensive and has traditionally been in such great supply that conservation has never seemed like a real necessity. But as water is being polluted and impured due to environmental pollution at present and in future, conservation of water may become more attractive. Generally conservation of water has become an urgent necessity in view of shortage of water, hence water production and use must be controlled and managed. The polluted water can be subjected for a series of treatments starting from simple process of sedimentation to the complex process of electrodialysis for its purification and this purified water can be circulated through the Municipal taps for drinking purposes also. Purification of polluted water bilogically could be done by employing fresh water mussels which are capable of absorbing metals inside the body and filter water 6 to 7 litres per day by a single animal.

6.4.3. Forests

Forestes are important major resources for wood for homes, furniture, fuel and paper etc. Forests are regulators of all our basic sources like soil, water and air. Our faints used to sit for meditation in forests for years together under the shade of the trees with total communion with nature. For normal rainfall and wildlife, 1/3 of the land area of any country must be forests. Therefore forests must be preserved and protected. Great *Eucalyptus* was introduced by Tipu Sultan in Kolar district of Karnataka in India as early as 1770. Around 3000 B.C., there was 80% of Indian land under plant cover, but by 1980, only about 21.1% was under forest cover. Due to heavy rate of deforestation, planting trees (afforestation) is essential to restore the ecoological balance required for well being of all forms of life especially that of mankind. Due to deforestation, Green House Effect will be resulted i.e., accumulation of CO_2 in the atmosphere. This increases the atmospheric temperature, thereby melting the polar ice caps (heat house effect) ultimately, results in the increase of sea level which makes the small Islands to be drowned. Forest can be preserved and protected by social forestry programmes. The slogan like one tree for every school going boy and girl and minimum 3 trees for every person in his life period must be implemented in practice. Further intensive forestry practices such as genetic subsidization which allows trees to grow more rapidly are combined with management practices to reduce the lentgh of the growth cycle. Thus more importance should be given for the protection of forests as given in our Indian slogan "Vriksho Rakshati Rakshitha"

6.4.4. Wild Life

The term Wild Life covers all non-cultivated and non-domestic life mostly birds and mammals, reptiles even fish are treated as wild life animals. Late Prime Minister Jawaharlal Nehru said "It is beatiful to shoot wild life with a camera rather than with a gun". Forest is the most important natural entity or the envelop for the existence of wild life. According to Wild Life Society of the World at Washington, 1/3 of the land area must be a forest to save wild life in its real sense. The forest suplies three distinct needs for the wild life, 1) place to breed in safety, 2) place of refuge and 3) place of adequate food supply. When there is disturbance in the Ecological balance in the forest community, wild life is drastically affected. One such good example is Hyenas threat in Anantapur District of A.P. When the favourite food, the patridge birds for Hyenas are being eliminated by humans and due to deforestation, the Hyenas are coming out of the forests and eating small sleeping human babies as food in summer, hence proper measures for preservation and protection must be taken to save wild life.

India has a rich and varied wild life comprising of fish, birds and mammals. More than 500 wild species of mammals are found in India. The Indian bison is the largest of the existing bovines, Indian rhinoceros is the biggest of all rhinoceros in the world and the one-horned rhinoceros cannot be found elsewhere in the world except in India. Indian elephant is much more handsome compared to its African cousin.

The Deer family is still richer and some of the most beautiful species like Chital, black and swamp deer are found only in India.

Wild life can be preserved and protected by adopting the following programme.

1) Conservation Education - We have to educate people about the facts and principles relating to conservation, of wild life. A high quality periodical publication is an essential part of the conservation education.
2) Wild Life Tourism - Both State and Central Governments have taken steps to promote wild life tourism which is a non-consumptive use of the resources. This can earn money and at the same time educate people about wild life wealth which must be protected in Sanctuaries, National parks, Zoos etc.

3) Grazing is repsonsible for spread of diseases from domestic animals to non-cultivated wild animals, hence grazing in forests must be stopped.

4) As collection and utilization of the forest resoruces severely affect the forest and wild life by the forest edge population - their socio-economic conditons must be studied, improved and control measures should be taken for their activities.

5) Wild Life Protection Act (1972) and Forest Conversation Act (1980) of Government of India, need to be updated and be strictly implemented for the protection of the wild life.

Therefore, there is greater need for the protection and preservation of every valuable natural resource like fisheries.

6.4.5. Fisheries

The term Fisheries includes fishes, crabs, prawns, oysters, lobsters etc. From the nutritive point of view, Fisheries form the most important natural resources. Fish is the most efficient among farm animals in converting feed into nutritions food. In fish meat the protein content is more than 20%, highest protein content in animal sources. In terms of conversion of proteins 40 Kgs. of grass = 5 Kg. of beef and 5 Kgs of beef = 1 Kg. of fish. Indian major scarps, catfishes, sarlines, mackerel, pomfrets, mullets, shrimps and prawns are good cultivable quantities of aquatic habitat. Rearing and protection of useful aquatic organisms mainly fishes and prawns is called aquaculture.

Fisheries production can be enhanced and Fishes can be protected through composite Polyculture method. In this method with minimum feed maximum fish food can be obtained and variety of fish species can be cultured at a time in an economical way. For e.g., the culture of three Indian major corps at a time in a pond comes under polyculture where the catla is surface feeder which feeds on the minute organism present on the surface, the rohu is a column feeder which feeds on for plantation and larvae and the mrigal is a bottom feeder which only feeds on the bottom debris and settlements. Hence there is no competition for food and survival among the three carps. Through the polyculture method as much as 5,000 Kgs. of fish per hectare per year may be produced as aganist only 600 Kgs. of fish per hectare per year through mono-culture method (mono culture means culture of only one kind of fish).

Another way of enhancing fisheries production is through induced breeding in which the pituitary extracts will be injected to very large fish breeders and thus bring about the early maturation and release of ova and sperm which fertilize and develops into fish seed. Fish yield a number of by products besides protein content like fish oils having vitamin A in shark liver and vitamin D in codliver. Fish are used as feed to poultry and cattle. Isinglass produced from air bladder fishes is used in the plastic industries. Some of the larveidal fishes like Pandusia, Chera and barbus eat larvae of mosquitoes, and etroplus eating on quinea worm thus malaria and elephantasis could be controlled biologically. Recent researchers have shown that more fish in the diet keeps the heart healtheir, i.e., the poly unsaturated fatty acids present in fish meat reduce the cholesterol level in the blood and inhibits the formation of thromboxine which is responsible for blood clot. A survey in India also revealed that people mostly eating fish tend to have a high intelligent quotient (I.Q.) due to more phosphorus content in fish meat. Further fish is a cheaper and easily digestible diet. It has been reported that in Scandinavian countries from small marsh fish, oil is prepared and this is used as substitute for petrol. Therefore there is greater need for the preservation and protection of very valuable natural resources like fisheries.

Check Your Progress 1 & 2

1. What are the Natural Resources ?
2. How do you solve the malnutrition ?

Note (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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6.5. CONFLICT OF TRADITIONALISM AND MODERNIZATION

India is very ancient country with full of traditions and beliefs with very rich historical and cultural heritage and above all with unique and great philosophy of its own which centres on the existence of God, Dharma and Ahimsa. Eventhough, India is abide by its traditional values and customs it is keeping pace with the developments in the arena of science and technology. If we take few concrete examples of struggle between tradition and modernization, birth control by artificial means is considered a great sin, however this superstitious belief is slowly disappearing and very quickly people are giving much importance to a small and limited family, because of the necessity of the present day conditions. Take for example, even the old traditions and beliefs of Indians are found to be highly useful in modern times also, in that from the vedic times Indians worship nature, plants, animals and their surroundings and preserve and protect them. Killing of animals and cutting of trees are also acts of sins. This tradition is actually helpful even in the modern times for the protection of natural resources and environment. Cow is worshipped in India and snakes can control the rodent population (rats etc.) which destroy the commercial crops.

Regarding water pollution, Ganga is an example for conflict between traditions and modernism. For ages there has been the belief among Hindus that bathing in the Ganga particularly at Varanasi is a good religious custom and that after bathing all sins will disappear, but modern view is that when most of the people take bath, they pollute the Ganga by contributing their wastes of the body into the waters and also by washing their cloths. Added to this lot of silt is carried down in suspension which gives her turbidity, so bathing in such contaminated waters is unhygenic. So is the case of disposal of dead bodies at the Banks of Ganga. Due to superstitious belief some people throw the entire dead body, partially burnt one or its ashes in the holy rivers which are substantially contaminating the waters. Further a British scientist was once shocked when he learnt of an Indian colleague suddenly taking a dip in the Ganga on an auspicious evening. He wondered how superstition had prevailed over science. In the Ganga Action plan which was formulated in 1984 by Department of Environment and the same was promoted and given top priority by Late Prime Minister Rajiv Gandhi for the control of pollution for the River Ganga. As per this plan Electro crematories were constructed at number of places on the bank of River Ganga for scientific disposal of the dead without contributing the polution in the river waters. Thus the old tradition has been changed into a scientific and modern thought. Thus no river evokes such feelings in the human mind as the Ganga does.

Take for example, our Neem tree which is considered as village Doctor for the many medicinal values it possesses and for the cure of share and greenary for the area. Traditionally also Indians worship Neam tree as village God because of its involvement in so many rituals. What has been traditionally coming with respect to Neem is also found to be rightly useful in the modern times in the sense that a number of Neem products (natural pesticides) are available in the market which when employed are found to kill harmful insects and pests in low concentration without any harmful effects on the non-target organisms. Thus, most of the Indian traditional customs and beliefs are explained on scientific lines and proved to cause good to the society and country, but very few traditions without scientific validity are slowly on the verge of disapperance and are not coming in our way of preserving and protecting the Natural resources. Therefore we can say that both traditionalism and modernism in the Indian society aims at the preservation, conservation and protection of natural resources and environment and ultimately, centres at National Development by controling population, poverty and pollution.

Check Your Progress - 3

How does the conflict arise between traditions and modranism in India ?

Note (a) Write the answer in the space given below.

(b) Compare your answer with the one given at the end of this unit.

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6.6. SUMMARY

India has unique philosophy which is very much different from rest of the world. It has a culture "Unity in Diversity" and a very rich historical past. India has very rich in major natural resources like land, water, forests, wild life and fisheries. Land can be preserved and protected and pollution of land may be avoided through the sanitary land fills. Water is a very valuable commodity for almost all activities of man and polluted water can be purified by subjecting it to a series of treatments. Forests are regulators of all our basic resources like soil, water and air and only 21% of the land area in India is forest as against the minimum requirement of 33%. Hence, afforestation should be increased. India has rich varied wild life which will be existed and protected by forests. Wild Life may be protected by creating natural habitats in the form of sanctuaries, National Parks and through conservation education and Wild life tourism, fisheries forms the best natural resource for the requirement of protein in controlling malnutrition. Fisheries can be enhanced through induced breeding and composite fish culture. In an ancient country like India there is a conflict between traditionalism and modernism and this struggle is slowly disappearing in view of tremendous progress in science and technology.

6.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Natural resources include land, water, forests, wild life and fisheries.
2. Fisheries can solve the problem in malnutrition in suplying proteinaeous diet at cheaper costs to meet the food problem.
3. In multi-cultural and multi-religious country like India the traditions play an important role in combination with modernism most of the time and in few cases work aganist modernism. Hence a conflict arises between the two.

6.8. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Give an account on the historical and cultural heritage of India.
2. What are natural resources ? And how are they preserved and protected with reference to forests, wild life and fisheries.
3. Enumerate about the management of land and water in India.

II. Answer the following questions in about 10 lines each.

1. Write briefly about Unity in Diversity.
2. Write a brief account on Ganga Action Plan
3. Briefly write about Indian Wild Life.

Prof. Md. Basha Mohiuddin

UNIT-7 : POST INDEPENDENCE INDUSTRIALISATION

Contents

7.1. OBJECTIVES

After gioing through this unit, you will be able to :

* trace out the preindependence industrialisation,
* discuss the post independence industrial development,
* analyse the state controls and regulatory mechanisms and
* describe the economic policy of India.

7.2. INTRODUCTION

Development has meant, and will continue to mean, many things to many people. To the economists who made the first big noise about it in recent years, it is another name for their eternal favourite, growth. To liberals, it is the twentieth century version of the 'progress' their tradition initiated in the nineteenth century. For the religions, it is the new name for peace. And for planners and policy makers, it represents their attempt to open to our people opportunities for a richer and more varied life.

The above comment, which comes from the first five year plan document, may appear somewhat uncharacteristic of the precision that it expected of planners. It is, however, very characteristic of policy makers who know that the promises they made must mean all things to all people. Thus defined, development becomes one of the easiest things to promise - it is meant for all, and something of it will always be fulfilled. As for the planners, at the end of the day they can always make the honest confession that there are promises to keep and miles to go.

The classic objectives of our Five Year Plans were "development along socialist lines to secure rapid economic growth and expansion of employment, reduction of disparities in income and wealth, prevention of concentration of economic power and creation of values and attitudes of a free and equal society". In order to achieve these objectives, the planners formulated a strategy of planned economic development.

7.3. PRE-INDEPENDENCE INDUSTRIALISATION

Government policy towards indigenous industry was on the whole unhelpful at times and hostile, during the greater part of the British rule in India. The first century of British rule, *viz.*, the period of the East India Company, saw the decline of nearly all indigenous industries. There were many reasons-economic, technological and political. The most important reason was the conscious policy adopted by the imperialist authorities on the one hand of direct prohibition of Indian cotton and silk goods entering Europe thereby destroying India's existing export market and secondly on the adverse of forcing an open-door policy in India for goods produced in Britain. Another key factor was the release of new technological forces in Britain by the Industrial Revolution and the competitive efficiency they gave to the industry there. The effects of this policy were compounded by the opening up of the Suez Canal, improvements in the mode of ocean transport, construction of railways in India and the introduction of uniform currency. With the political unification of India, and abolition of internal transit duties by 1856, the foundation of a national market was laid, and the sub-continent was opened upto unrestricted flow of goods of all variety made in Britain.

The general theme of the economic exploitation of the Indian people by the British and their mounting impoverishment was brought into sharp focus by a galaxy of writers like R.C. Dutt, Dadabhai Naoroji, Ranade and also Mahatma Gandhi.

Dadabhai Naoroji, a distinguished Indian economist, in his classic paper on the 'Poverty of India' (1876), emphasised that the drain of wealth and the capital from the country which started after 1757 was responsible for absence of development of India.

The economic drain of wealth prevented the process of capital creation in India but the British brought back the drained out capital and setup industrial concerns in India owned by British nationals. The government protected their interests and thus the British could secure almost a monopoly of all trade and principal industries. The British component of industries established in India further drained of Indian wealth in the form of remittances of profits and interest. Morever, the British firms dominated the Indian industrial scene and shifted the growth of Indian enterprise in industry. Thus, the economic drain which commended right from the inception of the British rule acted as a drag on economic development till 1947.

Bipin Chandra has examined the impact of colonial rule in modernising India. The British economists have always upheld that the backwardness of the Indian economy and its failure to modernise itself was largely due to the value system, i.e., spiritualism, asceticism, the caste system, joint family, etc. Similarly, the British economists have always argued that Indian capital was proverbially shy, it always sought safe avenues of investment and thus lacked the basic quality of adventure, which is an essential condition for dynamic enterprenuership. Bipin Chandra rejects both these arguments for absence of modernisation as mere shibboleths. He writes: "It is a historical fallacy to assume that India under British rule did not undergo a fundamental transformation, or that it remained basically traditional. But the modernisation of India was brought within the political parameters of a colonial economy. Thus, the colonial links between India and Britain resulted in the progress of the Industrial Revolution in Britain while it meant the modernisation of those sectors of the Indian economy which strengthened the process of integration of the Indian economy with British capitalism. It was, therefore, not an accident nor was it historically, exceptional that India was integrated into world capitalism without enjoying any of the benefits of capitalism, without taking part in the industrial revolution. It was modernised and underdeveloped at the same time.

7.4. ECONOMIC TRANSITION IN INDIA - A RESUME

The brief survey of the economic consequences of the British connection in India brings out that the impact of Industrial Revolution on the Indian economy under the British rule was in sharp contrast to its influence on the British economy. In England, the Industrial Revolution did cause unemployment in the rural areas, but the unemployed labour was soon absorbed by the new industries. The period of suffering was short. Moreover, the destruction of the old order was being compensated by the growth of new order of efficient and large scale production. But in India, the impact of Industrial Revolution meant the destruction of Indian handicrafts, but there was no substantial growth of modern factory industry. Consequently, a process of progressive ruralisation or deindustrialisation set in.

Secondly, the new land system, the commercial agriculture and the economic drain of India - all worked simultaneously in weakening the Indian economy. In England, the changes introduced during the period of Industrial as well as the Agrarian Revolution created momentum generators of economic development. Agricultural as well as industrial production recorded an increase and an era of prosperity set in. In India, the hostile attitude of a foreign goverment created built-in-depressors and thus the economy remained trapped in the vicious circle of poverty.

Thirdly, the development of railways and irrigation also intensified the exploitation of the Indian people through the policy of commercialisation of agriculture.

The British rule was a long story of the systematic exploitation by an imperialistic government of people whom they had enslaved by their policy of divide and rule. The benefits of British rule were only incidental, if any. The main motive of all British policies was to serve the interests of England. Thus, in 1947 when the British transferred power to India, we inherited a crippled economy with a stagnant agriculture and an underdeveloped industry, a proletariat and a peasantry steeped in poverty. As Jawaharlal Nehru put it "India was under an industrial capitalist regime, but her economy was largely that of the pre-capitalist period, minus many of the wealth producing elements of that precapitalist economy. She became a passive agent of modern industrial capitalism suffering all its ills and with hardly any of its advantages". It was this dead weight of a stagnant economy which the national government had to move after 1947.

Check Your Progress - 1

1. What is the main motive of British Policies?

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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7.5. CONSEQUENCES OF VARIOUS FORMS OF EXPLOITATION

(i) India remained primarily an agricultural country and its agriculture became commercialised to serve the interests of great Britain by exporting tea, coffee, spices, oil seeds, sugarcane and other foodstuffs, besides other raw materials.

(ii) India which was an industrially advanced country during the 16th and 17th centuries was not permitted to modernise its industrial sturcture during the 18th and 19th centuries. Her handicrafts were destroyed and she became an importer of manufactured goods.

(iii) The British employed the policy of discriminating protection along with imperial preference to have complete control over the Indian market. This also helped to provide safe and secure avenues for the British investors in India.

(iv) The British developed the economic infrastructure in the form of railways and irrigation and electricity works with a view to promote foreign trade and exploit India's natural resources to their advantage. Direct British investment was made in consumer goods industries like tea, coffee, and rubber plantations, but no effort was made to develop heavy and basic industries.

(v) The Managing Agency System did help to promote consumer goods industries in the intial phase, but became exploitative in character later. It appropriated nearly 50 percent of the gross profits as managerial remuneration.

(vi) The British exploited India through the economic drain via home charges. India was also forced to pay for several wars like Afghan and Burmese wars. This was indicative of the highly exploitative character of the British rule.

The net result of the British policies was poverty and stagnation of the Indian economy.

7.6. POST INDEPENDENCE INDUSTRIAL POLICIES

The history of the working of industrial policy in India since independence has been one of both substantial achievements and missed opportunities. It has been characterised by a constant interplay between the purely economic or industrial factors on the one hand, and a set of political or ideological considerations on the other, tempered further by politico-bureaucratic interventions. After attaining independence, India's policy makers had to make a choice between the nationalisation of industries and a free market economy. The former course was dictated by the proven attractions of the Soviet economy, the strong influence of Laskian socialism and of the nationalisation programme of the post-war Labour Party Government in Britain. On the other hand, India also had a well established private sector which had not only strengthened during world war II, but had also extended considerable support to the Congress Party during the freedom movement. Eventually the policy makers settled for a middle course in the form of a mixed economy that would combine both public and private enterprises. There also be a dominant public sector, by and large, covering the basic and key industries, but at the same time vast segments of industry including those considered strategic would be in the public sector, on the condition that it had to conform to certain broad investment patterns and priorties which arose out of the social and economic goals set for the nation by the Indian Constitution. The main instrument of government control over the future development of the private sector was to be a system of administrative controls. There was a legacy of war-time administrative controls (such as exchange control and capital issues control) left by the former colonial government and these came in as handy instruments of control, although for a different purpose. They were to be used no longer for war-time needs, but for regulating the growth of the private sector according to nationally defined ptiorities. Subsequently, new controls (industrial licensing and the companies Act of 1956, among others) were added to meet the new situation. Indeed, an impressive regulatory system has been created of indirect controls through budgetary, fiscal or monetary means and through direct and discretionary administrative controls. India's industrial regulatory policy is marked by the :

(1) need for multiple approvals of a single specific business activity, under different laws and policies;

(2) multiplicity of ministries, agencies and other government agencies involved in the approval procedure;

(3) vertical structuring of the decision - making authority along a long line of hierarchy in every ministry or government agency;

(4) assumption of a large number of line functions by the central secretariat in preference to state agencies or locally based central authorities;

(5) prevalence of direct discretionary administrative controls in preference to legislation type of controls through budgetary, fiscal or monetary means; and

(6) inevitably, a certain degree of political overlordship (through ministries, cabinet bodies and parliament) over the process of decision making in respect of industrial projects.

Discussion in parliament and at various other levels, as also in the press on specific projects and the need for political approval, introduce factors which further complicate the process. The interface between corporate growth programme and the governments regulatory role casts on industrialists and managers newer responsibilities and obligations unknown in industrialised countries. Indecision or delayed decision, dilatory procedures, conflict of objects, the system's inability to subordinate minor objects to an overall major object and the rejection of good industrial schemes are the inevitable outcomes.

Compared to the level of industrial development at the time of attaining independence there have been tremendous advances. But at the same time, one cannot but conclude that there could have been much more advance but for the backward push given by policy and procedural constraints. The inner core of policy and legal instruments consisted of (i) the Industrial Policy Resolution, 1956, the basic policy documents (ii) the Industries (Development and Regulation) Act, 1951, the central legal instrument, (iii) the Industrial Licensing Policy of 1973 and (iv) at last yet another policy document, namely the Industrial Policy Statement (those of 1978,1980, 1982 and 1984). Apart from this inner core of four direct controls, there was also an outer circle of several indirect but important, instruments of control, the more important among them being (i) the MRTP Act, (ii) the capital Goods Import Control, (iii) Government Policy with regard to foreign investment and foreign collaborations (iv) the companies Act with a large number of controls over the joint stock companies, (v) the capital issues control Act, and (vi) the role played by the government term-lending institutions led by the apex Industrial Development Bank of India in apprising projects and sanctioning and disbursing long-term loans for them. Between 1970 and 1991 companies covered by the provisions of the MRTP Act dealing with concentration of economic power, were required to obtain the Central Government's special approval under that Act to start new projects over and above the industrial licence. If any project involved in the import of capital equipment or machinery, a capital goods clearance (for which there is a separate procedure) becomes necessary. Foreign equity investment or technical collaboration required a company to have yet another separate approval for its project from an official body, the Foreign Investment Board. Even after all these clearances have been received, the financial institutions need to be approached on a long term basis. Inevitably, they assume a role which is strictly promotional, but nontheless acquire features of regulation and control.

All these policies and procedures have an important bearing on the formulation and implementation of new industrial projects or schemes for expanding an enterprise. We would first discuss the industrial policy Resolution, 1956 the magna carta for Indian Industry - and then discuss the cumulative effect of all the instruments of control and finally the latest Industrial Policy Statement of the Indian Government dated 22 July 1991.

7.7. INDUSTRIAL POLICY RESOLUTION, 1956

India had her somewhat tentative first Industrial Policy Resolution in 1948. By 1956 the need for further amplification of this policy and for extending the scope and coverage of the public sector were felt. The Directive Principles of State Policy of the Constitution adopted in January 1950 indicated the socio-economic goals towards which the efforts of the State were to be oriented. In the light of these principles, planning for economic development assumed special importance. A national planning commission was accordingly set up in March 1950 and the nation's First five-Year Plan was under implementation, the pursuit of a socialist pattern of society was accepted by parliament in 1954 as the principal objective of the nation s social and economic policy. Towards the end of the first five year plan, however, an urgent need was felt for an accelerated pace of development through the expansion, among other things, of heavy industries. This persuaded the government to reformulate its industrial policy in April, 1956.

The Resolution of 1956 declared:

"The adoption of the socialist pattern of society as a national objective, as well as the need for planned and rapid development, requires that all industries of basic and strategic importance, or in the nature of public utility services, should be in the public sector. Other industries, which are essential and require investment on a scale which only the state in the present circumstances could provide, have also to be in the public sector. The State has, therefore, to assume direct responsibility for the future development of industries over a wider area.

On this basis the new Industrial Policy Resolution classified industries into three categories having regard to the part which the State would play in each of them. In the first category were placed the industries the future development of which was to be the exclusive responsibility of the State (Schedule 'A'). The second category consisted of industries which would be progressively State owned and in which the state would therefore generally take the initiative in establishing new undertakings but in which private enterprise would also be expected to supplement the effort of the State (Schedule 'B'). The third category included all the remaining industries where future development would generally be left to the initiative and enterprise in the private sector.

The Resolution made it clear that "the division of industries into separate categories does not imply that they are being placed in water-tight compartments. Inevitably, there will be an area of overlapping between industries in the private and the public sectors. It will be open to the state to start any industry not included in schedule 'A' and schedule '"B' when the needs of planning so require or there are other important reasons for it". The growth of private enterprise in Schedule 'B' industries" with State participation" is also envisaged. Thus the genesis of the joint sector or even of what T.A. Pai has called the national sector long afterwards, can be said to lie in the 1956 Industrial Policy Resolution.

Stressing further the complementary role of both the sectors, the Resolution declared "further, heavy industries in the public sector may obtain some of their requirement of light components from the private sector, while the private sector, in turn, would rely for many of its needs on the public sector. The same priciple would apply with even greater force to the relationship between large scale and small scale industries".

Other principles emphasised in the Resolution were:

1) reduction of disparities in income and wealth and to prevent monopolies and the concentration of economic power in different fields in the hand of small number of individuals.
2) fair and nondiscriminatory treatment to public and private sector units where they co-exist;
3) encouragement to cottage and village small scale industries and modernising them so as to improve their competitive efficiency;

4) progressive reduction of disparities in levels of development between different regions;
5) the maintenance of industrial peace;
6) improvement of living and working conditions of workers and raising the standared of their efficiency;
7) developing the country's resource of technical and managerial personnel;
8) participation of workers, technicians and professionals in management;
9) responsibility of public enterprises to augment the revenue of the state and provide resources for further development in fresh fields.

The sum up, the Industrial Policy Resolution of 1956 gives the broad policy framework of industrial development, in India. Inspite of considerable changes in emphasis among various sectors which have taken place from time to time, this Resolution still remains the magna carta of Indian Industry and should be studied by all industrialists, managers and corporate planners in order to understand the broad national policy frame for industrial development.

Check Your Progress - 2

What is the central idea of 1956 Industrial Policy Resolution?

Note : a) Write the answer in the space provided below

b) Compare your answer with the one given at the end of this unit.

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7.8. EFFECTS OF STATE CONTROLS AND REGULATORY MECHANISMS

The industrial policy regime in India developed the strategy of promoting public sector in heavy and basic industries combining with it a process of import substitution. The State provided infrastructure and a leadership role of industrial growth. The private sector was expected to play a complementary role within the broad framework of a "mixed economy and this promoted the government to have a regulatory framework for the private sector. The purpose of this regulatory mechanism was to influence the pattern of investment down to the product level, decide the choice of technology, location, direct import content, foreign collaboration etc. This required a system of industrial licensing under the Industries (Development and Regulation) Act 1951. Though the small scale industries are exempted from taking a licence, any firm with the original value of plant and machinery below Rs 5 crores was required to obtain a licence. The firm was then expected to get foreign exchange clearance subsequently, the case was referred for MRTP clearance. The sequential procedure of obtaining clearance from a number of authorities created under IDR Act, MRTP Act, FERA Licence for capital goods imports and controller of capital issues for equity shares etc., all resulted in the excessive delays in the sanctioning of projects. The system of controls which was deliberately perpetuated by the bureacracy

resulted in corruption on enormous scale. Thus, the tardy and inefficent working of a regime of controls operated in a manner which had no regard for efficiency. The socialist rhetoric that private sector needs to be controlled against proliferation in banned or restrictive areas provided the ideological base for the continuance of these controls. This resulted in the slowing down of the pace of investment which had a growth choking effect'. It is, therefore, argued by several economists notably Bhagwati and Desai, Isher J.Ahluwalia who believe that industrial policy regime was directed towards "regulation" rather than "development" of industry. The process of administrative regulation resulted in slowing down the process of investment decisions. It also encouraged the process of taking recourse to illegal creation of capacities with the administrative mechanism failed to control, but only legitimised at some later stage. Besides this, the private sector did not find enough channels of investment in the sector earmarked for it to invest the accumulated surpluses, it, therefore, pushed resources either into speculative activity to earn short term profit maximisation or into industrial activity commonly described as 'parallel economy'. In the words of Isher J. Ahluwalia, the administrative limitations of the system created strong incentives for 'rent-seeking'. Thus, the system compelled the entrepreneurs to turn towards speculation and short-term maximisation rather than creative productive activity. Alternatively as the private sector tried to circumvent the system of controls, the result was to push industrial activity increasingly into the 'parallel' or the 'underground" sector.

Whereas it could be legitimately argued that bureaucratic allocation mechanisms, wherever they became shackless on the growth of industry, need to be dismantled and instead of a regulatory regime, development oriented regimes need to be strengthened yet one cannot fail to observe the positive aspects of these controls in promoting import substitution and encouraging skill formation. Pranab Bardhan rightly observes: "while clearly, such a regime in India has sheltered many white elements in the Industrial sector and lined many pockets in the corridors of power, the over-all dynamic impact of import substitutions in fostering skill formation and learning by doing in a whole-range of sophisticated manufacturing industries (producing engineering machinery, chemical and other products) may not have been negligible, although at a very high immediate cost to consumers and industrial users of domestic intermediate and capital goods'.

However, in the second phase, the Indian trade regimes have been moving towards liberalisation. Since 1975, a large number of capital goods and industrial outputs were put on Open General Licence(OGL) and 'free' licence lists. Similarly, the government continued to open more and more areas higher to reserved for public sector to the private sector. It stopped making any reference to the MRTP commission. In otherwords, the State, though kept a socialist rhetoric, it continued to more generally and more surely towards the private sector. Despite this tilt in favour of private sector, relaxation of controls and restrictions, industrial stagnation continued in the second period. Obviously, restrictive policies cannot be considered a good explanation for slow industrial growth in the second period. Pranab Bardhan concludes: "In any case, the Indian trade regime has not by and large being more restrictive in the second period under consideration than in the first (if anything, the trend has been towards greater liberalisation in recent years) and hence this may not be a good explanation of the industrial declaration in the second period".

7.9. REVIEW OF NEW ECONOMIC POLICY

The period from 1989-91 was one of Kaleidoscopic political changes that included three general elections and four governments being in office at the centre. Economic conditions sharply deteriorated particularly on the external balance of payment front and to a lesser extent on the inflationary front. But on the whole industry continued to perform well, thanks largely to the gradual deregulation that was set in motion under Rajiv Gandhi. Also this policy dictated by non-political compulsions and the national and international economic realities, continued unabated despite the changes in the political composition of the various governments at the Centre.

It remained for the Congress Government under Prime Minister, P.V. Narasimha Rao that came to power in June 1991 to restart the engine of economic growth with a series of breath taking industrial

and economic policy changes on 22 July 1991. The new measures announced in the statement are:

1) Industrial licensing will be abolished except for a short list of industries (18 in number) related to security and strategic concerns, social reasons, hazardous chemicals and overriding environmental reasons and items of elitist consumption. Industries reserved for the small scale sector will continue to be so reserved.

2) The areas reserved for the public sector has been reduced from earlier 17 (schedule A of 1956 policy) to 8. These are areas where security and strategic concerns predominate.

3) Automatic clearance will be given by the Reserve Bank of India to projects in 34 groups of industries with direct foreign investment upto 51% of equity. This list is given in Annexure of the policy.

4) Also there will be automatic clearance for proposals for capital goods imports:

   a) Increase where foreign exchange availability is secured through foreign equity participation, and

   b) If the CIF value of imported capital goods required is less than 25% of total value (net of taxes) of plant and equipment, upto a maximum value of Rs 2 crore. This scheme will however come into force from Aprill 1992 in view of current difficult foreign exchange situation. In other cases, import of capital goods will be required clearance from the Secretariat of Industrial Approvals (SIA) in the Department of Industrial Development according to the availability of foreign exchange resources.

5) There will be no requirement of obtaining industrial approvals from the Central Government in locations other than cities of more than 1 million population except for industries subject to compulsory licensing. Industries other than those of non polluting nature such as electronics, computer software and printing will be located outside 25 Km of the periphery of such town however be flexible location policy in respect of cities (with population greater than million) which require industrial re-generation.

6) The system of a phased manufacturing programme run on an administrative case by case basis, will not be applicable to new projects. Existing projects with such programmes will continue to be governed by them.

7) All existing units will be provided new broadbanding facility to enable them to produce any article without any additional investment.

8) The exemption from licensing will apply to all substantial expansions of existing units.

9) The mandatory convertibility clause will no longer be applicable for term loans from the financial institutions for new projects.

10) Foreign direct investment unto 51% will be allowed to trading companies primarily engaged in export activities.

11) Foreign technology agreements upto payments not exceeding Rs. 10 million and royalities upto 5% on domestic sales and 8% on export sales will now get automatic clearance.

12) Units on the assets in respect of Indian MRTP Co. and Dominant Co. in India have been removed. The Monoplies and Restrictive Trade Practices Act of India, 1969 (MRTP) regulated the economic activities of enterprises that were classified either controlled substantial expansions. There would now be no need for prior approval from the government for new undertakings, expansions, mergers, amalgamations, takeover, appointment of directors etc. This was legalised by a recent amendment of the MRTP Act, 1969 which among other things repealed the controversial chapter III.

Also significant are the following highlights of the small scale industry policy announced in August, 1991:

To Provide access to the capital market and to encourage modernisation and technological upgradation in the small scale industry sector, equity participation not exceeding 24% of the

total shareholding will be allowed in the SSI by other industrial undertaking including forcign participation.

- No licenses or approvals needed from the Government of India for the small scale industry sector only with a few exceptions.
- Investment limits of the tiny enterprises in India will be increased form the present limit of Rs. 2 lakh to Rs. 5 lakh
- The rules and procedures pertaining to the SSI sector handloom and handicrafts and agro-processing will be further simplified within a specified time-frame of three months. There will also be special promotional efforts and enterpreneurship development programmes.
- Single window Loan Schemes for the SSI sector have been enlarged to cover projects upto Rs. 20 lakh with working capital margin upto Rs. 10 lakh.

13) Small Industries Development Organisation (SIDO) of India will set up a Technology Development Cell (TDC) and an Export Development Cell (EDC) to provide technology inputs to boost exports of the small scale industry sector. TDC will interact with other industrial research & development organisatons in India and abroad.

The new industrial policy should also be viewed with several other measures by the new government such as the policy announcements in the Central budget of the same date and the trade policy annouced on 4 July, 1991. The opening up of atleast 9 industries in Schedule 'A' of the 1956 Resolution and all the 12 industries in Schedule 'B' to private enterprises opened up new horizons for private sector industry. This will go a long way in enlarging the role of the private sector and in making the public sector more efficient. In retrospect, it is easy to understand that industrial production has shown a pronounced tempo of increase during the 1980s largely in response to the policies of deregulation including delicensing of several industries and increasing use of broad-banding successful promotional efforts and good supportive performance of some of the key infrastructure sectors.

7.10. SUMMARY

In terms of growth, diversification and modernisation, Indian industry has a more impressive record than does agriculture. This is a very credible record, especially when one recalls the limited industrial base of pre-independence days and the country's dependence on the rest of the world even for basic consumer goods. Now a days, India is often proclaimed to be the ninth or tenth industrial power in the world-although what exactly this means is far from clear.

Once again, however, we need to examine the character of this industrial growth. Although manufactured products are now available throughout the country, the market for industrial products is a very limited one confined primarily to urban areas, and to a small segment of the population. Industrial goods may be there for every one to see, but access to them is severely restricted - not through any formal control but through the system's own restrictive features. Perhaps more Indians today wear chappals or use watches than ever before; in this sense industrial goods have spread. But the National Sample Survey's study of consumption patterns in the mid-1970s estimated that the average rural Indian spent just Rs. 12 per month on manufactured goods (including oil and sugar) This indicates that industrial goods, if spread, have been very thinly spread.

There is a related phenomenon we need to remember. As consumer goods become increasingly available in the economy (indicating in one sense the country's industrial progress), they remain inaccessible to a growing proposition of the population. Such goods, infact, stand little chance of becoming available to any but a small minority for a long time to come. Colour television sets, widely available to the upper sections of society, appear to have no chance of reaching even 10% of population in the foreseable future. In short, India's industrial growth is meant for and enjoyed by an extremely small, affluent section.

This is somewhat ironical, for industrial growth, more than agricultural growth, was supposed to be informed by public purpose and guided by public policy. The public sector was specifically

assigned the responsibility for making the pattern of industrial growth conform to social goals. Even the efficiency of the public sector was condoned of its alleged social purpose.

In practice, however, the public sector has proved (in the words of a former Deputy Chairman of the Planning Commission)' an appendix to the private sector meant to ensure its smooth running by providing the needed infrastructure and the basic production facilities'.

7.11. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The British rule was a long story of the systematic exploitation by an imperialistic government of a people whom they had enslaved by their policy of devide and rule. The benefits of British rule were only incidental, if any. The main motive of all British policies was to serve the interests of England. Thus, in 1947 when the British transferred power to India, we inherited a cripled economy with a stagnant agriculture and an underdeveloped industry.

2. The adoption of the socialist pattern of society as a national objective, as well as the need for planned and rapid development, requires that all industries of basic and strategic importance, or in the nature of public utility service, should be in the public sector. Other industries, which are essential and require investment on a scale which only the state in the present circumstances could provide, have also to be in the public sector. The state has, therefore, to assume direct responsibility for the future development of industries over a wider area.

7.12. MODEL EXAMINATIONS QUESTIONS

I. Answer the following questions in about 30 lines each.

1. How the pre-independence industrial policies have helped in strengthening the British Economy and resulted in the progress of the Industrial Revolution in Britain ?
2. What are the Post-independence industrial policies in India ?
3. What are the effects of State Controls and Regulatory Mechanisms of the industrial development of India ?

II. Answer the following questions in about 10 lines each

1. What are the consequences of various forms of exploitation by the colonial rulers ?
2. Write a short-note on the Industrial Policy Resolution of 1956.
3. Do you think that the 'New Economic Policy' of 1991 will help in the industrial development in India ?
4. What is the policy of government on the development of small scale industry ?

Dr. K. Venkataiah

UNIT - 8 : AGRICULTURE AND ENVIRONMENT

Contents

8.1. OBJECTIVES

After completing this unit you will be able to

* assess the needs of our country as far as food production is concerned,
* describe the method of fulfilment of these needs and
* explain the ill effects of green revolution.

8.2. INTRODUCTION

It is believed that what we now call agriculture or settled down cultivation began over 10,000 years ago when women and men domesticated plants. The then population of our planet earth was about 10 million, now it is over 5.5. billion. Moreover, agricultural man learned to domesticate a number of animals, which inturn require pasture land and other foraging zones, an area that in total grew to the equivalent of twice the amount of crop land. Today we share the planet earth with at least three billion heads of live stock and at the rate that cattle, sheep, goats and so on are increasing their numbers at the end of the century may see almost as many domesticated creatures as human beings.

Under ideal conditions, the annual global food production is adequate for feeding 6 billion individuals - the populations expected by the end of the century, a balanced varied diet. When considered on a regional basis, however, the crop yields in different regions of the world vary widely due to differences in climatic and environmental conditions and human endeavour- technology inputs and management.

In India, even after nearly fifty years of Independence, agriculture remains the dominant sector of economic activity, with 80% of the population residing in the rural areas and 72% of the work force depending on agriculture. The adoption of new technology, based on proper combinations of high yielding and hybrid seeds, water, fertilizers and pesticides led to a breakthrough in the supply

of food grains, ushering in the green revolution. It also effected industry raising significantly the demand for fertilizers, pesticides, agricultural machinery and energy.

Indian Agriculture has made significant progress in food production. In the year 1994-95, the crop production has reached 183 million tonnes. It is estimated that by 2000 AD, the food requirement would be 225 to 250 million tonnes to feed an expected population of one billion. To meet this challenge, we must produce 45 to 70 million tonnes of additional food grains. Since available cultivable land is likely to remain constant, we require to raise our productivity to the level of 2 t/ha by 2000 AD compared to the present productivity level of 1.4 t/ha. This might be possible by the application of modern technologies using good seeds, fertilizers, irrigation and suitable plant protection measures.

The principal objectives of agricultural policies during the past 20 years were to achieve self-sufficiency in food and to increase farm income equitably. The increase in gross cropped area (12%) has been marginal while the area under irrigation has doubled. There has been a 20-fold increase in pesticide and fertiliser consumption.

The estimated demand for 2000 AD cannot be met any further by increasing the area under crop land (143 M ha) without irreversible damage to forest cover. The solution therefore lies in closing the gap between actual and potential yields and thus go vertical rather than horizontal in agriculture. The steep hike in fertilizer consumption during the period 1965-1984 was mainly attributed to the introdution of High Yielding Varieties and bringing more area under cultivation. The per hectare consumption of NPK increased from the meagre 0.6 kg in 1950 to more than 50 kg by 1989-90. It is now estimated that the fertilizer consumption is expected to rise about 20 million tonnes by 2000 AD.

Pesticide consumption in India has risen from 2000 tonnes a year in the fifties to about 1.20 lakh tonnes in 1989-90. At the same time, the cropped area under plant protection coverage has increased from 6.4 million hectares in 1960-61 to over 80 million hectares in 1988-89. Pesticides are used in about 25% of our total cultivated land.

8.3. ENVIRONMENTAL IMPLICATIONS OF AGRICULTURE

Intensification of agriculture has in fact brought about many concerns such as : Soil erosion, desertification, water logging, salinification, surface and ground water contamination from fertilizers and pesticides, resistance in weeds, pesticide resistance of insects and other pathogens, loss of genetic diversity, disruption of ecosystem etc.

Even if we ignore the potential long term problems of climatic change, sea level rise and enhanced ultra violet - beta radiation, there are several constraints which, if not addressed immediately, could result in serious famines. These constraints relate to ecological foundations essential for sustainable advances in crop and animal productivity. Four of these foundations - land, water, biological diversity and energy are particularly important.

Nitrogen of nitrogenous fertilizers may get immobilised in the soil or get volatalised as ammonia. It may escape into atmosphere as products of denitrification (N_2 and N_2O), or get leached to ground water as nitrate or nitrite. The atmospheric burden of N_2O is 1500 Tg (Terra grams) i.e., 1500 million tonnes and is increasing at the rate of 0.2% per annum of which agricultural land contributes 0.8 Tg/annum. After 100 years, nitrogen oxide accumulation is likely to assume alarming proportion. If this trend continues, environmentalists feel that N_2O along with chlorofluorocarbons (CFC's) accumulated in the stratosphere will progressively deplete ozone layer. As a result, the effectiveness of the ozone layer as a protective shield for the earth against UV radiation will substantially decrease.

8.3.1. Fertilizers, their use and Environment

Fertilizer has played a vital role in increasing food grain production. From 0.13 million tonnes in 1955-56, its use has increased to 12.2 million tonnes in 1992-93.

Unrelenting population pressure and the need to produce more per hectare land has put great pressure on the nutrient balance of soils. Whatever fertilizer is used it is rapidly removed by crops and the indicators are clearly showing that the soil fertility is being depleted. At this stage the vast resources of organic and inorganic nutrients available can be used in an integrated manner to supply soil nutrients. The use of chemical fertilizers can be supplemented by bulky organic manures, green manures, crop residues, human and industrial wastes, composts and biofertilizers.

8.3.2. Phosphatic Fertilizers and Heavy Metals

The impact of heavy metals on human beings has been of great concern for more than three decades. The most striking incidence was Minimata disease in which hundreds of Japanese were seriously affected and many died through mercury contaminated fish. Similarly, excessive dietary intake of cadmium (Cd) by human beings led to itai-itai disease. Health hazards associated with intake of cadmium included renal damage, anaemia, hypertension and liver damage. Other heavy metals such as Pb, Cr, Cu and Zn when discharged into the water streams can enter the food chain and threaten man. It has been reported that cadmium is always present in trace quantity with phosphatic fertilizers. Thus continuous use of this fertilizer may build up Cd both in soil and crops.

8.3.3. Ecology of Green Revolution

Green revolution brought with it environmental problems also. When apparently fertile virgin land was brought under the plough, it might become more vulnerable to climate. This happened in the low rainfall regions of Oklahama and Virgin lands of Russian Steppes. When the surface vegetation was ploughed up, no roots remained to bind the soil. It dried in the hot summers, and the steppe winds carried it away, creating dust bowl conditons. In such cases the fertility of the soil declines and the land may eventually be abandoned.

In the tropics, heavy rainfall may wash away newly cultivated soil, carrying with it, seed, fertilizers and the nutrients which made the soil fertile in the first place.

A more subtle danger of high technology farming i.e., vulnerability of attack by pests or diseases - is associated with monoculture, that is, the widespread cultivation of a particular crop variety. Areas with a large number of farms growing many different varieties of a single crop have an in-built immunity to large-scale destruction by pests or diseases.

Another problem is increased nitrate levels created by run-off into rivers from nitrogen fertilizers. It is not recommended for drinking water to contain more than 10 to 12 mg of nitrate per litre- yet concentrations of this order can now be found for instance, in rivers in the United Kingdom. Thirty years ago this was not so. Nitrate, in itself, is not harmful to human beings. But it can be converted to nitrite by the action of intestinal bacteria, especially in young children. Nitrite is poisonous, and prevents the transportation of oxygen in the blood; infants affected turn blue and are in serious danger of death by asphyxiation.

8.3.4. Salinity

The supply of water has caused problems. Primitively irrigated areas can later on become water-logged or salty, so that plants cannot grow. It is estimated now that the area brought under irrigation each year roughly equal to the area lost through water-logging and salinization caused by inefficient irrigation.

The remedy is expensive. Crops may be grown that tolerate the conditions until, in time water table falls and the rains wash the salts from the soil. More usually drainage must be provided to remove the surplus water, more irrigation water must be poured onto the land and the salts must be leached away using valuable water that is really needed elsewhere.

Another disturbing feature is the massive shift of irrigation from surface water to ground water. The proportion of cultivated area irrigated by ground water has risen from about one third in 1965-66 to over 50 percent now. The water table is going down steadily and in many areas the static component of ground water is being tapped. Sea water intrusion into the acquifer is already widespread in parts of Gujarat and is likely to become widespread in Coastal Tamil Nadu. Further, eroded soils loose from 10 to 300 mm/ha/year of water. Fortunately there is a growing interest in vermiculture. Earthworms and other soil biota can help increase water infiltration. By increasing infiltration rates from 6 to 21 times, earthworms simultaneously decrease surface water run-off and reduce soil erosion loss.

Contour-bunding on degraded land can prevent water run-off and soil erosion thereby helping to increase food production for growing population. Check dams and underground dykes hold back water run-off and increase groundwater. Watershed management increases the agricultural productivity and ground water level.

The Green Revolution has brought other problems also. The use of artificial fertilizers and pesticides has caused widespread poisoning of land, water, wildlife and ultimately humans. India has one of the world's highest rates of pesticide poisoning and pesticide residues far in excess of healthy limits have been found in food stuffs being sold in several cities.

Check your Progress 1,2,3 & 4

1. What are the Componds which deplete ozone layer ?
2. What are the supplements to chemical fertilizers ?
3. What is the reason for itai-itai disease ?
4. Nitrite is poisonous to children - How ?

Note (a) Write the answers in the space given below.

(b) Compare your answers with those given at the end of this unit.

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8.4. ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USE

1. **Development of resistance in insect pests** : The indiscriminate use of pesticides has led to the emergence of more virulent pests that have developed a built in resistance to some of the frequently used chemicals. This problem has culminated in an outbreak of several secondary pests to the extent that several minor pests have assumed the status of major pests.
2. **Harmful effects of pesticides :** Pesticides are inherently poisonous chemicals. One has to take proper care during their use. Farmers in our country are not educated and properly trained

regarding safe handling and use of pesticides. Accidental casualities from misuse of pesticides are often reported from several places in India. Contamination of food commodities with insecticides like parathion, DDT, BHC, endrin etc. are matter of serious concern.

The continued search for new pest control chemicals resulted in the discovery of many unknown pesticides of plant origin. Few which have shown good potential as pesticide include natural pyrethrins, rotenoids and niconoids etc.

The neem tree (*Azadirachta indica*) contains some biologically active chemicals called limonoids. Scientists have isolated several limonoids from seeds, bark and leaves of neem. These limonoids have different modes of action. It has been possible for neem products to control more than 200 species of insects, mites and nematodes. Neem based products have insecticidal properties against phytophagous insects, flies, mosquito larvae, beetles, moths, grasshoppers, butterflies and cockroaches. Several companies in India are marketing neem based pesticides *viz.*, neemark, neemguard, nimbicidin achook etc. More extension work is needed to popularise neem products.

Check Your Progress - 5 & 6

5. What are the bilogically active chemicals in Neem tree ?

6. Name the pesticides of plant origin.

Note : (a) Write the answers in the space provided below .

(b) Compare your answers with those given at the end of this unit.

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8.5. DESERTIFICATION/LAND MANAGEMENT

Attempts to increase food production from marginal land in semi-arid areas is a further cause of desertification. Where expanding populations of people and animals lead to over-grazing, the striped soil is vulnerable to erosion. Modern methods of agriculture - planting single crops instead of more traditional and varied cropping cycles and cutting down or eliminating fallow periods - leave the soil drained of nutrients and also at risk of soil erosion.

Irrigation schemes in areas without adequate drainage are another important cause of desertification. They can have two effects; they may raise the water-table and hence cause water-logging of the soil; or they may bring salts and minerals to the surface, leaving the land saline and infertile. The effect of overgrazing, overcropping, poor irrigation schemes and deforestation are some of the causes for desertification.

Globally about one-third of agricultural land is devoted to crops and the remaining two-thirds is devoted to pasture for live stock grazing. In India pastures and grazing lands hardly occupy 40% of agricultural land, although we have 20% of world cattle, buffalo, sheep and goat population. Overgrazing of all community lands has converted them into barren lands.

8.6. PODU CULTIVATION

The Slash-and-burn type of primitive farming has been practiced for centuries. Much of the Europe's forest was cleared in this way. It is also known as Shifting cultivation. In Andhra Pradesh it is known as Podu cultivation while in the North-East India it is known as Jhum cultivation. Usually the farmers choose a hillside where they then fell selected trees in such a way as to make them bring down others as they fall. Having removed such timber as they need, they wait for foliage

to wilt, then fire the area. After it is cooled they plant their crops in the spaces they have cleared. The soil is temporarily fertile, but in time its fertility drops and the forest begins to regenerate. Eventually the area is abandoned and a new area is cleared. A group of such farmers works in a kind of rotation, returning to each site every eight to twelve years, depending on the region, and the system can be continued for long periods. Because of the increase in population sites are visited more frequently, soil fertility is not restored fully after each visit, so the cycle accelerates, and in time the area is reduced virtually to a desert. That drives the farmers deeper into previously untouched land. Slash and burn farming is one of the major causes of tropical forest clearance today.

Check your progress - 7

What is meant by podu cultivation ?

Note (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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8.7. BIODIVERSITY AND AGRICULTURE

Planet earth is endowed with a rich variety of life forms and the teeming millions of these living organisms have been well knit by laws of nature. Biodiversity, as this assemblage of life forms is referred to, has now been acknowledged as the foundation for sustainable livelihood and food security. Biological diversity includes (1) Species diversity, (2) Genetic diversity and (3) Ecosystem diversity.

India is regarded as a mega-diversity area from the point of view of richness of biological diversity, two of the 16 most threatened biodiversity hot spot locations are present in our country. These are the Eastern Himalayan region and the Western Ghats. Both are paradises for valuable genes and are fast getting to the stage of Paradise lost.

The Indian region alone has given to the world nearly 167 economical plants whose centre of origin/diversity lies in India, along with their 320 species of wild relatives and land races, for example rice, sugar cane, minor millets, brassicas, rice-bean, asiatic vignas, egg plant, banana, citrus, mango, cardamom, jack fruit, jute, edible dioscorea, black pepper, seed amaranthus, turmeric, ginger, several umbellifers and cucurbits, colocasia, jasmine, some orchids, bamboos and betelnut. Further, the opportunities and scope provided by genetic engineering, which allows the transfer of genes among the species, will increase the opportunities which the genetic diversity provides for enhancing agricultural productivity.

Broadly speaking biological diversity satisfies human needs in two different ways - direct and indirect. Biodiversity will help not only in increasing agricultural productivity but also in developing disease-resistant and pest-resistant varieties. It was evident in the early 1970s when an epidemic called grassy stunt virus destroyed more than 1,60,000 hectares of rice in Asia. It could be controlled from a single sample of wild rice *Oryza nivara* from Central India, which was found to be the only known genetic source of resistance to the grassy stunt virus. Besides 20 major genes from wild rice for disease and pest resistance are used in rice improvement programme.

Much of the spectacular success in the development of plant variety in the rich industrialised countries in the North are attributed to the richness of genetic diversity at the centres of origin and primary diversity of economic species located in poorer developing countries of the south. Modern agriculture focussed almost exclusively on monocultures and on maximising grain productivity and marketable surpluses from every square centimetre of land. Starting with the inroduciton of the Green Revolution in the 1960s, Indian farmers have increasingly been tempted into accepting a

handful of so-called high-yielding varieties (HYVs) of seeds. Being widely adaptable and economically remunerative given appropriate inputs (irrigation, fertilizers, pesticides) these seeds have displaced the indigenous varieties over vast areas in India. It is estimated, for instance, that a handful of HYVs of rice are now grown over 70 per cent of the paddy land in the country, in the case of wheat, it is 90 per cent. How much of the traditional diversity has been lost is anyone's guess; in the Godavari district of Andhra Pradesh, it was found that the loss of rice varieties was 95 per cent. Similar has been the fate of dozens of other crops: minor millets, pulses, sugar cane, cotton. This has also been the fate of livestock.

Green Revolution has helped to greatly increase our food grains production, and we have to continue to feed a growing population. The problem is the very HYVs on which this increase in output has been achieved are dependent on genes obtained from existing crop varieties or from the wild. By their very nature, the viability of these HYVs drops within a few years necessiating the infusion of new genetic material. By destroying the very genetic diversity on which such replenishment is based, modern agriculture proves itself to be suicidal.

Biological diversity can be preserved for posterity in two ways - *in situ* and *ex situ*. *Ex situ* maintenance of species is provided by Botanical gardens, Zoos and Aquaria, and of gene pools by germ plasm banks (seed stores, *in vitro* collections and field gene banks) and grass roots, collections of plant cultivars and animal breeds. *In situ* conservation is done by protecting areas rich in biodiversity. These include biosphere reserves, national parks, sanctuaries etc.

To achieve leadership in agriculture sector, the emerging areas that need to be given urgent considerations are (1) Environmental Engineering and Pollution Control, (2) Efficient water resource management, (3) Integrated Nutrient Management, (4) Increased use of bio-fertilizers, (5) Intergrated pest management, (6) Biodegradable pest control chemicals, (7) Botanical and bio-pesticides, (8) Development of stress resistant crop varieties, (9) Raising new High Yielding Varieties and Hybrid seeds through somatic cell fusion or protoplast fusion, and (10) Multiplication of genetically engineered transgenic plants.

8.8. SUMMARY

Agriculture began over 10,000 years, when the earth's human population was about 10 millions. In India 72% of work force depend on agriculture. Indian Agriculture has made significant progress in food production. The crop production in 94-95 reached 183 billion tonnes. There has been a 20 fold increase in pesticide and fertiliser consumption. Intensification of agriculture has brought many undesirable things such as soil erosion, desertification water logging, salinification ,surface and ground water contamination. Mono culture, shift of irrigation from surface water to ground water, outbreak of secondary pests and contamination of food stuffs with pesticides are some of the associated problems. Biological diversity is required to be preserved for posterity by in situ and ex-situ methods. Environmental engineering, pollution control, integrated nutrition management and multiplication of genetically engineered transgenic plants are some issues to be concentrated upon.

8.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The Environmentalists are of the opinion that the N_2O along with chlorfluorocarbons accumulated in stratosphere will progressively deplete ozone layer.
2. The supplements to chemical fertlizers are bulky organic manures, green manures and crop residues, human and industrial wastes, composts and biofertilisers.
3. Excessive dietary intake of cadmium by human beings cause itai-itai disease.
4. Nitrates consumed by children are converted to nitrites by bacteria in the intestine and these nitrites prevent transportation of oxygen in blood resulting in death by asphyxiation.

5. The bilogically active chemicals in neem tree are called limonoids.
6. The pesticides of plant origin are pyrethrins, rotenoids and niconoids.
7. The Slash-and-burn type of primitive farming is called podu cultivation in Andhra Pradesh.

8.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Discuss the status of agricultural protection before and after independence in India. Assign the reasons.
2. How is green resolution achieved in India ? what are its advantages and disadvantages.
3. What are the environmental effects carried by intensive agricultural practices.
4. Write about desertification, salination, monoculture and land management.

II. Answer the following questions in about 10 lines each.

1. What is the status regarding agriculture in the post independent time?
2. How is large food demand met within India in the post independent period.
3. What are the adverse effects of green revolution ?
4. Briefly describe the environmental implications of pesticide use.
5. Write a note on desertification and land management .
6. What is Podu cultivation.
7. Discuss the relation between Biodiversity and Agriculture.
8. How should biodiverty be maintained ?

Prof. T. Pullaiah.

UNIT - 9 : ANIMAL RESOURCES

Contents

9.1. OBJECTIVES

After going through this unit, you will be able to :

* list out the principles of genetics,
* distinguish and differentiate the traditional and modern methods of breeding,
* list out the measures to be taken for the production of quality wholesome meat,
* describe the characters of good meat,
* describe the meat preservation and conservation methods,
* explain the methods of poultry management,
* list out the terms associated with poultry,
* explain the diseases caused to poultry,
* list out the fish fauna in various rivers and reservoirs in India and
* describe the pond and tank fisheries.

9.2. INTRODUCTION

The over growing human populations have necessitated the need to produce more quantum of food, a fundamental factor required for the maintenance of life. The food required for human consumption should be a balanced diet with rich source of proteins. Several techniques and methods have been employed to improve the production of the animal based proteins in the form of milk, eggs and meat. This has substantially increased the milk, egg and meat production.

9.3. GENETIC RESOURCES

Genetics could be called a science of potentials since it deals with the transfer of information from parents to offspring and between generations. Various basic concepts have been established by observation and experimentation as principles of genetics. Some of these principles are : 1. The gene is the unit of inheritance. 2. Genes are arranged in linear order on chromosomes. 3. Chromosomes are generally single units in reproductive cells (egg and sperm) but they are paired in fertilized eggs and in body cells. 4. Members of a pair of genes and chromosomes segregate to different reproductive cells. 5. Members of different gene pairs are assorted independently with respect to those of other gene pairs in the formation of eggs and sperm. 6. Genes are units of DNA (Deoxyribonucleic acid) and are capable of replication. They carry coded messages that can be transcribed and translated into polypeptides, which may be either enzymes or structural proteins. 7. Changes (mutations) occur in genes and in chromosomes. Although genes are extremely stable, they are susceptible to occasional change or mutation which provides new alleles. 8. Multiple genes control the inheritance of quantitative traits (e.g., size, pigmentation). 9. Genes in population establish an equilibrium, the level of which can be changed by such factors as mutation, migration and selection, phenomena that provide the basis for race and species formation. 10. Inheritance patterns are associated with different systems of mating such as inbreeding and outbreeding.

Traditional Vs Modern Methods

Modern high yielding varieties of plants and animals are derived from 'wild' stocks but their productivity has been enormously increased by a combination of genetic and husbandry methods. In the traditional method of breeding, e.g., a cow was mated with a bull during its heat period. This can now be accomplished with greater reliability by artificially injecting the cow with the semen of a bull. This method is called artificial insemination. Similarly, improved breeds of poultry have developed which give more eggs and meat by cross-breeding the indigenous ones with high yielding exotic ones.

Genetic selection can be very effective to improve the performance characteristics such as growth rate, food conversion efficiency, disease resistance, fecundity, etc. The fundamental concept of selection is that like begets like but there is always some variation within a group of individuals, from which preferred progenitors can be selected to derive the domesticated line of animals or plants towards that combination of characteristics which are considered desirable. Thus, selective improvement is achieved by choosing the ideal organisms as parents.

Hybridization between different species rather than between different strains of same species has been of limited value in agriculture but may have more potential in aquaculture. Sterility is often associated with interspecific hybrids but the valuable characteristics of sterility and monosexuality can also be produced by other methods. The artificial modification of the chromosome set of an organism (chromosomal engineering), also permits the production of monosex and sterile individuals.

Inbreeding and outbreeding (crossbreeding) of inbred lines is antoher potentially valuable genetic technique. Inbreeding refers to the production of offspring by closely related parents, while outbreeding means the production of offspring by unrelated parents. Inbreeding is helpful to develop a desirable genotype by selecting certain traits. This can be achieved by restricting the animals mating in a

small circle, and preventing the introduction of alleles from outsiders. This tends to decrease variation within the group and to stabilize the type. Inbreeding combined with selection over periods of time has produced many valuable breeds of domestic animals. Intense inbreeding may lead to an unfortunate situation in certain breeds of cattle. Recessive genes for undesirable characteristics have become concentrated in the descendants of certain common ancestors. The most valuable result of outbreeding is increased vigor of the hybrids as compared with inbreeds. This heterosis is now providing greater efficiency in the production of meat, milk and eggs. Outbreeding results in less constancy in the population but with an increase in vigor of individuals.

Gamete manipulation and storage is another improvement in genetics. Genetic improvement of organisms is facilitated by the relative ease with which *in vitro* fertilization can be achieved. A variety of techniques have been developed for the manipulation of gametes and for their short and long term storage outside the parent's body. Cryopreservation of spermatozoa has been relatively successful and provides valuable long term storage which permits crosses between strains or species whose spawning is geographically or temporally separated. It can also provide a bank of valuable genetic variation or a source of unselected material with which it is possible to compare the performance of improved strains.

Much of the knowledge currently available for laboratory animals is being extrapolated to higher animals, with a view to transfer todays gene splicing and recombinant DNA technology to domestic animals. In these attempts, it is desirable to integrate the exotic genes with the endemic genome especially with the genes which influence the economic traits.

9.4. MEAT

Meat and meat food products are important sources of nourishment for mankind. The term meat is used not only to the striated muscles but also to all parts of the body suitable for human consumption. The most commonly consumed animal meats are horse, beef, pork, sheep, goat and poultry. The human body requires water, proteins, fats, carbohydrates, minerals and vitamins to produce energy, to build tissues and to regulate the life processes. Meat being a highly efficient source of multifarious proteins, has an important place in the human diet. The value of food stuffs depends mainly on the calories that it can supply.

Meat is a good source of proteins and fats, which have a very high biological value. The meat proteins (97% absorbable) contain all the essential aminoacids which are very valuable in replacing and maintaining the body proteins and in building up the body cells. Fats (95% absorbable) provide necessary heat and energy. Meat contains negligible amount of carbohydrates. It is rich in phosphorus, iron, copper and other minerals. However, it is poor in calcium. Meat is one of the richest sources of A and B vitamins (particularly of thiamine, riboflavine and niacin). Animal liver, especially that of sheep, is an excellent source of A vitamin.

9.4.1. Production of Wholesome Meat

For the production of quality wholesome meat, the following measures are to be taken.

1. Animals should be given sufficient rest, drinking water and very little food before slaughter.
2. Weak, debilitated and diseased animals should be eliminated.
3. Slaughtering and bleeding of the animal should be done without causing excitement.
4. The carcass should be examined and all diseased or unfit material should be destroyed for human consumption.
5. Great care should be taken not to contaminate the edible portions of the carcass while removing

the stomachs, guts and other such operations.

6. Strict environmental sanitation control should be adopted against the contamination of meat during transportation from the slaughter house to the market and its sale to the public.

7. For long time preservation or transportation, refrigeration facilities should be provided.

9.4.2. Characters of Good Meat

Meat should neither be of a pale pink colour nor should it have a deep purple tint. It should emit little or no oduor and the odour should not be offensive. It should be firm and elastic to touch and should hardly moisten the fingers. The bone-marrow should be firm, solid and light rosy-red.

9.4.3. Meat-Borne Diseases

The flesh of sick animals when consumed can cause serious diseases. Meat-borne diseases can be discussed under the following heads.

A. Meat-borne diseases of chemical or toxicological origin : It would be better to condemn the meat of animals with a history of repeated and excessive consumption of poisonous plants. Certain visceral organs, especially the liver, act as a detoxifier and the storehouse of specific toxic substances may prove to be injurious to human health on consumption. Excessive use of chemical preservatives, antibiotics and exposure to insecticides will upset the health of the consumer.

B. Animal diseases transmissible to man through meat (zoonoses): The infection from meat to man can be transmitted through consumption or through direct contact with the abraded skin or even through the unbroken skin or through respiratory tract. The important meat-borne diseases are the Anthrax, Tuberculosis, Brucellosis, Salmonellosis, Botulism, Staphylococcal meat intoxication, Taeniasis and Trichinosis. Hence, the meat of animals which are affected with the above said diseases should be condemned and destroyed after ante-mortem examination before slaughter.

9.4.4. Preservation and Conservation of Meat

The condition of the animals and the treatment they receive before slaughter determine the keeping quality of meat. As such, the animals should be in good body condition and have adequate rest and food. In pigs particularly, it is a good practice to give feed rich in carbohydrates before slaughter, so that the quantity of muscle glycogen is increased, favouring the formation of lactic acid. Meat from such animals is especially suitable for preservation, as formation of lactic acid increases the keeping properties of meat.

Character of rigor mortis is a good criterion to judge the quality of the meat. In 'rigor mortis' or 'setting' or 'firming', muscles become hardened, rigid and stiffened. They lose their normal elasticity and extensibility and become somewhat opaque. It probably occurs due to formation of lactic acid in the muscles resulting in coagulation of the myosin. The muscles of the head are affected first and then it spreads backwards over the body. Rapid development of rigor mortis is an indication that the meat is unsuitable for making preserved preparations as it will not keep well.

The method of slaughter also plays an important role in determining the keeping quality of meat. Any method which i) does not excite or exhaust the animal ii) renders bleeding easy iii) prevents muscular bleeding and iv) does not bring about too great a change in the pH due to muscular cramps, will increase the keeping quality of the meat. Methods of slaughter practiced in various parts of the world include - cutting the throat, stabbing the throat or breast or the neck or napeneck or pitching. In India, the most common methods of slaughter are 'halal' and 'jhatka', which are performed according to the dictates of religion. Healthy animals which sustain mechanical injuries

or died due to accident can be used for immediate consumption.

Methods of preservation of meat: Spoilage of meat is brought about by the action of putrefactive micro-organisms and enzymes. Inorder to conserve the meat, such actions should be prevented by the following methods.

A. Physical conserving method: Conservation by extraction of water and drying the meat quickly in the air. In this method, the meat gets so hard and tough and does not become soft even after soaking or coooking. Meat powder and meat extract fall in this category.

B. Conservation into tight containers: Muscles of the meat are cut into small pieces and put into tightly soldered tin cans either in fresh, pickled or boiled condition. The cans are boiled for 3 to 4 hours under steam pressure and extract the air by making a small hole. The hole is again soldered and heated.

C. Freezing: By freezing the meat, the bacterial activity can be ceased completely. Accelerated freeze-drying (AFD) is one of the latest methods of dehydrating the meat. Meat produced in this manner is porous and easy to rehydrate.

D. Storage in cold rooms: In cold rooms, the meat is stored between 0°C and 3°C. However, several precautions should be taken in cold rooms to make the storage effective.

E. Chemical methods: Preservation with salt (salting or pickling) is one of the oldest methods of preserving meat. Several preservatives containing borax, acidic calcium or potassium or sodium sulphites, salicylic acid, ammonium acetate, sodium acetate, formaldehyde, lactic acid, glycerine have been tried for the conservation. Some of the important substances approved as preservatives are Ascorbic and iso-ascorbic acids and their salts, butylated hydroxyaisole (BHA), ammonium hydroxide, hydrochloric, lactic, phosphoric and tartaric acids, stearyl chlorotetracycline and oxytetracycline. Ozone and carbondioxide are also used for this purpose.

F. Other methods include smoking, irradiation, painting with film forming solutions around the meat, dipping in metallic pectinate, immersion in purified cotton-seed oil, coating with oat flour, etc.

Check Your Progress-1

What is meat? What are the characters of good meat?

Note : a) Write your answer in the space given below.

b) Compare your answer with the one given at the end of this unit.

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9.5. POULTRY

Centuries ago, man has domesticated chicken descended from wild fowls widely found in Central India. Superior breeds of chickens with high production are used now-a-days all over the world in poultry.

Four principal breeds are commonly used in poultry. They are american, asiatic, english and mediterrancan breeds. The popular american varieties are Plymouth Rock, Rhode Island Red, New Hampshire, etc.. The asiatic breeds are Brahma, Cochin and Langshan. The english breeds are Sussex, Orphington, Australop and Cornish. The mediterranean breeds are Leghorn, Ancona and Minorca.

Commercial chicken available in India for egg production are Arbor acres, Hyline, Dexlab XL Link, Bobcok (B.V.300), Shaver starcross 288, H.H. 260 Hisex white, Ross tint, Nick chick (H & N), Keystone, Tatum T.173 and Tatum. For meat purpose, the most suitable chicken varieties are Shaver Starbo, Pikh, Arbor acres, Anak, Cobb Vencob, Ross, Hybro, Kegg-bro, Samrat and Hubbard.

In India, Andhra Pradesh occupies the first position in poultry farming with an estimate of 10.8 million layers and with an annual egg production of 2450 millions. Punjab and Maharashtra occupy the next position with an annual production of 1320 and 1300 millions respectively.

The important aspects to be studied in poultry are :

1. Housing and Equipment
2. Management of chicks; growers and layers
3. Poultry diseases
4. Poultry products
5. Marketing and Economics.

In villages the birds are allowed to move freely in open places. They move around by picking the stray and natural food available at different places. But in this process, they loose much energy for foood collection. These chicks lay a few number of eggs, which is uneconomical to the poultry farmer. Hence, an alternative to this, poultry farming is initiated, where the movement of the bird is restricted. This type of poultry farming may be semi-intensive or intensive. In the intensive systems, birds are housed on deep litter or in cages arranged in tiers. Two types of birds are grown in poultry, 1. Layers for eggs and 2. Broilers for flesh.

9.5.1. Poultry Housing

Housing provides ideal conditions for the chikens so as to realise maximum production. The following are to be considered in selecting the location for a poultry house.

1. Poultry farms and houses are to be located in non-residential areas.
2. They should be elevated from the ground.
3. They should be constructed in east-west direction along their length for better ventilation.
4. They should be close to transport facilities.
5. The ideal temperature to be maintained in a farm is 30° C and the relative humidity in the air should be 50 to 60%.

The poultry house flooring is to be laid either with cement or napa slabs. Its roof should be constructed with cement sheets or Palmyrah leaves.

In the deep litter system, the farm floor should be covered with a layer of saw dust, paddy husk or straw as a litter with a thickness of 4 inches. This litter may be raised to about 7 inches in

summer. Care should be taken to keep the litter dry using lime. Litter should be changed once in a year. In litter type of farming, generally 2,300 to 2,800 sq.cm. space is required for a bird (light breeds).

In cage system, 25 chicks can be housed in 36" X 48" cage and these cages are arranged in 2 to 3 tiers in poultry houses. The cage system has advantages over deep litter system in

1. minimizing the wastage of space and food.
2. easy identification of cannibalistic birds and culling
3. the involvement of less labour
4. easy collection of eggs
5. less mortality
6. having clean and heavy eggs.

9.5.2. Poultry Eqipment

These include equipment for brooder, grower and layer houses.

Brooder house equipment	:	Hover type brooders, feeders, debeakers and chick guard.
Grower house equipment	:	Feeders and waterers
Layer house equipment	:	Feeders, waterers, laying nests, layer cages.

9.5.3. Methods of Poultry Management

Brooding: One day old chicks brought from hatcheries are grown in the brooders. Brooding is the process in which care and management of the baby chicks are taken upto 40 to 60 days from the time of hatching. 10' X 12' or 12' X 12' brooder accommodates 250 chicks. 90 to 95° F temperature is maintained with the help of a hoover and bulb. Iron mesh used to cover the brooder is called *chick guard.*

Initially broods are fed with wheat or corn granules or broken grains. Food given to them from the 3rd day is called *'chick mash'* which contains 20% proteins with high calorific value. At the end of brooding, temperature in the brooders decrease gradually from 75 to 80° F.

The chicks grown from 7th week to 20th week are called *growers.* Theese are transferred to grower rooms from the brooders in the 7th week. The mash given to them is called *'grower mash'* which contains 18% of proteins.

The chicken at the age of 18 to 22 weeks lay the eggs and are called *layers.* Mash given to them at this stage is called 'layer mash'. At this stage, these are transferred to cages.

Broilers : The chicken used for flesh are called *broilers.* One square foot space is required for the maintenance of a broiler. Equipment required is similar to that of layers. The baby chicks brought from hatcheries are kept in brooder for 2 to 4 weeks. The food given to them is called *broiler starter mash* which contains 25% proteins. At the 7th week, each bird weighs about 1 to 1.5 kg. The food given from 7th week is called *broiler finish mash* which contains more carbohydrates and less proteins.

9.5.4. Terms Associated with Poultry

Cannibalism or picking : Habit of one chick picking at or eating another animal is called cannibalism. Causes of cannibalism are :

1. Nutritional deficiencies
2. High energy diet
3. Over crowding
4. Pellet feeding
5. Insufficient feeding and water supply
6. Excessive light or inadequate aeration
7. Hereditary factors.

proper debeaking is the effective way of preventing cannibalism.

Debeaking : Trimming of beak is called debeaking. It is carried out twice, first in 15-20 days age chicks and the second in 12 or 18 week old birds. Electronic debeakers will be used for this purpose. Debeaking minimizes the food wastage by birds and also prevents cannibalism.

Dubbing : The removal of comb and wattles is called dubbing. Dubbing enhances the egg production by 2%.

Culling : Removing the sick, unproductive birds from the poultry farm is called culling.

Broodyness : It is due to hormones and ectoparasites. Estrogens are injected to convert broody hens into egg laying hens.

Prolapse : The egestion of oviduct in female birds is called prolapse. This is due to high fat content in the diet.

9.5.5. Poultry Diseases

Diseases in poultry are generally due to ectoparasites like lice, ticks, mites, fleas, etc. and endoparasites like bacteria, virus, protozoans, fungi and nematodes.

The common bacterial diseases encountered in poultry are Fowl cholera, Pullorum disease, Coryza, Chronic respiratory disorder (CRD) and Spirochaetosis or tick fever. The most familiar viral diseases in poultry are Ranikhet disease, Fowlpox, Marek's disease, Infectious bronchitis, Laryngotracheitis, Lymphoid leukosis, Gumboro disease and Viral arthritis. Fungal diseases frequently noticed in poultry are Thrush, Brooder pneumonia and aflatoxicosis. Protozoan disease is coccidiosis by Eimeria. For the redressal of ectoparasites DDT is used and for the removal of nematode parasites, carbon tetrachloride or turpentine can be used. Nutritional deficiency diseases are prevented by giving supplementary nutrients like vitamins and minerals along with water or food.

9.5.6. Management Methods

The following management methods should be followed for profitable poultry.

1. Good breeds are to be selected for farming
2. Poultry housing should be constructed scientifically
3. Good feed is to be supplied
4. Hygienic conditions are to be maintained
5. Care should be taken to maintain poultry housing in all aspects
6. Incurable and heavily diseased birds should be removed
7. Treatment should be given immediately to the diseased birds
8. Proper accounts must be maintained
9. Marketing of the poultry products should be taken up

10. The recent advances in poultry farming should be studied regularly to put them in practice.

Check Your Progress - 2

Name the common bacterial, viral, fungal and protozoan poultry diseases.

Note : a) Write your answer in the space given below.

b) Compare your answer with the one given at the end of this unit.

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9.6. INDLAND FISHERIES

India has extensive inalnd water bodies with sustainable fisheries of commerical importance. The term inalnd fisheries is generally used to include not only freshwater but brackishwater fisheries also. The principal types of Inland water bodies are rivers, reservoirs, irrigation canals, ponds, tanks, lakes, estuaries, backwaters and marshy swamps. In India, the five major river systems, naturally formed lakes and man-made reservoirs constitute great potential capture fishery resources. In addition, there are a large number of tanks and ponds which constitute the country's most valuable culture fishery assets. Excepting for a few tanks, which are exclusively constructed for fish culture, the rest are meant mainly to serve the needs of agriculture, drinking water, cattle or dhobi tanks and to a lesser extent for fish culture. In the ponds exclusively under private management, fish and prawn are cultured. At present, India's inland fish production is 1.4 million tonnes.

9.6.1. Riverine Fisheries of India

The riverine fishery resources of India comprise five major river systems with diverse geographical and climatic conditions. They also vary in the distribution and abundance of their fish fauna. While the principal rivers and their main tributaries have a total length of about 27,359 km, the canals and irrigation channels having a length of 112,654 km, form a network throughout the country.

I. Ganga River System

It has the total length of about 8,047 km. It is one of the largest river systems in the world, drains from the southern slopes of the Central Himalaya and traverse through the States of Haryana, Delhi, Uttar Pradesh, Bihar, West Bengal, part of Rajasthan and Madhya Pradesh. Main rivers are the Ganga and the Yamuna.

A. Fishires: It has the richest freshwater fish fauna of India. Important groups are the Indian major carps *(Catla catla, Labeo rohita, L. fimbriatus and Cirrhinus mrigala)*, mahseers (*Tor* spp.), hilsa (*Hilsa ilisha*), cat fishes (*Mystus spp., Wallago attu*, etc), clupeoids, prawns, etc. The average annual fish landings from the Ganga river system is about 680 tonnes.

B. Fish Seed Resources : The collection of seed (Eggs, spawn, fry and fingerlings) on a commercial

scale is prevalent in Bihar, Madhya Pradesh, West Bengal and Uttar Pradesh, with Bihar alone contributing 52% of country's total production. In the Ganga system, the major carp spawn is available from May to September. For spawn collection, shooting nets and for fry and fingerlings, cast and drag nets are commonly used.

II. Bramhaputra River system

It has a length of 4,023 km. It drains from the northern slopes of the Central and Eastern Himalayas, Assam, Nagaland, Tripura, Bhutan, Sikkim and parts of North-West Bengal.

A. Fishiries : There are about 126 species of fish belonging to 26 families, of which 41 species form the fisheries of commercial importance. Cat fishes predominate the catches, followed by major carps, minor carps, hilsa, prawns and others. The total annual fish landings from the river Brahmaputra vary from 200 to 300 tonnes. The principal nets used for fishing are gill nets, drag nets, bag nets, cast nets, dip nets, long lines, traps and clap nets.

B. Fish Seed Resources : The major carp spawn is available in the lower Brahmaputra. Fingerlings are collected at a few centres in the Darrang and Goalpara districts of Assam.

III. Indus River System

Only a small segment of Indus river system lies in the present India where the important rivers are the Beas and the Sutlej covering the States of Himachal Pradesh, Punjab and Haryana.

A. Fisheries: The rivers harbour the exotic rainbow trout and brown trout in their uppear reaches and a variety of carps and catfishes in their lower sector. The trout streams of Kashmir constitute one of the worlds's richest sport fishing waters, attracting anglers and tourists from all over the world.

B. Fish seed resources : Two good spawn collection centres were located on the river Sutlej whereas the river Beas was found unsuitable for spawn collection. Fry and fingerling collections in these rivers are the only sources of fish seed for the Punjab state.

IV. East Coast River System

The main rivers of this system are the Mahanandi, the Godavari, the Krishna and the Cavery. They have a combined length of about 6,437 km.

A. Fisheries: The principal fish groups which support the fishery of the river Godavari are carps, catfishes, hilsa, murrels, prawns, etc. The total annual fish landings of the river Godavari varies from about 200 to 350 tonnes. The fishing gears used in river Godavari are the gill nets, seines, drag nets and cast nets. Seventy eight species of fish from the river Krishna (catfish dominant) and eighty species from the river Cauvery have been reported. Tributaries of the Cauvery from the Nilgiris have coldwater fish like trout and tench.

B. Fish seed resources: In the Godavari at Rajahmundry, the percentage of major carp spawn is only about 20%. At Nanded on Godavari, *Catla catla* was found to be the only major carp available in spawn in small quantities. Fry and fingerlings of major carps as well as juveniles are collected during the post monsoon months from the paddy fields in deltaic Godavari, Kolleru lake and the inundated low banks at Eturunagaram. These are collected by using basket traps.

In the Cauvery at Hogenakal and Kulithlai, both the eggs and spawn collections are usually of minor carps (*Cirrhinus reba* and *Labeo kontius*). In the deltaic paddy fields of Thanjavur district, the Indian major carps are available as fry and fingerlings. Dip nets and basket nets are used for their collection.

V. West Coast River System

In the south, the west coast river system drains the Peninsular India west of Western Ghats but further north, it includes the basins of the Narmada and the Tapti (the longest rivers with rich fauna)

and the drainage of Gujarat. The length of the rivers of this region is about 3,380 km.

A. Fisheries : There are about 23 species of fishes, the major groups being the carps, catfishes, murrels, spiny eels and featherbacks. the average annual fish landings is about 42 tonnes. The gears commonly operated are cast nets, gill nets and long lines.

B. Fish seed resources : The Indian major carps constitute about 20-25% of the total spawn collections from the Narmada in Madhya Pradesh. The percentage of *Catla catla* seed is high in Gujarat state. Narmada is the only river in India which is presently exploited for its mahseer seed regularly during October-January every year. In the river Tapti, at Bodhan and Kathor centres in the Surat district of Gujarat, *Catla catla, Labeo rohita* and high percentage of minor carp spawn are available.

9.6.2. Reservoir Fisheries

A reservoir can be defined as a large expanse of impounded water artifically created by putting across a stream an earthen, stone masonry or concrete bundh or dam. Reservoirs are formed for purpose of agriculture, irrigation, hydroelectric power, navigation, recreation, fishery development, preventive measure against floods and any other catastrophic event.

The different terms dam, weir, anicut, barrage, etc. take their origin variedly. They bear sluice openings for discharging water.

Reservoirs of India : Reservoirs are located both in hilly regions as well as in plains. The total number of reservoirs in India is 2365 (Large 58 with > 5000 ha, medium 152 with 1000-5000 ha and small 2155 with <1000 ha), covering a total area of 2 million hectares. The average annual fish production per hectare from these waters is very low, being 14.2 kg. Some of the most important reservoirs are given in the following table.

River System	River	Reservoir	State	Area (ha)
Ganga	Chambal	Gandhisagar	Madhya Pradesh	64,750.000
	Rend	Rihand	Uttar Pradesh	46,620.000
	Ganga	Kangsabati	West Bengal	11,396.000
Indus	Sutlej	Govindsagar	Punjab	16,838.720
East Coast	Mahanadi	Hirakud	Orissa	75,592.000
	Krishna	Nagarjunasagar	Andhra Pradesh	30,303.000
		Tungabhadra	Karnataka	37,814.000
	Cauvery	Stanley	Tamilnadu	15,343.750
	Periyar	Periyar	Kerala	606.000
West Coast	Tapti	Ukai	Gujarat	51,282.000

The fish contributing to the major fisheries of the reservoirs located in the northern river systems (Ganga, Brahmaputra and Indus) include T*or putitora, T. tor, Acrossocheilus sp., Schizothorax plagiostomus, Labeo dero, L. pangusia, L. rohita, L. boga, L. clabasu, L. bata, L. gonius, Catla catla, Cirrhinus mrigala, Puntius sarana, Bagarius bagarius, Wallago attu, Silonia silondia, Pangasius pangasius, Rita rita, Mystus* spp., *Ompak bimaculatus, Clupiosoma garua, Eutropiichthys vacha, Mastacembelus armatus, Garra gotyla,* etc. In the reservoirs of southern East-coast river systems (Mahanadi, Godavari, Krishna and Cauvery) the important fishery includes *Catla catla, Labeo rohita, L. fimbrialus, L. calbasu, L. bata, L. boga, L. boggut, L. pangusia, L. gonius, L. porcellus, L. kontius, Puntius, sarana, P. kolus, P. pulchellus, P. dobsoni, P. curmuca, P. dubius, P. carnaticus, P. pulchellus, P. dobsoni, P. micropogon, Cirrhinus mrigala, C. reba, C. horai, Osteobrama spp., Thynnichthys sandkhoi, Rita pavimentata, Mystus cavasius, M. seenghala, M. aor, M. punctatus, Tor khudree, T. mussulah, T. neilli, T. mosal, Bagarius bagarius, Pangasius pangasius, Wallago attu, Silonia childreni, Etroplichthys goongwaree, Pseudotropis taakree, Ompak bimaculatus, Osphronemus goramy, Etroplus*

spp., etc.

In the reservoirs of the west-coast river system (Narmada-Tapti river system), both Gangetic and Peninsular fish fauna are intermingled. In addition, the important economic species are *Labeo nigrescens, Puntius thomassi, P. jerdoni, P. filamentosus, P. curmuca, P. pulchella, Ompak malabaricus,* etc.

Several morpho-ecological changes occur in the productvity of reservoir when the riverine environment is transformed to lacustrine environment by damming the waters.

Development of Reservoir Fisheries :Inorder to develop the fisheries of the Indian reservoirs the following measures are suggestiable for adaptation.

i) Survey of the fish fauna of the river before impoundment of the reservoir.

ii) Clearance of submerged obstructions like tree trunks, buildings, weeds, etc. to permit easy exploitation of fish.

iii) Establishment of fish farms at dam sites for effective stocking of fish in reservoirs.

iv) Dense stocking of commercially important species of fish to get a maximum yield on an economically sound basis.

v) Survey of fish seed resources to decide the necessity and intensity of stocking from extraneous sources.

vi) Rehabilitation of fishermen and organisation of cooperative societies on the periphery of the reservoir.

vii) Topographical survey of the reservoir substrata.

viii) Experimetal fishing to determine the rate of catch and efficiency of nets.

ix) Commercial exploitation by either a) departmental fishing b) lease by auctioning c) issuing licenses to cooperative societies of fishermen and d) fishing on royalty basis to limit the extend of capture.

x) Provision of transport and marketing facilities at fish catching centres.

xi) Conservation and proper management of fish stocks.

Merits in the Constructions of Reservoirs

1. The production and catch rate of fish can be increased by taking good measures and techniques.
2. Alteration or manipulation of hydrobiological regimes increase fish growth rate so that higher sustainable yields can be achieved.
3. Transplantation and acclimatization increases the yield of reservoir.
4. Reservoirs are the means or measures of control of floods and other catastrophic events, recover man's living rate, preventing famine conditions.
5. Increases production through the culture of exotics and genetically viable species thereby filling unoccupied eclological niches through polyculture techniques.
6. Provision for recreation, navigation, irrigation, agriculture and hydroelectric power generation.

Demerits in the Construction of Reservoirs

1. Loss of replenishing stocks of andromous food fishes because the dam construction leads to blocking of migratory runs of fish adversely.
2. Reduction of productvity and fertility during trophic depression phase after initial filling of the

reservoir.

3. Overpopulation and forage leads to competition and finally mortality of some species.
4. Hydroelectric installations are hazardous to the movement of both migratory fishes of feeding and breeding.
5. Oxygen depletion at times of straficication leads to mortality and lack of nutrients thereby lessening the productvity.
6. Chemical treatments and pollution through various ways leads to the death of fishes of commercial importance.
7. Presence of unwanted fish and predatory fish compete and limit the availability of nutrients and food organisms to commercially viable food fishes.
8. Submerged vegetation, tree trunks, boats, etc. cause obstructions in the movement of fishes as well as for netting operations.

9.6.3. Pond and Tank Fisheries

Ponds and tanks constitute the most valuable culture fishery assets. culture of fish in ponds in India is an age old practice. As a source of food production, fish culture in ponds is gaining importance extensively all over the country both in private and public sectors. In India, culture of fish in freshwater ponds is carried out by adopting the polyculture system using the Indian major carps, viz., *Catla catla* (catla), *Labeo rohita* (rohu), L. *fimbriatus* (fimbriatus) and *Cirrhinus mrigala* (mrigal), etc. under semi-intensive and intensive culture system. The exotic carps such as *Ctenopharyngodon idella* (grass carp) and *Hypophthalmichthys molitrix* (silver carp) are also cultured along with Indian major carps in some parts of India. The common carp, *Cyprinus carpio* is the most popular fish in some parts of India, which is cultured singly or in combination with Indian major carps. The culture of commercially important air-breathing fishes such as *Clarias batrachus* (magur), *Heteroneustes fossilis* (singhi), *Channa* spp. (murrels) and *Anabas testudineus* (koi) are also practiced in a few ponds of India. Recently, freshwater prawn culture (mostly with *Macrobrachium rosenbergii* and *M. malcolmsonii*) and brackish water shrimp culture (mostly with *Penaeus monodon* and *P. indicus*) in ponds has taking rapid strides owing to its faster growth rate, high demand and lucrative price in foreign market.

In freshwater culture, the culture of Indian major carps is extensive and very popular in India since these fish have higher growth rate and fetch a good price in Calcutta market. Generally, the fish culture ponds ranges in size from 0.2 to 20 ha. The fish yield ranges from 2 to 15 tonnes/ha/year depending on the management practices adopted by the farmer.

The primary requisite for fish culture in ponds is the availability of water. A pond with one meter depth of water for atleast a period of 6 to 9 months availability is considered as a potential area for fish culture. Alkaline soils and waters have a high productivity than the acidic ones. Clayey soils have least loss of water due to seepage and are considered suitable. All soils and waters could be manipulated and used for fish culture provided there is enough water for a considerable time.

Major carps do not breed in pond waters hence fish seed is one of the major inputs in culture ponds. Initially, the fish spawn or fry are stocked in nursery ponds which are collected either from natural riverine sources or from hatcheries where the seed production is carried out by the technique of 'induced breeding'. For getting higher realization and yields, farmers prefer hatchery seed since riverine collections often contain a mixed lot resulting in lower yields. Generally, spawn at the rate of 20 to 50 lakh/ha are stocked in nursery ponds. For a maximum realization or survivability, the nursery ponds should be pre-prepared by following several steps such as ploughing, liming, controlling the predatory and weed fishes, aquatic weeds and insects, producing sufficient fish food organisms such as plankton through pond fertilization using both organic and inorganic fertilizers at required doses. Sometime after stocking the spawn, when plankton density decreases; supplementary feeds (rice bran, oil cakes, fish meal, minerals, vitamins, etc.) are to be provided until they grow to the

size of a fry of about 1 to 2 inches. At this size, they are to be transerred to the rearing ponds and made to grow to the size of a fingerling. Then they are used for stocking in the stocking ponds to grow to the table sized fish. Generally, the fingerlings of catla, rohu and mrigal are stocked at the rate of 3000 to 9000./ha. For proper growth and maxmimum sustained yield of carp, the ponds should be regularly monitored by maintaining optimal water quality parameters and plankton, the natural food of fishes. These can be achieved by using lime and fertilizers at required doses at regular fortnight intervals in the pond. In addition, supplementary feeds are to be provided @ to 10% body weight of fish to increase the carrying capacity of the ponds and to get maximum final yeilds.

In poorly managed ponds, low growth rate or mortality of fish occurs due to several reasons. Some of the reasons are the detereoration of water quality (mostly dissolved oxygen depletion, increase of toxic gases such as ammonia, hydrogen sulphide, etc. and formations of algal blooms due to indiscriminate use of fertilizers and feeds), poor quality and improperly stored feed, addition of toxicants, predators, diseases due to infections and parasitic organisms. The early detection and treatment for the above deleterious causes is often crucial for saving the crop from decimination. Among diseases, bacterial, fungal and protozoan infections cause heavy loss to the farmers. Lower yields and sometimes heavy mortality of fish are due to monogenetic trematode parasites (*Dactylogyrus* and *Gyrodactylus*) as well as copepod parasites (*Argulus*, *Lernaea* and *Ergasilus*).

Harveting of fish is carried out either once or twice or thrice during the grow-out period. Harvested fish are packed in bamboo baskets or plastic craters with equal quantity of ice and transported mainly to Howrah market and also to northeastern states of India.

In brackish water ponds which extend all along the coastal belt of India, shrimp culture has been developing at a tremendous pace. Brackish water fish culture is also practiced in several parts of India. The important cultivated Indian brackishwater fishes are *Elops* spp., *Megalops cyprinoides*, *Chanos chanos*, *Mugil* spp., *Rhinomugil corsula*, *Polynemus* spp., *Etroplus suratensis*, *Lates calcarifer*, etc. Pond shrimp culture is practiced mostly by culturing the tiger shrimp, *Penaeus monodon*, white shrimp, *P.indicus*, *P. semisulcatus* and *Metapenaeus* spp. Generally the culture period lasts for about 3 to 5 months. Initially the nursery ponds are stocked with seed (PL 20) either collected form natural source or from hatcheries. After one month, they are transferred to stocking ponds. Regular water quality management by monitoring the dissolved oxygen, salinity, pH, nutrients, etc. is very important in shrimp culture since these are very sensitive to rapid changes of water quality. Disease diagnosis and immediate remedial measures to control the diseases is an important aspect for profitable culture. Ponds are to be fertilized in order to develop natural food in the pond. In addition, supplementary feed pellets rich in proteins are to be provided for getting better yields. Depending on the management practices adopted, the yield varies from 500 to 1000 Kg/ha/crop in extensive and improved extensive culture systems. In semiintensive culture methods, the yield varies from 2 to 6 tonnes/ha/crop.

Culture of fish or prawn in ponds or seed production is very remunerative and could be taken up as a full time profession or as a part time job. It not only solves the employment probelm by self-employment but each such venture also provide employment for few others.

Check Your Progress - 3

What is composite fish farming ? Name the fish species commonly employed in fish culture.

Note : a) Write your answer in the space given below.

b) Compare your answer with the one given at the end.

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9.7. OCEAN FISHING

The marine fisheries of India are of utmost importance in augmenting the country's food resources and fetching in considerable amount of foreign exchange through the export of frozen and processed marine products to several countries. The fisheries harvested at present are constituted by pelagic and deep sea components, rich in varieties of fin fish species, crustaceans, molluscs, etc. Besides, the major capture fisheries which hold a big place in the country's fisheries production, a breakthrough has been effected in quite recent years to initiate the culture of selected species of fin fish, crustaceans and molluscs. The present level of marine fisheries production in India is about 1.8 million tonnes which shows more than 50% increase over the production in the late fifties of the century.

India occupies a central position in the northern portion of the Indian Ocean with the Bay of Bengal on the east and the Arabian sea on the west. The fish yield from the Indian Ocean region has been much lower than from the other oceans. The sea environment is very complex. The physical features of the land bordering the ocean, fluctuations in land and sea temperatures, the influence of wind and water currents, variations in the salinity of waters, upwelling, nutrients, intensity in the production of phytoplankton and zooplankton, oxygen saturation levels and a number of related factors have a great bearing on the scope for fisheries exploitation. India with a long coastline (6090 km) and a wide continental shelf in certain regions has good pelagic fishery resources supported chiefly by sardines and mackerels and also an abundance of demersal fishery resources consisting of benthic fishes, shrimps and other crustaceans in fair quantities. About 75% of the total fish yields come from the west coast regions because of a relatively broader continental shelf with upwellings of a higher magnitude than those found in the east coast. The fisheries of east coast are conspicuous by the virtual absence of mackerel and sardine shoals, being constituted by less valuable clupeoids, horse mackerels and silver bellies.

Indian marine fisheries are primarily exploited by a variety of indigenous traditional gear (nets) and non-machanized craft (boats), operating in shallow coastal waters less than 20 m deep. During the last two decades, significant progress has been made in machanising fish boats and introducing modern gear such as shrimp trawls and purse seines, etc. which enable the fishermen to exploit the fishery in deeper off-shore waters.

Fishing gears used are rampani, shore seine, nylon gill net, bottom set gill net, gill net, drift net, bagnet, purse seine, trawl net, boat seine, excircling net, hooks and lines, etc.

The Gujarat coast is well known for the fisheries like Bombay duck, (*Horpodon nehereus*), pomfrets (*Parastromateus niger* and *Pampus* spp.) and elasmobranchs (*Scoliodon, Carcharhinus, Sphyrn* and *Galeocerdo*). Prawns are also abundant here. Principal fish of the Maharastra state are Bombay duck, sciaenids (*Pseudosciaena, Otolithoides* and *Sciaena* spp). and other clupeoids (*Sardinella* spp., *Thrissocles* spp., *Anchoviella* spp., *Dussumeiria* spp., *Kowala*, etc.) Pomfrets and mackerel (*Rastrelliger kanagurta*). Other important fishes are catfishes (*Tachysurus* spp., *osteogeneiosus* and *Plotosus* spp.), elasmobranchs, ribbon fishes (*Trichiurus* spp., *Lepturacanthus* spp., etc.); eels, polynemids, *Carnax* spp. and seer fish (*Scomberomorous* spp.). Maharashtra ranks second in marine fish landings in India.

The Konkan coast (Goa) is famous for its large shoals for mackerel, *Rastrelliger kanagurta*, which continue to dominate the coasts of Karnataka and Kerala. Karnataka and Kerala coasts are equally well known for oil sardine, *Sardinella longiceps* and its related species and anchovies.

In the Kerala coast, in addition to oil sardines and Indian mackerel, several carangids, sharks and rays, sole, catfishes, small scianeids, pomfrets and others contribute to the fishery. Extensive beds of sea prawns also occur adjoining the coast of Kerala.

In the Kanya Kumari area, demersal and littoral perches such as rudder fish and rock perches ocur in abundance. Other important fishes are white fish, silver bellies, small sardines and anchoives.

Tamilnadu and Pondicherry ranks third in marine catches in India. The major fisheries of this region are the seer fish (the most lucrative fishery around Madras), sardines, elasmobranchs, ribbon fishes, carangids, sciaenids, perches, catfishes and prawns. The palk bay is one of the best fishing grounds for smaller sardines, silver bellies, common white fish and half beaks.

Andhra Pradesh ranks fifth in marine fish landings. Andhra Pradesh and Orissa coastal fisheries consist of miscellaneous groups of sardines, percoids, sharks, etc. Along the West Bengal coast, the most important fishes landed comprise various sardines, anchovies and clupeoids.

9.8. SOCIAL IMPLICATIONS

Fishing is one of the traditional occupations. It provides sustenance directly and without much time-lag between the effort and its results as is the case in agriculture. In olden days, fishing is one of the occupations of the poorest stratum of the society. Because of the nature of the activity, fishing has largely remained a non-commercialized occupation. On account of lack of adequate possibilities of storage and preservation, selling remains confined to the local markets. Most of the fishermen being socially and economically backward, live in pathetic conditions in their old hutments without basic civic amenities. Eventhough fisheries engage a sizeable population and provide a source of income to lakhs of rural coastal households belonging essentially to poor fishermen communities, relatively very little effort has been exercised for the upgradation and uplift of the industry. In a view to develop the weaker sections like fishermen, the co-operative organizations are started. Co-operative institutions play a significant role in the socio-economic devclopment of fishermen in the following ways.

a) organization of fishermen at dispersed centres or locations

b) providing them with short and long term capital for meeting their working capital requirements and for investments in mechanization of crafts respec ively.

c) purchasing the costly inputs like fishing nets and other equipment.

d) preservation of fish catch by setting up cold storage processing plants on a large scale and

e) ensuring higher and stable levels of income to member fishermen.

Till the middle of the present century, fishing in the sea was by conventional artesenal craft viz., the catamaran, navas, etc., operating in shallow coastal waters with taditional nets. During the sixties and afterwards, significant progress has been made in machanizing fish boats and improving the modern gears such as shrimp trawl, purse seines, etc. By the end of 1977, the number of mechanized boats in the country were estimated to be 8,086. Bigger vessels are equipped with frozen storage facilities and efficient gear that enable the craft to be on the sea for about 24 days and to exploit the fishery in deeper offshore waters. With this progress as well as by the formation of co-operative societies, the socio-economic condition of the fishermen was improved and many entepreneurs also entered this field and exploited the seas. Upto 1980 capture fisheries both from sea and rivers were catering to the nutritional needs of the nation. Thereafter, as the capture fishery production became

steady, increased attention was paid towards culture fisheries.

Culture fisheries is one of the major income generating activities. It brings about integrated rural development. Along with crop production and animal husbandry, agriculture improves the quality of the life of rural poor. The profits realized in fish culture attracted many people to convert their agricultural lands into myriads of fish ponds. Even professionals like doctors, engineers, lawyers as well as many private companies are coming forward to take up aquaculture as a full time occupation. In Andhra Pradesh, especially in lake Kolleru area, the low-lying agricultural fields were frequently inundated by the flood waters damaging the paddy crop. The uncertain paddy production in these flood prone areas prompted the farmers to change their main avocation from agriculture to aquaculture. The successful fish culture has influenced the tremendous expansion of freshwater aquaculture in the country which inturn provide impetus to the development of brackish water aquaculture, another recent revolutionary change taking place in the country. Some of the farmers not aware of the scientific culture practices are indiscriminately using the fertilizers, feeds and pesticides in the ponds. It is ultimately leading to an environmental problem resulting poor yields of culture organisms and heavy loss to the farmer.

Aquaculture is providing regular employment to the people and indirectly it is supporting people involved in various supplementary activities such as fish feed supply, fish harvest, ice manufacture, packing, transportation, etc. in the region.Essential infrastructure and communication facilities such as roads and telecommnication net works are also improved along with the growing aquacultural activities.

Potentiality of aquaculture has transformed and provided self-confidence to the rural people to such an extent that even landless farmers are now taking up the tanks and ponds on lease basis to start fish/shrimp farming for their livelihood. Through the industry is still suffering from major constraints like fluctuating market prices, increase in the cost of inputs, additional taxes and disease problems to the fish, the industry is still flourishing because fish farmers are finding solution to most of these problems and it is profitable than agriculture especially in low-lying areas.

9.9. SUMMARY

The food requied for human consumption should be a balanced diet with rich source of proteins. Animal based food, viz., the eggs, meat, fish, etc. form a balanced diet. To improve the production of these animal resources, genetic selection, hybridization, inbreeding, outbreeding, cryopreservation, etc. are often employed.

Among the animal based foods, meat and meat products are the important resources for manking. The most commonly consumed animal meats are : horse, beef, pork, sheep, goat and poultry. While producing the quality meat, care should be taken to choose healthy animals and environmental sanitation control should be adopted. The meat chosen for consumption should neither be a pale pink colour nor a deep purple tint. It should not emit bad odours and it shoud be firm and elastic. The flesh of sick animals when consumed can cause diseases of a) chemical or toxicological orgin b) animal diseases transmissible to man through meat and environmental contamination of meat. The meat produced from different animals should be properly preserved by employing scientific methods.

In polutry two types of birds are grown. They are layers (for production of eggs) and broilers (for production of flesh). These chiks are grown in semi-intensive or intensive methods by employing deep litter methods or cage culture method. The diseases in poultry are due to ecto-or endoparasites, bacterial and viral infections or nutritional disorders. Proper management methods are to be employed in poultry farming to get good yields.

The term fisheries include the finfishes (fishes) and shell fishes (shrimps, molluscs, etc.). The inland fisheries include riverine fisheries, reservoir fisheries and tank/pond fisheries. In riverine and reservoir fishery, capture fishery is resorted to, whereas in tank and pond fishery, culture fishery

is practiced. Normally, the three major carps namely *Catla catla, Labeo rohita* and *Cirrhinus mrigala* are cultured by enriching the natural food (plankton) by the fertilizers or by giving supplementary food like deoiled rice bran, groundnut oilcake, sunflower cake, soybean cake, etc. In brackish water ponds, culture of shrimps (*Penaeus monodon and P. indicus*) is taken up.

The capture to culture fishery has enormously changed the life style of the fishermen communities. In the recent years fish culture has attracted the attention of people from all walks of life. Even doctors, engineers, lawyers, etc. are entring into the fish/shrimp culture on a large scale. Fish culture also helped in raising subsidiary units like processing plants, ice industry, transport, etc. Due to culture fishery, in areas like Kolleru, the infrastructural facilities like roads, electricity, telecommunications are developed.

9.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The term meat is commonly used for the striated muscles of horse, beef, pork, sheep, goat and poultry. But all parts of the body suitable for human consumption is also referred to as meat.

2. The common bacterial diseases are Fowl-cholera, Pullorum disease, Coryza, Chronic respiratory disorder (CRD) and Spirochaetosis or tick-fever. The well known viral diseases in poultry are Rankhet disease, Fowl-pox, Marek's disease, Infectious bronchitis, Laryngotracheitis, Lymphoid leucosis, Gumbora disease and viral arthritis. The fungal diseases encountered in poultry are Thrush, Brooder peneumonia and Aflatoxicosis. The protozoan disease known in poultry is Coccidiosis.

3. Composite fish culture is the culture practice in which more than one species is employed for culture so as to tap the total resources in the entire water column.

Commonly culturable fishes in ponds are the Indian major carps such as the surface feeder, *Catla catla* (catla), the column feeder, *Labeo rohita* (rohu) and the bottom feeder, *Cirrhinus mrigala* (mrigal). The exotic carps like *Ctenopharyngodon idella* (grass carp) and *Hypophthalmichthys molitrix* (silver carp) are also cultured along with the major carps.

9.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. What are the meat borne-diseases ? Add a note on the preservation and conservation of meat.
2. What is poultry housing ? What are the ideal conditions requied for the selection of a poultry house.
3. Give an account of the riverine fisheries of India.
4. Explain in brief the tank fisheries of our region.

II. Answer the following questions in about 10 lines each.

1. Give an account of the measures taken for the production of wholesome meat.
2. Give an account of the methods of poultry management.
3. Briefly explain the reservoir fisheries of India.
4. Give an account of the marine fish resources of Gujarat coast.

Prof. M.K. Durga Prasad.

BLOCK - 3
ENERGY FUTURES

UNIT - 10 : CONVENTIONAL ENERGY SOURCES

Contents

10.1. OBJECTIVES

After completing this unit you will be able to :

* define and classify different forms of conventional energy sources.
* explain the principles involved in energy extraction.
* describe merits and demirits of conventional energy sources
* describe the issues and challeges related to these sources.

10.2. INTRODUCTION

Energy is the basic force responsible for running the machine of life. Infact energy is the capacity to do work and all living things must work. All organisms like a virus, a bacterium, small or tall trees, animals or human beings need energy. The sun is the source of all energy forms. Energy plays a vital role in the economic development of a country and welfare of the human beings. Indeed, a direct correllation exists between the level of energy consumption and economic development. The standard of living is found to rise with increase in per capita energy consumption. Energy is some or the other form which is essential for every type of economic activity like domestic, agriculture, transportation, industrial or commercial. About 60% of the total primary energy supply in India comes from commercial energy sources like coal, oil, gas, hydro and nuclear sources. The balance is met for non-commercial sources like fire wood, animal and agricultural wastes. Energy can be derived from a variety of natural sources which can be classified into conventional energy soures and non-conventional energy sources.

10.3. CONVENTIONAL ENERGY SOURCES

Conventional energy source are also called finite or exhaustible sources of energy in which fossil fuels like coal, oil, natural gas and nuclear fuels are used. Non-conventional sources of energy are those from which there is a continuous flow of energy in our environment which can be tapped. These are renewable and non exhaustible which includes solar energy, wind energy etc.

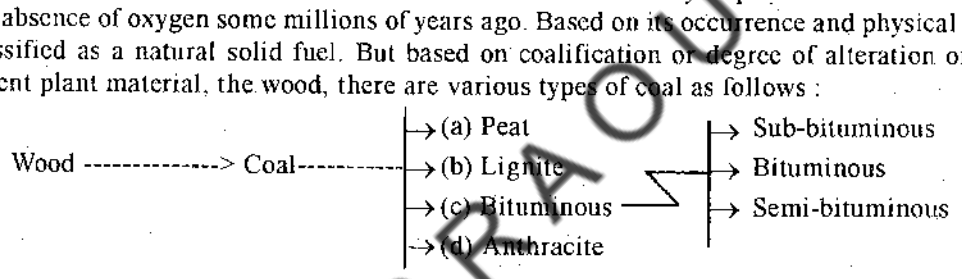
10.3.1. Fire Wood

It is natural solid fuel. It can be kindled easily and gives maximum intensity of heat very quickly. It is obtained from forest. Freshly cut wood contain 25 to 50% of moisture which on air drying reduced to about 15%. It consists of carbon (C), Hydrogen (H), Oxygen (O) etc. The average composition of wood on dry moisture free basis (percentage basis) is C = 55, O = 43, H = 6, N = 0.5, ash = 1. The calorific value of air dried wood is about 3,500 to 4,000 Kcal/kg. fire wood burns readily producing a long and non-smoking flame producing a very little quantity of ash. Wood largely used as a domestic fuel. Its industrial uses like boiler fuel etc are limited due to rapid ignition, high intensity of flame and quick burning. Generally wood prepared for fuel is called as fire wood.

10.3.2. Coal

Coal is hard opaque blackish mineral, mainly carbonized plant matter found in strata below earth's surface. It is highly carbanaceous matter which has been resluted from alteration of vegetable matter like plants by a process called as biogeochemical process. It consists mainly of carbon, hydrogen, nitrogen and oxygen besides non-combustible inorganic matter like ash. The process of coal formation is not a rapid one but is enormouly lengthy, spread over millions of years. Under the effects of high pressure, moderate tempareture, heavy rain fall and micro-organisms like bacteria, the plants got transformed into coal over a long span of time of millions of years. Coal is called fossil fuel because of its occurrence and storage in earth's crust.

Classification of Coal : Formation of coal is based on the decay of plants buried in earth's crust in the absence of oxygen some millions of years ago. Based on its occurrence and physical state coal is classified as a natural solid fuel. But based on coalification or degree of alteration or rank from parent plant material, the wood, there are various types of coal as follows :



Anthracite is the purest form of coal which results in the progressive transformation of wood with the decrease in hydrogen, nitrogen, oxygen, sulphur and volatile matter with a corresponding increase in carbon content, hardness and calorific value.

Peat is the brown fibrous jelly like mass and regarded as first state of coalification of wood. It contains more moisture of about 80 to 90%.

Lignite which is also called as brown coal is soft and compact textured coal. Its moisture content is also more about 60%. Bituminous coal is called as common coal which is pitch black to dark grey coloured consists of laminated structure of alternate very bright and dull layers. It is of three types: sub-bituminous, bituminous and semi-bituminous. Anthracite is highly carbanaceous and highest rank coal. It is hardest, dense and lustrous burns without smoke.

Coal Reserves : The total global coal reserves are estimated about 6,000 billion tonnes. China, Russia and U.S.A are the major producers of coal. India is the fourth largest coal producing nation in the world. There are about 125 billion tonnes of coal inclusive of proved and indicated reserves upto to the depth of 1200 meters in India. Andhra Pradesh is endowed with rich coal reserves and it is one of the few coal producing states in India. The Singareni Collieries Company Limited undertakes the management and operation of coal fields with a Stretch of 320 kms and the total reserves of A.P. are bout 8,500 million tonnes upto a depth of 600 meters. The coal reserves are said to last for about another 150 years based on the present rate of consumption.

Coal Mining : It deals with the excavation in earth for extracting coal upto a depth of 1200 meters. Before the advancement of technology, coal mining was carried out by many labourers manually

under dangerous circumstances. Coal mining has now become free of all sorts of risks due to the advances in mining technology. Mining methods like open cast mining, underground mining etc. are on use globally. Mining by open cast involves the removal of top earth surface of the coal field and removal of coal by mechanical lifts. Under ground mining involves tunneling of the field and subsequent removal by trolleys.

Coal Exploration : In order to expedite the exploration work in coal field the following new technologies are contemplated.

A) Extensive non-core drilling coupled with geophysical logging to expedite the investigations.

B) Use of remote sensing techniques

C) Computer applications in devising models for qualitative and quantitative aspects of the area.

Applications of Coal : Coal is the main source of energy, it satisfies about 50 to 60% of our energy needs. It is not only primary source of energy but also secondary. Its uses are vast both direct and indirect like power generation through thermal power plants, use in steel industry, steam-based industries, apart from its domestic use for cooking, space-heating and other purposes.

Quality of Coal : Selection of coal is based on high calorific value, low moisture content, low ash content and uniform size. Coal is analysed by proximate and ultimate analyses to find out the content of moisture, volatile matter, ash, carbon, nitrogen, sulphur and oxygen on percentage basis. A good quality coal should have less moisture, volatile matter, ash, low content of hydrogen, nitrogen and oxygen with high content of carbon. Higher the percentage of carbon in coal, greater is its calorific value and better is the quality.

Table 10.1. Important features of Coal

Coal Rank	Carbon (%)	Calorific Value (Kcal/kg)	Occurrence in India
Peat	55-57	4,200 - 5,400	Niligiri Hills (TN)
Lignite	60-70	6,500 - 7,100	Neyveli (TN), Assam, Bihar,
Sub-Bituminous	75-83	7,100 - 7,500	Bengal, Bihar, Orissa
Bituminous	78-90	8,000 - 8,500	- do-
Semi-bituminous	90-95	8,500 - 8,600	- do-
Anthracite	92-98	8,650 - 8,700	Kashmir etc

10.3.2. Hydrocarbons

Hydrocabons are compounds consisting of hydrogen and carbon with small amounts usually not more than 5% of substances containing other elements. Crude petroleum, commonly known as crude oil, when extracted from the ground, varies in appearance from a light, straw-coloured mobile liquid to a black viscous fluid and some times semi-solid product. It consist mainly of gaseous and liquid hydrocorbons dissolved or dispersed in it. In petroleum chemistry, the chief interst lies in the hydrocarbons, the componds containing, hydrogen and carbon. These may occur as chains of carbon atoms or rings. The chain types are known as cyclic componds consisting of aromatics and naphthenes.

Aliphatic hydrocarbons are those which can considered to be derived from parent hydrocarbon, methane, (CH_4), Aliphatic hydrocarbons may be sub divided into three series.

A) Paraffins : Meaning unreactive compounds in which the carbon atoms have formed chains and all the spare valencies are saturated with hydrogen atoms e.g. methane, ethane, etc.

B) Olefins : These are reactive than paraffins and consit of double bond between

two carbon atoms e.g., ethylene.

C) Acetylenes : These are also respective and consist of triple bond between two carbon atoms. e.g., acetylene.

Of the aliphatic hydrocarbons, the paraffins are of the greater interest in petroleum technology.

Geography of petroleum: Petroleum and natural gas are generally called oil and gas. Important hydrocarbons are the sources of conventional energy. Petroleum products have been known for many thousands of years , e.g., Bitumen was known in Biblical times, seepages of oil from the ground have often been reported, but it was only 150 years ago that the first well was drilled for oil in pennsylvania, U.S.A. It was not until the begining of the present century, with the advent of motor car that phenomenal expansion of the industry occurred. Although oil has been found, and produced. in over 50 different countries. Large-Scale production has tended to be concentrated in a small number of areas. Thus at the present time, over 90% of world production is from the U.S A., Caribbean, Russia and the Middle East.

Petroleum which means rock oil is the source for most of the liquid fuels like petrol, diesel of present day use. It is composed of paraffins, olefins, napthenes and aromatics with small amounts of inorganic compounds containing oxygen, nitrogen, sulphur. The average composition of petroleum is C=79.5 to 87% H=11.5 to 14.8% ; S=0.1 to 3.5% with traces of oxygen and nitrogen

Classficiation of petroleum

1) Paraffinic-type which consists mainly of paraffins from CH_4 to C_{35} H_{72} and a little of naphthenes.
2) Asphaltic-type which consists of mainly cycloparaffins or napthenes with a little of paraffins and aromatic hydrocarbons.
3) Mixed-type which consists of both paraffin and asphaltic type hydrocarbons.

Mining of Petroleum : Petroleum, usually floats upon a layer of salt water and occurs at different places varying from 500 feet to 15000 feet. It is brought to earth's surface by drilling holes in the earth's crust and enveloped by natural gas, it comes very rapidly through the pipes by pressure, later it is pumped through ordinary lift pumps. Refining of petroleum can be transformed into various useful products by a process called refining. Petroleum as such cannot be used for any purpose, so refining is necessary which gives various products like petrol, diesel kerosene etc.

Petroleum products like petrol, diesel oil are the important sources of conventional forms of energy. Many industries and almost the whole transportation sector depends on the accessability and availability of these products. Price hike of these products has always had an immediate impact on economy of the world.

Petroleum reserves on global scale are estimated to be about 2000 X 10^{10} barrels. Based on present trend of global consumption of petroleum product, the reserves will last upto another 25 to 30 years only.

Natural Gas : It mostly occurs in close proximity with crude oil. There are huge reserves of natural gas globally. U.S.A. is the major producer. Indian reserves of natural gas are estimated to be about 250 billion cubic meters. It is exhaustible and non-renewable source of energy consisting of lower hydrocarbons like methane. Its use does not produce ash or smoke, it is non-polluting. Its huge quantity is wasted by flare up. Due to the advances in technology now a days its uses are on the rise like electricity generation, use in automobiles in the compressed form etc.

India though rich in coal reserves has to look for petroleum, which is a better type of fuel between the two for the easy transporation, storage and handling. To use coal as a fuel, we need to make it smokeless, also we have to provide bigger and isolated space for its storage with frequent cleaning arrangements.

In the case of petroleum there is no problem of disposal of ash like in coal. The petroleum, whether it is gas or liquid is not only a neater fuel to use but also has many advantages even for industries with regard to its efficiency, feeding to burners and cleanliness over coal.

Petroleum oils contain a very high amount of energy in relation to their weights. Due to its high energy in oil, it is considered as the best source of energy for the world. Automobiles, Aeroplanes, Trucks, Busses, Tractors are run mostly on petroleum products only. These days most of the ships on highseas consume mainly oil for their energy or power. An oil driven ship can cover three times distance without refuelling as compared to a ship using coal.

Railways are switching more and more to dieselisation of locomotives all over the world, because of the lower cost of running per kilometer.

Various types of agricultural machines consuming oil are used in farms. They have reduced the demand for labourers in agricultural fields. More over the output per acre has also increased many times on account of power driven equipment. Oil products are used to spray the agricultural fields and thus save the crops from the growth of the weed and bugs. Oil fuels provide energy to run the machine in many factories. Fuel oil is burned in generating stations to produce steam which causes generators to move and produce electric power to be used for various purposes. For the above mentioned reasons petroleum is preferred to coal all over the world as a fuel for energy.

The principal petroleum products consumed in india are LPG, kerosene, diesel oil and fuel oil. Kerosene is used mostly for lighting and cooking purposes, diesel oil for running pumpsets, motor transport and trains; furnace fuel oil is largely used as boiler fuel. There does not appear to be any large scope for cutting down the consumption of kerosene and diesel oil. Indeed consumption of these items are at the bare minimum now.

Check Your Progress - 1,2 & 3

1. What is conventional source of energy ?
2. What is coalification ?
3. What is refining ?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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10.3.4. Hydro-Electric Power Plants

Water is a great potential source of energy. The generating stations or plants which obtain energy from water are called hydroelectric power plants. Water possess two types of energy. The flowing water may possess only kinetic energy. The flowing stream of water may have both kinetic and potential energy or simply potential energy at some elevation with respect to low datum level like water falls, water stored in reservoir, water stored at the back of a dam. Hydro-electric power is electrical power obtained from conversion of potential and kinetic energy of water. The potential energy of a volume of water is the product of its weight and the vertical distance it can fall.

$$Ep = WZ$$

Where Ep = potential energy; W = total weight of water; Z= vertical distance of water fall.

The water stored in reservoir is allowed to fall on the blades of a turbine placed at the lowest level of the dam. The initial cost of harnessing water and converting the potential energy into electircal energy is quite high but operational expenses are quite less. Hydro-electric plants are quite economical.

Types of Hydro Electric Power Plants (HEPP) : These are based on reservoir capacity.

1. Run-of-river plant : This type of plant has no storage facilities. Power generation is totally dependent on the flow of the river. This type is usually built for purposes like navigation, recreation, irrigation etc. Power generation being only incidental.

2. Base load HEPP : It is also without storage but it is located on the river that provides a minimum flow capable of serving the power demand without supplementary steam generating facilities. This type of plant utilizes only a small proportion of the river flow.

3. Run-of-river plant : A small amount of daily, weakly, or seasonal cycle of storage can greatly increase the reliable capacity of a hydro plant. The water not required for generation during low power demand periods can be stored and same can be used during high periods of power demands.

4. Peak load plants : Depending on the size of the utility, peak demands may be several times the magnitude of the low demands at night. These fluctuations in demand necessitate generation facilities whose fall capacity is used only a few hours a day during periods of peak power demand.

5. Pumped storage HEPP : This plant deals with storing of large quantities of energy generated during periods when excess generating capacity is available, to be used later. Water is pumped from a low reservoir to a higher one by steam power or base load hydro energy when power demand is low. When power required, the water generates power by flowing through a turbine back into the low reservoir.

Micro /Mini/Small hydro electric power plants : Water power, mostly in the form of large scale plants already produces about a quarter of the world's electricity. Smaller installations acquire special significance because they offer shorter construction times, less environmental impact and ever renewable source of energy. The micro level plant produce less than 100 KW (Kilo Watt)

Table 10.2. Generation capacity of Hydroelectric plants :

Plant size	Generation capacity (in kilo watt. KW)
1. MICRO	< 100
2. MINI	< 1000
3. SMALL	< 5000

The smaller the size, the lesser the technical complexicity, lower the investment and easier for installation and executors.

Countries like China, France, Germany, Thailand etc. have commissioned these small scale hydro-electric power plants (S.H.E.P.P) in large numbers. The total capacity of mega watts (MW) is given in Table 10.3.

10.3. The total generation capacity of SHEPP in other countries.

Country	Total power generation capacity by SHEPP in mega watts
China	6300
Sweeden	1050
France	390

Power generation by small hydro electric power plants is a very potential source of energy.

As per latest estimates 5000-6000 MW power potential is available through small and mini hydro-electric plants in India.

10.3.5. Thermal Power Plants (T.P.P)

The generating stations which use solid fuels like coal are called Thermal Power Plants / stations and plants using liquid fuels are called diesel power stations. Thermal power constitutes about 62% of the total installed capacity. The important components of T.P.P are Boiler Turbine, Condenser, Alternator. T.P.P. employ steam turbines.

The steam is obtained from high pressure boiler producing steam from water. Boiler needs solid fuel like powdered bituminous coal which gives off less ash.

In the boiler the fuel is burnt and the water is converted into high pressure steam which is further superheated in super heater. The super heated steam is passed in the turbine to rotate its blades, thus it converts heat energy into mechanical energy. This steam is further reused. The turbine acts as a prime mover of the alternator which converts mechanical energy into electrical energy. The over all efficiency of TPP varies from 20 to 26%.

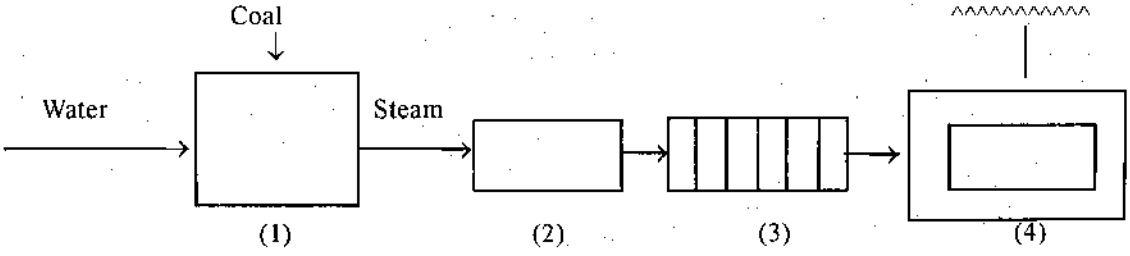

Fig. 10.1. Thermal Power Generation System.1. Boiler. 2. Super Heater. 3 Turbine. 4. Alternator.

Boiler : It is one of the essential elements in TPP. It consists of a closed vessel in which water is heated to steam at the required pressure. Boilers are of various types like fire-tube type, water-tube type, Bent tube etc.

Steam turbine : It is a machine which converts heat energy of steam into mechanical energy by expanding steam from higher pressure to lower pressure. The important types of turbines are impulse type or reaction type, blend of both the types.

Condenser : It handles large volumes of water vapour at low pressure with the help of cool water and maintains high vaccum at the steam inlet. The important types of turbines are Jet condenser and surface condenser.

Major air pollutants from T.P.P include particulate matter (fly ash), oxides of sulphur, nitrogen, carbon emissions. The control of particulate as well as gaseous emission is very much essential.

Techniques for controlling particulate matter & emissions from a TPP are available which removes the particulate emission released into the atomosphere. The important controlling equipment are mechanical collector, wet collector, fabric filters, electro static precipitators etc.

The gaseous emission like sulphur dioxide is removed by blue gas desulphurisation or by desulphurisation of coal before use.

Treatment of blue gases is essential otherwise it creates air & water pollution. Though TPP supply power continuously, their adverse impacts include coal depletion and deposition of fly ash. Suitable alternative sources to tackle this problem are essential.

Major share of the additional power generation capacity in future will also be able to contribute by installation of thermal power plants using coal as fuel.

Check Your Progress - 4

What is a turbine ?

Note : (a) Write the answer in the space provided below

(b) Compare your answer with the one given at the end of this unit.

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10.4. ISSUES AND CHALLENGES

Coal is one of the major polluter of our environment. It pollutes the environment at various stages right from its extraction form the earth. Its purification, transportation and usage cause environmental pollution. Coal processing methodologies like coal gasification and coal liquification cause environmental pollution. About 60% of coal is used in thermal power plants where combustion of coal creates gaseous and particulate pollution affecting plants, animals, human beings and materials with short-term and long-term effects. But the use of low ash coal and proper pollution control devices may control coal-based pollution of the environment. The challenging task lies not only in coal production but also coal-conservation which can be achieved by more scientific mining methods like open cast mining, long wall mining, shield mining etc.

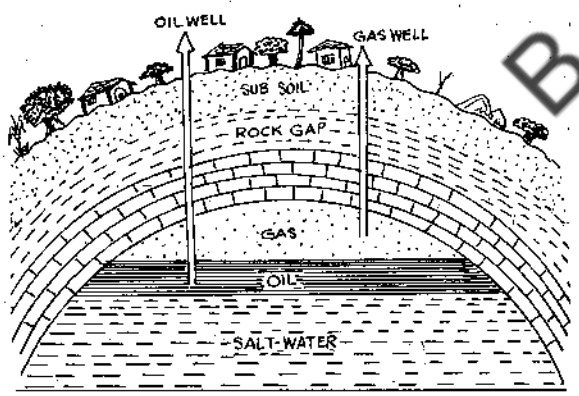
Extraction and refining of petroleum, transportation, storage and usage of petroleum products like petrol, diesel etc. are associated with environmental impacts like gaseous emission of hydrogen

sulphide, carbon monoxide and unburnt hydrocarbons which cause bad effects on human beings. Oil spills which frequently occur disturb precious aquatic environment of seas and oceans. Automobile exhaust gases also cause an alarming effect on human health. These are the major issues related with the use of petroleum products. But a majority of these bad effects can be controlled using appropriate technologies like installing catalytic convertors to the automobile exhaust pipes to control undesirable exhaust gases like carbon monoxide etc.

As already mentioned, petroleum is non-renewable source of energy. If it exhausts totally, the petro-based lifestyles, industries, tansportation sector will come to a halt. As petroleum products are used in transportation, power generation, space heating, domestic cooking etc, its depletion is the major concern facing the global scenario. The challenging task is to devise efficient technologies which can conserve petro-products and development of alternative energy sources and technologies to replace or partly substitute petro-technologies. Need based suitable and sustainable technologies are most essential in every part of the globe to face the possible depletion of petroleum source of energy.

Large scale multi-purpose project based hydro-electric power plants affect the environment in terms of ecological imbalance, displacement of human settlements, flooding of forests, agricultural lands, soil erosion and seismic effects etc. At the same time there are beneficial effects such as irrgigation, fishing and drinking water supply. Environmental impact assessment study is the suitable tool to assess the adverse effects and beneficial effects. Feasibility of the project depends only on the quantitative beneficial effects. Otherwise the proposed project has to be withdrawn.

In the continuing search for new energy strategies and alternatives to fossil fuels like coal and petroleum products, and in the context of high and ever increasing costs of fossil fules, and their dwindling reserves, one trend unremarked - the steady rise of activity of small scale hydro electric power plants. They do not cause ecological imbalance, dislocation of flora, fauna & human settlement, deforestation etc unlike large hydro electric power plants. Smaller plants acquire special merits because they offer less environmental impact - the most important factor for its approval and execution. These plants are best suited for rural electrification as well as irrigation.



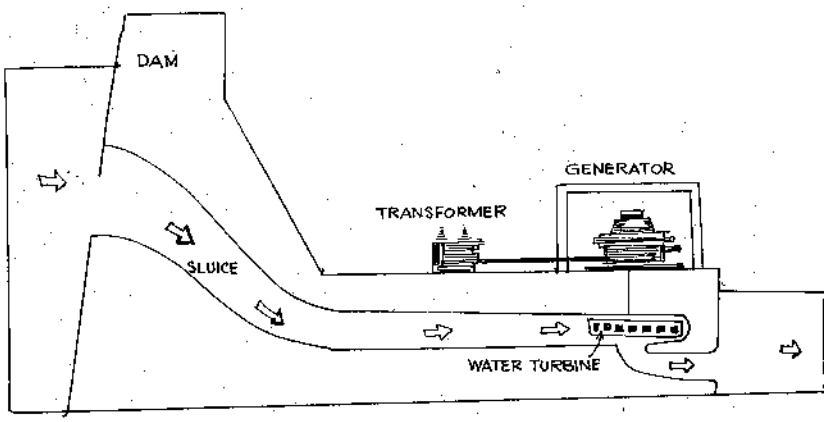


Fig. 10.2. Occurance of Petroleum or Crude Oil.

Fig. 10.3. Hydroelectric Power Generation System

Indian energy scenario : Duc to the limited availability of fossil fuel reserves and as India can not always afford to import oil spending considerable amount of valuable forcign exchange, it is impertative for India to look for new and renewable energy sources like solar, bio-mass, bio-gas, tidal, geothermal etc. to sustain and improve its developmental activities. The participation of our planners, political leaders, scientists and technologists is very much essential to devise innovative methods to solve the energy problems facing the country today.

10.5. SUMMARY

Harnessing energy from various conventional sources is an essential aspect of power generation which is technologically most viable and at the same time it is essential to assess the environmental impacts to take up the follow up action. This unit explains in detail various gases, petroleum products, their reserves, mining, different types of extraction techniques and refining processes. In the light of ecological, social and cultural impacts by large scale hydro electirc power plants, an altenative model of small scale hydroelectric power plant also dealt with in this unit. Working of thermal power plants also explained.

10.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1. A conventional energy source which consists of fossil fuel sources like coal and petroleum products such as petrol, kerosene, L.P.G.(liquified petroleum gas). These are non-renewable.
2. Coalification is the process in which plants and other matter of vegetation are converted into coal under favourable conditions in earth's crust. It is an extremely lengthy process taking several millions of years.
3. Refining is a process in which crude oil or petroleum is subjected to high temperature to obtain various important products like petrol, diesel, kerosene, L.P.G. etc.
4. Turbine is a device which converts potential energy of water into mechanical energy to produce electricity.

10.7. MODEL EXAMINATION QUESTIONS

I. Answer the following qeustions in about 30 lines each.

1. What are the important sources of conventional energy ? Explain the merits and demerits of each source.
2. What is mini-hydro electric power plant ? Explain its significance.
3. Explain the working of a thermal power plant.
4. Discuss the energy related issues facing the world and their alternatives.

II. Answer the following questions in about 10 lines each.

1. Explain the coal reserves in Andhra Pradesh.
2. Explain the applications of coal.
3. What are the qualities of good coal ?
4. What are hydrocarbons ? Explain the three series of aliphatic hydrocarbons.
5. What is hydroelectric power plant ? Explain any one type of hydroelectric power plant.

Prof. M. Ayub Hussain Khan

UNIT - 11 : ALTERNATIVE ENERGY SOURCES

Contents

11.1. OBJECTIVES

After going through this unit you will be able to :

* define and differentiate renewable and non-renewable sources of energy,
* indentify and describe different sources of renewable energy,
* describe the availability, distribution, principle of extraction and conversion of renewable energy and
* describe the advantages and limitations and issues and challenges related to these energy sources.

11.2. INTRODUCTION

The demand for energy consumption will continue throughout the world, fossil fuels will fail to meet this ever increasing demand before 2020 A.D. Oil dominated world economy must change now with the development of alternatives to conventional fuels. The miserable state of present and future global energy scenario in general and our country in particular clearly shows the urgent need to explore alternative energy sources with energy cost progressively being pushed up due to depleting fossil fuel reserves, alternative energy sources are being examined seriously which only forms the basis for sustainable energy development and also the answer for coal based technology.

11.3. RENEWABLE AND NON-RENEWABLE ENERGY SOURCES

Renewable Sources are the major sources for alternative energy structure. These are non-conventional and called as renewable because they are, infinite, inexhaustible and supply energy continuously. Important renewable energy sources are Biogas, solar energy, Wind energy , Tidal energy, Geothermal energy etc. Energy generation from these sources and its applications in various fields are increasing day by day throughout the world. These sources are non-polluting and environment-friendly.

Non- Renewable Sources are conventional sources of energy which are limited and took millions of years to form under earth's crust like fossil fuels such as coal, oil, natural gas and nuclear fuels like Uranium, Thorium etc.. These sources are totally exhaustible, once consumed cannot be recurred.

Check Your Progress - 1

What is the difference between renewable and non-renewable sources of energy ?

Note : (a) Write the answer in the space provided below

(b) Compare your answer with the one given at the end of this unit.

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11.4. BIOGAS

The basis for the formation of biogas is biomass which consists of organic matter produced by all types of plants like trees, shrubs, grasses, algae, domostic and industrial waste, wood waste, bagasse, human and animal excreta. The energy stored in the biomass can be conveniently converted into liquid and gaseous fuels by various methods. Biogas is one of the derived fuels which can be easily handled and burnt than raw biomass. Biogas possesses many advantages over other conventional solid fuels that it can be produced at a central point and distributed over a wide area and its use produces no smoke and ash.

The production of biogas from animal dung, human waste known as gassification is the most sought after technology in many developing countries. Bio-degradable cellulosic material like agro waste, forest waste, sugarcane-waste (bagasse), water hyacinth, kitchen waste, garbage waste are the other raw materials for bio-gas production. Bio-gas is produced in bio-gas plant and it consists of digestor and gas holder.

Biogas plants are classifed into two important classes.

1. **Continuous Type :** It consists of single and small digestor which produces gas continuously with lesser period of digestion and least operational problems.
2. **Batch Type :** It consists of several digestors which produce gas intermittently. This plant is expensive with more operational problems.

Other types of plants available are dome type and drum type.

Biogas is produced by Thermo-chemical conversion (pyrolysis) or Bio-chemical conversion. Pyrolysis method produces low or medium calorific (heating) value gas comprising of carbon monoxide (CO) and Hydrogen (H_2) gases. Biochemical method carried either by fermentation or anaerobic digestion. Fermentation involves the decomposition of complex organic compounds by the action of micro-organisms like yeast, bacteria, enzymes etc. to produce ethanol liquid which may further be converted into high heating value gas. This method require more energy and cost. Anacrobic digestion involves the microbial decomposition of biodegradable organic matter in the absence of oxygen (anaerobic process) in an underground massonry tank called anaerobic digestor at a temperature range of 35-70° C and at ambient biomass are first broken to sugar, alcohols, organic acids etc. by acid producing bacteria. These products then finally converted to Methane (CH_4), Carbon dioxide (CO_2), and other trace gasses by Hydrogen.

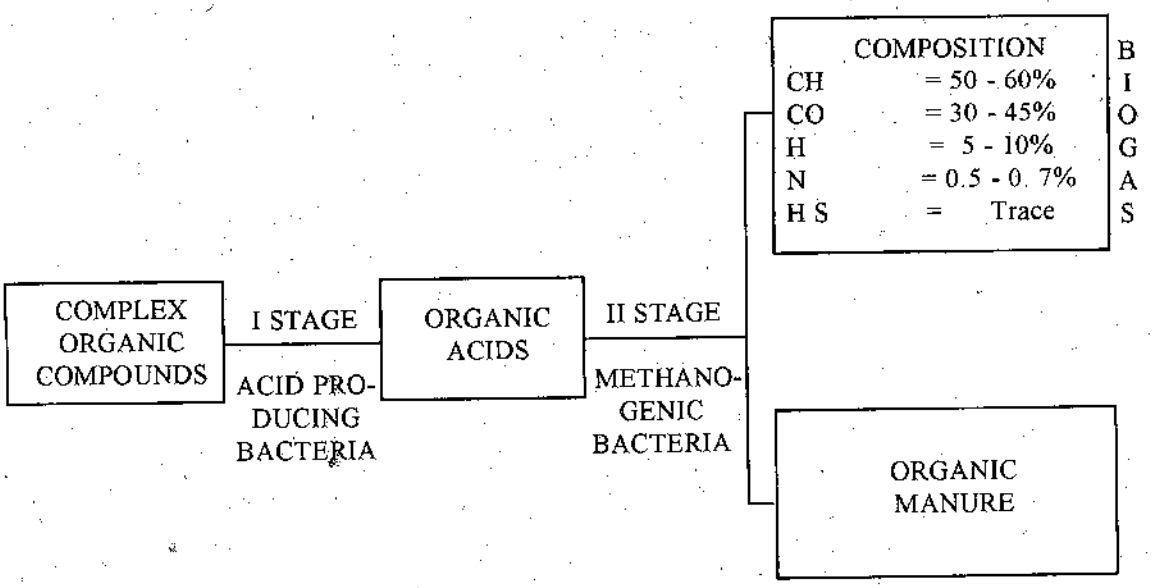

Fig. 11.1. Bio-gas Production Processes

Another important feature of anaerobic digestion is the utilization of residual matter or byproduct as manure which consists of higher composition of soil nutrients like potassium, oxygen and phosphorous necessary for agricultural purposes.

Biogas production is technoeconomically viable and its conversion to electricity is cost effective. Biogas is cheap, non-polluting and environment-friendly renewable source of energy.

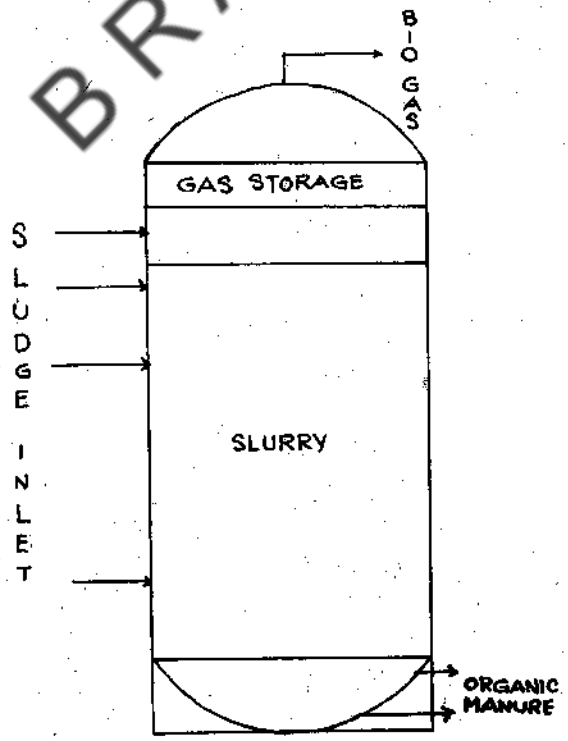

Fig. 11.2 A typical single stage conventional Biogas plant.

Advantages : Biogas is useful for domestic cooking, space heating, small scale power generation, Irrigation, lighting, operating small IC engines. Now a days biogas is also considered for various high temperature industrial operations. In india the domestic type biogas plants popularly known as gobar gas plants being supplied by the khadi and village industries commission (KVIC). Under the national non-conventional energy project hundreds of community biogas plants have been commissioned with heavy subsidies from the government in rural areas to control deforestation and encourage people to become self-reliant in energy aspect.

Check Your Progress — 2 & 3

2. What are the uses of Biogas ?

3. What is the composition of Biogas ?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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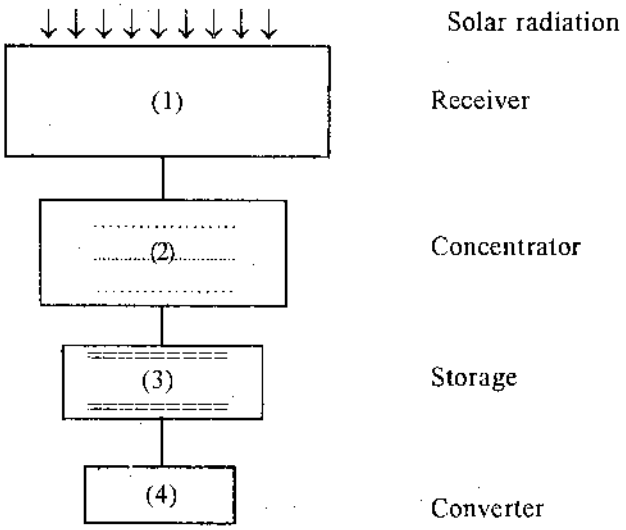
11.5. SOLAR ENERGY

An Exceedingly high temperature in the sun which acts as a furnace where nuclear re-arrangement reactions like transmutation of hydrogen atoms into helium atoms (fusion) are taking place. This process releases extremely high amount of energy which radiates out in all directions in the form of electromagnetic waves called solar energy. Solar energy travelling in the form of radiation is called radiant energy, a part of this in wave lengths between 400 u to 760 u is called light energy which can be readily converted into heat energy as can be experienced in the open sun when sunlight striking the ground is partly converted into heat which warms the soil or any other objects. It is the most appropriate form of energy for many applications. It is sustainable, cost effective, cheaper and cleaner than fossil fuels. Its cost is independent of world wide price rise and demand of conventional fuels. Its production is reliable, easier and non polluting. It is renewable source of energy and it also generates other renewable energy sources like boigas, wind energy indirectly. It is one of the most promising alternative energy source for the future and ideal solution for present and future energy crisis. It is present every where in abundance. India being a tropical country receives ample sunlight in all the seasons in most of its parts. Solar energy equivalent to 75,000 million kilo watt hours (KWH) hits the earth every day and a mere 0.1% of this is sufficient to meet the energy needs.

Harnessing solar energy has been a challenging task and dream of scientists and technologists. Over the years many stystems have been diviced to trap, store and use solar energy by two important conversion methods which are discussed here.

Solar Thermal Conversion : This method deals with direct conversion of solar energy into heat or thermal energy. In this process sun's radiant energy is converted into heat energy ranging in temperatures from 100° C- 1700° C. This heat energy used for various purposes like water heating, solar cooking, water distillation and desaliniation (removal of salts). This heat energy can also be used for producing chemicals, fuels from biomass and generating electricity. The system for converting solar thermal

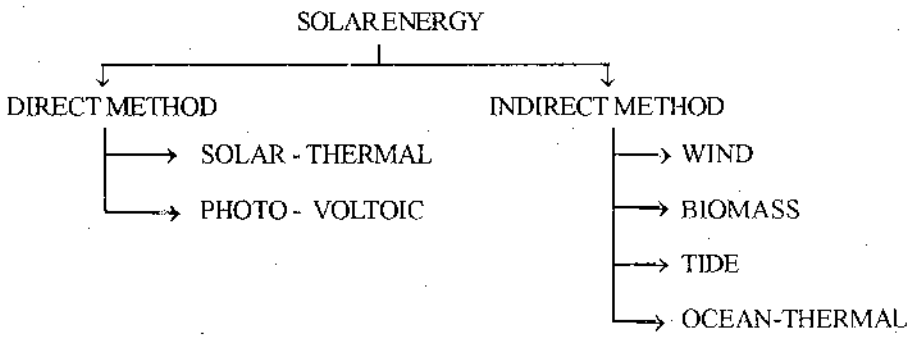
energy into electricity consists of solar rays collector, fuel combustor, fluid flow distributor, storage device, heat engine, electric generator and a control system. This whole assembly converts solar energy into electrical energy efficiently and effectively.



11.3. Solar-Thermal Energy Conversion system.

Solar Thermal Conversion : It consists of direct conversion of sun-rays into electricity which is called solar electricity or photovoltoic energy. This is non-polluting, clean, reliable and renewable source of energy. This system based on a cell called as photovoltoic cell (PV cell) made from silicon and each cell produces half volt of D.C.electricity. Larger assembly of PV cells produce more amount of electrical energy. The important PV cells are (a) Single cell (b) Poly crystalline cell (3) Amorphous cell. The potential for PV power is enormous. India is producing PV modules of 1 mega watt capacity. PV power is useful in street lighting, water lifting, telecommunications, Railway signalling, calculator and watch modules, Defence purposes, Radio & TV sets etc. One of the greatest importances of PV system is generation of electricity without turbines, without all sorts of pollution and the system can even be monitored by remote control with cheap maintenance cost.

Utilization of Solar Energy - Various Methods : Various methods of Solar energy utilisation are given below.



11.6. WIND ENERGY

Wind is the air in motion. Although it is a motion in three dimensions, usually the horizontal component is considered in terms of direction and speed. It is one of the earliest natural energies available to mankind. The oldest method of capturing the wind was the sail used first on ships and then on land. Wind mill, the device to capture wind appears to have originated in Persia (now Iran)

some two thousand years ago and used for lifting water and grinding grain, later Holland and Denmark mastered in this technology. A renewed interest in wind energy use came after the 1973 energy crisis. Wind energy generation depends on wind speed.

Wind power varies with the cube of the wind speed. As per theoretical calculations a wind device can generate 1 kilo watt (kw) of energy by intercepting one squre metre of the air current with a wind speed of 9 meters/sec, but it can produce 35 watts only with a wind speed of 3m./sec. Wind results from air in motion which arises from a pressure gradient. Winds are basically caused by the solar energy irradiating the earth. Wind has an annual statistical energy distribution. The energy content of the wind in any particular location depends on height of the wind mill, local landscape, climate etc. Conversion of the energy of motion (Kinetic energy) of the wind into mechanical energy can be utilised to generate electricity. Most wind machines located at least 6 meters above the ground converts wind energy into mechanical energy consist of a number of blades radiating from a central axis which may be vertical or horizontal.

When the wind blows against the blades they rotate around the axis and produce rotational motion which can be utilised to generate electricity.

The wind forms and parks producing mega watt range power have become common in USA. In India also wind energy-forms are generating power in Gujarat, Tamil Nadu and Orissa. Largest wind farm in Asia with 10 MW capacity has been commissioned in Lamba, Gujarat.

Based on the present data available the total wind power potential in Andhra Pradesh is around 11.331 X 10^6 mega watt hours per annum as per the theoretical estimation. Areas like Vishakapatnam, Sri Kakulam, Machilipatnam, Nellore, Tirupathi, Ananthapur and Dindigal near Hyderabad are blessed with moderately good wind speed for most part of the year.

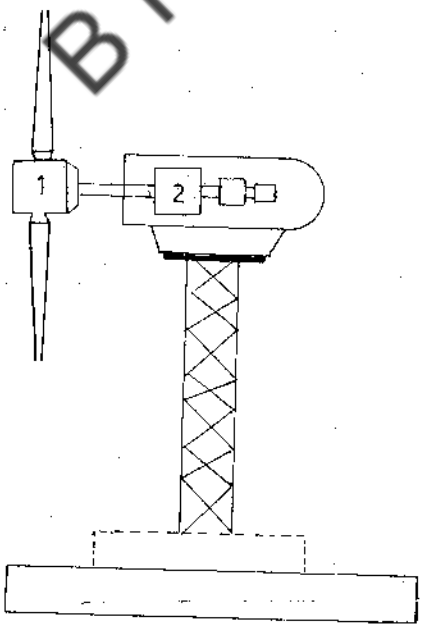


Fig. 11.4. Wind to electrical power generation system. 1. Wind generator. 2. Electric generator

Considering all the aspects of commissioning, operation and maintenance the cost of wind power generation has been estimated as Rs. 1.18 Per kilo-watt hour which is more competitive to diesel, thermal, hydro-electric power.

Advantages : Wind energy systems are non polluting, cost effective and renewable resource of energy.

Limitations : Wind energy availability is dilute and fluctuate in nature. Wind energy systems are noisy in operation, requires large areas and high rise structures. Proper design and development may make wind energy systems cost effective and troubfe free.

11.7. TIDAL ENERGY

Tide is a periodic rise and fall of the water level of the sea which is caused by the gravitational influence of the moon (and to a lesser extent the sun) on the water covering the earth. About 70% of the tide producing force is due to moon and the rest is due to the sun. The average tide in the open sea is less than one metre high. In some areas of globe, (France & Russia) tidal ranges are upto 16 metres. Depending on relative heights tides are called Low Tides and High Tides. Tidal energy is one of the important forms of renewable energies. In the eleventh century the first attempt made in Great Britain to utilize tidal energy was in the form of "Tidal Mills". Later France and Spain followed it. After the advent of cheap coal and steam early use of tidal energy declined gradually. Following the energy crisis in the 1970's, the tidal energy received renewed attention.

Tides represent an unlimited source of energy. If a part of this wast energy can be converted into electrical energy it would be an important source of power. The important fact of the tidal cycle is the difference in water surface elevations at the high tide & the low tide. If this differential head could be used in rotating a hydraulic turbine, the tidal energy can be converted into electrical energy by means of a generator. This principle is based on the fact that water at the time of high tide, is at high level there. The same water can be discharged back into the sea through the low tide through the turbines, thus producing power. The principle appears to be simple, but operational difficulties involved are many, like varying times and ranges of tides.

The world's first tidal power plant was commissioned in France at La Rance in 1966 with the average tidal range of 8.4m. Later Russia and some other countries like Canada, Korea followed it. In India, techno-economically feasible Projects are in Gulf of Kutch and Cambay. Andhra Pradesh being second largest among the marine states with 960 kms long coastline may well play an important role in tidal energy extraction.

The three basic components of a tidal power plant are :

1. The power house which consists of the turbines, electric generators and other ancillary equipment.
2. The dam or barrage whose function is to form a barrier between the sea and the basin.
3. The sluice-ways which are used to fill the basin during high tide or vacate the basin during the low tide as per operational necessity.

Check Your Progress - 4

The worlds first tidal power plant was commissioned in.....at..... in the year .....

Note : (a) Write the answer in the space provided above.

(b) Compare your answer with the one given at the end of this unit.

Advantages : Tidal energy is renewable and totally independent of rain or dry spell for any length of

time. It is environment-friendly, obtained by clean process technology without any unhealthy waste discharges like gases, ash etc. Tidal energy plants conserve valuable land, forest and do not affect cultural, social, geographical fabric of any region as they are exclusively executed on the seashore only.

Limitations : Tidal Power Generation depends on certain range of tidal cycle. Turbine machinery may get corroded with sea water, high chromium stainless steel proved to be good corrosion resistant. To generate power with variable tidal range, bulb-turbine technology needs a lot of improvement. Cost is not favourable compared to other sources of energy.

11.8. GEOTHERMAL ENERGY

The earth is a hot plastic mass of rock covered by a thin cover of cooled rigid crust. Inside the earth's crust is an enormous amount of hot springs and geysers. Geothermal energy is defined as all of the heat stored in the earth's crust above 15° C. It forms when the enormous heat energy at about 4000° C in the core of earth rises closer to the surface of the earth due to cracks of faults as per plate techtonics theory. The heat from earth's core is dispersed through the surface at a small rate compared to sunlight and produces a thermal gradient whose average is less than 30° C per KM. There are some areas around the globe which are geothermal most sensitive with a thermal gradient ranging from 100 to 300° C / km. These geothermal spots or hot spots can be liquid dominated, vapour or steam dominated, and hydrological factors. Geothermal sources are of three basic types which are (1) Hydrothermal ; (2) Geo-pressured and (3) petrothermal. Depending on the nature of Geothermal fields it is convenient to classify earth's surface into three broad areas :

1. Non-Thermal areas with a temperature gradient of 10-40° C per km depth.
2. Semi-Thermal areas with a temperature gradiet of 40-80° C per km depth. These are capable of producing hot water above 100° C.
3. Hyper-Thermal areas with a temperature gradient of more than 80° C per KM depth.
   a) Wet fields, where the water is pressurized with more than 100° C.
   b) Dry fields where dry saturated steam produced above atmospheric pressure.

Historically, the first application of geothermal energy dates back to 1300 in Iceland for space heating, cooking and medicinal purposes. In 1800 it was used on large scale to recover boric acid. In 1897 geothermal steam was used to drive a small steam-engine at Larderallo, Italy and at the same place in 1904 it was converted into electrical energy. Since then much progress has been made to extract natural heat and today there is thriving geothermal Industry. It is gradually being used as non-conventional source in view of the ever increasing demand for power and the limited potential of the conventional sources. At present, worldwide geothermal electrical power capacity stands at 5828 MW representing a 59% increase in the past five years. Most parts of the globe are known as thermal reservoirs like Himalayan territory, Japan, Malaysia, Korea, Phillippines, China and costal region of USA. In India a 7.5 tonne capacity cold storage pilot plant was installed at Manikavan, Himachal Pradesh by GSI-IIT, Delhi. Geothermal energy has highest energy density and it is technocconomically feasible. It is classified as renewable because the energy from the earth's interior is almost in-exhaustible as Solar or Wind energy.

Advantages : Geothermal energy production is the cheapest when compared with conventional energy sources and needs least investment. Geothermal power production is pollution free with negligible toxic waste.

In the long term, geothermal energy must rank as one of the world's major alternative fuel resources. There are about 340 known thermal areas in India, 46 of these are above 150° C which could generate about 2000 MW of electricity for a period of 30 years.

Limitations : Pipes, turbine blades gets corroded with hot ground water containing dissolved

substances and to overcome this stainless pipes and blades should be used. Hot water and steam loses heat when brought above grounds. So for effective use of geothermal energy, it should be used at the source.

11.9. ENVIRONMANTAL IMPACT : OPTIONS & CHALLENGES

The renewable energy sources like solar radiation, wind, biogas, tidal energy etc. are available in all parts of our country even though there are variations in volume/quantity at different regions. The vital factor for energy extraction are the availability of source in abundance, easy accessability to tap the source, uninterrupted and countinuous supply of raw material or source and cost effectiveness of the power produced. Different regions have varied climatic conditions and natural resources depending upon the geographical location of the particular region. Out of all the sources available, one has to choose the favourable and suitable technologies for maximum harnessing the energy at low cost.

Before the selection of technologies for extracting non-conventional energy from natural resources, a qualitative & quantitative study has to be conducted. While conducting the study, attention has to be paid not only to renewable energy sources but also to the non-renewable or conventional or commercial energy sources available in plenty. This exercise is essential as the current technologies in some areas, specially in solar are more efficient and cost effective when a mixed technology or hybrid technology of conventional and non-conventional sources are utilized.

Energy generation form renewable energy sources will not cause any adverse environmental impact. Power production from these sources is virtually pollution free and will not produce any significant waste, toxic substances as in conventional energy generation like Thermal Power Plants, Atomic power plants. Commissioning of hydroelectric power projects cause a lot of cultural, social and environmental dislocations, displacements and disturbances, whereas installation of renewable energy production devices like solar power plants, wind mills etc. Cause no threat to the human - being in particular and the environment in general. So the energy generation from renewable sources is environmentally safe and its development requires little investment compared to other conventional energy sources.

The only challenging task is to develop large scale energy producing systems to harness renewable energy from the biomass, sun, wind, tide and from the earth, continuously at a cheaper cost and its availability to the rural, urban and remote areas without any difficulties.

India is well endowed with solar and water resources which can be exploited for power generation. The country should adopt a two fold approach. Firstly to use the renewable energy sources in an optimum and integrated way to energise villages and secondly to generate power from these sources in megawatt range to feed the same into the grid system.

11.10. SUMMARY

This Unit covers various alternative energy sources which are easily available and renewable in nature. These sources are bio -mass, solar energy, wind energy, tidal energy, geothermal energy etc. These sources are the only solution to conventional sources like coal, oil, natural gas etc. This unit briefly explains the principles of extraction and conversion of energy into desirable forms and applications in domestic and industrial sectors. Environmental impact of each alternative energy source also has been discussed. Their advantages like purity, cost-effectiveness, environmental compatability also explained in this unit. This unit dictates the need and solution for present day energy crisis and emphasizes on energy generation which should be techno-economically feasible, rurally available, non polluting, culturally and socially refreshing.

11.11. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Renewable sources are those which are inexhaustible and infinite like solar energy. They recur once used and do not deplete with time. Non-renewable sources are those whose availability is time bound, limited and depends on utilization. they exhaust once used e.g. Fossil Fuels like coal, oil etc.
2. Bio-gas is mainly used for cooking purposes in rural areas, it is also used for space heating, lift irrigation and high temp industrial application.
3. Bio gas contains methane (CH_4) Carbondioxide (CO_2), Hydrogen (H_2), and the rest consists of trace gases.
4. France, La Rance, 1966

11.12. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each

1. Explain the renewable and non-renewable sources of Energy.
2. Explain the process of conversion of energy from sunlight.
3. How do you capture wind into energy ?
4. How do you produce geo-thermal energy ? What are the advantages and limitations of it ?

II. Answer the following questions in about 10 lines each

1. Explain the two important types of biogas plants.
2. What is wind energy ? Explain its advantages and limitations.
3. Explain the three basic components of a tidal power plant.
4. What are the advantages & limitations of geothermal energy.
5. What are the advantages and limitations of tidal energy.

Dr. M. Ayub Hussain Khan.

UNIT - 12 : NUCLEAR ENERGY

Contents

12.1. OBJECTIVES

After going through this unit you will be able to :

* explain the principle and sources of nuclear energy
* describe the working of a nuclear power plant
* describe the present status of the nuclear power
* describe the Indian nclear power programme
* list out the limitations and hazards of nuclear power plants
* compare nuclear and other power plants.

12.2. INTRODUCTION

Energy is the ability to do work and it is in different forms as heat, light, sound, electricity, chemical, mechanical energy and matter too. Energy not money, is the real "currency" of the world. It is an important input for development, and is used for household, agriculture, transport and industrial complexes, and therefore its demand is increasing with the changing civilization. Per capita energy consumption of man at different stages of development is given in table 12.1. Table 12.2 gives information about the energy consumption of industrialized countries. The rapid increase of the world's production and the limited resources of energy call for a new order with great emphasis on the need for not only finding new forms of energy but also to conserve the available resources of energy. It is also important to recognise that the desire of every nation is to improve its standard of living by demanding an ever increasing share of the energy available in the world. Therefore, a better utilization of the known resources of energy is quite necessary to meet the world's future demand.

All the energy we use in our daily activities comes from various conventional sources distributed by commercial and state institutions. About 88% of the world's present energy production comes from coal (27.3%), oil (38.6%) and natural gas (21.0%) and burning of biomass (115) for cooking and other uses. The coal and oil deposits are to exhaust one day, and so there is an urgent need to minimise their utilization and develop other sources of energy. One of the future promising energy sources is nuclear energy.

Table - 12.1. Energy Consumption (Per capita) for different Stages of the Development of Man

Stages of Development	food	Daily per capita consumption (Megajoules)		
		Home & Commercial	Industrial & Agriculture	Transport
Primitive Man	8	-	-	-
Hunting Man	12	8	-	-
Primitive Agricultural Man	16	16	16	-
Advanced Agricultural Man	24	48	28	4
Industrial Man	28	128	96	56
Technological Man	40	164	364	254

(Source : Ambio, Feb., 1992)

Table - 12.2. Energy Consumption by Industrialized and less Developed Countries (1980)

	Population (billions)	Energy Consumption per capita, GJ/Y	Total Energy consumption (Quad/Y)
Industrial countries	1.1	199	221
Less developed countries	3.3	17@	57
Total	4.4	216	278@@

(Source : Ambio, Feb., 1992)

GJ = Gigajoule = 10^9 Joules ; Quad = Exajoule = 10^{18} Joules

@ = Excludes 14 GJ/Y per capita of non-commercial energy;

@@ = Excludes 47 Quad/y of non-commercial energy.

12.3. PRINCIPLES OF NUCLEAR ENERGY PRODUCTION

Nuclear energy can be produced by fission and fusion reactions.

a) **Nuclear Fission** : The controlled release of energy from nuclear fission reaction, led to the development of this energy source in the post war period for generation of electrical power.

In terms of Einstein's mass energy relationship, one gram of uranium releases on fission, 8.1 X 10^{10} Joules of energy, the same quantity released by the combustion of 2.7 tonnes of coal or 14 barrels of oil.

Nuclear fission is a nuclear change in which nuclei of certain isotopes with large mass numbers, such as uranium - 233 and 235 and plutonium - 239, are split into lighter nuclei when struck by neutrons (Fig. 12.1).

Actually, neutrons are present in the mass of these elements; what is needed is to assemble the material to a critical level. In addition to the splitting of atoms and release of energy, fission of each atom results in the release of one or more neutrons for each atom split; on the average 2.5 neutrons are produced for each uranium-235 undergoing fission. Some of these neutrons can, in turn, bombard and be captured by other fissionable atoms releasing more energy, producing more neutrons and creating a continuously sustained reaction, which is very fast indeed, called nuclear chain reaction

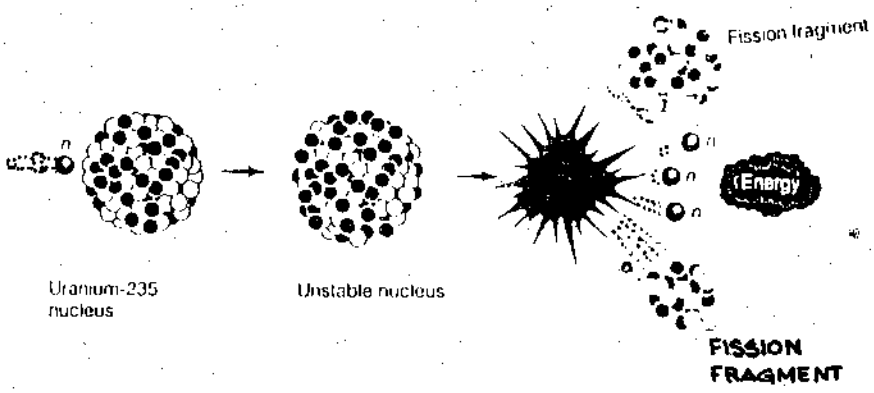


Fig. 12.1 Fission of uranium - 235 nucleus by a slow moving neutron

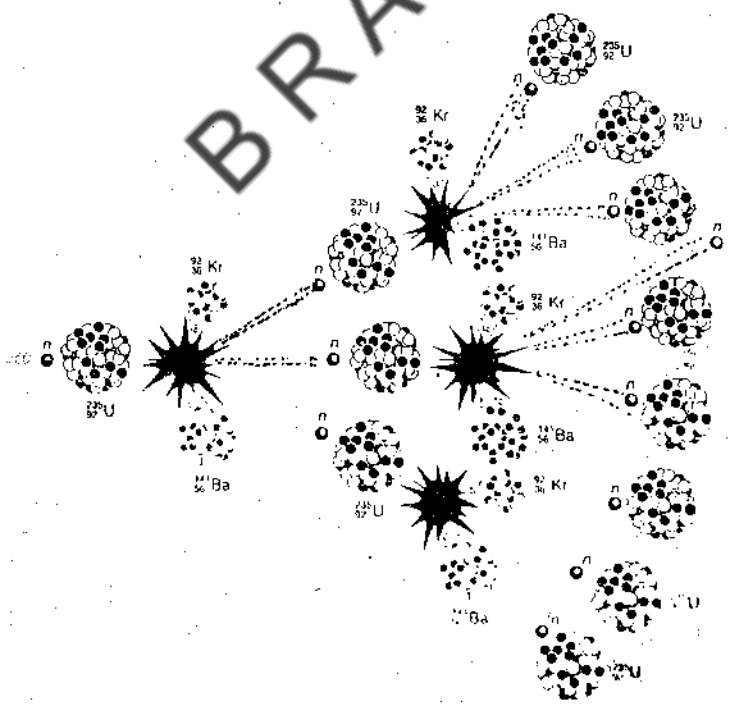


Fig. 12..2. A nuclear chain reaction initiated by one neutron triggering fission in a single uranium- 235 nucleus

The fission reaction for uranium - 235 can be represented as

$$^{235}U_{92} + {}_{0}^{1}n \longrightarrow X + Y + 2.5\ {}_{0}^{1}n + 47X\ 10^{9}\ K.\ cals.$$

From the above reaction, it can be inferred that 235 gms of uranium-235 releases 4.7 X 10^9 Kilo calories of energy, whereas 235 gms of carbon (coal) on combustion releases only 1.84 X 10^3 Kilo calories. In the above equation, X and Y are atoms of elements with masses 85-110 for X and 125-150 for Y, most of them are highly radioactive and spontaneously disintegrate emitting highly energetic α-and β- particles and X - rays.

Of the three atoms that can undergo fission, only uranium-235 occurs in nature comprising about 0.7% of naturally occurring uranium. The abundant component of uranium is uranium - 238 which does not undergo fission with neutrons directly, but it can be converted into plutonium - 239 which is fissionable, by bombardment with neutrons according to the reaction.

$$^{238}U_{92} + {}_{0}^{1}n \longrightarrow {}^{239}U_{92} \xrightarrow[\text{decay}]{\text{Rapid}} {}^{239}NP_{92} \xrightarrow[\text{decay}]{\text{Rapid}} {}^{239}Pu_{93}$$

(NP = Neptunium) (Pu= Plutonium)

In any nuclear reaction using natural uranium as a fuel, a portion of uranium - 238 is converted to plutonium-239. Some of the plutonium will react by fission and some will be left in the reactor fuel. This unreacted plutonium represents the future supply of nuclear fuel. It is radioactive, chemically very reactive and can be used not only as a reactor fuel but for making the highly destructive nuclear weapons.

b) **Nuclear Fusion** : Nuclear fusion is a very potential source of energy. This involves the fusion of two nuclei of a light element to produce nuclei of a heavier element. For example isotopes of hydrogen with mass numbers 2 or 3 fuse to give a nucleus of helium - 3 or helium - 4.

$$^{2}_{1}H + {}^{3}_{1}H \xrightarrow{100\ \text{million}^{\circ}C} {}^{4}_{2}He + {}^{1}_{0}n + \text{energy}$$

$$^{2}_{1}H + {}^{2}_{1}H \xrightarrow{1\ \text{billion}^{\circ}C} {}^{3}_{2}He + {}^{1}_{0}n + \text{energy.}$$

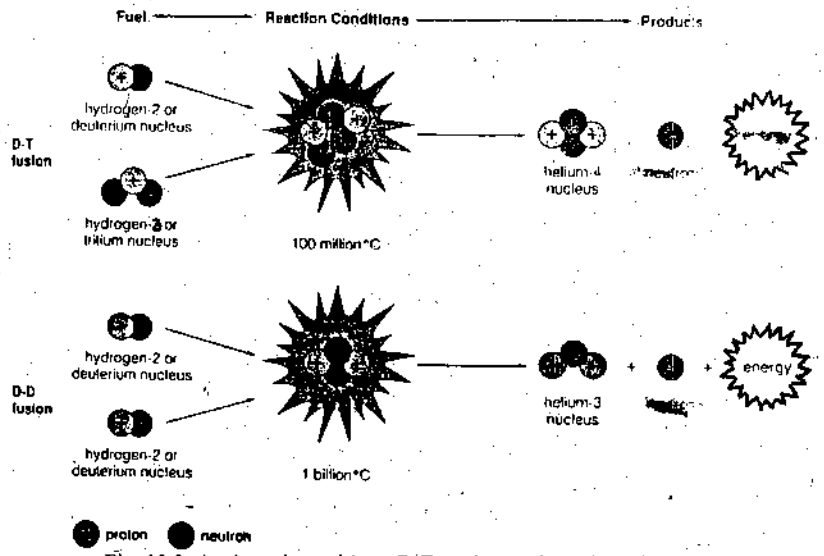


Fig. 12.3. the deuterium-tritium (D-T) and denterium- deuterium (D-D) nuclea r fusion reactions which take place at extremely high temperatures.

These reactions release tremendous quantities of energy. But they can occur only at temperatures of the order of 50 to 100 million degrees celcius. For this reason, these ractions are called thermonuclear fusion reactions.

Hydrogen isotope with mass number 2 (called heavy hydrogen or deuterium) is present to the extent of only one atom in 5000 atoms of ordinary hydrogen, as water which is available in unlimited quantities. The energy that could be released from the small amount of heavy hydrogen present in a gallon (4.546 litres) of ordinary water would be equivalent to the heat energy produced by burning 300 gallons (about 1400 litres) of oil. Consequently, the thermo-nuclear energy, theoretically available from fusion reactions using heavy hydrogen, is fantastically high.

The sun converts 650 million tonnes of hydrogen into helium every second, releasing the energy equivalent to four million tonnes of mass per second in the form of radiant energy. The earth receives just a minute fraction of this energy which sustains all its activities.

Scientists believe that the extraction of energy from controlled thermonuclear fusion reaction will be possible in a few decades time. When this happens, the world energy problem will be solved for hundreds of thousands of years because oceans contain enough heavy hydrogen to provide all the energy people may ever need. But it is very difficult to harness this energy without any negative impacts on earth. Scientists are developing technologies to harness this energy for the beneficial uses of mankind without any negative impacts.

Check Your Progress - 1

What is meant by nuclear fission and nuclear fusion ?

Note (a) Write your answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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12.4. NUCLEAR POWER GENERATION

The greatest peaceful use of nuclear energy is the generation of electric power. The intense heat produced in a nuclear reactor is used in the same way that coal or oil is used for power generation. A nuclear power station will differ from an ordinary coal burning power plant only in the fuel burned and in the furnace in which it is burned which is depicted in figure 12.4.

A nuclear reactor is a pressure vessel, designed to contain and provided for fission, fissile material (fuel) in a self-sustained and controlled manner. The heat produced by fission is extracted and used for converting to water into steam which drives the turbine which in turn operates the generator to produce electric power. There are essentially five main components in nuclear reactor.

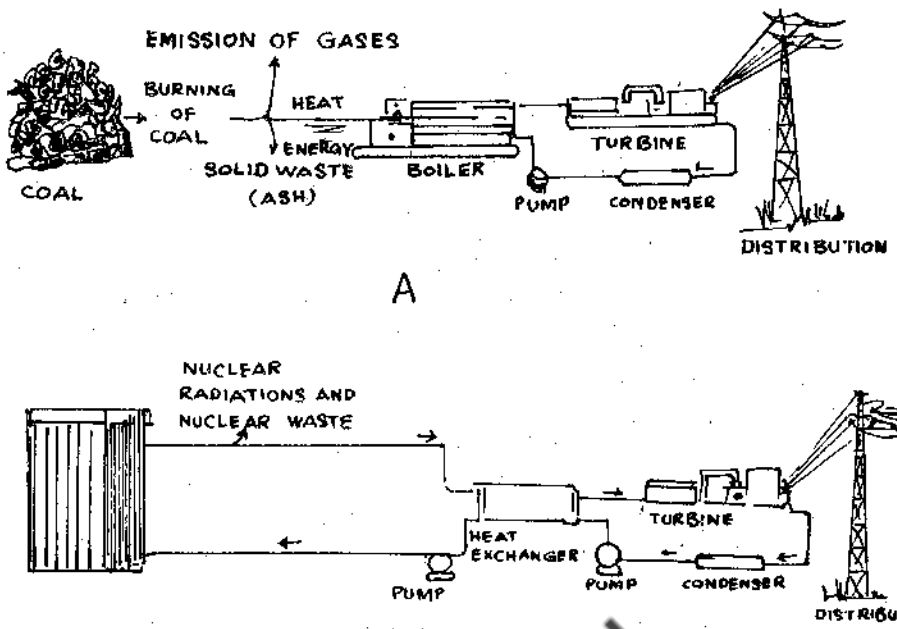

Fig. 12.4. Electric power plants. A. Coal based thermal power plant. B. Nuclear power plants

i) The fissile material or fuel like uranium which is usally in the form of rods or slugs.

ii) A moderator which slows down the neutrons to the required speeds.

iii) Control mechanism for the control of the reactor, which consists of rods of a material like cadmium or boron, which are capable of mopping up excess neutrons. Through suitable positioning of these control rods, the chain reaction can be allowed to occur at the desired level. If the chain reactions were to build up in the reactor it could lead to the release of enormous energy and burn up and melt down the reactor with grave consequences.

iv) A coolant for extracting the heat from the reactor : The coolant keeps the reactor at sufficiently low temperatures to avoid heat damage to the fuel and the materials of construction and also extracts the heat from the reactor for the production of steam for the operation of the turbo-generator. The coolant can be air, carbon dioxide, water (ordinary or heavy) or a liquid metal, for example, sodium depending upon the type of the reactor.

v) A shield which completely encloses the reactor providing protection from the hazardous radiation from the reaction.

Three fourths of the world's commercial reactors use ordinary water, called light water as a moderator. Key parts of sun light water reaction (LWR) are the core, fuel assemblies, fuel rods, control rods, moderator and coolant (Fig. 12.5). The core of an LWR typically contains about 40,000 long, thin fuel rods bundled in 180 fuel assemblies of around 200 rods each.

Control rods are made of materials such as boron or cadmium that absorb neutrons. The rods are moved in and out of the reactor core to regulate the rate of fission and the amount of power the reactor produces.

Moderator circulates round the fuel rods and the fuel assemblies and slow down the neutrons emitted by the fission process so that the chain reaction can be kept going.

A coolant circulates through the reactor core and removes heat to keep fuel rods and other materials, from melting and to produce steam that spins generators to produce electricity. Most of the reactors use water as coolant. A few gas cooled reactors use unreactive gas like helium or argon as coolant.

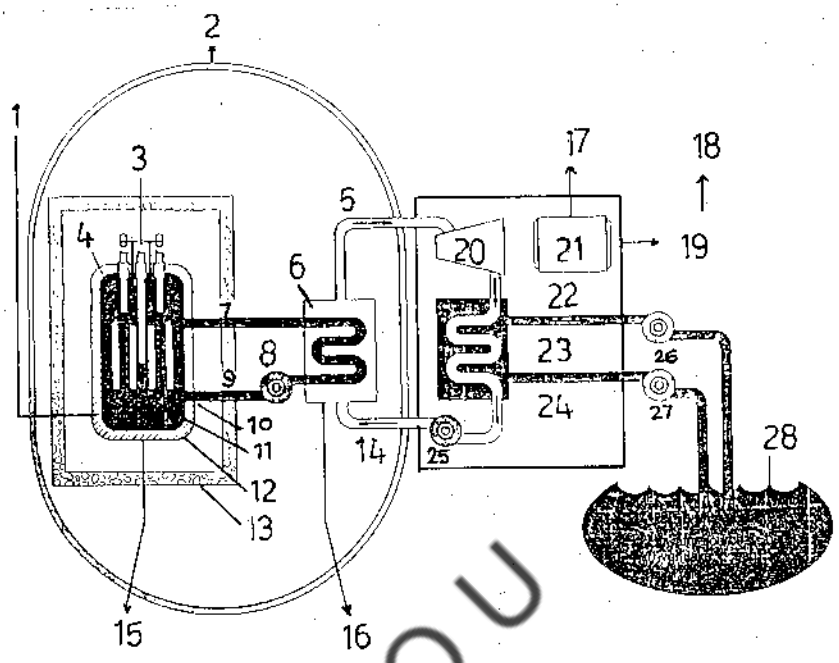

Fig. 12.5. Light water moderated and cooled nuclear power plant with a pressurised water reactor. 1. Uranium fuel input (Reactor core). 2. Small amounts of radioactive gases. 3. Emergency core cooling system. 4. Control rods. 5. Steam. 6. Heat exchanger. 7. Hot coolant. 8. Pump. 9. coolant.

After the reactor 's operated for a certain period, the fissionable uranium- 235 in the fuel decreases and can no longer be used to generate electricity. These spent fuel rods which contain the new element plutonium, which is useful for fission and high level radio-active wastes, are removed from the reactor core and are stored in pools of water that absorb the heat that is released by the decaying radio-active wastes called the fission products. Most of the fission products decay over a period of one to five years. But the activity of some fission products persists for a long time. Notable among them are strontium-90 and Caesium-137 with half lives of 28.9 years and 30.2 years respectively. The gaseous fission product Iodine-131 with a half life of 8.1 days is also a hazard in the event of its leakage during the reactor operation.

Half life of an element is defined as the length of the time during which one half of the atoms of a radio-active element disintegrates. The longer the half life, the longer the activity persists. Plutonium which is highly toxic, is radio-active decaying with a half life of 24100 years. For example the radioactivity of fission products in a nuclear reactor operated at 1000 kilo-watt power for one year has the following values at different intervals after the reactor is shut-down.

Time	Activitiy (in curies)
0	693573
100 days	144130
1 year	36964
5 years	6527

(one curie is the activity associated with one gram of radium)

After some time the fuel rods are reprocessed to extract the small quantity of the fissionable plutonium and the fission products from uranium. This is highly complex process involving remote control operation. The Department of Atomic Energy, Governent of India, has installed a nuclear fuel reprocessing plant at Tarapur. The safe disposal of the nuclear waste is presently a matter of great concern all the world over.

Check Your Progress - 2

What is meant by half life ?

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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12.5. COMMERCIAL NUCLEAR POWER GENERATION

The first commercial nuclear power plant began power generation at Calder Hall, UK in 1957. By 1991, a total of 420 nuclear power plants were operating or being built around the world. Nuclear power's share of electricity production remained high in 1991 in the following countries.

France	-	72.7%	Czechoslovakia	-	28.6%
Belgium	-	59.3%	Finland	-	33.3%
Sweden	-	51.6%	Germany	-	27.6%
Hungary	-	48.4%	Japan	-	23.8%
North Korea	-	47.5%	Spain	-	35.9%
China	-	37.8%	Switzerland	-	40.0%
UK	-	20.6%	CIS (USSR)	-	12.6%
USA	-	21.7%	India	-	1.8%
Canada	-	16.4%			

12.6. INDIAN NUCLEAR POWER PROGRAMME

India's nuclear power generation is only 1.8% of the total. There is an urgent need to improve the neclear power as the demands for power are incrasing fastly whereas the total production from hydro-electric and thermal (coal) are not increasing at the same pace.

The first nuclear plant came up in 1969 at Tarapur which consists of two boiling light water units with enriched uranium as the fuel each with 160 MWe gross capacity. The units built subsequently are of the pressurised heavy water type using natural uranium as the fuel and heavy water as the moderator. The information on the entire programme by Department of Atomic Energy till the end of the centrury is presented in Table 12.3.

Table - 12.3. India's Nuclear Power Programme.

Units	Reactor type	Gross Capacity (MWe)	Year of Commissioning
I. Units in Operation			
1. Tarapur Units 1 & 2	BWR	2 X 160	1969
2. Ranapratapsagar -1	PHWR	220	1972

3. Ranapratapsagar - 2	"	220	1980
4. Kalpakkam - 1	"	235	1983
5. Kalpakkam - 2	"	235	1985
6. Narora - 1	"	235	1991
7. Narora - 2	"	235	1992
8. Kakrapara - 1	"	235	1992
II. Units under construction			
1. Kakrapara - 2	PHWR	235	1993
2. Kaiga - 1 & 2	"	2 X 235	1996
3. Ranapratapnagar - 3 & 4	"	2 X 235	1996-97
III. Units planned			
1. Kaiga	PHWR	4 X 235	
2. Tarapur	"	2 X 500	
3. Ranapratapsagar	"	4 X 500	
4. Koodamkulam	"	2 X 1000	

BWR = Boiling light water type reactor

PHWR = Pressurised Heavy Water type reactor.

Actually plans were drawn for generation of 10,000 MWe by the end of this century. But these targets were reduced to 5700 MWe due to financial crunch.

The programme ultimately aims at utilizing the vast resources of thorium, the fertile material available in the country to the extent of 3,60,000 tonnes as against the uranium reserves of 70,000 tonnes. The uranium reserves can support the first stage programme of 10,000 MWe and will also yield plutonium. In the second stage, use of plutonium in fast breeder reactors with thorium as the blanket material will not only enable the generation of power but will yield uranium-235 which can be used as fuel in the third stage.

Valuable experience for the design and consturction of breeder reactor is being gained by the Indian Scientists and Engineers through the construction and operation of a fast breeder reactor at the Indira Gandhi Centre for Atomic Research at Kalpakkam in Tamil Nadu. A spent fuel reprocessing plant meant for the extraction of plutonium is located at Tarapur.

Several heavy water plants have been located all over the country for the manufacture of heavy water for the pressurized heavy water nuclear power plants.

Check Your Progress - 3

What are the places of occurrence of nuclear power plants in India which are under operation?

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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12.7. LIMITATIONS AND HAZARDS OF NUCLEAR AND OTHER POWER PLANTS

Nuclear power plants are not associated with any significant quantities of primary pollutants such as carbon monoxide, sulphurdioxide, nitrogen dioxide, etc. The carbon-dioxide emissions from nuclear plants amount only to 1% of the amount of emissions form a coal-fired plant. Consequently, there is no contribution to the greenhouse effect or acid rain from this source. To quote Alvin M. Weinberg, a member of the group of scientists that developed the first experimental fission reactors at the University of Chicago in 1941, "a properly operating nuclear reactor and its subsystems are environmentally a very benign energy source". The words "properly operating" implies much responsibility on our future generations to exercise the vigilance and discipline necessary to keep our nuclear fires well behaved.

The amount of waste heat transferred from the steam to the condenser is of the same order as the heat transferred from a thermal power plant. A 1000 MWe of thermal (coal) power plant may require about 400 hectares of land only for a cooling water pond. The land requirements for setting up nuclear power plants are much smaller compared to hydro-electric power projects.

Under normal operating conditions nuclear plants release only minute quantities of radioactivity into the environment through the cooling water and into atmosphere. That quantity of radio-activity is almost of the same order as the quantity of radioactivity released by the thermal plants in the shape of uranium and its decay products present in the solid waste, fly ash. The additional exposure of radiation to which people in the vacinity of nuclear reactor are subjected to, represents only 2% of the unavoidable exposure form the natural background radiation.

Unlike the other power generation systems, nuclear power generation calls for stringent measures for the management of radioactive material emissions and wastes at every stage of fuel handling, mining of uranium, preparation of fuel, reactor operation, spent fuel reprocessing and decommissioning of the reactor after it has served its utility which normally ranges from 25 years to 40 years.

Here is a comparison of the fuel requirements and wastes produced in power plants of 1000 MWe operating at 75% load factor.

Requirements

i) Nuclear power plants : A pressurised light water nuclear plant would require 27 tonnes of enriched uranium which corresponds to a few truck loads. The corresponding quantity of natural uranium is 160 tonnes.

ii) Thermal power plants : a) A coal fired power plant would need 2.6 million tonnes of coal each year which corresponds to the load carried by 5 trains each transporting 1400 tonnes every day.

b) A oil-fired plant would require 2 million tonnes of fuel per year which is about 10 super tanker loads.

Wastes

I. Nuclear Power Plants : (i) a) High level wastes, 27 tonnes of spent fuel, when reprocessed and the fission products are verified as glass, these wastes occupy a volume of 3 cu m. b) Intermediate level wastes - 310 tonnes. c) Low level wastes - 460 tonnes d) Some low level radio-active gases from the stacks without any public health significance. e) Tailings from uranium mines and ore-processing plants are smaller in volume than the corresponding coal tailing per unit of electricity produced.

II) Coal fired plant

a) Air pollutants :

1) Carbon dioxide - 6.5 million tonnes.

2) Sulphur dioxide - 110,000 tonnes (assuming 1% S in the coal)

3) Oxides of nitrogen - 22,000 tonnes.

b) Solid Waste

1) Ash - 320,000 tonnes containing 400 tonnes of toxic heavy metals.

III) Oil fired plant

a) The air pollutants emitted from oil fired plants are

1) Carbon dioxide - 5.7 million tonnes

2) Sulphur dioxide - 37,000 tonnes

3) Oxides of nitrogen - 24,800 tonnes

Handling of Radioactive Wastes from Nuclear Power Plants :Low and intermediate level radio-active wastes are produced in the course of the operations of the nuclear power plant. The radio-active pollutants are separated by different methods such as filtration, ion-exchange, reverse osmosis, chemical treatment, evaporation, etc. These are immobilized in matrices like cement, bitumen and polymer, sealed in containers and burried in engineered shallow-reinforced cement structures in the plant area itself. The burrial area is regularly monitored.

High level radio-active wastes are produced during the reprocessing of the spent nuclear fuel. Their volume is very small but they are hazardous for very long periods extending to hundreds of years. These wastes are immobilized in highly inert matrices such as glass and put in thick corrosion-resistant steel containers and buried in stable deep geological granite repositories choosen after careful study, corrosion and degradation processes as well as solubility and transport are limited by the low availability of water in these structures.

A comparison of detriments of Coal and Nuclear based electricity per giga watt year is presented in table 12.4.

Table 12.4 Comparative Detriments of Coal and Nuclear based Electricity per gigawatt-Year

Detriment	Coal	Nuclear
Radioactive effluents and emissions	10^8 Bq (mostly as uranium and thorium and decay products)	10^{17} Bq (mainly as Kripton-85 gas, Global emission of radon-222 gas from natural sources is out at greater than 10^{19} Bq/y)
Sulphur dioxide	45,000 tons	200 tons (Due to use of carbon-based power for fuel processing etc)
Carbon dioxide	10 million tons	5 X 10^5 tons (Same as just above)
Carbon monoxide	750 tons	30 tons (Same as just above)
Hydrocarbons	260 tons	10 tons
Crude ore or coal mine	2 million tons	0.5 million tons (According to grade of ore)
Final fuel "Burnup"	3 million tons	500 tons
Typical land disturbance for initial mining etc.	50 hectares	10 hectares

Typical power station site area.	100 hectares	60 hectares
All occupational and non occupational deaths associated with full fuel cycle.	10-200	1-3
All occupational fatalisers	0.5-500	0.0- 0.09

Note : Bq = Requerrel which corresponds to one radioactive disintegration per second.
(One Curie = 3.7 X 10^{10} disintegrations per second)
(Source : Endeavour, Vol. 12, P. 163 (1988))

Over the past 35 years since nuclear reactors came into existence, considerable experience has been gained by the scientists in evolving decommissioning methods for old reactors and their connected facilities. Scientists are confident that it is possible to carry out the decommissioning operations while protecting the environment, the workers and the public.

The costs are insignificant in comparison with the value of energy produced and work out in the range of 10 to 15% of the total capital cost taken at the same reference year as the basis. In India, this value is put at 1.25 per watt. In the light of the experience gained so far, the most advantageous method of decommissioning is to remove the fuel from the reactor and mothball the plant for about 50 years before undertaking total dismantling.

The greatest risk from nuclear energy sources arises from accidents due to malfunctioning of the reactor, defective materials of construction and poor management. Nuclear energy was considered as the best resort for the world energy problem till two major reactor accidents at the Three Mile Island (US, 1979) and Chernobyl (USSR, 1986) have shaken the confidence of the public. Of the two, the accident at Chernobyl was more serious, killing more than 30 people immediately and subjecting an unknown number of people in several countries in USSR and Europe to radiation exposure which will have long term effects. About 7000 kilograms of highly radio-active material containing Iodine-131, Strontium - 90, and Caesium - 137, Plutonium and several other radio-active nucleides with an estimated total activity of 50 to 100 million curies was released in the accident to the reactor and got dispersed over vast areas in Europe. The accident was reported only to be due to human error or poor management of the reactor and this has been agreed by several nuclear scientists throughout the world after carefully analysing the situation.

In the weeks following the mishap, fresh vegetables in many countries showed activity much above the safety levels. Large populations in the area around the reactor were evacuated. They still continue to live outside the restricted zone. Some forecasts suggest that as many as 40,000 deaths could occur due to cancer in the surrounding countries, mainly in Europe, due to the radio-activity released.

About 800 dumps of radio-active waste threaten to contaminate the ground water sources. It is estimated that the financial losses from the accident through clean up, health care for victims, relocations of residents, replacement cost of the reactor, cost of agricultural output and lost export earning for USSR alone would amount to 5000 million dollars. The incurred by other countries due to the effects of fall out of radio-activity was also substantial. Of late, some scientists are expressing anxiety about the safety of the cement concrete built to cover the damaged reactor which has been showing cracks due to the heat generated in the entombed core.

12.8. OPTIONS AND CHALLENGES REGARDING POWER GENERATION

The cost of nuclear energy per KWh (Kilo Watt hour) compares approximately with that of coal even though it is slightly higher and hydro-energy is the cheapest (Table 12.5 and 12.6). But we have to depend on rains for hydro-energy which have been erratic and it will be possible to meet the increasing demand from the Hydro source at all. There is little possibility to increase power from hydroelectric source due to various problems. In the case of thermal, the coal deposits are depleting and there are environmental pollution and solid waste (ash) management problems. So, there is a need to strike a balance in optimising the use of all forms of energy-hdyro, thermal and nuclear. The projects covering all these sources should be improved so that we can best use the advantages of power generation and minimise disadvantages.

Table 12.5. Cost of Energy from Conventional Sources.

Source	Unit	Capital cost per Unit (Rs.)	Operation and Maintenance	Fuel Cost Per	Cost of Energy Per	Interest and Depreciation
Nuclear	KW	35,000	0.5% of capital costs	0.79	0.55-1.70@	17% of capital costs
Hydro	KW	32,500	2.5%	NIL	0.50	15%
Coal	KW	30,000	2.5%	0.50	0.57 -1.20@	17%
Gas	KW	25,000	2.5%	0.92	1.8 - 2.0	18%

(Courtesy : Tata Energy Research Institute, New Delhi)
@ : Economic Times, September 6, 1992

Table 12.6. Cost of energy from renewable sources.

Source	Centralized or decentralised	Unit	Capital Cost KWH	Total annual costs Rs./year	Useful life (years)	Cost of Energy Per Rs. Per KWH
Windfarm	Centralized	KW	30,000	5,516	20	3.15
Solar thermal	"	KW	80,000 to 125,000	13,110 to 19,235	20	17.49
Solar Photo-Voltaic	Decentralized	KW	110,000	18,245	25	11.70
Small hydel	Centralized	KW	30,000	4,324	30	1.65

(Source : Natural Resources Forum, November, pp.305-314 (1992)))

Eventhough hydro-energy and coal energy will continue to receive preference, nuclear energy, though currently under cloud, will play an increasing role in power generation, till non-conventional energy sources- like Solar and Wind energy become significant through technological break through.

At the dawn of independence, the rated capacity of the power generation which was essentially hydro was 1360 MW. By 1992 this rose to 70000 MW including thermal and nuclear along with hydro-energy. India is expected to achieve lower middle income status by 2015. If this expectation were to materialise, the per capita power production, which is the Chief index of economic growth

has to record a three fold rise from the current level of 253 KWh per capita to a record 750 KWh per capita. So, India has to develop the conventional (coal, hydro and nuclear) and non-conventional energy sources.

While developing nuclear energy, it is important to perfect technology and management such that there are no accidents in nuclear reactors.

12.9. SUMMARY

One of the future promising energy sources is nuclear energy. Nuclear energy can be produced by fission and fusion reactions.

Nuclear fission is a nuclear reaction in which the nuclei of certain isotopes of heavy elements are split into lighter nuclei, when bombarded with neutrons. Nuclear fusion involves the fusion of two nuclei of a light element to produce neclei of heavier element.

A nuclear reactor is a pressure vessel designed to produce energy through a fission reaction, which is used for converting water into steam which spins the generator to produce electrical energy.

Unlike other power generation systems, nuclear power plants require stringent measures for the management of radio-active materials and wastes at every stage.

12.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Nuclear fission is a nuclear change in which nuclei of certain isotopes with large mass numbers, such as uranium 235 are split into lighter nuclei when struck by neutrons.

   e.g., ${}_{92}^{235}U + {}_{o}{}^{1}n \longrightarrow X + Y + 2.5\,{}_{o}^{1}n + 4.7 \times 10^{9}$ K.Cals.

   Nuclear fusion is a nuclear change in which two nuclei of a light element fuse to produce nuclei of heavier element. For example the isotopes of hydrogen with mass numbers 2 and 3 fuse to give nuclei of helium - 4.

   ${}_{1}^{2}H + {}_{1}^{3}H \xrightarrow{100\text{ million }^{\circ}C} {}_{2}^{4}He + {}_{o}^{1}n$ + energy

2. The length of time during which one half of the atoms of a radioactive element disintegrates is called half life of that element.
3. The nuclear power plants which are under operation in india are located at Tarapur, Ranapratapsagar, Kalpakkam, Narora and Kakrapara.

12.11. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Explain the principle of nuclear reactions with suitable examples.
2. Describe the working of a nuclear power plant.
3. What are the limitations and Hazards of nuclear power plant ?

II Answer the following questions in about 10 lines each.

1. Why is nuclear fusion called a thermo nuclear reaction ?
2. What is the role of moderator and coolant in a nuclear power plant ?
3. Compare the wastes generated by a nuclear power plant and coal based thermal power plant.

Prof. N. Someswara Rao

BLOCK - 4

HUMAN ACTIVITY AND POLLUTION

UNIT - 13 : AIR AND NOISE POLUTION

Contents

13.1. OBJECTIVES

After completing this unit you will be able to :

* explain the meaning of air pollution,
* list out the sources of air pollution,
* describe the nature of air pollution,
* list out the effects of air pollution on human, animal and plant health,
* explain the principles of air quality monitoring,
* describe the role of transportation systems in air pollution,
* explain the meaning of noise pollution,
* list out the sources of noise pollution and
* assess the effects of noise pollution on life systems.

13.2. INTRODUCTION

Air pollution may be defined as any atmospheric condition in which certain substances are present in the ambient air at concentrations and for duration harmful to man and his environment. However, there are many other similar definitions for air pollution and the Indian standards Institution gives the following definition (IS-4167, 1966).

"Air pollution is the presence in ambient atmosphere of substances, generally resulting from

the activity of man, in sufficient concentration, present for a sufficient time and under circumstances which interfere significantly with the comfort, health or welfare of persons or with the full use, or enjoyment of property". The substances satisfying the above descriptions may be treated as the air pollutions. The pollutants may be gaseous substances like sulphur dioxide, hydrogen sulphide, carbon monoxide and oxides of nitrogen or particulates like smoke, dust, fumes, aerosols and many others.

Air pollutant emissions may be either due to natural phenomena or due to human activities like industrialisation. The pollutants arising out of industrial activity are often by-products of external combustion while they are byproducts of internal combustion in transportation system.

Noise is unwanted sound. It is an erratic, intermittent or random oscillation. Physically noise is defined as complex sound having little or no periodicity. Physiologically, acoustically and electronically it is defined as a signal that bears no information. Psychologically, noise is any sound which is unpleasant or unwanted. The sound of steam escaping from the safety value of a steam locomotive, the sound of surf breaking on a beach, and the sound coming from a stone crushing operation are some of the examples of noise.

Noise pollution is nothing but dumping of the undesirable sound into the environment and like any other pollution it adversely affects the humans. However, a particular sound may be musical to one but noise to another, pleasent when soft, but noisy when loud, acceptable for a short time but disurbing when prolonged.

13.3. AIR POLLUTION

The source of Air Pollution, nature of Air pollution, effects of air pollution on life systems and transportation systems are described in detail in this section.

13.3.1. Sources of Air Pollution

The sources of air pollution are numerous. They can be grouped in various ways basing on the type of the sources, number and spatial distribution of the sources and type of emissions. For instance, they can be grouped into two major types of sources (1) Natural sources and (2) Anthropogenic sources.

Natural Sources include volcanic eruptions, forest fires, dust atoms, cosmic dust, extra-terrestrial bodies, sea spray, forest terpenes, natural decay of matter, natural gas emission, pollen grains from flowers, microbial spores and electrical discharge during storms. The natural sources have a major share in the release of aerosols, sulphur compounds and oxides of nitrogen into the air compared to that of anthropogenic sources; the latter sources overwhelm the former in the release of oxides of carbon.

However, the man made pollutant emissions are of great consequence as they are prone to accumulate under certain atmospheric conditions. Some of the contributors to the anthropogenic sources of air pollution are : (1) Transportation, (2) Industrial fuel burning and process wastes, (3) Domestic heating, (4) Electric Power generation, (5) Deforestation, (6) Refuse burning, (7) Agriculture and (8) Wars.

In addition to these there are a number of minor sources such as particulate matter from rubber tyres and asbestos brake linings of vehicles; organic compounds in perfumes, after-shave lotions, aerosol sprays etc. The transportation accounts for more than 46% of the total pollutants produced per year and hence, remains the principal source of air pollution. The automobiles such as cars, scooters and trucks; locomotives, boats, and aeroplanes release huge amounts of CO, NOx, and hydrocarbons in addition to leaded gas and particulate lead (in petrol driven vehicles). Eventhough the industrial sector is often blamed as the main culprit of the problems of air pollution it is not the major contributor, with about 30% share. A large number of industries such as chemical industries,

paper and pulp mills, cotton mills, metallurgical plants and smelters, petroleum refineries, mining and synthetic rubber industries together contribute to this burden. The common pollutants from these industries include various types of inorganic and organic gases and particulates. The most common among them are : CO_2, CO, SO_2, H_2S, NOx, particles of dust, carbon, metals and other solids and liquids.

The various sources can also be broadly grouped as stationary sources and mobile sources with further subdivisions as point and area sources, and line and area sources respectively. Point sources are large stationary sources such as power plants, oil refineries and pulp and paper mills. Line sources are mobile sources with definite routes, eg., highway vehicles and channel vessels. Finally, area sources are small stationary sources and mobile sources with indefinite routes, e.g., open burning, port vessesl, evaporative losses etc.

13.3.2. Nature of Air Pollution

Air Pollution can be classified as primary pollutants and secondary pollutants. Primary pollutants are those that are emitted directly from the sources. Typical primary pollutants include particulate matter such as ash, smoke, dust, fumes, mist and spray; inorganic gases such as sulphur dioxide, hydrogen sulphide, oxides of nitrogen, ammonia, carbon monoxide, carbon dioxide and hydrogen fluoride; olefinic and aromatic hydro-carbons; and radioactive compounds. Of the large number of primary pollutants emitted into the atmosphere only a few are present in sufficient concentration to be of immediate concern. These are sulphur dioxide, oxides of nitrogen, carbon monoxide, hydrocarbons and particulate matter.

The secondary air pollutants are those that are formed in the atmosphere by interactions among two or more primary pollutants, or by reaction with normal atmospheric constituents. Pollutants such as sulphur trioxide, ozone, aldehydes, ketones, peroxyacetyl nitrate (PAN), and various sulphate and nitrate salts come under this category. Secondary pollutants are usually formed from chemical or photochemical reactions in the atmosphere.

Air pollutants are also grouped as : 1) Natural contaminants, e.g., natural fog, pollen grains, bacteria, and products of volcanic eruption; (2) Aerosols (Particulates), e.g., dust, smoke, mists and fumes; and (3) Gases and vapours. Certain of these terms are explained below.

Particulate Matter : The term 'Particulates' refer to all atmospheric substances that are not gases. They can be suspended droplets or solid particles or mixtures of the two. Particulates can be composed of inert or extremely reactive materials, ranging in size from 100 μm down to 0.1 μm and less.

Dust : It contains solid particles of the size ranging form 1—200 μm. These particles are formed by natural disintegration of rock and soil or by mechanical process of grinding and spraying. Fine dust particles act as centres of catalysis for many of the chemical reactions taking place in the atmosphere.

Smoke :It contains fine liquid or solid particles of the size ranging from 0.01 to 1 μm and is formed by combustion or other chemical processes.

Fumes : These are solid particles of the size ranging from 0.1 to 1μm and are normally released from chemical or metallurgical processes.

Mist : It is made up of liquid droplets generally smaller than 10 μm which are formed by condensation in the atmosphere or are released from industrial operations.

Fog : It is the mist in which the liquid is water and is sufficiently dense to obscure vision.

Aerosols : Aerosols refer to the dispersion of solid or liquid particles of microscopic size, such as dust, smoke or mist in gaseous media. An aerosol can also be defined as a colloidal system in which the dispersion medium is a gas and the dispersed phase is solid or liquid.

Vapours : Vapours are gaseous forms of substance which are normally in the solid or liquid state under ambient conditions.

13.3.3. Effects of Air Pollution on Life System

Pure air is one of the basic needs for most of the organisms and man can survive only for a very few minutes without it. To support life air should not be contaminated. Further, air is a medium through which toxic substances enter and affect living systems. When the pollutants are discharged into the atmosphere in such high concentrations as to overwhelm the natural scavenging ability of the atmosphere, they persist at high concentration and cause harmful effects on the life system. The effects can be acute or chronic. Further, the extent of damage depends upon the nature of the pollutant as well as that of the other pollutants present along with it. There are also cases of synergistic effects known. Some pollutants can cause great damage even in trace concentrations whereas others can do so when present in higher concentrations only. Moreover, air pollution can affect all the three important living systems namely, human, animal, and plant systems

Effects on Human Health : The health hazards caused by air pollution depend on (1) Nature of the pollutants, (2) Concentration of the pollutants, (3) Duration of exposure, (4) State of health of the receptor and (5) Age group of the receptor. In general, susceptibility is greater, the effects of air pollution on human health are the worst in the winter season.

Much of the knowledge of the effects of air pollution is based on acute effects. The air pollution disasters of Meuse Valley in Belgium, Donora in USA, Poza Rica in Mexico, London (smog) in England, Los Angels (smog) in USA, Seveso in Italy and the worst ever Bhopal disaster in India are examples of manifestations of acute effects. The chronic effects, originating from continued exposure to low concentrations, have far reaching implications leading to mutagenesis, teratogenesis and carcinogenesis.

The air pollution directly affects the humans via inhalation and bodily contact. Therefore, the skin, mucus membranes and the respiratory system are the first receptors. The general health effects include: eye, nose, throat and respiratory tract irritation; increase in mortality and morbidity rate; severe aggravation of chronic pulmonary diseases like bronchitis and asthma; asphyxiation; heart and brain damage; silicosis; asbestosis; and genetic damage.

Many people are exposed to common air pollutants in their occupations. The traffic policeman, the automobile mechanic and the truck dirver in a big city may all have substantial exposures to CO, NOx and lead in association with their occupations. Therefore, such individuals have an unusually high risk from exposure to community air pollution.

Effects on Animals : In addition to being subjected to suffering the ill-effects of breathing polluted air, animals become ill by eating fodder contaminated with air pollutants. However, in certain cases humans and animals differ in the effects produced by pollutants.In farm animals especially, the danger obviously is not in inhaling the polluted air, but in the ingestion of forage which has been contaminated with pollutants from the air. The ultimate poisoing in these cases is a two step process involving (1) accumulation of the air-borne contaminant in the vegetation and forage and (2) subsequent poisoning vegetation. The pollutants responsible for most livestock damage are fluorine, arsenic and lead.

Cattle and sheep are most susceptible to fluorine. Symptoms and effects of acute poisoning include loss of appetite, rapid loss of weight, decline in health, lameness, diarrhoea, muscular weakness and death. Fluorine is a cumulative protoplasmic poison and leads to animal fluorosis. Arsenic in dusts or sprays on plants can lead to poisoning of cattle. In acute arsenic poisoning the symptoms are severe salivation, thirst, vomiting, feeble and irregular pulse and respiration. The animals become restless and develop diarrhoea. Death may succeed after the development of high temperature and convulsions. In case of chronic poisoing depression of the central nervous system as well as sterility

may develop; paralysis and death are the ultimate manifestations. Chronic lead poisoning has been observed frequently in horses that have been grazing on forage near smelters, lead mines, and in orchards that have been sprayed with insecticides containing lead. Paralysis of muscleas of the larynx and difficulty in breathing are the main sysmptoms observed. The acute effects of lead poisoning are similar to those of arsenic. It is also reported that the life expectancy of pets like dogs living in smog affected cities has come down.

Effects on Plants : Plant response to pollutants varies among species of a given genus and among varieties within a given species. In other words, plants differ in their susceptibilities to a pollutant. For example, some plants are sensitive to fluoride but resistant to sulphur dioxide. Further, the respose of vegetation to air pollution also depends upon climatic factors like duration of light, wavelength and intensity of light, temperature and humidity.

The gaseous pollutatants are important phytotoxicants and they include sulphur dioxide, fluoride, ozone, PAN (Peroxy-Acetyl Nitrate), methane, chlorine, hydrogen chloride, oxides of nitrogen and hydrogen sulphide. The gaseous pollutants enter the leaf along with the air via the stomata during the normal plant respiration cycle. The pollutants destroy plant chlorophyll, disrupt the photosynthetic process, and consequently reduce food production. Particulates reduce the amount of light reaching the leaf and may also clog the stomata and lower carbon dioxide intake to some extent and thus interfere with the photosynthesis.

The air pollution may lead to (1) Necrosis (Killing or collapse of tissue), (2) Chlorosis (loss or reduction of chlorophyll), (3) Abscission (dropping), and (4) Epinasty (downward curvature of the leaf due to higher rate of growth on the upper surface) of leaves.

The effects of some of the pollutants on plants are summarised in table - 13.1.

Table 13.1. Effects of Pollutants on Plants

Pollutant (1)	Dose (2)	Effect (3)
SO_2	Mild	Interveinal chlorotic bleaching or leaves
	Severe	Necrosis in interveinal areas and skeletonised leaves
O_3	Mild	Flecks on upper surfaces, Premature aging and suppressed growth.
	Severe	Collapse of leaf, necrosis and bleaching.
F	Cumulative	Necrosis at leaf Tip.
NO_2	Mild	Suppressed growth, leaf bleaching.
CH_4	Mild	Epinasty, leaf abscission.
PAN	Mild	Bronzing of lower leaf surface, suppressed growth; Young leaves more susceptible.

Check Your progress - 1 & 2

1. Define air pollution
2. What are secondary pollutants ? Give three examples.

Note : (a) Write your answers in the space give below
(b) Compare your answers with those given at the end of this unit.

13.3.4. Air Pollution Monitoring

Sampling and measurement of concentration of air pollutants is generally known as air quality/ pollution monitoring. Monitoring facilitates evaluation of current trends in air quality with respect to prescribed standards. Assessment of ambient air quality as well as stack emissions are important in the control of air pollution. Further monitoring is essential to have baseline data on air quality of industrial and densely populated cities. Air pollution can be controlled only through an integrated approach and such an approach involves three important steps - (1) Physico-chemical monitoring of air, (2) Biological monitoring and effect of pollutants on vegetation, farm animals and human systems, and (3) correlation between physico-chemical monitoring and biological monitoring.

Physico-Chemical Monitoring : Physico-chemical monitoring involves : (i) Investigation of micrometeorology of the area and location of sufficient number of study and sampling sites, basing on the meteorological data. (ii) Chemical characterisation of pollutants and regular periodic determination of their concentrations at the sampling sites, and iii) Preparation of an inventory of pollution sources and their emissions. (iv) Final quantification and determination of overall concentrations of pollutants at sites far away from the polluting sources.

The physico-chemical monitoring is a two stage process involving sampling and chemical analysis. The sampling strategies adopted depend upon the nature of the pollutant, its concentration, environmental conditions, etc. Four different techniques are employed in collecting a gaseous pollutant. They are absorption sampling, adsorption sampling, freeze out or condensation sampling and grab sampling. In the absorption sampling the gaseous pollutant is collected by absorbing it in a liquid to form a nongaseous substance while it is retained on a solid surface in adsorption sampling. The condensation sampling implies condensation of the gaseous pollutant from the air stream. In the grab sampling the air sample is collected and allowed to come into equilibrium with a suitable absorbing solution in the collecting device.

For particulates three different collection techniques are used and the selection among them depends upon the nature of the particulates. The three techniques are gravity technique, filtration technique and precipitation technique. The gravity technique is used to collect settleable particulates that settle out of the atmosphere as a result of gravitational pull. The filtration technique is employed to collect suspended particulates that do not settle out of the air readily. In this technique the suspended particulate matter is forced to deposit on a porous filter by drawing air through it using a suction pump. The High volume sampler utilises this principle and it is frequently used to sample the suspended particulate Matter (SPM). Thermal precipitation and electrostatic precipitation come under the precipitation techniques. If air containing particles in suspension is brought into contact with a heated surface, a dust free space develops between the surface and the particles, owing to the action of thermal potential that causes the particles to migrate from a zone of higher temperature to one of lower temperature.

This is the principle involved in the thermal precipitation technique. The electrostatic precipitation uses an applied high voltage to produce electrostatically charged particles from particulate matter and to force the so-formed charged particles to migrate out of the air stream into a collecting electrode surface.

The sampled pollutants are finally subjected to chemical analysis and their quantities determined. Depending upon the concentration of the pollutant either volumetric, gravimetric or instrumental methods of analysis is employed for the estimations. However, the present trend, especially in the developed countries, is towards the use of automatic instrumental methods (Continuous automatic analysers). In these methods the sample collection, processing and analytical determination are carried out continously in the proper sequence. Table - 13.2 summarises some of the chemical analysis techniques used in monitoring of specific air pollutants.

Table 13.2. Chemical Analysis Techniques.

Pollutant	Analytical technique used
SO_2	Spectrophotometry - West Gaeke's methods; Conductometry in continuous SO_2 analysers; Amperometry.
CO	Non-dispersive infra-red spectrophotometry; Gas chromatography.
NOx	Chemiluminescence ; Spectrophotometry - Griess - Saltz - man technique.
H_2S	Spectrophotometry - Methylene blue method; UV molecular absorption.
Hydrocarbons, Volatile Pesticides	Gas chromatography in conjunction with mass spectrometry (GC-MS)
Particulate matter	- Gravimetry - High volume sampler; chemical microscopy for characterisation of particles; Atomic absorption spectrophotometry, neutron activation analysis, X-ray fluorescence, Inductively coupled plasma emission spectroscopy, etc., in metal particulates;

A Fourier Transform Infrared spectrometer with Gas Chromatographic interface and coupled to a Mass Spectrometer (GC/FTIR/MS) provides a very rapid and precise identification and characterisation of certain inorganic and organic compounds.

Biological Monitoring : Vegetation when affected by pollution, develops symptoms which are characteristic of the pollutant. Hence, such symptoms may help in identifying the causative pollutant. In fact, observations of injury on sensitive plant species have not only provided a means of monitoring pollutant emission from a source but also served as valuable tools in determining the geographical distribution of a pollutant over large areas. The biological monitoring involves :

i) Listing of growing plants on substratewise on bark , soil, wall, etc., as well as preparation of an inventory of plants present at each site.

ii) Study of growth behaviour and fertility of plants.

iii) Scientific and periodic evaluation of branching pattern, canopy-size and canopy geometry of each tree species,

iv) Periodic microscopic investigations of plant samples to decipher external and internal changes.

v) Evaluation of productivity patterns,

vi) Determination of concentration of persistant pollutants in soil and plant samples and of certain biomolecules in plant samples, and

vii) Detailed evaluation of acute and chronic posionings supposedly caused by pollutants on farm animal and human systems.

Correlation of Physico-chemical Monitoring and Biological Monitoring involves :

i) The study of relationship between the pollutant levels in the air and as detected in the plants.

ii) Delineation of the industrial/urban areas into different pollution zones based on pollutant concentrations in air, soil and plant samples, and

iii) Selection of plants for creating shelter belts in highly polluted areas, etc.

Finally monitoring helps in deciding proper locations for industries, preparation of pollution maps for cities, suggesting suitable guidelines and control methods and thus in the abatement of pollution.

In many countries the legal standards for ambient air quality are prescribed by the governments with an aim to keep the pollutant concentrations at safe levels. However the standards may vary slightly from country to country depending upon their meteorological and geographical features, and the population density.

Table - 13.3 shows the primary standards set for certain pollutants by the Governement of USA.

Table - 13.3. Primary Air Quality Standards of USA (Ambient Air)

Pollutant	Air quality Standard, Microgram/ Cubic meter, $\mu g/m^3$
Sulphur dioxide	80, annual artithmatic mean; 365, max. 24 hrs. value may occur once each year.
Oxides of Nitrogen	100, annual arithmatic mean 10 mg/m^3 max. 8-hr value may occur once each year; 24 mg/m^3 max.
Carbon monoxide	1 hr value may occur once each year.
Particulate matter	75, annual geometric mean; 260, max. 24 hr value may occur once each year.
Hydrocarbons	160, max. level that may occur 6-9 AM. once each year.

About 80% of India's industrial production is concentrated in 8 to 10 large industrial centres leading to severe local air pollution problems. Some data on the air quality of some of the Indian cities are shown in Table - 13.4 for the sake of information in the Indian context.

Table 13.4. Mean and Maximum Pollution levels reported in short term survey of Indian cities (Yanna War P.K. et al., 1970, Ind. J. Envntl. Health, 12, 255-383).

City	Air Quality, micrograms per cubic meter					
	SO_2		NO_2		SPM	
	Mean	Max.	Mean	Max	Mean	Max
Bombay	63	372	42	297	329	2900
Calcutta	38	54	-	-	365	507
Ahmedabad	13	25	20	23	598	704
Kanpur	86	288	75	245	488	550
Delhi	41	236	21	66	924	1031

The Indian ambient air quality standards for residential and rural areas for SO_2, NO_2 and SPM in terms of $\mu g/m^3$ are 80, 80 and 200 respectively.

13.3.5. Transportation Systems

Transportation systems can be broadly divided into two types *viz.*, surface transportation systems and Air transportation systems.

The former type can be further divided as land transportation systems (Road and Railways) and water transportation systems (Inland Water and sea transportation). The air pollution arising out of water transportation systems is less significant compared to that due to land and air transportation systems. The air traffic leads to serious implications as the pollutions are being directly released into the troposhere and lower stratosphere. The air-craft emissions are also implicated in the depletion of stratospheric ozone.

The main contributors to air pollution among the surface transport systems are petrol powered and diesel powered vehicles. The petrol powered cars, motor cycles, scooters, autorickshaws, etc., are the emitters of considerable quantities of carbon monoxide, oxides of nitrogen, lead and hydrocarbons while the diesel powered cars, buses, trucks and trains emit large quantities of smoke. CO and hydrocarbons. The emissions from the gasoline (petrol) powered vehicles are generally grouped as (a) exhaust emissions, (b) crank-case emissions and (c) evaporative emissions. The amount of pollutants that an automobile emits depends on a number of factors such as the design and operation. The exhaust emissions vary with the air-fuel ratio, spark timings and the engine operating conditions. Hydrocarbons are the main components of crank - case and evaporative emissions. The automobile emissions besides being poisonous also lead to the formation of photochemical smog in the presence of strong sunlight because of their very composition.

Carbon monoxide results from incomplete combustion of fuel. If there is not enough air in the air-fuel mixture to completely burn the fuel or insufficient time in the cycle of combustion to complete. all the carbon in the fuel cannot be burnt to carbon dioxide and some of it stops at carbon monoxide stage. At the high temperatures in the engine cylinders during the combustion process, nitrogen and oxygen in the air combine to form nitric oxide. Nitric oxide when exhausted into the atmosphere gets oxidised to nitrogen dioxide. Soot emissions in the exhaust result from the decomposition of hydrocarbon fuel, nucleation of carbon particles in the flame, growth of soot nuclei, agglomeration of particles and finally soot oxidation. Lead particles originate from the tetraethyl lead added as anti-knock agent to petrol while hydrocarbon emissions are due to evaporation from crank case and fuel tank.

In many developed countries, the hazards from automobile pollution were recognised well in time and preventive measures were taken to check them. The prosperity of these countries is leading to the increased use of personal transport vehicles, thus aggravating the pollution problem.

Though the total number of automobiles used in India is small compared to USA, the pollution is significant here due to (a) poor maintenance of vehicles and roads, (b) concentration of the automobiles in industralised metropolitan cities with poor planning and (c) Badly planned roads and traffic flow. The main approaches available in the context of control of this form of air pollution are :

a) Engine design modification,

b) Fuel modification,

c) Treatment of exhaust gases,

d) Exhaust gas recirculation,

e) Proper traffic and road planning including good maintenance,

f) Adoption of community transport in preference to personal transport vehicles,

g) Prevention of over loading and over speeding.

Check Your Progress 3 & 4

3. What is meant by air pollution monitoring ? What is the other name given to it ?
4. Mention the important air pollutants normally present in the auto-exhaust.

Note : a) Write your answers in the space given below.

b) Compare your answers with those given at the end of this unit.

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13.4. NOISE POLLUTION

Sources of noise pollution, nature of noise pollution, the effects on life forms, noise pollution transportation systems are described in detail in this section.

13.4.1. Source of Noise Pollution

Natural sources of noise are less important compared to man made sources. Noise created by waves in the sea, thunder storms, gale and wind, etc., may be treated as of natural origin while that produced by buses, trucks, cars, horns, automatic foundation diggers, bulldozers, vibrating foundaries and lathes, loudspeakers, aeroplanes, etc., comes under man made type. There has been a considerable increase in noise due to increasing human activity during the past century.

13.4.2. Nature of Noise Pollution

"Sound is a mechanical distrubance, propagated in an elastic medium and of such a character as to be capable of exciting the sensation of hearing". Alternatively, "sound is the sensation of hearing excited by mechanical disturbance." These statements hold good for noise as well, because noise is also a form of sound. Sound is defined in terms of its direction, frequency, and the magnitute of disturbance in the air. The frequency is usually expressed in hertz (cycles per second) while the magnitude is measured as sound pressure. Sound intensity, under certain conditions, can be derived directly form sound pressure and it is proportional to the square of the latter.

The noise is usually measured either by (1) Sound pressure or by (2) sound intensity. The sound intensity is measured in decibel (dB). Decibel is a ratio expressed as the logarithmic scale relative to a reference sound pressure level. The dB is expressed as

$$\text{Sound Intensity level} = 10 \log_{10} \frac{\text{Intensity Measured (I)}}{\text{Reference intensity (Io or dB} = 10 \log 10\ I/I_o}$$

The level of noise is usually expressed in terms of Sound Pressure Level (SPL) in dB.

SPL = 20 log 10 P/P_o, Where P is pressure variation measured in Newtons per square meter (N/m^2) and Po is the standard reference pressure equal to 2×10^{-5} N/m^2.

Human ear can detect the sound frequencies ranging from 10 to 20,000 Hertz and this range is called sonic or audible range of frequencies.

Loudness is an observers auditory impression of the strenth of the sound. The loudness of a multifrequency (Normal) sound is not linearly related to its intensity. Human beings perceive sounds that have the same intensity but different frequencies as different loudness since the ear is a non-uniform transducer whose sensitivity varies from ear to ear.

A list of typical nature of noise and the corresponding intensities is given in Table - 13.5

Table 13.5. Noise sources and their sound pressure levels.

Nature of Sound	SPL dB (decibels)
Breathing	10
Soft whisper	15-20
Male speach (at 3 meters)	60
Normal conversation	55 - 60
Normal trafic	50- 90
Heavy trucks	90
Silencerless motorbikes	100 - 110
Stereos	110-117
Commercial jet aircraft (at 30 meters)	120 - 140
Space rocket at Launching	170 - 180

13.4.3. Effects of Noise Pollution on Life Systems

Noise disturbes human peace and tranquility. It interferes with human activities at three levels (1) Audiological level, interfering with the satisfactory performance of the hearing mechanisms, (2) Biological level, interfering with biological functions of the body, and (3) Behavioural level, affecting the sociological behaviour of the subjects.

Audiological Effects : Noise induces hearing loss. Individuals differ in their noise induced hearing loss. Brief noise exposure may cause temporary loss of haring while long duration exposure may result in permanent hearing loss. Short intense exposures to noise cause acute accoustic trauma, the damage being caused by excessive vibration of the organ of corti. Temporary deafness occurs at 4000-6000 Hz. and this effect is known as Temporary Threshold Shift (TTS). In longer exposures the organ of corti will be totally damaged and permanent loss of hearing occurs at 100 dB. In addition to loss of hearing due to excessive noise, impulsive noise also causes psychological and pathological disorders.

Bilogical Effects : Noise affects the concentration and efficiency of man. This is especially true in the case of activities which demand special vigilance and thinking. Noise at relatively low levels causes the tiny blood vessels in the fingers, toes and skin to contract, cutting down the blood supply there. Noise can be lethal to heart patients and aggravate the condition of people suffering from cardiovascular diseases by causing aggregate of red blood cells in the blood vessels to contract in spasm under noise, thus resulting in the cloting of blood. There may also be endocrine and glandular stress responses to environmental noise. The respiratory system is affected in the 40-60 HZ range because of resonant characteristics of the chest. Noise also causes muscles to contract leading to nervous break down, tension and even, insanity. In brief, the general effects of noise on the body occur through sympathetic division of the automatic nervous system. Noise is also reported to cause eosinophilia, hyperglycaemia, hypokalaemia and hypoglycaemia by a change in body in fluids.

Behavioural Effects : Noise causes anxiety, insomnia, fright, and emotional stress. There are reported cases of outrageous behaviour induced by noise, some times leading to murders. Noise also causes dissatisfaction, disinterest and affects work performance. Noise can either increase or decrease work efficiency, depending on its intensity, duration and frequency distribution etc. Table 13.6 shows some of the sound pressure levels against the effects they cause.

Table 13.6. Important sound pressure levels (SPL)

SPL dB	Nature of effect
O	Threshold of audibility
85	Deafness initiation
90	Permanent deafness
120	pain
140	Extreme limit of human tolerance; prolonged exposure causes insanity
150	prolonged expossure causes burning of skin.

13.4.4. Noise Pollution Monitoring

As already mentioned the noise level is expressed in terms of sound pressure level (SPL) in decibels (dB). Sound level meters are used to measure sound pressure levels. The noise level at a site depends upon many factors. For instance noise levels along roadways depend upon numerous factors such as the distance from the roadway to the observation point, the total volume of traffic, the average speed of traffic, percentage of trucks in the total traffic volume, slope of the road, the type of road surface, the surrounding terrain and the location of natural and artificial barriers. The complex dependence of the noise level on all such variables must be taken care of by adopting a suitable computer program and the overall noise level monitored. This is the ideal way of assessment. However, there are some simplified versions of assessment available. One such version requires no accoustical experience but a knowledge only of the distance from the road way to the receiver, the number of vehicles passing per hour and their average speed. Another simple test for revaluating noise uses speech interference criteria to rate the noisiness of proposed housing sites. The only requirements are a measuring tape and two persons. One person reads aloud from a book and the other moves away until he can only catch a scattered word or two in ten seconds period. If difficulty in understanding occurs at a distance of two meters or less, the site is unacceptable for housing. The site is considered normally acceptable if hearing becomes difficult at 8 to 21 meters.

In the industrial context, a long-term programme should be drawn up involving workers participation to keep noise and vibration risks under control. Measurements made in places of work should be repeated at suitable intervals and a record of the readings maintained properly. These measurements should be repeated wherever there is a change in premises, equipments or production which might affect noise and vibration. Likewise, they should be repeated with a view to assess the effectiveness of the preventive action being taken. An inspection programme should be drawn out to check the effectiveness of preventive measures. Special attention should be paid to inspection check list to reduce noise or vibration or both, as well as personal protective equipment and its use.

Statistics should be derived from the data obtained by medical examinations, so as to ascertain whether the preventive action taken is statisfactory. The medical records should also be used for research purposes, and for epidemiological studies intended to help in defining more precisely maximum permissible levels as well as to collect data on individual sensitivity. The data on noise and vibration measurements should be correlated with health monitoring data.

The menace of noise pollution is growing day by day in the cities of the world. The noise level in Bangkok streets is one of the worst in the world. The noise level was found to be over 90 dB in 1972. Delhi is next to only a few cities in the world in noise pollution. Table 13.7 summarises the acceptable levels for outdoor and indoor noise.

Table 13.7. Acceptable sound pressure levels.

Location	SPL, dB
Rural	25-35
Suburban	30-40
Residential (Urban)	35-45
Urban (Residential; Business)	40-50
City	45-55
Industrial area	50-60
Music rooms	30-35
Hospitals, class rooms, Auditorium	
Apartments, Hotels, Homes,	35-40
Large public offices, Banks, Stores etc.,	45-50
Restaurants	50-55

The optimum international levels prescribed by WHO are 45 dB in day time and 35 dB during night.

13.4.5. Transportation Systems

Among the transportation systems, the road and air transportation systems contribute considerably to the noise pollution. The people living around air-ports are being punished, for no fault of them, by being subjected to unbearable levels of noise pollution created by air-craft. Besides the noise created by running engines of automobiles, the noise of horns, especially the air horns, is enhancing the overall noise pollution. The explosion in the use of personal transport vehicles is increasing the noise load of cities tremendously.

Aircraft noise is causing much more discomfort than that from road transport. Loud noise produced by high speed jet aircraft is continously increasing in proportion to their deployment in various national and international airlines. The Sonic boom generated by supersonic aircraft like concorde is adding another dimension to the noise pollution; sonic boom is a type of noise (shock waves) produced by supersonic aircraft which causes annoyance, damage to property and fright as well as mental anguish to animals. The impact of aircraft noise can be understood from the fact that aircraft noise is a sensitive issue in developed countries.

Check Your Progress - 5,6, & 7

5. What is noise pollution ?
6. What is meant by sonic range ?
7. What do you understand by the term 'Audiological effect'?

Note : a) Write your answers in the space given below

b) Compare your answers with those given at the end of this unit.

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13.5. POLLUTION IMPACT ANALYSIS

Until recently, all the developmental activities of man have almost ignored environmental considerations. With the realisation of the problems of pollution associated with the so called development, attempts are now being targeted for sustainable development. A proper sustainable developmental strategy analyses the changes or impacts of an impending action on the total environment. In other words, Environmental Impact Analysis (EIA), " a study of the probable changes in the various socioeconomic and biophysical characteristics of the environment which may result from a proposed or impending action ", is an essential component of sustainable development.

A complete understanding of the proposed action and the environment constitute steps one and two of the EIA, in that order. The third step deals with the projection of the proposed action into the future and determination of the possible impacts on the environmental characteristics, quantifying the changes wherever possible. The final step incorporates the results of the analysis in such a manner that the analysis of probable environmental consequences can be utilised in the decision making process.

The environment of both natural and man-made factors besides many attributes (elements/variables). Further, there are complex interrelationships among these attributes rendering the characterisation of the environment difficult. Changes in the attributes of the environment and their interrelationships are defined as impacts and changes in environmental attributes provide indicators of changes in the environment. According to one system of general listing there are 49 different attributes spread over seven different categories encompassing the biophysical and socioeconomic environment. The seven categories are : air, water, land, ecology, sound, human aspects, economics and resources. Of the two categories discussed in this unit, *viz*., air and noise, air attributes are factors that indicate the quality of the air.

Basically two kinds of environmental factors relate to air quality. They relate to : 1) Structure elements of the environment and 2) Inputs to or emissions from human activities. Factors relating to the former are stability, temperature, mixing depth, wind speed and direction, humidity, precipitation, pressure and topography; while dust, fumes, flyash, smoke, soot etc., are the factors relating to inputs from human activity. The following nine attributes are utilised in describing impact on the air environemnt : 1) Diffusion factor, 2) Particulates, 3) Sulphur oxides 4) Hydrocarbons, 5) Nitrogen oxides, 6) Carbon monoxide, 7) Photochemical oxidants, 8) Hazardous toxicants and 9) Odours. The first attribute, the diffusion factor, is related to the structure and elements of the environment while the remaing eight to the emissions from human activities.

The level of sound (noise) is an important indicator of the quality of the environment. Ramifications of various sound levels and types may be reflected in health and/or in aesthetic appreciation of an area. The noise in an environment is indicated by many attributes, but the selected ones are : Physiological effects, psychological effects, communication effects, perfomance effects and social behaviour effects.

The remaining 35 attributes relate to the other five categories mentioned earlier. Eventhough all this appears to be so complex, generalised procedures for conducting environmental impact analysis in the manner indicated by the four steps mentioned previously have been developed and the methods include : 1) Adhoc approach, 2) Overlay method, 3) Checkilists methods, 4) Matrix method, 5) Network method, 6) Evaluation systems, and 7) Computer aided EIA. A discussion of these methods is well beyond the scope of this sub-unit.

13.6. POLLUTION AND COMMUNITY ACTION

Community awareness is an essential prerequisite for any community action meant to fight the menace of pollution. Therefore the community must be well informed on the various aspects of

pollution, besides the rights, duties and obligations of the citizens, by all possible ways and means. In the present context of air and noise pollution, the inadvertent countribution of community to pollution is very significant and informed citizens can control the pollution from their side to a considerable extent. Further, the community can form forums such as environmental protection cells to fight pollution. The forums may get organised into different committees like study committee, legal action committee, publicity and communication committee etc., each one attending to achieve specific objectives. These forums should also insist on the public participation in decision making processes and this approach goes a long way in controlling pollution. All the available brain power of the community should be mobilised to organise mass movements, if required. The community should also insist the Government for an open discussion on decisions which are taken in a haste or under pressure from vested interests. It should also propagate the message of population control among the masses because population explosion is one of the major contributors to pollution of all types.

13.7. SUMMARY

Air pollution is an atmospheric condition in which certain substances are present in the ambient air at concentrations and for durations harmful to man and his environment, while noise pollution means dumping of the unwanted and hazardous sound into the environment. Even though both the types of pollution originate from natural as well as anthropogenic sources the contribution from man made sources is the only significant one in the case of noise pollution. However, man made and natural sources contribute significantly to the air pollution. Interestingly, transportation is a very important contribution for air and noise pollutions.

The major types of air pollutants are SOx, NOx, CO, hydrocarbons, particulates and photochemical oxidants. These pollutants are exceedingly detrimental to the health of man, animals and plants. The health effects can be acute or chronic in nature and they include eye, nose, throat and respiratory tract irritation and damage; increase in mortality and morbidity rate; severe aggravation of bronchitis and asthma; heart and brain damage; etc.

The effects of noise on the human health are no less important. Noise causes audiological effects like temporary or permanent loss of hearing and biological effects like cardiovascular and pulmonary diseases, hypoglycaemia, hypertension, etc. Noise is also known to cause anxiety, annoyance, insomnia, fright and emotional distress.

Community action backed by awareness programme has a vital role to play in fighting the means of pollution in general, and air and noise pollution in particular.

13.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Air pollution may be difined as any atmospheric condition in which certain substances are present in the ambient air at concentrations and for durations harmful to man and his environment.
2. Secondary air pollutants are those substances that are formed in the atmosphere by interactions among two or more primary pollutants, or by reaction with normal atmospheric constituents. Sulphate salts, ozone and peroxyacetyl nitrate (PAN) are the examples.
3. Sampling and measurement of concentration of air pollutants is known as air pollution monitoring. It is also called air quality monitoring.
4. Carbon monoxide, oxides of nitrogen, particulates and hydrocarbons are the pollutants normally present in the autoexhaust.
5. Noise pollution is dumping of the undesirable sound into the environment.
6. Sound in the frequency range of 10 to 20,000 Hz is called sonic range of sound.
7. Loss of hearing due to noise is called audiological effect.

13.9. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. What are primary and secondary air pollutants ? Discuss their sources in detail.
2. What are particulates ? Give a brief account of their types and characteristics.
3. Discuss the principles involved in the sampling techniques used in gaseous and particulated pollutants.
4. What are the effects of polluted air on life systems ?
5. Discuss the role of transportation systems in air and noise pollution.
6. How does noise affect human helath ?

II. Answer the following questions in about 10 lines each.

1. Write short notes on Bilogical monitoring of air pollution.
2. Describe the role of automobiles in pollution.
3. What is sound ? What are its characteristics ? How is it usually expressed ?
4. Write a short note on impact analysis.
5. Discuss the role of community action in pollution control.

Dr. S. N. Dindi

UNIT - 14 : WATER POLLUTION

Contents

14.1. OBJECTIVES

After completing this unit you will be able to :

* define pollution,
* list out the sources of water,
* describe the water quality,
* describe the sources of water pollution,
* describe the chemical and microbial contamination of ground water
* explain different aspects of pollution of surface water,
* describe the effects of various pollutants on health.
* describe the defence mechanism to control pollution.

Water is more critical than energy. We have alternate sources of energy. But with water there is no other alternative - EUGENE ODUM

14.2. INTRODUCTION

Man is making use of great strides in science and technology to exploit the natural resources in order to provide himself with better comforts. In the process he is tampering with the ecosystem, which ofcourse includes himself.

Environment has been defined as "the sum total of all conditions and influences that affect the development and life of organisms". Our environment can be broadly divided into three components - air, water and land. A group of individuals of one kind of organisms is called population and all the populations living in a given area form a community. The community and the non-living environment with which it interacts is considered as an ecosystem. Disturbances in the ecosystem generally results in pollution problems.

Pollution can be broadly defined as "the unfavourable alteration of the surroundings wholly or largely as a byproduct of man's action, through direct or indirect effects of change in energy pattern, radiation levels, chemical and physical constitution and abundance of organisms". A pollutant is any material or set of conditions that imposes a stress on or unfavourably alters an individual organism, population, community or ecosystems beyond normal environmental limits.

Human beings realised the problem of air pollution due to smoke and soot since the beginning of the utilisation of fire. In the recent years, air pollution and its possible global consequences like greenhouse effect and ozone depletion have been drawing serious attention.

Human beings were also aware of the water pollution problems which might have forced them to move their settlements frequently.

In 1941, for the first time it was recognised that water is a vector for virus caused diseases during an epidemic of poliomyelitis. Later, the route for the spread of hepatitis and other alimentary diseases was also established as drinking water polluted with viruses or bacteria. Incidents of various epidemics like polioyelitis, cholera, typhoid, gastroenteritis, hepatitis etc., killing thousands of people througout the world were reported and are being reported even in the present days of technological development. In tropical countries, these incidents generally occur during rainy season probably because of improper drainage, stagnation of sewage and sullage and resulting seepage through the soil thus polluting the ground water or due to the contamination of drinking water by the sewage through leaks in pipelines etc.

One of the serious chemical pollution problems experienced by mankind is that of mercury pollution in River Minamata of Japan and Wabigoon-English river of canada where thousands of people suffered from chronic dieseases. The next well known chemical pollution is due to cadmium which is the root cause for a chronic disease known as Itai-Itai.

Even though there might have been several water pollution problems experienced by people in several parts of India in the past years, the first reported episode of hazardous waste release was noticed in 1986 when the river Ganges was set a flame near Monghyr, Bihar State. Discharge of crude oil and other petroleum products along with the refinery effluents into the river and subsequent fire resulted in the suspension of drinking water supply to the town of Monghyr for few days. In Madhya Pradesh, serious environmental pollution hazards hangs over vast tracts of rich forest and agricultural lands. Situated along the 32 km long course of river Sankini, which carries huge quantities of fine iron ore dust wash out from the prestigous Bailadila Iron Ore Project. The pollution threat has assumed such serious proportions over the past few years that the entire river has been turned red thus seriously hampering the drinking water needs of the people in villages on the banks of the river.

It is recognised that Ganges, the largest river in India which serves the domestic and agricultural water needs of the largest population of the country is highly polluted not only due to the discharge

of effluents from a variety of sources such as chemical, tanning, distilleries, sugar and paper industries but also from discharge of municipal and rural sewage and sullage, agricultural farms, cattle pens etc. throughout the river basin. The Indian Government initiated a major action plan called "Ganga Cleaning Programme" the major objectives of which is to make the municipalities and industries effectively treat their effluents before discharging them into the river. Several other action plans are also under implementation wherein the discharges of wastes of any kind into the river are being checked. The government is spending a few thousand crores of rupees for these programmes to achieve its objective of keeping the Ganges and other river waters clean so that it can be used for drinking and other purposes.

14.3. WORLD WATER RESOURCES

Water is our most abundant resource, covering about 71% of the earth's surface. This precious film of water helps maintain the earth's climate, dilutes pollutants and is essential to all life.

However about 97% of the earth's volume of water is found in the oceans and is too salty for drinking, growing crops and most industrial uses except cooling.

The remaining 3% is fresh water and is in the form of ice caps, glaciers, lakes, rivers and ground water (table-14.1)

These figures about water resources may be put in a different manner. If the world total water supply were only 100 litres, the supply of fresh water is about 0.5 litres and only 0.003 litre (just one-half tea spoon) is our usable supply of fresh water. (Fig. 14.1)

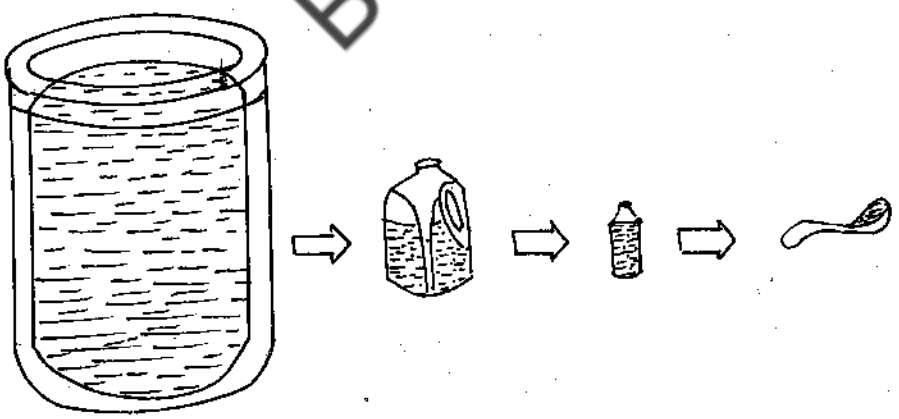

Fig. 14.1. The fraction of usable fresh water in the worlds total water supply.

Fortunately this fresh water supply is continually collected, purified and distributed in the hydrologic (water) cycle (Figure 14.2). This natural recycling and purification process works as long as we don't pollute water faster than it is replenished, over load it with slowly degradable and non-degradable wastes, or withdraw it from slowly renewable underground deposits faster than it is replenished. Unfortunately we are disrupting the water cycle by doing all of these things.

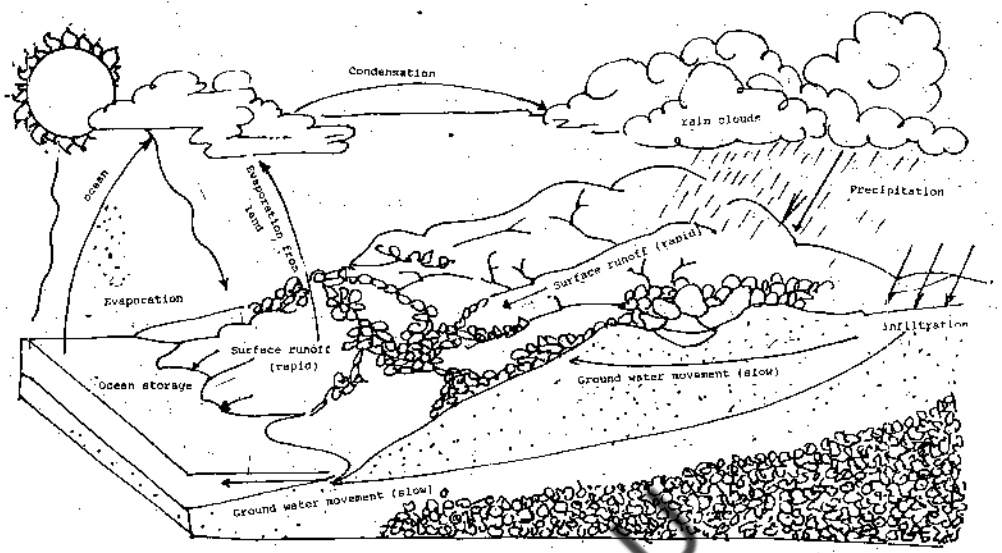

Fig. 14.2. Hydrologic cycle.

14.4. SURFACE WATER AND GROUND WATER

The fresh water we use comes from two sources - surface and ground water.

Precipitation that does not infiltrate into the ground or return to the atmosphere by evaporation or transpiration is called surface water. It is fresh water that is on the earth's surface in streams, lakes, wet lands and reservoirs.

Some precipitation seeps into the ground and fills pores i.e. spaces or cracks in soil and rock in the earth's crust. The area where all available pores are filled by water is called the zone of saturation and the water in these pores is called ground water. The water table is the upper surface of the zone of saturation. (Figure 14.3). There is 50 times as much ground water below the earth's surface as there is in all the world's streams and lakes.

Table 14.1. The Distribution of the Planetary Water Balance

Source	% of Total
Oceans	97.2
Ice caps, glaciers	2.12
Ground Water down to 4000 m	0.67
Fresh water lakes	0.0089
Saline lakes or inland seas	0.0079
Soil moisture and Vadose water	0.00279
Atmosphere	0.00092
Rivers	0.00009
Total	100.0

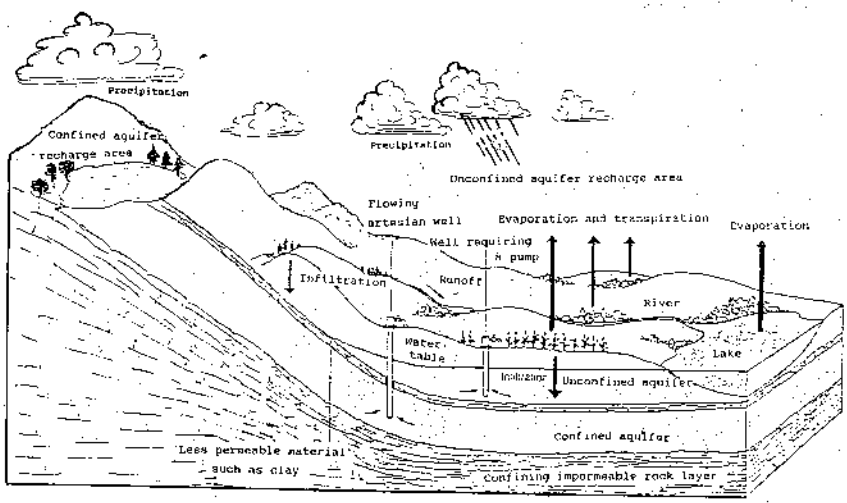

Fig. 14.3. The ground water system.

A geologic unit saturated with water and sufficiently porous and permeable to yield economically significant amount of water is called an aquifer. The aquifers are of two types - unconfined and confined or perched.

Unconfined aquifers are relatively close to the surface and thus receive recharge from the downward seepage of water through the overlying unsaturated zone. Hence this easily contaminated locally by imporper waste disposal.

Confined aquifers are overlaid by a confining layer having little or no hydraulic conductivity and are outcrop of the aquifer.

In an unconfined aquifer the elevation of the water surface inside the well will be that of the water table, while in a confined aquifer the water level in the well may rise under pressure to an elevation for above the top of the aquifer.

Check Your Progress - 1

What is an aquifer ?

Note : a) Write your answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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14.5. URBAN AND RURAL SCENE OF WATER SUPPLY

Most of the cities in India depend on either natural or man-made water lakes for the water supply. Man-made water lakes and reservoirs vary in size from small basins of a few hectares to valley impoundments where the water area is vast and generally these are filled by the river waters.

However some reservoirs are designed to retain water in rainy seasons for use afterwards.

For cities and towns the water stored thus is generally clarified, filtered, chlorinated and then supplied to the people through public distribution system using pipe lines. The water is distributed generally without assessing the water quality, though the quality is assessed at the water treatment stations in a few major cities.

The people in rural areas mostly depend on rivers, lakes and open wells and borewells for their water supply. The quality of water is assessed by themselves only by its physical appearance and taste.

In many rural areas people have to spend a good part of their time fetching water, often from polluted streams. Many women and children walk 10 to 20 kilometres a day carrying heavy, water-filled jars and pots.

14.6. CONCEPT OF WATER QUALITY

Often it is tempting to view quality in the context of a simple hierarchy based on purity, where water with the lowest concentration of constituents is viewed as the best. This may seem logical but, unfortunately, meaningful evaluation of water quality is not that simple as many other factors are to be taken into consideration. This point can be established through a simple example.

If one uses a scale based on purity, sea water would be classified as relatively poor because it contains high concentrations of salts and distilled water as good because it contains low concentration of salts. It is well known that variety of fish and other organisms can survive in sea but not in distilled water because they require salts, trace metals and nutrients. Thus distilled water is of poor quality for the survival of fish and other aquatic organisms.

Secondly, water used in boilers should not contain any salts as they form scales and reduce their efficiency and cause the problems of corrosion. So, in this context, distilled water is of excellent quality wheras sea water is of poor quality.

On the other hand either sea water or distilled water are not fit for human consumption, as drinking water must be of different quality.

These examples, illustrate that water quality can not be evaluated meaningfully regardless of the purpose for which the water is being considered. While evaluating the quality of water one must consider both (a) concentration of various constituents in the water. (b) uses that the resource will be called on to satisfy.

Quality can be judged accurately only by comparing concentrations of various constituents in water with those optimum, for the intended uses. Thus water quality is not absolute. It has practical meaning only when related to some specific purpose of water.

14.7. WATER QUALITY AND ITS IMPORTANCE

Generally the term water quality refers to characteristics or attributes of water, good or bad, that relate its acceptability for certain purpose or uses. From a technological point of view, water quality characteristics are usually defined in terms of appropriate physical, chemical and biological parameters,

preferably those which can be measured quantitatively and reproducibly to avoid ambiguity in reporting or discussing them.

The period during 1890-1925 marks the beginning of major concern regarding water quality, especially drining water. This concern led to rapid advances in the development and application of water treatment technology apart from extensive evaluation of the resulting impact of these improvements in human health. During this course the key processes of filtration and chlorination were applied broadly to drinking water supplies, resulting in dramatic reduction in the incidence of waterborne diseases.

Simultaneously, the waste water treatment was first recognised as an important adjunct to the water supply. Thus, the rapid progress in water quality and its control was fuelled by concern about public health. In recent years, new concerns about potential health impact of toxic substances have arisen from the indentification of potential carcinogens and teratogens in drinking water sources and foods derived from aquatic life.

Table 14.2 summarises common water uses and classifies them as to whether they involve

i) its withdrawl from the water course

ii) its use in place without removal

iii) the realisation of benefits by using the flow characteristics of a stream.

Table - 14.2. Major Beneficial uses of Water

Types of use	withdrawl	In place	Flow use
I. Water Supply			
a) Domestic and Municipal	✓		
b) Industrial	✓		
c) Irrigation	✓		
d) Stock and wild life	✓		
II.			
a) Fish		✓	
b) Sheel fish		✓	
c) Others		✓	
III. Recreation and water sports		✓	
IV. Commercial navigation		✓	
V. Aesthetic values		✓	
VI. Hydoelectric power production			✓
VII. Waste disposal			✓

14.8. SYSTEMS FOR MEASURING WATER QUALITY

Water quality usually is a dynamic subject to major changes with or without human intervention. Various parameters are used to describe and specify quality characteristics. Therefore, decisions on the type of parameters to be measured, on the methodology and time of sample collection, sample preservation and selection of appropriate methods for the analysis involve an extraordinarily complex matrix of variables.

The systems used for determining water quality can be classified into five groups.

i) Analysis based on measuring concentrations of specific constituents of water in which they are reported directly and quantitatively.

ii) Analysis based on direct and quantitative measurement of quality characteristics. The parameters may be experessed on predetermined arbitrary scales, which actually may not be related to the concentrations of any specific constituents.

iii) Measurements of specific constituents or quality characteristics that are different from those of principal interest but are associated with them.

iv) Measurement of the effects of constituents as contrasted with their concentrations in water.

v) Description or specification of water characteristics in qualitative terms.

14.9. WATER QUALITY CRITERIA

Table 14.3 summarises several water quality criteria published by the Enironmental Protection Agency (EPA), United States of America for various substances in drinking waters to be used for selected purposes. It must be emphasised that they should not be viewed as valid and absolute limits, but only as guidelines that can be used for preliminary judgements.

Similarly, the Government of India, through the Department of Environment, Central Pollution Control Board (CPCB) and Bureau of Indian Standards specified standards for water quality for drinking purposes which are presented in Table 14.4.

The values presented in the tables 14.3 and 14.4 may be viewed as concentrations that usually assure safety across a wide range of circumstances found in practice. Lower concentrations may be safe whereas slightly higher concentrations might not preclude the specified use of the water but might represent only a reduction in the margin of safety.

The criteria summarised in Tables 14.3 and 14.4 should be used with caution because they have been abstracted from a document of several hundred pages. There is always a risk of how, when and by whom they were compiled. Information is being developed continuously in this area and each criterion constituents on beneficial uses.

No published criteria ever should be considered as final, but they are valuable and could be taken principally as the guidelines. Unfortunately this limitaiton is not always recognised by regulatory agencies and other concerned sections of the society.

Table - 14.3. Standards of Physical and Chemical Quality for Drinking Water
(American Standards -EPA)

Sl No.	Characteristics	Acceptable Limit	Allowable Limit
PHYSICAL			
1.	Turbidity	5	25
2.	Colour	5	50
3.	Taste and odour	Un-objectionable	Un-objectionable

CHEMICAL

4.	pH Value	7.0 - 8.5	6.5 - 9.2
5.	Total solids	500	1500
6.	Total Hardness (as $CaCO_3$)	—	—
7.	Calcium (as $CaCO_3$)	75	200
8.	Magnesium (as $MgCO_3$)	50	150
9.	Iron (as Fe)	0.3	1.0
10.	Manganese (as Mn)	1.0	0.5
11.	Copper (as Cu)	1.0	1.5
12.	Zinc (as Zn)	5.0	15
13.	Chlorides (as Cl)	200	600
14.	Sulphates (as SO_4)	200	400
15.	Magnesium sulphate and sodium sulphate	500	1000
16.	Fluorides (as F)	1.0	1.5
17.	Nitrates (as NO^-_3)	45	45
18.	Arsenic (as As)	—	0.05
19.	Chromium (as Cr^{6+})	0.05	0.05
20.	Lead (as Pb)	0.05	0.10
21.	Cadmium (as Cd^{2+})	—	0.01
22.	Mercury (as Hg^{2+})	—	—

Note :

1. The limits in column first designated (acceptable' apply to water that would generally be acceptable to the consumers.
2. Values in column second in excess of those designated as 'allowable' would considerably impair the potability of the water supply and hence would constitute grounds for rejection of the water as a public supply for domestic use.

Table - 14.4. Essential Characteristics of Drinking Water (Indian Standards-CPCB)

Sl. No.	Substance or characteristic	Requirement/ Desirable Limit	Permissible limit in the absence of alternative source
	Essential Characteristics		
1.	Colour	5	25
2.	Odour	Unobjectionable	—
3.	Taste	Agreeable	—
4.	pH value	6.5 to 8.5	No relaxation
5.	Hardness (as $CaCO_3$)	300	600
6.	Iron (as Fe)	0.3	1.0
7.	Chlorides (as Cl)	250	1000
8.	Residual free chlorine (as Cl_2)	0.2	No relaxation
9.	Dissolved solids	500	2000
	Desirable Characteristics		
10.	Calcium (as Ca)	75	200

11. Copper (as Cu)	0.05	1.5
12. Manganese (as Mn)	0.1	0.3
13. Magnesium (as Mg)	30	100
14. Sulphate (as SO_4^{2-})	200	400
15. Nitrate (as NO_3^-)	45	100
16. Fluoride (as F^-)	1.0	1.5
17. Mercury (as Hg)	0.001	No relaxation
18. Cadmium (as Cd)	0.01	No relaxation
19. Arsenic (as As)	0.05	No relaxation
20. Lead (as Pb)	0.05	No relaxation
21. Zinc (as Zn)	5	15
22. Anionic detergents (as MBAS)	0.2	1.0
23. Chromium (as Cr)	0.05	No relaxation

Note : All values are expressed in mg/l unless otherwise mentioned.

14.10. WATER QUALITY STANDARDS

Water quality standards are different from objectives and criteria. Water quality standards are the means by which regulatory agencies define their requirements for water sources. The development of standards must include careful attention to programme objectives and quality criteria for the designated uses but they must also consider several additional factors of the matter including economic aspects, public needs and desires, public and political reactions and practical feasibility.

As contrasted with criteria, standards are relatively rigid reflections of laws and regulations and usually are viewed as absolute. Water quality standards may not always relate directly to the specific quality criteria for uses to be protected.

The standards used in water quality control are broadly divided into :

i) Design Standards

ii) Performance Standards

iii) Procedural Standards

Design standards specify certain characterstics that are required in water supply or waste water disposal facilities.

Performance standards specify the final result that must be produced and the type of facilities used. For example they indicate the maximum concentrations of some constituents in the water supplied.

Procedural standards define various approaches and methods that must be followed in water quality control activities.

The different types of standards, although mutually exclusive, often prove most effective when applied simultaneously to regulate various aspects of water quality control. However each has an important role to play and offers advantages and disadvantages in specific applications that should be understood and carefully considered.

The development of background data that can be used as a foundation for decisions, must have a high priority in pollution control programme. The broad categories of information required for that purpose include :

i) Physical characteristics (type, size, flow etc.) ii) Present uses of the resource, iii) Present physical, chemical and biological quality of water, iv) Local needs and desires concerning future uses of the water course, v) Quality characteristics necessary to protect it for those selected uses, vi) Social and economic aspects of the matter.

Among others, information on physical, chemical and bilogical quality of water is very important to provide an accurate base line data that define present conditions. These data are especially important in establishing reasonable uses of water sources and identifying the potential pollutants that probably require control.

The standard levels for domestic water supply incorporate available data for human health protection. Such values may be different from the criteria levels necessary for protection of aquatic life. The health risk due to toxic chemicals in drinking water differs from that caused by disease causing microbes. The problems associated with chemical constituents arise primarily from their ability to cause adverse effects after prolonged periods of exposure. Of particular concern are cumulative poisons and carcinogens.

The guideline values indicate tolerable concentrations, but they must not be interpreted as standards for water quality. Several inorganic elements for which guidelines have been recommended are recognised to be essential elements in human nutrition. No attempt has been made here to define a minimum desirable concentration of such substances in drinking water. The guideline values for these substances are concentrations that should not be exceeded over long period of time because of the potential hazards of ingesting excessive amounts of these substances. None of the organic substances have any known beneficial properties. Synergistic and antagonistic reactions among many quality constituents in water also are recognised even though the precise definition of such reactions and their relative effects have not been identified with scientific precision.

14.11. SOURCE OF WATER POLLUTION

The major sources of water pollution are of two types- point sources and non-point sources (figure 14.4).

Point Sources discharge pollutants at specific locations through pipes, ditches, or sewers into bodies of surface water. Examples include factories, sewage treatment plants, active and abandoned underground coal mines, off shore oil wells, and oil tankers. Because point sources are at specific places they are fairly easy to identify, monitor and regulate.

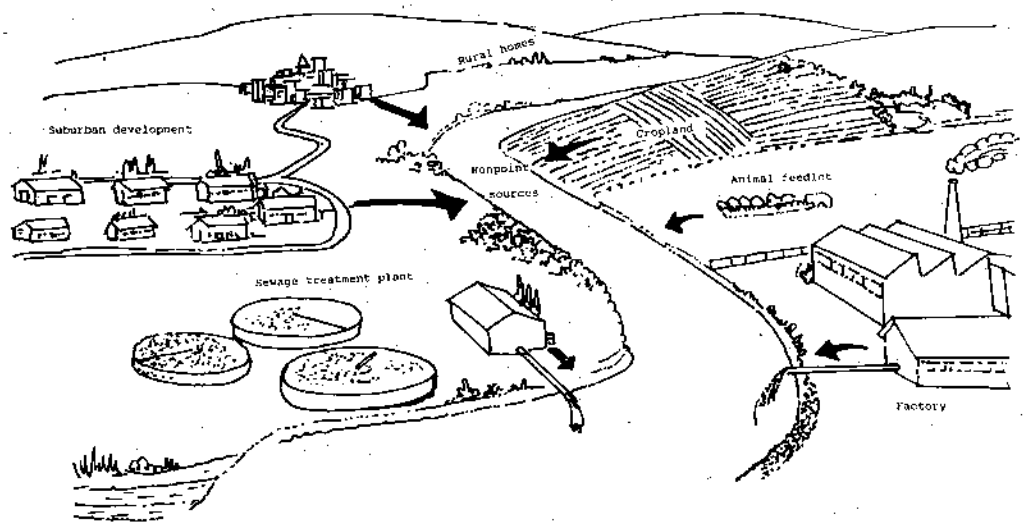

Fig. 14.4. Point and Non-point Sources of Water Pollution.

Non point sources are big land areas that discharges pollutant into surface and underground water over a larger area and parts of the atmosphere where pollutants are deposited on surface waters. Examples include run off into surface water and seepage into the ground from agricultural fields, live stock feedlots, logged forests, road ways, houses, septic tanks and construction areas.

Check Your Progress - 2

Name the important sources of water pollution

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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14.12. CHEMICAL POLLUTION OF GROUND WATER

Ground water is the source of drinking water for a large population through out the world. Except for chlorination in few instances, ground water is rarely treated, presuming it to be a naturally protected and free of impurities, compared to the surface waters, because it comes from deep within the earth. Various activities like intense agriculture, power generation units such as hydel, thermal, nuclear, chemical and other industries have produced numerous potential sources of ground water contamination (Figure 14.5) Indentification of these sources is very important to monitor and to adopt suitable control measures.

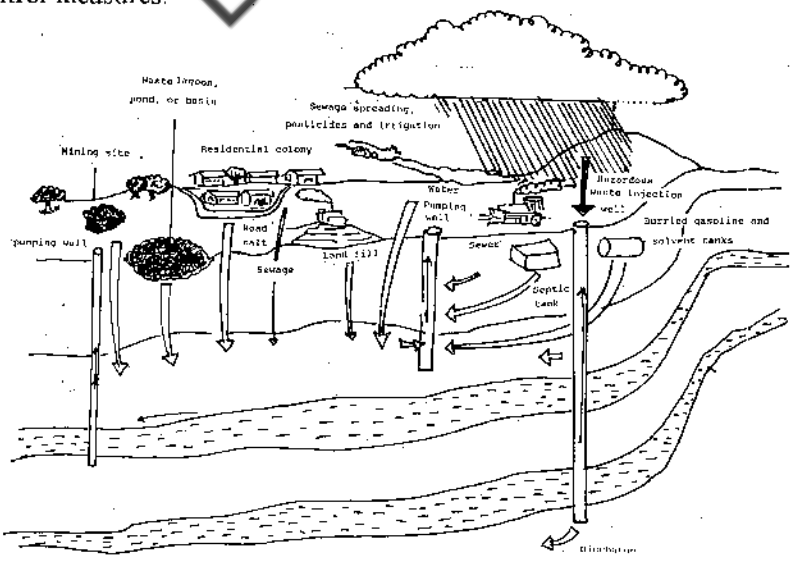

Fig.14.5. Major Sources of Ground Water Pollution

The most important types of ground water contamination are :

a) Urban pollution - due to land fills of municipal wastes, seepage of septic tanks and drainage waste waters.

b) Industrial pollution- due to seepage of chemicals from industiral effluents and other wastes.

c) Agricultural pollution - due to excessive use of fertilisers and pesticides.

Various sources and the potential contaminats that enter the ground water are listed in table 14.5.

Table - 14.5. Sources of Groud Water Contaminants

Source	Potential of contaminant
Accidental spills	Inorganic and organic chemicals
Deep well injection	Inorganic and organic compounds, radioactive materials and radionuclides
Hazardous waste disposal sites	Inorganic compounds (especially materials cleaning solvents and degreasing compounds
Industrial liquid waste storage ponds and lagoons	Inorganic compounds (heavy metals) cleaning solvents and degreasing compounds
Land fills, industrial	Inorganic and organic compounds
Land disposal of liquid and semi-solid industrial wastes	Organic compounds, heavy metals, cleaning solvents and degreasers
Land disposal of municipal waste water and waste sludges	Organic and inorganic compounds, heavy metals and microbiological contaminants.
Municipal land fills	Organic and inorganic compounds
Intense agriculture	Fertilizers, organic and inorganic compounds and pesticides
Huge storage tanks	Organic cleaning and degreasing compounds, petroleum products and various other hazardous wastes.

In several countries through out the world, the lack of monitoring at an ample number of places wherever there is a potential for contamination, besides the lack of comprehensive analysis of water quality of large areas through out the country, rule out the possibility for a reliable determination of the extent and severity of ground water degradation and associated health risks. Segments of important aquifers in big cities are known to be degraded and may perish forever as sources of drinking water.

Some portion of our population might have been exposed to chemical contamination for an unknown period of time. Most ground water contamiantion incidents are local and effect generally the upper most aquifers. The area below which ground water quality is significantly degraded is typically less than a kilometer long and half of kilometer wide with pollutants moving at an average rate of less than 1/2 meter/day.

On the other hand the resource itself is huge. At any chosen location, there can be a sufficient supply of ground water to single family for its use besides at other places many aquifers yielding much more quantity of water to an individual well. Although the specific volume of contaminated ground water may be only a small percentage of the nations ground water resources, the impact of

this contamination can be very large. There is a critical need to identify and manage the source of contamination not only for protecting public health but also in preserving the resource.

14.13. MICROBIOL CONTAMINATION OF GROUND WATER

Many of the problems associated with water quality are due to the presence of organic matter from natural sources and waste water discharges, i.e., domestic waste and waste water from cess pools. This organic matter is normally stabilised bilogically with the help of microorganisms which utilise either acrobic or anaerobic oxidation system to produce new cells of organisms. So domestic sewage or waste water from septic tanks always contains bacteria, viruses, protozoa and helminths which are pathogenic to man.

The most common bacterial species associated with sewage are *Salmonella* species (the cause of typhoid), *Shigella* species and *Vibrio* species (both associated with severe gastroenteritis). Over 100 different types of pathogenic viruses have been isolated from faecal material, including poliovirus, coxsackievirus, norwalk agents, adenovirus, rotavirus and hepatitis - a virus, These viruses have been associated with a wide variety of diseases in man, including paralysis, gastroenteritis, hepatitis, meningitis and eye infections.

In general, parasitic protozoa and helminths are not a problem associated with ground water contamination, because their large size results in highly efficient removal by filtration through soil. Bacterial and viral contamination of ground water is a serious problem that can result in large out breaks of water borne diseases throughout the world. Because of limitations in surveillance, the number of reported water borne disease out breaks is believed to be only a fraction of the total number that can occur every year.

The fate of pathogenic bacteria and viruses in the subsurface are determined by their survival and their retention by soil particles which depend upon the climate (temperature and rainfall), nature of soil and nature of microorganisms.

The survival of microorganisms is greately prolonged at low temperatures. Below 4° C they can survive for months or even years. At higher temperature they die off fairly rapidly. Adsorbed viruses are protected to some degree against thermal effects, so their survival is prolonged even at higher temperatures. Soil properties that control the survival of bacteria and viruses in the soil are listed in Table 14.6.

TABLE 14.6. Factors Effecting Virus Survival.

Factor	Remarks
Moisture content	Greater survival time in moist soils and during times of high rain fall.
Moisture-holding capacity	Survival time is less in sandy soils with lesser water-holding capacity
Temperature	Longer survival at low temperatures, longer survival in winter than in summer.
pH	Short survival time in acid soil than in alkaline soils
Sunlight	Shorter survival time at soil surface
Organic matter	Increased survival and possible regrowth when sufficient amounts of organic matter are present
Antagonism from soil microflora	Increased survival time in sterile soil.

Adsorption of viruses onto soil particles offers protection against factors responsible for viral inactivation in the soil. Soil pH, exchangeable aluminium and resin extractable phosphorous can be correlated with virus survival and the details are presented in Table - 14.7.

Table 14.7. Factors Effecting Virus Survival

S.No.	Factors
1.	As virus adsorption to soil increases, virus survival increases.
2.	Virus survival increase with increasing levels of exchangeable aluminium.
3.	Virus survival decreases with increasing pH and resin extractable phosphorous.
4.	As temperature increases, the survival decreases.
5.	Aerobic soil micro-organisms adversely affect virus survival while anaerobic micro-organism have no effect.
6.	In general, virus survival is less at lower moisture levels.
7.	Fulvic and humic acids may mask virus ineffectively.

In summary, survival of those enteric microorganisms retained near the soil surface would be expected to die off at a fairly rapid rate due to the combined effects of sunlight antagonism and drying. On the other hand, those organisms that penetrate the aerobic zone could be expected to survive for a more prolonged period of time. Several surveys indicate that rainfall and well depth are related to the microbial quality of ground water. Studies indicate that shallow drinking wells have high median coliform values (MPN/100 ml.) while deep wells have low MPN count.

14.14. POLLUTION OF SURFACE WATER

There are two possible sources of pollution of surface waters : a) Natural sources b) Man-made sources

a) **Pollution by natural sources** : Contamination of water resources by natural sources are mostly due to plant and animal wastes carried by the water from the forest regions, dissolution of salts along the river path, turbidity due to soil erosion etc. The turbidity is high during mansoon and a few days after but slowly settles down to almost clear water. Contamination with bacteria is a general feature due to wastes of plants and animals carried by water and their subsequent exposure to atmosphere continuously.

b) **Pollution by man-made sources :** The rivers, canals and lakes not only provide water for industrial, domestic and other purposes, but also serve as best sinks to discharge industrial effluents, sewage from cities and towns and agricultural run off. This endanger the rivers with organic, inorganic chemicals and bacteria and viruses.

Throughout the world most of the rivers and lakes are either already polluted to alarming levels or getting polluted due to discharge of untreated or partially treated wastes from industries, mines, agricultural runoff, sewage of municipalities etc. Almost all the major rivers in India, such as the Ganges, Narmada, Mahanadhi, Tapati, Godavari, Krishna, Cauveri and even several small ones are highly polluted or have been getting polluted due to indiscriminate discharge of effluents from a variety of industries such as chemical, tanning, distilleries, textile, paper mills, ceramic and also mine-discharge, sewage and sullage.

In this connection, it is worth mentioning that the Government of India has initiated major action to clean and control the pollution in some of the rivers in India. This is planned mainly by insisting the industries, municipalities and corporations to treat their wastes and effluents thoroughly before discharging them into the rivers. This is further checked by monitoring the discharges into the rivers at all places.

There are reports about the presence of virus in well water contaminated from the septic tanks and their existence even in chlorinated water, in the absence of evidence of bacterial contamination. This raises concern about the efficacy of chlorine disinfection of contaminated ground water.

The movement of viruses and bacteria in soil is influenced by factors like rainfall, pH, soil composition, flow rate, soluble organics, cations, adsorption characteristics of the virus and bacteria and degree of saturation. Coliform bacteria have been observed to be trasported in loomy sand aquifers for several kilometers. Viruses have been shown to travel up to 0.5 km horizonatally in the ground water through sewage infiltration basins.

14.15. HEALTH EFFECTS

Impact of Various chemical, physical and biological parameters on health and hygiene are given below.

The physical parameters are colour, turbidity and taste and odour

(i) **Colour :** Although colloidal forms of iron and manganese occasionally are the cause for colour of water, the most common causes are complex organic compounds originating form the decomposition of naturally occurring organic matter such as tannins, humic acid and humates. Colour in water is an important parameter in terms of aesthetic consideration, therefore, water should be virtually free from substances producing objectionable colour. The most common causes for the colour of water are complex organic compounds originating form the decomposition of natural organic matter like tannins, humic acid and humates. Colloidal iron and manganese also occasionally cause colour to water.

ii) **Turbidity :** Turbidity in water is caused by the presence of suspended matter such as clay, silt, organic and inorganic colloids, plankton and other microscopic organisms. It renders the potable water unattractive to the consumer. It can also have a significant effect on the microbiological quality of drinking water because the nutrients absorbed on the surfaces of the particles enable bacteria to grow more effectively compared to those in free suspension. Thus excessive turbidity exerts a significant chlorine deamand for disinfecting the water.

iii) **Taste and Odour** : In the assessment of drinking water quality taste and odour are complementary, the farmer is most useful in detecting inorganic constituents of drinking water, and the latter organic constituents. The presence of objectionable tastes in a public water supply may cause consumers to seek alternative sources of potable water. Therefore, the water meant for drinking must be free of objectionable taste and odour for the large majority of the population.

The Chemical parameters are Aluminium, Arsenic, Cadmium, Chromium, Mercury, Lead, hardness, chlorides and residual chlorine, nitrates , fllorides etc,

i) **Aluminium :** Aluminium compounds are abundant in nature and are often found in water. The salts of aluminium are used extensively in water treatment for the removal of colour and turbidity (levels of aluminium in treated water : 0.01 to 2 mg/L). Compared to aluminium intake through food, that of water is small. Aluminium does not appear to be an essential nutrient to man. Its salts are generally complexed with phosphate and excreted in the faeces. The chronic use of large quantities of aluminium hydroxide in the form of antacids can lead to excessive loss of phosphate from the system. Ingested aluminium accumulates, to some extent in the skeleton, testis, heart muscles and bones whereas inhaled aluminium accumulates in the form of dust in the lungs and lymph nodes. Aluminium has been found to be neurotoxic. It causes neuro-gibrillary degeneration, neuronal loss, dialysis dementia and Alzneimer's diseases.

ii) **Arsenic** : Many arsenic compounds are water soluble and thus arsenic contamination of water may occur. Arsenic exists in trivalent and pentavalent states and its compounds may be either organic or inorganic in nature, all of which are known to be absorbed in the system. Following exposure to arsenic, it enters the blood and subsequently the liver, muscles, kidneys, spleen

and skin whereas smaller concentrations are also found in the brain, uterus, heart, thyroid, pancreas, hair and nails. The inorganic forms of arsenic are known to get transformed to mono and dimethyl compounds in humans. Surface and ground waters may contain soluble arsenic upto 10 ug/L.

Trivalent arsenic may inhibit the activity of many enzymes by reacting with sulphydryl groups, reactions involving such groups are considered to be responsible for the toxic action of arsenic compounds.

There is no firm evdence that arsenic in any form is essential to man. Sub-acute and chronic arsenic poisoning may be insidious and pernicious. The symptoms of mild chronic poisoning (0.05-5 mg) are fatigue and loss of energy. In more severe intoxication (5-50 mg), the symptoms observed are gastrointestinal catarrh (inflammation in mucous membane and related effects), kidney degeneration, tendency to edema, poly-neurities, cirrhosis, bone marrow injury, exfoliate dermatitis, altered skin pigmentation and skin cancer.

Acute poisoning by arsenic (70-180 mg), involves the central nervous system leading to coma and death.

iii) **Cadmium** : Drinking water may contain 1 mg/L of cadmium under normal circumstances. The solubility of cadmium in water is influenced by the nature of the source of cadmium and the acidity of the water. Surface waters that contain more than 5-10 micrograms of cadmium per litre have probably been contaminated by dishcarges of industrial wastes or by leaching from areas of land fill. It may also be from soils to which sewage sludge has been added, in tap water it may enter through piping and other fittings.

Cadmium is fairly readily absorbed through ingestion or through the lungs. Alimentary absorption is affected by a number of factors such as age, concentrations of calcium, zinc, iron and protein deficiency. Absorbed cadmium will enter the blood and become concentrated in certain parts of the human body. The cadmium to a large extent is bound to a protein of low molecular mass, known as metallothionine. This metal-binding protein is belived to be involved in cadmium transport and absorption since cadmium has, a long biological half life in the body, and it accumulates with age.

Diseases such as bronchitis, emphysema, anaemia and renal stones may be caused by cadmium pollution. The renal cortex is generally accepted to be the critical organ for cadmium accumulation in human body. The classical renal effects of cadmium in human body are associated with proteinuria, glucosuria and aminoaciduria. As was the case in Japan in the outbreak of Itai-Itai disease, irreversible renal injury occurred in those most severely exposed, especially in elderly women.

iv) **Chromium :** Because of the low solubility of chromium, generally the levels found in water are usually low (less than 5 μg/L). However, contamination due to industrial effluents may result in high values upto 20-40 μg/L. The chromium may be in trivalent or hexavalent oxidation states depending on acidity either as soluble salt, complex or insoluble hydroxide particle.

Chromium is absorbed through both gastrointestinal and respiratory tracts. Chromium is distributed in human tissues, skin, muscle and fat. A homoeostatic mechanism involving hepatic or intestinal transport mechanisms prevents accumulation of excess trivalent chromium.

Trivalent chromium appears to be necessary for glucose and liquid metabolism and for utilisation of amino acids in several systems. It also appears to be important in the prevention of mild diabetes and atherosclerosis in humans.

Hexavalent chromium at 10 mg/kg of body weight of a human being, will result in liver necrosis, nephritis and death whereas lower doses will cause irritation of the gastrointestinal mucosa. Hexavalent chromium in high doses has been implicated as the cause of digestive tract cancer and lung cancer, cutaneous and nasal mucous membrane ulcers in workers of industries processing hexavalent chromium.

v) **Mercury** : The levels of mercury in fresh water bodies are less than 0.0002 mg/L whereas levels up to 0.03 mg/L have been reported in polluted rivers and lakes.

Mercury serves no beneficial physiological function in human beings. Each of the chemical states (metal itself, inorganic compounds, and organomercurial compounds) has intrinsic properties that dictate independent toxicological assessment.

Inorganic form of mercury accumulates in kidney whereas organic forms are found in blood, bound to red cells. Organic forms of mercury (methyl mercury) is highly toxic due to its lipid solubility which permits it to pass through biological membranes, more easily than inorganic form of mercury, especially into brain, spinal cord and peripheral nerves and across the placenta. In natural water, under normal conditions of temperature and pH, inorganic mercury can be converted into methyl mercury.

Mercury intoxication may be acute or chronic, and toxic effects vary with the form of mercury and its mode of entry into the organism for human beings, the fatal oral dose of mercury salts range from 20 µg to 3.0 mg. Symptoms of acute inorganic mercury poisoning include pharyngitis, gastroenteritism, vomiting followed by ulcerative haemorrhagic colitis, nephritis, hepatitis and circulator collapse. Chronic mercury poisoning results from exposure to small amounts of mercury over extended time period. Dramatic instances of toxicos is in human beings occured in Japan (the Minamata disease), Iraq, Pakistan and Guatemala.

The major effects of mercury poisoning take the form of neurological and renal disturbances. Mercury also causes gonadotoxic and mutagenic effects and disturbs the cholesterol metabolism.

vi) **Lead :** In general, the levels of lead in drinking water are low, 10-20 µg/L. In places where water is extremely soft, has acidic pH and, lead plumbing and lead-lined storage tanks are commonly used, the concentrations of lead can be as high as 300 µg/L. Lead levels as high as 2000 µg/L due to industrial discharges are also reported. Lead pipes also contribute dissolved lead to the water flowing through them. Lead in the environment exists almost in the inorganic form except small amounts of organic lead which results from the use of leaded gasoline and from natural alkylation process that produce methyl lead compounds.

In human beings, lead is absorbed from consumed water, enters blood and is distributed to soft tissues and bones, which reaches to an equilibrium after prolonged exposure. Lead accumulates in bones with time.

Lead passes through the placenta easily and faetal blood has almost the same lead concentration as maternal blood. Lead also passes the blood brain barrier, although the brain does not accumulate lead.

Lead has no beneficial or desirable nutritional effects. Lead in high doses has been recognised as a cumulative metabolic poison. Some of the symptoms of acute poisoning are tiredness, severe intestinal cramps, paralysis of nerves, loss of appetite and fatigue, slight abdominal discomfort, irritability, anaemia and in case of children behavioural changes. These symptoms usually develop slowly.

Lead at low levels can reduce the activity of the enzyme porphobilinogen-synthase, which is involved in the normal haeme synthesis at the stage of conversion of aminolevulinic acids to porphobilinogen. Lead also has a tendency to bind to mitochondria, leading to interference in the regulation of oxygen transport and energy generation. In some instances, high blood lead levels have been found in mentally retarded children.

vii) **Hardness** : Water hardness is the tradional measure of the ability of water to react with soap, hard water requiring a considerable amount of soap to produce lather. Hardness is mainly due to calcium and magnesium salts whereas strontium, iron, zinc, barium and manganese salts also contribute to some extent. It is expressed as temporary hardness (carbonate hardness) which can be removed by boiling, and permanent hardness (non-carbonate hardness) which can not be removed by boiling.

The principal natural sources of hardness in water are sedimentary rocks, seepage and run-off from soils. Hard water normally originates in areas with thick top soil and lime stone formation. Ground water is generally harder than surface water. Effluents discharged from chemical (inorganic) and mining industries also contribute to hardness of surface and ground waters.

There is a tendency for soft water areas to show higher mortality rates than hard water areas.

It is generally agreed that the association between water hardness and mortality is strongest with mortality from cardio-vascular disease, although other causes of death may be involved. Diseases like nervous system defects, anencephaly, perinatal mortality and varous types of cancer have also been correlated with hardness of water.

viii) **Chloride and Residual chlorine :** The presence of chloride in natural waters (ground or surface) can be attributed to the dissolution of salts in soil, discharges of effluents from chemical industries, sewage discharges, contamination from fuses, leachates and sea water intrusion in coastal areas. Chloride is present in concentrations around 10-50 µg/L in surface waters and 50-200 mg/L in ground waters.

Chloride is the most abundant anion in the human body and contributes significantly along with its associated cations to the osmotic activity of the extracellular fluid. Absorption of chloride is almost complete in the normal individuals. The taste threshold for chloride in drinking water is dependent upon the associated cation, but it is usually within the range 200-300 mg of chloride per litre.

when chlorine dissolves in water, it hydrolyses according to the reaction :

$$Cl_2 + H_2O \longrightarrow HOCl + H^+ + Cl^-$$

Unless the concentration of chlorine solution is above 1000 mg/L, all chlorine will be in the form of HOCl or its dissociate ions H^+ and OCl^-.

The ratio between HOCl and OCl is a function of the pH with 96% HOCl remaining at pH 6, 75% at pH 7, 22% at pH 8, and 3% at pH 9. The relationship of HOCl with pH is significant as the undissociated form appears to be the bactericidal agent in the use of chlorine for disinfection.

Current chlorination practice of potable water varies in dosage from 1.0 mg/L to about 16 mg/L. This variation is directly related to the quality of the raw water supply, i.e. the degree of pollution, concentration of nutrients, temperature, pH etc. But the addition of excess chlorine or hypochlorites to water containing nitrogeneous material, rapidly forms chloramines. Both residual chlorine and chloramines are known to be toxic to human beings. So it is important to control the concentration of residual chlorine to reduce the formation of chloramines. In general, it is advisable to maintain 0.5 mg/L - 1.5 mg/L of residual chlorine at the tap ends.

ix) **Nitrates and Nitrites** : Nitrates and nitrites are considered together because their inter conversion occurs easily in the environment. The health effects of nitrate are due to its ready conversion to nitrite in the body.

The sources of nitrate for ground and surface waters are fertilizer run off from agricultural fields, decayed vegetable and animal matter (conversion of organic nitrogen by the bacteria present in soils and in water with sufficient oxygen), domestic effluents sewage, sullage, sludge disposals on land, industrial discharges, leachates from refuse dumps etc. Nitrate contamination of water sources may result from a direct or indirect discharge. It may be due to the percolation (seepage) over a period of time, some times few years.

The concentrations of nitrates in natural waters are generally in the range of 10-50 mg nitrate -N/L. In the case of nitrite the levels are often less than detection limits i.e., 0.005 mg/L. (nitrite-N per litre) but relatively high levels (20 mg/L nitrite-N per litre) are also reported. Chlorination of water reduces the concentrations of nitrite to almost negligible levels.

It is well known that nitrate is absorbed in the upper gastrointestinal tract and concentrated into saliva by the salivary glands, may enter the stomach etc. and can readily, be converted to nitrite. The nitrite formed is hazardous. Nitrite oxidises haemoglobin to methaemoglobin and thus adversely affects the oxygen supply through blood. It may react in the human body with secondary and tertiary amines and amides to form nitroso amines which are carcinogenic. Normally 1-2% of the body's haemoglobin is in the methaemoglobin form but when the proportion is more than 10%, clinical effects are detectable. This causes Cyanosis and the whole body gradually becomes blue leading to the disease, known as methaemoglobinemia, which may

ultimately result in death.

Studies have been carried out reporting high levels of nitrite being responsible for cases of infatile methaemoglobinaemia. According to some suggestions pregnant women are also at a greater risk than a normal adult.

In China and Srilanka, the highest mortality from gastric cancer is reported to be in the area where both nitrate and nitrite are high in drinking water compared to those in other areas where the nitrate and nitrite concentrations are low. Water with nitrite concentrations over 1 mg/L should not be used for infant feeding. Water with significant nitrite concentrations usually would be heavily polluted and probably bacteriologically unacceptable.

x) **Fluoride** : In most surface and ground waters, fluoride concentrations are in the range of 0.5 - 1.5 mg/L. But in areas with rich fluoride containing minerals, well waters may contain upto about 10 mg/L of fluoride. There are some rivers and lakes when the concentrations of fluoride are high due to contributions through soil and some times through industrial discharges.

Fluoride ingested with water is almost completely absorbed, rapidly distributed throught the body, retained manily in the skeleton and to some extent in the teeth. The amount of fluoride in bones increases upto age of 55 years.

Fluoride in low concentrations is esential to human beings. Fluoride reduces the solubility of the enamel of teeth under acidic conditions and thereby provides protection against dental caries. The incidence of caries decreases as the concentration of fluoride increase to about 1 mg/L.

Bone tissue constantly undergoes remodelling by a process that is initiated by resorption of old bone and subsequent formation of new bone as a replacement. Osteoporosis is a diseases in which the process of new bone formation does not keep pace with resorption, so the total amount of bone becomes less than normal. This deficit in total, weakens the mechanical strength of the bones and increases their tendency towards fracturing. Fluoride, through mechanisms that are not well understood, appears to be the only available agent that can stimulate bone formation directly, i.e., a treatment for osteoporosis, even though there may be some side effects such as arthralgies - pain in joints, and gastrointestinal disturbances.

At high doses, fluoride can interfere with carbohydrates, lipids, proteins, vitamins, enzymes and mineral metabolism. Many of the symptoms of acute fluoride intoxication are the results of its binding effect with calcium. Skeletal sequestration and renal excretion are the two major ways by which the body prevents the accumulation of toxic amounts of the fluoride ions.

Long term consumption of water containing 1.5 - 2.0 mg/L of fluoride may lead to mottling in patients with long standing renal disease or polydipsia, generally in children. Skeletal fluorosis has been observed in persons when water contains more than 3 - 6 mg/L of fluoride. Intake of higher concentrations for long periods result in crippling skeletal fluorosis. These effects are more pronounced if calcium and magnesium intake is also less.

In higher doses, fluoride is acutely toxic to human being, pathological changes include haemorrhagic gastroenteritis, acute toxic nephritis and various degrees of injury to the liver and heart muscles, cardiac arshythmias, i.e., ventribular fibrillation, effects thyroid which results in vomiting, abdominal pain, nausea, diarrhoea and even convulsions.

xi) **Microbiological Examination of Water :** With the establishment of the microbiological theory of disease, the need for uncontaminated water supplies was fully understood, and necessary actions have been taken by the governments, and the W.H.O. to ensure adequate health conditions for the public.

Biological pollution of water is due to bacteria, fungi, viruses, protozoa, plankton, helminths and other macro invertebrates (rotifers, worms, water fleas etc.,) contamination by sewage or human excrement is the greatest danger associated with drinking water. Faecal pollution of drinking water may introduce a variety of intestinal pathogens like *Salmonella, Shigella*, enterotoxigenic *Escherichia coli, Vibrio cholera, Yersinia enterocolitica* and *Campylobacter fetus*. These organisms may cause

diseases that vary in severity from mild to severe gastroenteritis and sometimes fatal dysentry, cholera or typhoid, fever and meningitis. Sewage polluted water may contain the viruses of poliomyelitis, other enteroviruses, and hepatitis viruses. Other organisms naturally present in the environment and not regarded as pathogens may also cause occasional opportunist disease. Included in this category are *Psuedomonos*, *Flavobacterium*, *Klebsiella* and *Serratia*.

Obviously, there can be no State or Country with positive community health and well being without safe water supply. Incidents of various epidemics like poliomyelitis, cholera, gastroenteritis, etc. killing thousands of people have been on record. Even in developed countries, there are reports about water borne diseases. In USA about 300 cases of enteric diseases due to bacterial infections transmitted via contaminated water are reported every year.

In developing countries, diarrhoeal diseases are the leading cause of childhood mortality. Every year up to 1,000 million diarrohoeal episodes cause four to five million deaths (WHO Report 1980). Several surveys place the incidence of amoebiasis from 8.5 to 100 percent. Wide spread lethargy, lack of initiave, weakness, tiredness and even the dull earthy apperance of the skin in many Indians is ascribed to chronic amoebiasis. In India, during 1955-96, the epidemic of hepatitis killed 35000 people in New Delhi due to faecal contamination of drinking water. During 1989 also, gastroenteritis caused by contamination of drinking water by sewage resulted in death of a few thousand people at New Delhi itself.

14.16. DEFENCE MECHANISMS TO CONTROL POLLUTION

Natural defence mechanisms in the subsurface mitigate the effects of a pollutant source by causing a reduction in the concentration of the contaminant in solution. They are :

a) **Physical process :** Contaminants entering the soil zone may be diluted infiltration by mixing with rain fall (precipitation). Dilution may also take place by diffusion in the unsaturated zone, which may occur due to mixing on a molecular level, as ions move from points of higher to lower concentrations. Within the saturated zone, contaminants are again diluted by mixing uncontaminated ground water recharge that is added to the saturated zone down stream of the contaminants source, causing the contaminant plume to be depressed below the water table.

b) **Chemical processes** : Chemical processes in the subsurface include precipitation, absorption and hydrolysis. Precipitation results in the formation of a crystalline substance within the porous material which may undergo dissolution if chemical conditions within the aquifer change. While precipitation reactions are important in describing the evolution of ground water chemistry in regional flow systems, absorption, hydrolysis and decay are of greater interest in contaminant's hydrology. Absorption refers to the removal of chemicals from solution by fixation on to porous material itself. Absorption is quantified by means of distribution coefficient which is dependent on the nature of ions (chemicals) and the porous materials.

Hydrolysis refers to the chemical reaction of a compound with water and half of the hydrolysis depends on temperature and pH, many inorganic and organic substances undergo hydrolysis and lose their activity.

c) **Biological processes :** Biodegradation of organic matter is one of the nature's gifts to man, as it degrades huge quantities of wastes (domestic and some industrial) generated by man to generally usefull products such as manure. In the recent years, several man made chemicals which are not biodegradable pose serious pollution problems.

Some of the treatment methods developed to remove various contaminants from water are listed in table 14.8

Table - 14.8. Some of the reported Treatment Options.

Technology Status	Technology	Contaminant Class or Specific contaminant removed
Field Tested	Carbon adsorption	VOC's and SOC's
	Packed tower and diffused air-aeration	VOC's
	Ion exchange	Nitrates
	Reverse osmosis	Radium
Pilot Tested	Reverse osmosis	Nitrates and Uranium
	Ion exchange	Uranium
Promising Technologies	Conventional treatment with powdered activated carbon	SOC's
	Ozone oxidation	VOC's, SOC's
	Reverse osmosis	VOC's SOC's
	Ultraviolet Treatment	VOC's SOC's
	Ion Exchange	Radium
	Selective complexer	Radium
	Aeration	Radon
	Carbon adsorption	Radon

VOC = Volatile Organic Compounds and SOC = Solid Organic Compounds.

14.17. SANITATION

According to the World Health Organisation, 1.5 billion people do not have a safe supply of drinking water and at least 5 million people die every year from water borne diseases that could be prevented by improvements in drinking water supplies and sanitation.

For many centuries, we are depending on water carriage to dispose off certain wastes. By this, we mean that water is used to collect and transport objectionable and/or harmful materials from one location to another. It may be surprising, but most of the water obtained from the resources by individuals, municipalities and industries are in fact used to collect and move wastes. It is generally accepted that good sanitation practices in cooking, household cleaning and personal hygiene are beneficial to the public health. All these activities require proper handling and disposal of unwanted or waste substances and this is usually accomplished through water carriage.

The large differences in the avilability of good water supplies and sanitary waste water handling along with disposal are mostly responsible for the much higher number of incidences of diseases and shorter life longevity between developing and developed countries.

Most industrial uses are for water carriage of wastes that is the removal of heat, impurities or by-products through various types of processes. Technology is now available for recovery and/or reuse some waste materials productively and it is hoped that additional and improved ways to use materials now discarded as wastes will be developed in the near future. As an ideal approach, the above technique would be a boon to mankind as it not only eliminates the problem of waste dump but also generates a useful product. However, practical considerations in houses and industries often

make it impossible or prohibitively expensive to reclaim or reuse most waste water constituents because of their complex chemical characteristics and extremely diluted concentrations. When recovery and reuse are not feasible, society ought to opt for the alternative of waste disposal to land, air or water. The discharge of wastes into air and land indirectly affects the water sources, through acid rain or contamination of ground water sources by leachates from wastes. Treatment of wastes at the source of generation (for industries) and at a common point (for sewage) would reduce to some extent the environmental problems due to the wastes generated.

14.18. WATER MANAGEMENT

i) Methods for managing water resources : The important way to manage water resources is to increase the supply by constructing dams and reservoirs, tapping more ground water and diverting the surface waters to the required zones.

The other and ofcourse a better way is to improve the efficiency of water supply and use, and to minimise the wastage of water.

Some arid areas of India, China and U.S.A. are now supported by removing the earth capital in the form of ground water faster than it is being replaced by natural resources. But this practice can go on so long before farming must be abandoned and the populations of parched cities are reduced by migration.

Thus it makes much more sense economically and environmentally to put the primary emphasis on improving the efficiency of water use.

The dams built across rivers and streams provide a controllable supply of water and for the power generation. More over they reduce the danger of flooding.

But the benefits of dams must be weighed aganist their costs. Dams are expensive to build and displace people and destroys vast areas of wildlife habitat and agricultural land.

Faulty construction, earthquakes, floods, land slides etc cause dams to fail, taking a terrible foll in lives and property. The studies in U.S.A. reveal that the dam safety programmes are generally inadequate because of weak laws and budget cuts.

Over use of ground water can cause or intensify several problems like aquifer depletion, subsidence and intrusion of salt water into aquifers.

Thus there is need to adopt alternative methods to meet the demand of fresh water.

Desalination, i.e., removing disolved salts from ocean water or brakish ground water is an appelling way to increase fresh water supplies. Distilation and reverse osmosis are the two most widely used desalination methods.

Distillation involves heating salt water until it evaporates and condenses as fresh water, leaving salts behind in solid form.

In reverse osmosis, high pressure is used to force salt water through a thin semipermeable membrane to get fresh water.

Unnecessary Water Waste : In most of the countries the water is unnecessarily wasted, because of various reasons. For example, the people of United States, the world's largest water user waste about 30 - 50% of the water used. Thus proper steps are to be taken by the government and various local bodies and voluntary organisations to minimize the wastage of water.

Reducing the Irrigation losses : About 70% of the water used goes for irrigation and almost two-thirds of this water is wasted.

Most irrigation systems distribute the water by downslope or gravity flow through unlined field ditches. This method is cheap but about 50% of the water is lost by evaporation and seepage.

Drip irrigation greately reduces water use and waste. It involves the supply of water through perforated pipelines which deliver small quantities of water close to the roots of plants.

Effluents from sewage treatment plants are rich in plant nutrients, mostly nitrates and phosphates. These are presently dumped into water ways where they disrupt aquatic ecosystems It makes more sense to return these nutrients to the land to fertilize trees, crops and other vegetation.

Reducing the water waste in Industries and Houses : Manufacturing process can either use recycled water or can be redesigned to use less water and minimize wastage. For example manufacturing aluminium from recycled scrap rather than ore reduces the water consumption by about 97%.

Flushing toilets, washing hands and bathing account for about 75% of the water used in a typical home in most of the developed countries. This can be avoided by a more rational use.

Leaks in pipe lines, toilets etc waste about 20 to 35% of water withdrawn from public supplies. This can be checked with a little care.

14.19. COMMUNITY ACTION

Several bacteriological contaminations of drinking water leading to serious diseases are being reported every year from one quarter of the country or the other. The major source of this contamination is nothing but the household sewage and sullage. Hence, the people should realize the intensity of water pollution that they themselves cause. The voluntary organisations and the educated section of the country should come forward to awaken the public and to take necessary steps for the proper sanitation and drainage.

At the same time the government should take necessary steps to control the contamination of water sources from various industrial pollutants.

Table 14.9. gives the various remedial and preventive measures that should be taken to protect the water from different sources of contamination.

Table 14.9
Remedial and Preventive Measures for Protection of Water Supplies

Source and mode of supply	Evidence of information available	Immediate remidial measures	Preventive action avoiding recurrence
Open dug wells	Pollution usually expected to occur	a) Clean well if necessary and shock-chlorinate, followed by continuous chlorination b) Recommend boiling of drinking water, use of disinfectants and/or filters in the home	Convert to a protected, converted well with hand-pump or device for raising water isolated from the user; discourage construction of new open dug wells; promote community education and participation.
Un-piped supplies from covered wells or shollow or deep tubewells with hand pumps or motorised pumps	Findings of sanitary inspection unsatisfactory.	Confirm bacteriological quality and if necessary recommended boiling or use of disinfectant and/or filters in the home	Eliminate pollution sources and/or repair well if necessary to remedy shortcomings found in sanitary insepction.
		a) If an alternative safe supply is not available, recommend boiling or use of disinfectants in the home b) Confirm bacterial quality c) Conduct a detailed sanitary inspection and remedy shortcomings found	a) Take opportunity to promote community education and participation Feed information on the episode and sanitary survey results back to the water-supply agencies to help in deciding whether the technologies used and the codes of practice followed are appropriate.
Untreated piped supplies	Findings of sanitary inspection unsatisfactory. Unsatisfactory bacterilogical quality of water at sources.	Confirm bacteriological quality and if necessary recommend boiling or use of disinfectant and/or filters in the home. a) Chlorinate supply if feasible or recommend boiling or disinfection in the home. b) Conduct a detailed sanitary inspection and shortcomings found	Eliminate pollution sources and/or repair system, if necessary, to remedy shortcomings found in sanitary inspection. Protect the source and its catchment (this is very important)

Table 14.9 contd..

Source and mode of supply	Evidence of information available	Immediate remidial measures	Preventive action avoiding recurrence
	Unsatisfacory bacteriological quality of water in the distribution system	a) If source is unsatisfactory, procced as above b) If source is satisfactory but distribution system is suspected, chlorinate supply or recommend boiling or disinfection in the home. c) Conduct a detailed sanitary inspection of distribution system and remedy shortcomings found.	Frequent and improved supervision of the distribution system and promote repair and maintenance are essential, especially for intermittently operated system.
	Localised epidemic of enteric infection.	a) Take sample for bacteriological quality determination; without waiting for this result, chlorinate general supply or recommend boling or disinfection in the home. b) Conduct a detailed sanitary inspection of source and distribution system, and remedy shortcomings found.	Frequent and improved supervision of the source and distribution system is necessary; careful operation and maintenance of such systems are essential especially for intermittent systems.
Treated piped supplies	Findings of sanitary inspection of source, treatment plant and/ or distribution system unsatisfactory.	Confirm bacteriological quality and if necessary recommend boiling or use of disinfectant and/or filters in the home.	a) Frequent and improved supervision of the whole system is necessary; careful operation and maintenance are essential for intermittent systems. b) Ensure that routine sanitary inspections are carried out. c) Feed information back to the water supply agencies.

Table 14.9 contd..

Source and mode of supply	Evidence of information available	Immediate remedial measures	Preventive action avoiding recurrence
	Unsatisfactory bacteriological quality of water treatment or in the distribution system.	a) Ensure adequate chlorination of general supply recommend boiling or disinfection in the home.	a) Frequent and improved supervision of the whole system is necessary; careful operation and maintenance are essential especially for intermittent systems.
		b) Conduct a detailed sanitary inspection of whole system and remedy shortcomings found.	b) Ensure that routine sanitary inspections are carried out.
			c) Feed information back to the water supply agencies
	Localised epidemic of enteric infection	a) Take sample for bacterilogical quality determination; without waiting for this result, chlorinate general supply or recommend boiling or disinfection	a) Frequent and improved supervision of the source and distribution system is necessary; careful operation and maintenance of such systems are essential, especially for intermittent systems.
		b) Conduct a detailed sanitary inspection of source and distribution system, and remedy shortcomings found.	b) Ensure that routine sanitary inspections are carried out.
			c) Feed information back to the water supply agencies.
Untreated community rain water collection system	Localised epidemic of enteric infection	Chlorinate water in collection reservoir (tank, container, etc.), or recommend boiling or disinfection in the home.	a) Ensure that collection surfaces are in a sanitary condition and that bypass for initial collected water is properly operated.
			b) Promote community education and participation.

14.20. SUMMARY

Pollution can be broadly defined as the unfavourable alteration of the surroundings wholly or largely as a by-product of man's action.

The fresh water we use comes from two sources surface and ground water.

The water quality is not absolute and it can be judged only by comparing the concentrations of various constituents in water with those optimum for the intended uses.

Water quality standards are the means by which regulatory agencies define their requirements for water courses.

The major sources of water pollution are of two types - point sources and non-point sources.

Many of the problems associated with water quality are due to the presence of organic matter from natural sources and waste water discharges.

Water borne diseases, which kill about 5 million people every year can be prevented by improving the drinking water supplies and sanitation.

Water resources can be managed by increasing the supply by constructing dams and tapping more ground water. A better alternative is to improve the efficiency of water supplies and to minimize water waste.

14.21. CHECK YOUR PROGRESS : MODEL ANSWERS

1. A geologic unit saturated with water and sufficiently porous and permeable to yield economically significant amounts of water is called an aquifer.
2. The major sources of water pollution are of two types- point sources and non-point sources.

   Point sources include factories, sewage treatment plants, coal mines, oil wells and non-point sources include seepage of run off water from agricultural lands,logged forests houses and road ways. Because the point sources are at specific places they are fairly easy to identify, monitor and regulate.

14.22. MODEL EXAMINATION QUESTIONS

I. Answer the following questions is about 30 lines each.

1. Give brief account of world water resources.
2. Write a note on water quality and its importance.
3. Explain the chemical and Microbial pollution of ground water.
4. Write the health effects of a) Arsenic b) Mercury c) lead d) Chloride and e) fluoride
5. Explain the microbiological examination of ground water.
6. Write note on water management.

II. Answer the following questions in about 10 lines each.

1. Define the terms pollution and pollutants.
2. Write a brief note on the sources of ground water contamination.
3. Explain the factors that effect the survival of virus.
4. Write a note on the toxic effects of chromium.
5. Write a note on the reported options for the treatment of drinking water.
6. What are the systems used for determining water quality ?
7. Describe the standards used in water quality control.

Prof. N. Someswara Rao

UNIT - 15 : LAND MANAGEMENT

Contents

15.1. OBJECTIVES

After completing this unit you will be able to :

* explain the importance of forests, agricultural, and grasslands, and delineate the management methods;
* describe the use of chemical fertilizers and their impact on the environment;
* list out the causes of desertification;
* delineate ecological guidelines for the construction of dams and installation of industries at proper locations to avoid major environmental and human disasters.
* describe the causes of solid waste and methods for its disposal;
* describe the change in social behaviour and lifestyles through time and also the community actions that have been taken and that should be taken for the creation of environmental awareness in the public.

15.2. INTRODUCTION

Land is one of the most important components of our environment. It supports all vegetation and meets the major requirements of energy for us and feed for our cattle. Top soil which is the upper layer of soil supports our agriculture and produces the food that sustains us. It is depressing to note that about 8.1 million square kilometers of once-productive land comprising crop-land, forests and grasslands have become desert in the last 50 years. Each year almost 61,000 square kilometers of new deserts are formed in the world. Topsoil is eroding faster than it forms on about 35% of the world's cropland resulting in a loss of about 24 billion metric tons of topsoil a year. Crop productivity on one-third of the earth's irrigated cropland has been reduced by salt buildup in topsoil. Topsoil waterlogging has reduced productivity on at least one-tenth of the world's cropland. About half of the world's original expanse of tropical forests has been cleared. Each year about 2,02,000 square kilometers of tropical forest is destroyed and another 2,02,000 square kilometers are degraded. Within 30 to 50 years there may be little of these forests left. In more developed countries, 3,12,000 square kilometers of forest has been damaged by air pollution. Also, many remaining areas of diverse, ancient forests are being cleared and replaced with more vulnerable tree farms that greatly reduce wildlife habitats and biodiversity. All this show that land has been overused and even abused over the centuries. Land fertility rate decides the future of a country. The way the soil being used is posing threat to its productivity. Careless use of soil results into reduction in quality and quantity of woodland, grassland and cropland and also cause soil erosion and degradation of watersheds and catchments; and deforestation and desertification. Due to demographic pressures, land is under increasing stress due to sprawl in agriculture, industry and urbanisation.

15.3. FORESTS AND AGRICULTURAL LANDS

15.3.1. Importance of Forests

The importance of forests, management of forests, Agricultural land management and soil conservation and land use control are described in detail in this section. The commercial and ecological importance of forests is given below.

a) **Commercial Importance** : The importance of forests is viewed in two ways. Forests supply us with timber for housing, biomass for fuelwood, pulp for paper, medicines, and many other products, worth over $ 150 billion a year. Many forest lands are also used for mining, grazing livestock, and recreation. They are flooded to provide reservoirs for hydropower dams and flood control.

b) **Ecological Importance** : Forests have many vital ecological functions. Forested watersheds act as giant sponges, absorbing, holding, and gradually releasing water that recharges springs, streams, and aquifers. Thus, they regulate the flow of water from mountain highlands to croplands and urban areas and help control soil erosion, the severity of flooding, and the amount of sediment washing into rivers, lakes, and artificial reservoirs. They paly an important role in the global carbon cycle and act as an important defence against global warming. Through photosythesis trees help remove carbon dioxide from and add oxygen to the air, which explains why the world's lush tropical forests have been called "the lungs of the earth". Forests provide habitats for a larger number of wildlife species than any other land ecosystem, making them the planet's major reservoir of bilogical diversity. They also help buffer noise, absorb some air pollutants, and nourish the human spirit by providing solitude and beauty. In view of the importance of the forests for the very sustenance of every living species, it is imperative for us to protect the earth's remaining forests and stop further destruction. The remaining forest cover must be properly managed for the continued delivery of raw materials for use by man.

In India, the effective forest cover at present is hardly 14%. We are losing about 1.5 million hectares of forest cover every year. At this rate India will have no real forest cover left in

another 40-50 years. India is regarded as a megadiversity area from the point of view of richness of biological diversity. Two of the 16 most threatened biodiversity "hot-spot" locations are present in our country. These are the eastern Himalayan region and the Western Ghat. Both are paradises for valuable genes and are fast getting to the stage of "paradise lost" because of increasing human and commercial pressures on forest land. Therefore, it is inevitable to protect the present forestlands in India and find ways how to manage them keeping in view the social needs and ethics.

15.3.2. Forest Management

There are two basic forest management systems : 1) Even-aged management and 2) Uneven-aged management.

1. **Even-aged Management** : In this system, trees in a given stand are maintained at about the same age and size, harvested all at once, and replanted naturally or artificially so that a new even-aged stand of a single species of faster-growing softwoods. Such stands of one or only a few tree species are called tree farms. They need close supervision and usually require expensive inputs of fertilizers and pesticides to protect the monoculture species from diseases and insects. Once the trees reach maturity, the entire stand is harvested and the area is replanted with seeds or seedlings. Genetic crossbreeding and genetic engineering can be used to improve both the quality and quantity of wood produced from tree farms.
2. **Uneven-aged Management :** In this system, trees in a given stand are maintained at many ages and sizes to permit continuous natural regeneration. Here, the goals are to sustain biological diversity, sustain long term production of high-quality timber, provide a reasonable economic return, and allow multiple use of a forest stand.

There are a number of methods in harvesting the tree yield but the method chosen depends on whether uneven-aged or even-aged forest management is being used. It also depends on the tree species involved, the nature of the site, and the objectives and resources of the owner.

1. **Selective cutting method :** Mature or intermediate-aged trees in an uneven-aged forest are cut single or in small groups. This reduces crowding, encourages the growth of younger trees, and maintains an uneven-aged stand with trees of different species, ages, and sizes. Over time the stand will regenerate itself. This method helps protect the site from soil erosion and tree damage by the wind.

2. **Shelterwood Cutting Method :** It is the removal of all mature trees in an area in a series of cuttings, typically over a period of ten years. This method can be applied to both systems of forest management. In the first harvest, selected mature trees, unwanted tree species, and dying, defective, and diseased trees are removed. This cut opens up the forest floor to light and leaves the best trees to case seed and provide shelter for growing seedlings. After a number of seedlings have taken hold, a second cutting removes more of the remaining mature trees. Some of the best mature trees are left to provide shelter for the growing young trees. After the young trees are well established, a third cutting removes the remaining mature trees and allows the even-aged stand of young trees to grow to maturity. This method allows natural re-seeding from being crowded out. It leaves a fairly natural-looking forest that can be used for variety of purposes. It also helps reduce soil erosion and provides good habitat for wildlife.

3. **Seed-tree Cutting Method :** In this method, harvesting nearly all the trees on a site is done in one cutting, leaving a few seed-producing, wind-resistant trees uniformly distributed as a source of seed to regenerate a new crop of trees. By allowing a variety of species to grow at one time, seed-tree cuting leaves an aesthetically pleasing forest useful for recreation, deer hunting, erosion control, and wildlife conservation. Leaving the best trees for seed can also lead to genetic improvement in the new stand.

4. **Clear Cutting Method** : It is the removal of all trees from a given area in a single cutting to establish a new, even-aged stand or tree farm. After all trees are cut, the site is reforested naturally from seed released by the harvest, or foresters broadcast seed over the site or plant genetically superior seedlings raised in a nursery.

   Clearcutting on a positive side increases the volume of timber harvested per hectare, reduces road building, often permits reforesting with genetically improved stok and shortens the time needed to establish a new stand of trees.

Clearcutting on a negative side on steeply sloped land leads to severe soil erosion, sediment water pollution, flooding from melting snow and heavy rains, and landslides when the exposed roots decay. It leaves ugly, unnatural forest openings that take decades to regenerate and reduces the recreational value of the forest. It also reduces biological diversity.

Protection of Forests from Diseases and Insects : A healthy, diverse forest is rarely prone to microbial, fungal and insect diseases. A tree farm of one species is highly vulnerable to attack by diseases and insects because of lack of natural defenses. The best and cheapest way to prevent damage to forests from diseases and insects is to preserve and maintain forest biological diversity.

Protection of Forests from Fires : A ground fire in a forest destroys the organic matter in the live soil which is necessary to maintain the proportion of humns. Nitrogen in the decomposed leaf moulds is also lost. Repeated burns may expose the dead soil which when trampled over by grazing animals get pulverised and the dislodged particles are washed away with the first heavy monsoon shower. Severe fires can kill standing trees and may even scorch or completely burn them. Sometimes, fires are caused deliberately by the local people to drive away some animals which are destructive to crops or to burn the stubs of perennial grasses to get a flush carpet of young grass. Fires may also start spontaneously say from lightning or by the rubbing of clums of bamboos in a strong wind. The effects of fire are generally distinguished into surface fires, crown fires and ground fires. Surface fires are low-level fires that usually burn only under growth and leaf litter on the forest floor. Crown fires are extremely hot fires that burn ground vegetation and tree tops. They usually occur in forests where all fire has been prevented for several decades, allowing the building up of dead wood, leaves, and other flammable ground litter. Ground fires occur as a result of surface fires which burn partially decayed leaves, or peat, below the ground surface.

Fire protection activities include the organization, training, instruction and management of a fire-control force, and inspection and maintenance of fire control improvements, equipment and supplies to ensure effective fire suppression. The prophylactic treatment consists of maintenance of sufficiently broad, cleared strips all around the forest and running criss-cross inside it, at suitable intervals. These are called FIRE LINES. They are kept clean of inflammable material during the fire season to act as a barrier for advancing fire. Sometimes, strips of evergreen trees are planted on the periphery of valuable plantations of highly inflammable deciduous species particularly along the sides abutting on main roads. The most important preventive measure is the creation of public opinion so that incendiarism is not resorted to and fires are not started by carelessness.

15.3.3. Agricultural Land Management

The cropland is under increasing stress due to urbanization, village expansion, highways, industrialization, etc. The destructon of fertile land and the repeated use of the same land over longer periods of time for raising crops caused the sterility of soil. The use of fertilizers is being practised for changing the soil for production. There are two major types of agricultural systems to grow crops and raise livestock throughout the world.

1. **Industrialized Agriculture** : It produces large quantities of a single type of crop or livestock for sale both within the country where it is grown and to other countries. It involves supplementing solar energy with large amounts of energy from fossil fuels, mostly oil and natural gas. This

agricultural system is practised on about 25% of all cropland, is widely used in more developed countries. This system is supplemented by plantation agriculture, in which specialized cash crops such as bananas, coffee, and cacao are grown.

2. **Subsistence Agriculture :** It is a traditional agricultural system which produces enough crops of livestock for the farm family, survival and, in good years, enough to have some left over to sell or put aside for heard times. The farmers of this agricultural system supplement solar energy with energy from human labour and draft animals. This agricultural system has three major types of cultivation : 1) shifting cultivation of small plots of tropical forests, 2) intensive crop cultivation on relatively small plots of land, 3) nomadic herding of livestock. These forms of agriculture are practised by half the people on earth, particularly who live in rural areas in less developed countries.

Crop production is increased either by cultivating more land or by getting higher yields from existing cropland. Increasing the yields per hectare has been strongly felt and that has been termed as "Green Revolution" which involves planting monocultures of scientifically bred plant varieties and applying large amounts of inorganic fertilizer, irrigation water, and pesticides. The developed fast-growing hybrid varieties allowed the farmers to grow two to three consecutive crops a year on the same parcel of land.

Despite our technological clearness only about 22% of the earth's land surface is suitable fo rmodern agriculture. At present agriculture in India involves about 64% of people and 47% of the total land area. The food production increased to higher levels which has been achieved due to advances in agricultural research, increased use of fertilisers and pesticides, extensive use of irrigation, increase in agricultural credits, expandion of cooperation and better agricultural extension and integrated rural development.

Crop yields must be increased per hectare on existing cropland and from expansion of green revolution technology to other parts of the world. The yields can be increased in two basic ways: one is to alter natural environments to fit the needs of crops involving use of fertilizer, irrigation water, and spraying of pesticides. The other may is to genetically alter plants and livestock animals so they better fit their environments. This involves developing high-yield plant strains that have greater resistance to insects and disease, thrive on less fertilizer, make their own nitrogen fertilizer like legumes, do well in slightly salty soils, withstand drought, and make more efficient use of solar energy during photosynthesis.

15.3.4. Soil Conservation and Land-use Control

The practice of soil conservation involves using various methods to reduce soil erosion, to prevent depletion of soil nutrients, and to restore nutrients already lost by erosion, leaching, and excessive crop harvesting. Almost all methods used to control soil erosion involve keping the soil covered with vegetation.

1. **Conventional Tillage Farming** : The land is plowed, disked several times, and smoothened to make a planting surface. This is a practice that makes it vulnerable to erosion.

2. **Conservation Tillage Farming :** This method is also known as minimum-tillage or no-till farming. For the minimum tillage farming, special tillers break up and loosen the subsurface soil without turning over the topsoil, previous crop residues, or any cover vegetation. For no-till farming, special planting machines inject seeds, fertilizers, and weed-killers into slits made in the unplowed soil. The conservation tillage method reduces fuel and tillage costs, water loss from the soil, and soil compaction in addition to reducing soil erosion. It also increases the number of crops that can be grown during a season. Yields are higher than yields from conventional tillage. But this method is no cure at all for the conservation of soil. Because it requires increased use of herbicides to control weeds that compete with crops for soil nutrients. Neverthless, this method is in wide use in different parts of the world.

3. **Contour Farming** : It involves plowing and planting across, rather than up and down the sloped contour of the land. Each row planted at a right angle to the slope of the land acts as a small dam to help hold soil and slow the runoff of water. With this method soil erosion can be reduced upto 30 to 50%.

4. **Terracing :** This method can be applied on steeper slopes. The slope is converted into a series of broad, nearly level terraces with short vertical drops from one to another. Some of the water running down the vegetated slope is retained by each terrace. Thus, terracing provides water for crops at all levels and decreases soil erosion by reducing the amount and speed of water runoff.

5. **Strip Cropping :** It involves a series of rows of one planted in a wide strip. Then the next strip is planted with a cover crop, which completely covers the soil and thus reduces erosion The alternating strips of row crops and cover crops reduce water runoff and help prevent the spread of pests and plant diseases from one strip to another. They also help restore soil fertility if nitrogen-rich legumes are planted in some of the strips.

6. **Allery Cropping :** It involves planting of crops in alleys between hedgegrows of trees or shrubs that can be used as source of fruits and fuel-wood.

Gully Reclamation and Windbreaks : Water runoff quickly creates gullies in sloping land not covered by vegetation. Such land can be restored by gully reclamation. Small gullies can be seeded with quick-growing plants to reduce erosion of soil. In deeper gullies, small dams can be built to collect silt and gradually fill in the channels. Rapidly growing shrubs, vines, and trees can also be planted to stablize the soil. Erosion caused by exposure of cultivated lands to high winds can be reduced by windbreaks, or shelter belts, long rows of trees planted to partially block wind. They are effective if land not under cultivation is kept covered with vegetation. Wind breaks also provide habitats for birds, pest-eating and pollinating insects, and other animals.

Land-use control to reduce erosion is to prohibit the planting of crops or the clearing of vegetation on marginal land. Such land is highly erodible because of a steep slopes, shallow soil structure, high winds, drought, or other factors. The most widely used approach for controlling land use is Zoning, in which various parcels of land are designated for certain uses. Zoning can be used to protect areas from certain types of development and to control growth.

Check Your Progress - 1, 2 & 3

1. What are tree farms ?
2. What is meant by industrilised agriculture ?
3. What are the crops grown in plantation agriculture ?

Note : a) Write your answers in the space provided below.

b) Compare your answers with those given at the end of this unit.

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15.4. GRASSLANDS

Grasslands are regions where the average annual precipitation is great enough to allow grass to prosper. Average precipitation and average temperature, along with soil type, are the major factors determining the particular type of desert, grassland, or forest in a particular area. Acting together, these factors lead to tropical, temperate, and polar deserts, grasslands, and forests. Grasslands are naturally dominated by a large number of individuals of the family Poaceae.

Tropical grasslands or savannas are found in areas with high average temperatures, two prolonged dry seasons during winter and summer, and abundant rain, the rest of the year. They occur in a wide belt on either side of the equator beyond the borders of tropical rain forests. Land covered with native grasses has important ecological roles. Such grasslands act like a giant sponge, soaking up scarce rainfall so that it does not run off the land in one big rush. This helps provide water for springs and streams year-round. Grasses also shield the life-nurturing topsoil from the erosive force of wind and rain. The savannas with grasses, shrubs, small trees, and soil provide food and habitats for many types of wildlife. Temperate grasslands are found in the large interior areas of most continents. They show different types of grasslands - tall-grass prairies and short-grass prairies in the western United States and Canada; the pampas in South America, the veld in south Africa, the steppes that stretch from central Europe into Siberia. In these grassland types, winds blow almost continuously and evaporation is rapid. Due to thick network of grass roots, the soil is held in place as long as it is undisturbed. The soil of these grasslands is most fertile and are major areas for growing crops in the world. Polar grassland, or Arctic tundra, is found in areas just below the Arctic ice region.

During most of the year this ecosystem is bitterly cold, with icy gale-like winds, and is covered with ice and snow. Winters are long and dark, and average annual precipitation is low and occurs mostly as snow and sleet. The tundra is capeted with a thick, spongy mat of low-growing plants such as lichens, sedges, mosses, grasses, and low shrubs. Decomposition of dead organic plants is slow because of the cold temperatures.

15.4.1. Indian Grasslands

The Indian grasslands are not climax formations but have developed secondarily after the destruction of forests. These grasslands are divided into eight major types depending on the dominance of particular grass species.

1. ***Sehima-Dichanthium* type :** The grasslands with ***Sehima sulcatum, S. nervosum*** and ***Dichathium annulatum*** as dominant grasses are found in the black soils of Maharashtra, Madhya Pradesh, South western parts of Uttar Pradesh and parts of Tamilnadu and Karnataka.
2. ***Dichanthium-Cenchrus* type** : The grasslands with ***Dichanthium annulatum*** and ***Cenchrus ciliaris*** as dominant fodder grasses are found in the sandy loam soils of the plains of the Punjab, Hyryana, Delhi, Rajasthan, Eastern Uttar Pradesh and Madhya Pradesh, Bihar, Bengal, Coastal Maharashtra and Tamilnadu.
3. ***Phragmites-Saccharum* type :** This type of grassland with ***Phragmites karka*** and ***Saccharum spontaneum*** as dominant grasses are found in marshy localities of Terai areas of northern Uttar Pradesh, Bihar, Bengal, Assam and in the swamps of sunderbans and Kaveri delta of Tamilnadu.
4. ***Bothriochloa* type :** This type of grassland is a localised one with pure dense growth of ***Bothriochloa-odorata***. It is distributed on high rainfall paddy areas of Lonavala tract of Maharashtra. This sweet-scented grass is used in thatching huts.
5. ***Cymbopogon* type :** This type of grassland is restricted to the low hills of the Western Ghats, Vindhyas, Satpura, Aravali and Chhota Nagpur.
6. ***Arundinella* type :** This is a grassland with ***Arundinella nepalinsis*** and **A**. ***setosa*** as dominant

grasses is found on high hills of the western ghats, Nilgiris and throughout on lower Himalayas.

7. ***Deyeuxia-Arundinella* type** : This type of grassland is on temperate regions of upper Himalayas.
8. ***Deshchampsia-Deyeuxia* type :** The grassland with these tow grass species as major component is restricted to the Himalayas above 24, 500 m altitude in the alpine to subarctic region.

The increase in human population is accompanied by increase in livestock population. As a result, over-grazing with consequent denudation of the forest and vegetal cover takes place. People move to new areas and the number of grazing animals increases; all this cause over-grazing, soil erosion and desertification. This calls for our immediate concern to protect our vegetal cover from grazing animals.

Any type of grassland has a herbivore carrying capacity, the maximum number of herbivores a given area can support without consuming the metabolic reserve needed for grass renewal. Carrying capacity is influenced by season, grassland condition, annual climatic conditions, past grazing use, soil type, kinds of grazing animals, and how long animals graze in an area. Light to moderate grazing is necessary and must be encouraged for the health of grasslands. Because, it maintains water and nutrient cycling needed for healthy grass growth and healthy root systems, hinders soil erosion, and encourages build up of organic soil matter.

15.4.2. Grassland Management

The goal of management of grassland is to maximise livestock productivity without degrading the quality of grassland. These are some techniques for better management of grasslands.

1. **Stocking Rate :** This technique is to control the number of a particular kind of animal grazing on a given area, so it does not exceed the carrying capacity. The stock of grazing animals will be maintained in normal productive years so that the animals can be sold in drought years for profit.
2. **Rotational Grazing** : The grassland is divided into compartments. The animals are allowed into each compartment for grazing in alternative years. This way each compartment will have a grazing year alternated with a non-grazed year. This technique gives us always a mature and full grown stand during grazing year. Further, it provides the cattle a continuous supply of fodder in successive periods.

   There are other methods which are more expensive and less widely used. The growth of unwanted plants can be suppressed by spraying herbicides, mechanical removal, or controlling by burning. A cheaper and more effective way to remove and to control unwanted vegetation is to allow short term trampling by large number of livestock. Growth of desirable vegetation can be increased by seeding and applying fertilizer, but this method is too expensive. Periodic reseeding of the desired grass vegetation is an excellent way to restore severely degraded grassland. Improved fodder grasses/herbs/shrubs are to be developed.

Check Your Progress - 4 & 5

4. What are the major factos what determine the type of grassland

5. Where do you find savannas ?

Note : a) Write your answers in space provided below.

b) Compare your answers with those given at the end of this unit.

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15.5. CHEMICAL FERTILIZERS AND THEIR IMPACT

The use of chemical fertilisers and their effects on the environment is given below.

15.5.1. Use of Chemical Fertilizers

The use of chemical fertilizers is aimed at increasing the agricultural production in order to meet the requirements of the continually increasing human and cattle population. Chemical fertilizers are inorganic materials of a concentrated nature used mainly to restore the soil fertility in order to supply essential nutrients to crop plants. The fertilizers are also called as "artificial" or "inorganic manures". The most common plant nutrients in these fertilizers are nitrogen, phosphorus and potassium. The nitrogen is present in the form of ammonium ions, nitrate ions, or urea; the phosphorus is present in the form of phosphate ions and potassium as potassium ions. Other plant nutrients may also be present in low or trace amounts. Nitrogen fertilizers are divided into four groups according to the manner in which the nitrogen is combined with other elements. They are nitrate, ammonia and ammonium salts, chemical compounds containing nitrogen in the amide form, and plant and animal by-products. Sodium nitrate is a pioneer nitrogenous fertilizer which is directly available to plants. Ammonium sulphate, ammonium nitrate, ammonium sulphate nitrate are mixed forms of usable fertilizers and are important particularly for acidic soils. Ammonium chloride is another form of nitrate which is largely used in industries.

Urea is a highly concentrated nitrogenous fertilizer and suitable for most crops. It can be applied to all soils. Ammonia is applied directly to the soil from special containers. Its use is very expensive. Calcium ammonium nitrate is fine free-flowing nitrogenous fertilizer and applied to neutral and acid soils. Phosphate fertilizers are classified as natural phosphates, treated or processed phosphates, and by-product phosphates and chemical phosphates. Rock phosphate as it is found in nature is not used as a fertilizer in this country. Superphosphate is the most widely used phosphoric fertilizer and suitable for all crops and applied to all soils. Basic slag is a by-product of steel factories. It is used as a fertilizer after pulverization. Bone-meal in the form of raw bone-meal and steamed bone-meal s used as phosphate fertilizer. Potassic fertilizers in common use are i) muriate of potash (potassium chloride) and ii) sulphate of potash (potassium sulphate). These salts are important constituents of the waters of oceans and inland seas. These potassic fertilizers are applied to any soil.

All these forms of chemical inorganic fertilizers are produced on commercial basis and sold at high prices. The use of these fertilizers is a necessary evil for higher yields of the crop on a limited parcel of land deficient of plant nutrients. Fertilizer use is clearly an important component in agricultural growth and its potential is greatest where land resources are scarce. The chemical fertilizers are easily transported, stored and applied in proportions suited to the actual requirement of different crops and soils. Throughout the world, their use increased about Tenfold between 1950 and 1990.

15.5.2. Enviornmental Impacts

1. Intensive use of fertilizers can have many undesirable side effects on the environment.
2. It leads to eutrophication of streams, lakes and coastal water. Eutrophication is the excessive growth of algae, water hyacinths, duckweeds and other water plants which thrive on the nutrients run-off from the fields charged with chemical fertilizers. The quality of water deteriorates to such a degree that fish and other aquatic life are threatened and drinking water supplies reduced.
3. Nitrate and phosphate fertilizers used on the soil enter the wells, ponds and ground water; this leads to water pollution. These waters are thus rich in nitrates. The water is then unfit for drinking and also causes various diseases. This water when taken by us, the nitrates are converted to nitrites by microbial flora of intestine. These nitrites then combine with the haemoglobin of blood to form methaemoglobin which interferes with the oxygen carying capacity of the blood.

The disease produced is called methaemoglobinaemia. This leads to various ailments and damage to respiratory and vascular system, blue coloration of skin and even cancer.

4. The fertilizers do not add humus to the soil. Unelss animal manure and green manure are added to the soil along with commercial chemical fertilizers, the soil's content of organic matter gets reduced and thus its ability to hold water will decrease. If not supplemented by organic fertilizers, inorganic chemical fertilizers cause soil to become compacted and less suitable for crop growth. The chemical fertilizers also lower the oxygen content of soil and prevent added fertilizer from being taken up as efficiently.
5. Chemical fertilizers are made up of only a few minerals. Thus they impede the uptake of other minerals and imbalance the whole mineral pattern of plant body. Many crops today lack potassium due to excessive use of nitrogenous fertilizers. Excessive potash treatment decreases valuable nutrients in foods, such as ascorbic acid (Vitamin C) and cartotene. Liming can prevent the release and uptake into the plants of cobalt, nickel, manganese and Zinc. Superphosphate may lead to copper and zinc deficiency.
6. Plants also become less resistant to diseases. Nitrate fertilizers increase the total crop yield by carbohydrates but at the expense of protein. Corn and wheat grown on soil fertilised with nitrogen, phosphorus and potassium showed a 2-0-25% decline in protein content and increase in carbohydrate content. Further, subtle balance of aminoacids is disturbed within the protein molecule lowering the quality of the protein.
7. Consumption of low quality protein leads to malnutrition.
8. Fertiliser use produces over-sized fruits and vegetables but they are more prone to insects and other pests.
9. Overtime, the acumulation of fertilizer compounds and other substances can lead to lower soil fertility and excessive concentration in the crops cultivated.

15.6. DESERTIFICATION

Desertification is the process leading to the formation of desert. It may be caused due to climatic factors, human factors and interactions between climate and culture. Desert formation due to climatic change is a result of abusive land use or of improper land use practices. Natural desertification is greately accelerated by practices that leave topsoil vulnerable to erosion by water and wind. The major cause of desertification is overgrazing of grassland as a result of too much livestock on too little land area. The other causes are improper soil and water resource management that leads to increased erosion, salinization, and water-logging of soil; cultivation of land with unsuitable soils; deforestation and surface mining without adequate replanting; soil compaction by farm machinery, cattle hooves, and the impact of rain drops on denuded soil surfaces. These destruction practices are intensified by rapid population growth, high population densities, poverty, and poor land management.

Desertification often starts as patchy destruction of productive land. Increased dust particles in the atmosphere lead to desertification. The continuous drought over a series of years in the humid zone would also lead to desertification. Indications are clear that the temporary phenomena of meteriological drought in India is tending to become permanent one. This trend is not restricted to the edges of the existing deserts.

As a result of gross mismanagement of natural resources including land, certain irreversible changes have triggered the breakdown of nutrient cycles and microclimatic equilibrium in the soil indicating the onset of desertic conditions. The consequences of desertification on the socio-cultural milieu are many. The most obvious consequence is water scarcity which lead to a high incidence of water diseases. Others include intensified drought and famine, declining living standards, and swelling numbers of environmental refugees whose degraded land can no longer keep them alive. The world's rural people affected by desertification is 230 million in 1989. It is expected that 350 million more people may be affected by desertification by the end of this century.

In 1977, a United Nations Conference on Desertification was held at Nairobi. They came out with a plan of action to halt or sharply reduce the spread of desertification and to reclaim desertified land. However, little had been done to reclaim the desertified land because of inadequate efforts and funds.

Check your progress - 6

What is desertification and how is it created ?

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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15.7. CONSTRUCTION OF DAMS AND LOCATION OF INDUSTRIES

The construction of dams, benefits that occur due to them and the location of industries are dealt in this chapter.

15.7.1. Construction of Dams

The construction of dams is to manage water sources for proper utilization. Rainwater and water from melting snow that would otherwise be lost can be captured and stored in large reservoirs behind dams built across streams,. By controlling stream flow, dams reduce the danger of flooding in downstream areas and allow people to live on the fertile floodplains of major streams below the dam. They also provide a controllable supply of water for irrigating arid and semiarid land below the dam. Hydroelectric power plants, which use the energy of water flowing from dam reservoirs, generate more than 20% of the world's electricity. Reservoirs behind large dams can also be used for outdoor recreation such as swimming, boating, and fishing.

The benefits of dams and reservoirs must be weighed against their costs. There are a number of environmental side effects which have been classified into three categories.

1. Impacts within and around the area covered by the dam and reservoir.
2. Downstream effects caused by alteration in hydraulic regime.
3. Regional effects in terms of overall aspects including resource use and socio-economic aspects.

The impacts caused by construction of dams and reservoirs include changes in the microclimate, loss of vegetal cover, soil erosion, variation in water table and enhanced seismic activities due to pressure of water.. The nature and magnitude of the impacts vary with the project locations and the conditions therein. In hilly tracts, blasting operations for road construction can cause considerable damage to the environment through loosening of hill sides and resultant landslides, sedimentation of reservoirs, drying up of springs and flash floods. The creation of new settlements for the workemn and rehabilitation of project oustees in the watershed areas may aggravate the seriousness of advance impacts. The guidelines refer to the environmental components to be kept in view during site selection. These include short and long term impact on population in the unidentified and watershed areas; impact on wildlife, impact on land use, potential seismic impact of reservoir loading, water balance and hydrological regime, siltation, socio-economic impacts such as rehabilitation of project oustees and public health problems.

The cost for environmental protection and mitigative measure should also be considered while estimating the overall cost of the dam. These include measures like compensatory afforestation, restoration of land in construction areas, control of aquatic weed, control of water and soil borne diseases, and rehabilitation of project oustees.

The safeguards for the following are to be guaranteed before the clearance of a project.

1. Submergence of valuable agricultural and forest areas.
2. Siltation of reservoirs due to degraded catchment conditions.
3. Satisfactory rehabilitation of oustees.
4. Loss of flora and fauna.
5. Reservoir induced seismicity, and
6. Water-borne and soil-borne diseases.

Nevertheless, the social, environmental and even economic cost of the dams far outweighs their benefits. The most important social consequence of big dams is the displacement of millions of tribals from their homeland and their eventual influx into urban areas, almost as refugees. In view of this, scientists, environmentalists, journalists, social activists, lawyers and bureaucrats have now taken up the cry against the construction of big dams. There was a mounting opposition from these people against the construction of big dams such as Sardar Sarovar Project, Gujarat, Narmada Sagar Project, Madhya Pradesh, Bodhghat Project, Madhya Pradesh and Tehri Dam Project in Uttar Pradesh.

15.7.2. Location of Industries

Industrial development is essential for the economic prosperity of any nation. The need of industrial growth is more so in the developing countries. But, industrialization is a mixed blessing. Because, it brings economic growth and high standard of life at the cost of environmental degradation. However, the rate of environmental degradation can be minimised if proper care has been made about the location of industries and the impact of such industries on the environment and people, With a view to ensure the sustenance of industry with minimal environmental degradation, an assessment committee called "Environmental Impact Assessment" (EIA) has been formed. This committee will look into the environmental implication aspects of the location of industry and also directs the project authorities to incoporate suitable measures in the project. The EIA particularly touches upon the factors of meterology and air quality, hydrology and water quality, occupational safety and health effects and impact on sensitive targets. The responsibility of impact assessment of industries is assigned to the Ministry has an Environmental Impact Assessment Wing for this purpose. There is also an Environmental Appraisal Committee (EAC) which elicits multi-disciplinary inputs for the appriasal of projects. The Ministry has constituted the EAC for the following sectors:

1. River valley, multipurpose, irrigation, and hydel power projects,
2. Industrial projects,
3. Mining projects and
4. Thermal power projects.

The project authorities have to furnish the following documents for environmental appraisal of a development project.

1. Detailed Project Report (DPR), 2. Filled-in Questionnaires; and 3. Environmental Impact Statement (EIS) along with Environmental Management Plan.

Environmental management plan seeks the information on the following : safeguards and control measure proposed to prevent or mitigate the adverse environmental impacts; plans for rehabilitation

of project oustees; contingency plans for dealing with accidents, diasters; monitoring and feed-back mechanisms on implementation of necessary safeguards; treatment and disposal of liquid effluents; emissions and solid wastes; prevention and control of noise and vibrations; precautions for occupational safety and health; preventive maintenance of control systems; recovery and reuse of waste products; plantation and vegetal cover; disaster planning; and environmental management plans for ensuring implementation of necessary safeguards. There are also some guidelines which provide a list of locations which may be avoided for the set up of industries. They include coastal areas at least 500 meters from the high-tide line, National parks and sanctuaries, estuaries, wetlands, archeological monuments, flood plain of riverine system and major human settlements.

15.8. SOLID WASTE DISPOSAL

The production of solid waste and disposal methods of the same are clearly dealt with in this section.

15.8.1. Production of Solidwaste

Solid waste is any unwanted material which is not a liquid or a gas. The solid waste comes from mining, soil and natural gas production, and industrial activities. Most mining waste is left piled near mine sites. This waste pollutes the air, surface water, and ground water. Most industrial solid waste, such as scrap metal, plastics, paper, fly-ash from electric power plants, and sludge from industrial waste treatment plants, is disposed of at the plant site where it is produced. Municipal solid waste comes from homes in or near urban areas. The waste contains paper, bottles, crockeries, plastic containers, polythene and other packing materials. All this is thrown as garbage and rubbish. These pile up in public places and cause obstruction in daily life. There are also other used things such as automobile spares, machines, cycle parts, etc. thrown as junk. The wastes from building material, sludge, dead animal skeletons, heaps of crop residues, litter, etc. also contribute to solid waste. Human excreta is a notorious source of solid waste. It is an important cause of environmental pollution and intestinal diseases.

15.8.2. Disposal Methods

Solid wastes cause much problem, the problem is too severe in the more developed countries. In most of the developing countries, wastes are disposed by the crude dumping method without any formal regulation or control allowing unrest and uncontrolled burning of combustible components. With a view to solve the problem of solid waste disposal, some methods have been suggested for better disposal system.

1. Recycling: It is a low-technology resource recovery method. The glass, paper, metals and plastics from municipal solid waste are put into separate containers. Compartmentalized city collection trucks or volunteer recycling organizations pick up the segregated wastes and sell them to scrap dealers, compost plants, and manufacturers. This method saves more energy and provides more jobs for unskilled workers. collecting and selling aluminium cans, paper, plastics and other materials for recycling are important source of income for many people, particularly the homelss and poor.

2. Landfilling: A landfill is a land waste disposal site in which wastes are spread out in thin layers, compacted, and covered with a fresh layer of decay or plastic foam each day. After a landfill has been filled the land can be graded and used as a park, an athletic field, a wildlife area or other recreation area. However, this disposal system causes pollution problems,. The underground organic wastes at landfills due to anaerobic decomposition produces explosive methane gas and toxic hydrogen sulfide gas. The build up of these gases can cause asphyxiation or one spark can cause an explosion. Further, when rain filters through a landfill it leaches out inks, metals, and toxic materials. The leachate seeping contaminates the ground water and nearby surface water.

3. Burning of Solid Waste : Burning solid-waste in incinerators kills disease-carrying organisms and reduces the amount of waste. This waste then can be put in landfills. Although the amount of materials to be buried in landfills is greatly reduced, in this method, it releases toxic gaseous pollutants into the air while in burning. The combustible solid trash burned in waste-to-energy-incinerators releases heat. The heat thus released can be used to generate electricity.

4. Composting: Biodegradable solid from slaughter houses, food-processing plants, kitchen and yard waste, manure from animal feedlots, and municipal sewage sludge is used for composting. This waste is mixed with soil and decomposed by aerobic bacteria to produce compost. The compost is a good soil conditioner and fertilizer.

5.Converting Solid Organic Waste to Biogas: Plants, organic wastes, sewage, and other forms of organic solid biomass can be converted by bacteria and various chemical process into gaseous and liquid biofuels. Biogas technology is very popular one for the production of biofuel. The biogas digester bacteria are anaerobic and convert organic wastes into methane fuel. This fuel is useful for heating and cooking. After the biogas has been separated, the solid residue is used as fertilizer.

6. Awareness: Creation of a sense of environmental awareness among all strata of men, women and children so that they do not throw solid wastes, particularly garbage, junk, etc. at public or private lands but keep them in solid waste bins provided for the purpose by the municipal authorities.

6. Check Your Progress - 7

What is solid waste and what are the effective disposal methods?

Note: a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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15.9. SOCIAL BEHAVIOUR

Man's social behaviour towards the environment has been changing depending upon his stage of development. For primitive man 'Nature' appeared to be a wilderness. It hightened him by its unfolded mysteries. Gradually, the primitive man has recognised the nature as a source of sustainance to him. The primitive people are hunter-gatherers. They survived by gathering wild plants and hunting and killing wild animals from the nerby environment. Their knowledge of nature enabled them to survive in wilderness. The primitive people made conscious efforts to keep their population size in balance with available food supplies. Population control practices varied with different cultures but included abstention from sexual intercourse, infanticide, abortion, late marriage, and feeding infants with breast milk as long as possible. This prevented the hunter-gatherers from undergoing rapid population growth.

The advanced hunter-gatherers gradually developed improved tool and hunting weapons. Some learned to burn vegetation to promote the growth of food plants and plants favoured by the animals they hunted. The advanced communities with the developed instruments had a greater impact on their environment than early hunter-gatherers. But beacuase of their small numbers, mobility and dependence mostly on their own muscle power to modify the environment, the environmental impact

of these communities was fairly small and localized. The successive generations gradually shifted from mobile hunting and gathering societies to settled agricultural communities where people survived by learning how to breed wild animals and to cultivate wild plants near where they lived. This is a major cultural shift, known as the "Agricultural Revolution". The settled agricultural communities practised slash and burn cultivation and shifting cultivation methods in their agricultural system. The practice of these methods had shown relatively little impact on their environment. However, the growing populations needed more food and more wood for fuel and buildings. Consequently people cut down vast areas of forest and plowed up large areas of grasslands. Such massive land clearings destroyed and degraded the habitats of many forms of plant and animal life, causing or hastening their extinction, thus affecting biodiversity. The gradual spread of agriculture has resulted in the control of wild nature. Later, social change occurred in the form of "Industrial Revolution:. It arose as a response to absolute resource scarcity in England. This Revolution changed men's relationship with the earth more than the Agricultural Revolution. It represented a shift from dependence on renewable wood and flowing water as a source of energy to non-renewable fossil fuels - first coal, later oil and natural gas. Increased agricultural production plus the concentration of factories in cities made the farmers to move to the cities for work alongwith many benefits for people. The advanced industrial societies have intensified many existing resources and environmental problems and created new ones. The key factor responsible for rapid economic growth and today's environmental problem is the greatly increased use of cheap fossil fuel. It is also responsible for most of the world's air pollution and much of its water pollution. Most people in today's industrialized societies have a "throwaway worldview" based on the following beliefs: They are apart from nature; they are superior to other species; their role is to conquer and subdue wild nature to further our goals by humanizing the earth's surface; resources are unlimited; the more we produce and consume, the better off we are; the most important nation is one that can command and use the largest fraction of the world's resources.

Social change in the present generation is gradually taking place in a small but growing number of people who urge to adopt a sustainable-earth world view. They believe that the earth does not have infinite resources and that ever increasing production and consumption will put severe stress on the natural processes that renew and maintain the air, water, and soil and suport the earth's variety of potentially renewable plant and animal life.

Conclusion: Man is new at the most running point since the Agricultural revolution. Social behaviour in human species must change for sustaining and for caring the earth. It means that each of us, particularly the communities which have industrialized lifestyle must change their individual consumption habits and lifestyles to reduce the environmental impact. Those who care for the earth and adopted earthcaring lifestle must urge individual citizens to think globally and act locally to sustain the earth. The earth caring lifestyle would involve - adopting practices from all the world's cultures, and using existing and new forms of appropriate technology to help sustain the earth's life-support systems for humans and other species. Individuals will have to change their life-sytle to reduce rsource waste, environmental degradation and pollution. Emphasis will have to shift from pollution control to pollution prevention, from waste disposal to waste prevention and reduction, from species protection to habitat protection, and from increased resource use to increased resource conservation.

15.10. COMMUNITY ACTION

Our natural resources are fast depleting because of their indiscriminate and exploitative use. If this is continued at this pace, we will have no resources left in the near future. Therefore, it is necessary to conserve and manage our natural sources in such a way that they can be renewed and used by the present generation while maintaining their potential to meet the needs and aspirations of the future generations. For conservation of natural resources, every citizen must participate and take a role in protecting them. Citizens in a collective form must act together to stop further destruction

of our natural resources, particularly forests which provide a wealth of biodiversity without which the survival of man is impossible. It is the responsibility of communities of people to act for the protection and conservation of natural resources. A very good example of community action for the protection of forests is **Chipko Movement**.

Chipko movement is also called "Tree-Hugging Movement". Some illiterate tribal women in Uttar Pradesh have commenced this unique movement to protect the remaining trees in a nearby forest from being cut down. It gathered momentum in 1978 when the women faced police firing. Women and children went into the forests, flung their arms around trees and sat around them to prevent commercial loggers from cutting them down. This successful movement spread rapidly as their action inspired the women of other Himalayan villages to protect their forests. This movement also emphasized the role of forests in making soil, water and pure air which are the basis of life. It later continued under the leadership of Shri Sunderlal Bahuguna. He presented the plan of this movement for protection of soil and water through ban on tree-felling in the Himalayas, at the UNEP meeting held in London in June 1982. Every standing green tree in the forest is a sentry to protect us from avalanches and landslides to have our soils and conserve our water. Important gift of tree to us is not timber, but soil, water and oxygen. Further, the plan of this movement is to make communities self-sufficient in all their basic needs - food, fodder, fuel, fibre and fertilizer trees.

The Chipko movement gradually spread to other parts of this country. But, there was not regular movement in those places. However, Chipko reached Karnataka as Appiko movement. In Karnataka, the Appiko movement started in Salkani village of Sirsi taluka in North Kanara District, on 8th, September 1983. Gradually, the Appiko was launched in other talukas of the North Kanara district. Due to this, local contractors became much nervous and made them to stop tree felling. People from many other countries such as France, Germany, Sweden, Switzerland, etc., were also inspired by this movement against destruction of forests. The Chipko in Uttar Pradesh and Appiko in Karnataka are the movements organised by the action of the communities of people.

Community action must also be there against wrong location of dams and industries that cause much environmental degradation effecting all living beings including man. People must act to protect the aerial environment from the emissions of industrial chimneys and surface and ground water from solid waste disposed off by the industries. Equally important is the action of people against littering public places with domestic wastes, human excreta, etc. which cause serious diseases.

To achieve anything in a community, one has to generate social awakening. Social awakening results in social cohesion and political solidarity. From this springs the required political will. Once the community is organized, it does not stop at the point of achieving its object for which it came into existence. It proceeds to add new feathers to its cap, thereby the movement would have positive results and also positive impact on the quality of life of people.

15.11. SUMMARY

Forests are commercially and economically important. Ecological relationships of the forersts are particularly valued for the very sustenance of every living species. The indifferent attitude of man towards forest has shown him as a beast. In view of the decimated forest lands, immediate measures should be taken for their conservation and management.

The agricultural lands are shrinking due to increased village expansion, urbanization, highways, industrialization, etc. The repeated use of the same land for raising crops leads to soil sterility. For increased crop yields, one way is to alter natural environment to fit the needs of the crop and the other way is to genetically alter the plants so that they better fit to their environments. Industrialization and subsistene agricultural systems are the two major types practised to grow crops and also raise livestock throughout the globe. Diffrent methods are practised for soil conservation and for controlling landuses.

Grasslands are the regions where the average annual precipitation is high enough to allow and prosper the grasses which are dominantly the members of Poaceae. Tropical and polar grasslands are the major grasslands in the world. Indian grasslands are developed following the destruction of forests. Different types have been identified depending on the dominance of particular grass species. Grasslands are very important for grazing animals and there is a need to manage them using different techniques.

Chemical fertilizers are used to increase agricultural production. They are concentrated inorganic material and restore soil fertility. But, they produce many undesirable side effects such as eutrophicaion, water pollution, soil oxyzen depletion, reduction of disease-resistance in plants etc.

Desertification is caused due to climatic factors, human factors and interactions between climate and culture; it leads to desert formation. It is a result of gross misamanagement of natural resources above and within the earth.

Construction of dams is to manage water resources for good use. Industrial development is to prosper economically at individual and national lavel. The places where the dams and industries are located are very important with reference to the environment. Therefore, in selecting the location, certain areas have to be avoided and due consideration must be given to minimise environmental degradation, health hazards, etc., The Ministry of Environment and Forests has issued certain guidelines to fulfil and submit certain documents guaranteeing environmental safety to the Environmental Appraisal Committee by the project authorities.

Solid waste is any unwnted material which comes form industries and homes. It causes health problems. It should be disposed properly. Some methods have been suggested for better disposal system. They include recycling, land-filling, burning, composting, conversion to biogas, etc.,

Man's social behaviour has changed in accordance with his stage of development. The primitive man were hunter-gatherers, later settled as agricultural communities and then as industrial society. The social change in the present generation is towards sustainable-earth urging the individual citizens to think globally and act locally.

Indiscriminate and exploitative use of natural resources is a peril which in long run may lead to the disappearance of all living things including man on the earth. Therefore, every citizen must take responsibility and in a collective form act against the misuses and abuse of natural resources. The best examples of community action are "Chipko" movement in Uttar Pradesh and "Appiko" movement in Karnataka.

15.12. CHECK YOUR PROGRESS : MODEL ANSWERS

1. In the forest management, all or most of the trees from a diverse old growth or secondary forest and the site is replanted with even aged stand of single species of faster growing soft woods. Such stands of tree species are called tree farms.
2. The production of large quantities of a single type of crop or livestock for sale within or outside the country is called industrilised agriculture.
3. The cash crops such as bananas, coffee, cocoa are grown in plantation agriculture,
4. The major factors that determine the type of grosslands are average precipitation and average temparature along with soil type.
5. Savannas are found with high average temperatures, two prolonged dry seasons during winter and summer and abundant rain during the rest of the year.
6. Desertification is the process leading to desert formation. It may be caused due to climatic factors or due to the gross mismanagement of natural forests.

7. Solid waste is an unwanted material and comes from industries, markets and homes. Recycling, land-filling, burning, composting, conversion to bio-gas, etc., are the methods for effective disposal of the solid waste.

15.13. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write briefly the importance of forests and agricultural lands and their management.
2. What are the chemical fertilizers and how are they used ? Give briefly their impact on the environment ?
3. What is solid waste and its sources ? Describe the disposal methods.

II. Answer the following questions in 10 lines each.

1. What is grassland ? Briefly write about grasslands in India.
2. Write about desertification.
3. What is environmental impact assessment ?
4. Write a brief account of social change from the time of primitive man.
5. What is 'Appiko Movement' and describe its genesis ?

Dr. A. J. S. Raju.

UNIT - 16 : TOXIC WASTES

Contents

16.1. OBJECTIVES

After completing this unit you will be able to :

* define the terms waste, toxicant and toxic waste,
* listout the sources of toxic wastes,
* describe the nature of toxic wastes and their magnitudes,
* discuss about the problems associated with accumulation of toxic wastes,
* describe the principles underlying the toxic waste disposal methods and their limitations,
* suggest ways and means of control of toxic wastes.

16.2. INTRODUCTION

Wastes, in the ecological sense, are materials which are no longer useful to man, as are byproducts and residua (dross, slag, offal) as well as liquid and gaseous effluents, including raw sewage. Some of the wastes contain substances which can adversely affect organisms including man and hence are

poisonous or toxic to them. The 1978 edition of Registery of Toxic Effects of Chemical Substances published by the National Institute for Occupational Safety and Health, USA, gives the following long and encompassing definition for a toxic substance:

" A toxic substance is one that demonstrates the potential to induce aner, tumours, or neoplastic effects in man or experimental animals; to induce a permanent transmissible change in the characteristic of an offspring from those of its human or experimental animal parents; to cause the production of physical defects in the developing human or experimental animal embryo; to produce death in animals exposed via the respiratory treact, skin, eye, mouth or other routes in experimental or domestic animals; to produce irritation or sensitisation of the skin, eyes, or respiratory passages; to diminish mental alertness, reduce motivation, or alter behaviour in humans; to adversely affect the health of a nomral or disabled person of any age or of either sex by producing reversible or irreversible bodily injury or by endangering life or causing death from exposure via the respiratory tract, skin, eye, mouth or any other route in any quantity, concentration, or dose reported for any length of time".

Typical toxic substances include O_3, CN^-, CO, $COCl_2$, NOx, SO_2, Cl_2, Br_2, Particulates, $NO3^-$, NO_2^- heavy metals like Cd, Hg, Pb, As, Sb, Be, Mn, Ni; hydrocarbons, phenols, alcohols, epoxy compounds, ethers, aldehydes, nitriles, nitrosamines, solvents used in glues, nail polish removers and biocides.

In the light of the above definition, Toxic Wastes are wastes containing toxic substances or **Toxicants** and the science of toxic substances is known as Toxicology. The simple examples of toxic wastes are the automobile exhaust and the process wastes of chemical industries. The likelihood of damage or harm, which may arise from a toxic substance, is usually defined as Hazard. However, the term Hazardous wastes is much wider in scope compared to the term Toxic Wastes. "Hazardous wastes mean wastes other than radioactive wastes which by reason of their chemical reactivity or toxicity, explosive, corrosive or other characteristics causing danger or likely to cause danger to health or the environment, whether alone or when coming into contact with other Wastes".

Developments in the history of toxicology began more than 3000 years ago. Hippocrates, the Greek scholar identified arsenic, antimony, mercury, gold, copper and lead as toxic substances, as early as in 460 BC. Exploding growth in human population and rapid industrialisation after world war-II added new dimensions to the problem of toxic waste accummulation and disposal. According to the "International Register of Potentially Toxic chemicals" of the United Nations Environmental Programme, there are over four million known chemicals in the world today and another 30,000 new compounds are added to the list every year. Apart from their benefit to increasing production, living standards and health, many of them are potentially toxic. Many of the chemicals emitted into the environment from various types of industries are known to produce toxic effects on human, and aquatic ecosystems.

The various toxic wastes produced by man in his variety of activities enter the abiotic environment and are known to ultimately affect biotic environment. Migration of toxic chemicals through ground and surface water increases contamination of drinking water sources. Chemical contamination of vegetation and crops results in tropic transfer of toxic chemicals. The toxic substances affect human and animal health directly through contact or inhalation and indirectly through ingestion of contaminated water and foods. The detection of traces of toxic chemicals in drinking water supplies, in polar ice caps, in birds' egg and even in mother's milk, and episodes such as Minamata Bay in Japan and Love Canal in USA are indicators of the risks posed by release of the toxic wastes into the environment.

16.3. SOURCES

There are both natural and anthropognic sources of toxic substances and the environment is the ultimate sink for these toxicants. In a majority of the cases, toxic substances are the unrecovered products of industrial processes and constitute the hazardous components of the industrial effluents

or wastes. In certain other instances over-indulgence in the use of materials and subsequent discharge of these materials into domestic wastes may transform the latter into toxic wastes. As the anthropogenic sources of toxic wastes are of greater concern than those of natural, the former are dealt first.

16.3.1. Anthropogenic Sources

The catastrophe of toxic wastes is the result of man's many activities aimed at generating more food, materialistic prosperity, comfort and luxury. His various activities culminating to toxic wastes problem include industrial, agricultural, domestic, energy production, and health and hygiene.

Industrial Sources : Most industries generally produce wastes containing toxicants such as heavy metals, and other inorganic and organic compounds. However, the specific toxicants present in the wastes of one industry differ from those present in the other depending upon the raw materials used and the production process involved etc

Fertiliser, pharmaceutical, textile, paint, asbestos, pulp and paper manufacturing, lead battery manufacturing, viscose rayon manufacturing, electroplating, copper pickling, galvanising, rubber processing, ore mining, ferrous and nonferrous metallurgy, organic and petrochemical, leather tanning, and biocide manufacturing industries are some of the sources which generate a variety of toxic wastes. The probability that a toxic waste stream is produced at an industrial site can be estimated based on a set of material production- consumption characteristics.

Agricultural Sources : The indiscriminate use of chemical fertilisers and biocides in agriculture is the source for large scale accummulation of toxic wastes in soil and water bodies, by natural processes such as leaching and runoffs.

Domestic Sources : The domestic waste water of urban areas is a source of many toxic materials. Lead containing street dusts, prescription and over the counter (OTC) drugs, pesticides of house hold, pet or garden use, cosmotics, adhesives, solvents, polishes and deodorants are commonly found in the domestic/Municipal sewage.

Other Sources : Nuclear power plants, nuclear reactors, nuclear tests, nuclear installation, fission and fusion product processing units, etc., serve as sources of yet another type of highly toxic wastes, viz., wastes containing radionucleides.

Toxic wastes also result from the operations of many small institutions like research laboratories and hospitals. Infact the chemical and pharmaceutical research laboratories liberate highly concentrated toxic wastes into the environment. Finally, the auto-exhaust is no less a source of toxic wastes than others.

16.3.2. Natural Sources

Hypothetically even if all the toxic waste producing activities of man are stopped, Nature is capable of releasing toxic materials into the environment. Infact, the toxic load arising from natural materials is quite significant.

However, it is not proper to use the term toxic wastes in the natural context, and hence we limit to the term sources of toxicants in this case. People are exposed to natural toxicants in air, water and food. Natural toxicants include minerals, fungal and plant toxins, animal venoms and some products of natural phenomena such as forest fires, volcanoes, and erosion. Various metallic elements occur as anions in water and, interestingly, many elements in trace concentrations are essential for health and the list of essential elements continues to grow. The natural leaching processes of minerals brought about by water brings toxic elements into water bodies.

Polynuclear aromatic compounds are products of the combustion of organic compounds and are

formed in virtually all burning operations, including forest fires. Natural processes were bringing toxicants into the air and water long before man started to make his contribution, for example the release of CO, SO_2, NO_x, particulates etc., into the environment by natural processes.

Check Your Progress - 1 & 2

1. What are wastes, in an ecological sense ?
2. Name some of the broad categories of anthropogenic sources of toxic wastes.

Note : a) Write your answers in the space given below.

b) Compare your answers with those given at the end of this unit.

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16.4. NATURE AND MAGNITUDE

The nature of toxic waste and the magnitude of toxic waste generated are described in this chapter.

16.4.1. Nature

In its physical nature the toxic waste can be a solid, liquid, gas or sludge and may arise from a wide range of industrial, commercial, agricultural and domestic sources. The same industry may discharge the waste in more than one physical form. In chemical nature the toxic waste can be inorganic, organic or both, depending upon the chemical composition of it. The waste stream compositions vary very widely depending upon the industry or source. Even among the same product manufacturing units waste may differ depending upon the further utilisation of the processes involved, by-products isolated, etc.

The toxic waste arising out of a fine chemical manufacturing unit may contain residual containing various heavy metal compounds. The wastes stream from a dye manufacturing industry may contain sludge containing amino, nitroorganics. Similarly an endosulphan manufacturing unit may have wastes containing considerable quantities of complex organic polymers, hexachloro-cyclopentadiene, butenediol etc.

16.4.2. Magnitude

The magnitude of toxic waste generated depends upon many factors such as the process technology involved, raw materials utilised, treatment and recovery procedures adapted etc. In order to correctly assess the magnitude and pollution potential of toxic wastes generated in a country, it requires complete and systematic data collection on the various types of toxic waste generating sources and its careful analysis. For the sake of information and completeness, typical data collected by NEERI, Nagpur in the context of Indian scenario are shown in Table - 16.1. The table is product based rather than industry or source based. Though the toxic wastes form only a small fraction of all the wastes generated by industry or allied activities, their impact can be catastrophic as they affect human health

TABLE - 16.1. Toxic Waste Generation in some Products Manufacture

Product Plant capacity Tonnes per Annum (1)	Toxic Waste Stream Components (2)	Waste Generation Kg/ton product (3)
Castic soda, 77,000	Brine purification sludge containing mercury, 8.5 g/Kg sludge and Ca & Mg salts.	33
Barium salts, 23,000	Filter press sludge containing Ba, Si, Fe and unreacted mineral.	86
Fine chemicals manufacture-Cr, Co, Cu, Cd, Pb, Hg, Ni, Zn, Sb.	Residue containing all the heavy metal Compounds	6850
Sodium dichromate, 21,600	Leached residue brownish black in colour, turns yellow under sunlight, contains 0.4 to 0.8% Cr^{6+} and 12 to 14% total chromium.	1200
Aniline, 12,000	Tarry waste containing 5% phenyl cyclohexamine, 30% O-aminophenol,m 20% tar and traces of nitrobenzene.	3.0
Nitrobenzene, 20,000	Crude nitrated aromatics from purification	2.5
Nitrotoluene, 3,100	Residue from distillation, 40% dinitrotoluene, 10% p-, m-nitrotoluene, 50% nitrotoluene, tarry materials.	
beta-Naphthol, 1950	Tarry residue containing naphthalene, Sulphones, sulphur compounds, 2-3% naphthol.	213
Acrylonitrile, 24,000	HCN, 5.9 Kg; aceto - and acrylonitriles, ammonia, 9.6 kg per tonne product.	0.33 Kg; 1.3 m^3/ tonne (liquid waste)
Dyes and Dye-Intermediates, 10,700	Blackish - brown sludge containing amino, nitro organics.	470
Dichlorodiphenyl trichlorocthane, DDT, 5000	1) Tarry waste containing raw materials, reaction products.	4.0
	2) Highly acidic waste water containing 185-480 Kg H_2SO_4 and 1.05 Kg DDT Per tonne DDT made.	50 to 60 m^3/tonne (Liquid waste)
	3) Lime sludge from neutralisation of waste water containing 0.05% DDT on dry basis.	2000
Hexachlorocyclohexane (BHC), 4520	Residue containing pesticide and benzene.	19

Malathion, 1080	Semisolid black material with complex organics, pesticide residue, intermediates.	10 to 20
Endosulfan 1500	Solvent recovery distillation bottoms containing. complex organic ploymers, hexachlorocyclopentadiene, butrnediol	100
Phorate 480	Semisolid odourous material containing ethyl mercaptan, formalin, and phorate	100
Carbaryl 235	Semisolid tarry residue containing carbaryl and intermediates.	150
BHC, DDT and carbaryl dusting powder, 3600	Fine dust containing steap-stone, BHC, DDT and carbaryl pesticides.	5
Ethanolamines, 3000	Polyethanolamine and ethanol amine sludge.	255

Check Your Progress - 3

3. What is the nature of toxic wastes ?

Note :a) Write your answer in the space given below

b) Compare your answer with the one given at the end of this unit.

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16.5. ACCUMULATION AND HAZARDS

The accumulation of toxic wastes and the hazards caused due to toxic wastes are described in this section.

16.5.1. Accumulation

As was mentioned earlier the toxic wastes from various sources, if untreated reach the ultimate sink namely, the environment. Either during the transport or after reaching the ultimate sink, a toxicant may be rendered harmless by natural processes or, as it often happens, it may accumulate in the environment. Exchange of the toxic substances may also take place among the segments of the environment, viz., atmosphere, lithosphere and hydrosphere.

It has also been noticed that some of the toxic substances find their way from the abiotic environment into the biotic environment and get accumulated in the biota. Bioaccumulation is well-known with persistent pesticides. Both animals and plants have the ability to concentrate certain compounds in their body tissues - any substance which is slightly more soluble in the tissues than in the sourrounding water will be concentrated more in the tissues of the organisms. The chlorinated pesticides like DDT, 2,4-D and mirex and others like diazinon and diquat have the greatest tendency for bioaccumulation.

Fish (golden shiners) are reported to take DDT at 0.265 ppt (parts per trillion) in water and concentrate it 1,00,000 times in their body; oysters taking DDT at 1 ppt in sea water can concentrate it 70,000 times and water fleas taking DDT at 0.5 ppt in water, can concentrate it 1,00,000 times in their bodies.

Accumulation of DDT in Food Chain : DDT accumulates in animal tissues, soil and humus in concentratations thousands of times, higher than that is found in air and water, through food chain. The cycle of food chain consists of plankton in sea water which contains about 0.04 ppm DDT. The claims that digest plankton concentrate it to ten times i.e., 0.4 ppm. Fish feeding on clams contain 2.4 ppm DDT, while DDT level goes upto 75 ppm in birds which eat fish. It was also reported that the DDT concentration rose to about 15 ppm in man fed on fish containing DDT.

As regards to bioaccumulation of toxicants other than the pesticide residues wheat and rice in particular have been shown to concentrate cadmium when grown on cadmium polluted soil. Similarly mercury in low concentrations in water gets bioaccumulated to high levels in predatory fish and animals, in the form of methyl mercury. The fish Atlantic Blue Marlin accumulates upto 170 ppm total mercury in its kidney. Selenium in more than trace concentrations is toxic to some organisms but many plants like Vetch, Woody Astor, Golden weed and Princes plume are known to accumulate selenium to an extent of 15,000 ppm in their bodies ad serves as Selenium 'Beath' indicators. It appears that, in certain of the cases, the phenomena of bioaccumulation can be used advatageously. For instance, recent investigations have shown that the worst water weed, Water Hyacinth, can absorb most of the toxic substances in domestic and industrial waste-waters.

16.5.2. Hazards

Toxic wastes can affect human and animal health through different mechanisms and routes of exposure. The potential pathways of release and exposure to toxic wastes include :

1. Sorption by soil and its direct contact with aquatic and terrestrial biota and man through food;
2. Evaporation to atmosphere and their deposition or contact or inhalation by all life forms and
3. Leaching or direct surface runoff into water and subsequent exposure to or ingestion by living forms.

Adverse health hazards may involve any organ of the body or any of the vital physiological functions. The factors that govern the extent of damage include the nature and metabolism of the chemical, characteristics of the individual and compounding variables, viz., personal habits and prevalence of other diseases.

The health hazard that arises also depends upon the duration of expousre and the dose, and the effect may range from minor irritation to death. The well documented toxic effects observed in man are nasal, throat, digestive and respiratory tract irritation and damage; pulmonary edema, irreversible respiratory system damage; asphyxiation; anesthesia and central nervous system depressing (narcosis); methemoglobinemia; diarrhoea; liver, renal and brain damage and cardiac failure. Some far reaching toxic effects include genetic hazards like mutagenesis, teratogenesis and carcinogenesis. For instance, several industrial wastes, biocides and most radioactive materials have mutagenic properties causing changes in cell DNA, thereby producing heriditary chages. Heavy metals such as lead, cadmium and mercury are found to cause birth defects and attack liver, kidneys and central nervous system. Some organic toxicants such as carbon tertrachloride, trihalomethane are known to act as teratogens and damage developing embryo and fetus. Several other organic substances such as benzene, vinyl chloride etc., are known as carcinogens. some toxicants produce cancer directly by initiating the growth of malignant tumours while others may permanently alter cells making them susceptible to other toxic substances.

The health hazards caused by toxicants may be broadly divided into two classes - acute and chronic effects. Acute effects manifest themselves immediately upon short term exposure at high concentrations, and chronic effects become evident only after continuous exposure to low levels. The

chronic effects are very difficult to demonstrate and are consequently less obvious.

It is appropriate to mention the 'Love canal episode here as it created a sense of awareness about the hazards posed by toxic wastes. Love canal was a waste chemical disposal site in the south eastern section of the city of Niagara Falls, New York. The canal was excavated in the 1980s in an effort to connect Lake Ontario with the upper section of the Niagara River, but was abandoned for lack of financial support. For decades the defunct canal served as a recreation site for swimming and skating. During the 1940s, it was taken over as a waste chemical dump and finally transferred to the local board of education in 1953. Since that time, the canal area has been troubled with seepage of noxious chemical and evoolution of toxic chemical vapours. It is believed that the dump site contains appreciable amounts of about 80 toxic substances. Seepage of toxic substances from the dump site has required the evacuation of about 200 homes. It is feared that a number of health problems have resulted from exposure to toxic chemicals.

A brief account of the human health hazards caused by some of the toxicants is summarised in Table - 16.2.

Table - 16.2. Toxicants and Hazards

Toxicant (1)	Hazards (2)
Lead	It is a neurotoxin; Poisoning results in convulsions, delerium, coma, severe and irreversible brain damage and death; Behavioural disorders.
Cadmium	Cardiovascular disease and hypertension; interference with Zinc and copper metabolism, kidney damage; bone fracture.
Mercury	Nerve and brain damage; kidney damage; Chromosome breakage; Birth defects.
Nickel	Respiratory problems; lung cancer
Arsenic	Gastrointestinal damage; liver and kidney damage and muscular weakness.
Chromium (VI)	Nausea, Vomiting, Shock and coma
Cyanide	Deadly toxic; rapidly acting poison; chemical asphyxiation at cellular level.
Fluoride	Mottled teeth; weakening of bone; weight loss; thyroid and kidney injury.
Nitrogen dioxide	Pulmanary irritation and haemorrhage, eye irritation, loss of resistance to influenza
Halogens	Respiratory tract irritation, damage; pulmonary edema, coughing, nose bleeds.
Sulphur dioxide	Eye, nasal and respiratory tract irritation; emphysema, bronchitis.
Carbon monoxide	Impairment of judgement and visual pereption; reduced mental activity; Death due to chemical asphyxiation- restriction of oxygen transport from lungs to cells due to carboxyhemoglobin formation.
Ozone	Mucous membrane irritation; Nasal and throat irritation, congestion in the chest; pulmonary edema
Phosgene	Irritation of alveolar walls and capillaries with gradual edema, asphyxiation and heart failure.
Benzene	Toxic to hematopoietic system; causes cancer.
Halogenated Hydrocarbons	Central nervous system depression; liver damage and kidney damage.

Check Your Progress - 4 & 5

4. Why does a substance like DDT get accumulated in the tissues of organisms like fish ?

5. What is the difference between acute and chronic toxic effects ?

Note : a) Write your answers in the space given below.

b) Compare your answers with those given at the end of this unit.

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16.6. DISPOSAL METHODS AND PROBLEMS

The aim of any toxic waste treatment is to see that the waste is returned to the nature in a harmless form and with little dusturbance to the ecosystem. It is necessary to isolate those substances which do not originally exist in the nature and those which have the potential to adversely effect the environment. However the methods of treatment and disposal vary as the toxic wastes dffer widely in their chemical nature and physical state.

Some toxic wastes contain valuable materials. Whenever this is the case, recovey and reuse is one of the most desirable methods of toxic waste avoidance. Silver, selenium, mercury, thallium, copper, lead, chromium, zinc and other heavy metals, once they are removed from water or air streams, are often recovered rather than land disposed. It is uneconomical to reclaim these metals only when they are very minor constituents of the waste or when the quality of the product is adversely affected.

Usually, the wastes are subjected to pretreatment before they are subjected to ultimate disposal. The pretreatment procedures may include; cementation- to immobilise the sludges to facilitate convenient disposal; centrifugation - to separate solids from liquids; freezing; thickening; dewatering by sand drying beds and vacuum filtration; and submerged combustion to concentrate the waste. The pretreatment procedures depend upon the particular disposal method adopted.

The economics of waste disposal will determine, ultimately, the amounts and types of wastes that will be moved to distant disposal sites. However, the treatment of the waste at the source of generation itself is preferred if safety and other factors permit. The use of common waste treatment plants is ideal for small industries to get safe and economic waste treatment and disposal.

There are four major ultimate disposal methods in vogue at present to deal with toxic wastes. They are 1) Deepwell disposal, 2) Incineration. 3) Land burial and Landfills, and 4) Ocean disposal. Chlorinolysis and wet air oxidation are two other methods of waste disposal even though they are of limited applicability.

The particular waste disposal method adapted in a situation depends both upon the physical state of the toxic waste-gas, liquid, solid or sludge and the chemical nature of the waste. In certain of the cases a combination of these methods is used to render the toxic wastes harmless.

16.6.1. Deep Well Disposal

Deep well disposal is a system of disposing of raw or treated, filtered toxic wastes by pumping the wastes into deep wells where they are contained in the pores of the permeable subsurface rock,

separated from other ground water supplies by impermeable layers of rock or clay. The depth at which these wastes are discharged varies from a few hundred feet to over 2000 feet and well head injection pressures for some wells may require 4000 psi. Deep well disposal requires the injection of liquid waste into a porous subsurface stratum which contains non-commercial brines. The wastes are merely stored below ground in strata which are sealed by impervious strata, thus isolated from usable underground water supplies or mineral resources.

Injection wells can be used by virtually any type of industry which is located in the proper geologic environment and which as a waste product amenable to this method. A number of industries are presently using this method. The largest users of deep well disposal systems are the chemical pharmaceutical industries. It is desirable to monitor injection wells to determine the extent of travel of injected waste permitting the detection of well casing or cement failures, the escape of waste through fractured or faulted cap rocks, or through other abandoned or operating wells and the loss of permeability in the injection horizon during injection.

16.6.2. Incineration

Incineration is a controlled process that uses combustion to concert a waste to a less bulky, less toxic, or less noxious material. The principal products of incineration from a volume stand point are CO_2, H_2O and ash, while the products of primary concern, due to their environmental effects, are compounds containing S,N and halogens. When the combustion products form an incineration process contain undesirable compounds, a secondary treatment such as after-burning, scrubbing or filtration is required to lower the concentrations to acceptable levels prior to atmospheric release. The solid and liquid effluents from the secondary treatment processes will occasionally require treatment prior to ultimate disposal. Incinerators are generally classified by the form of waste which they burn. There are 10 basic types of incinerator units.

The type and form of waste will dictate the type of incinerator unit required. If the waste is a gas containing organic materials which are combustible then incineration should be considered as a final method of disposal. Catalytic incineration is applied to gaseous wastes containing low concentrations of combustible materials and air. Catalytic systems have been used widely in the oxidation of paint solvents odours arising from chemical manufacture, food preparation, lithographing ovens etc.

Incineration is one possibility for the destruction of combustible and partially combustible liquid wastes. Non combustible liquids cannot be treated or disposed of by incineration. A partially combustible waste may also contain material dissolved in the liquid phase which, if inorganic in nature, will form an inorganic oxide upon combuston and require secondary collection prior to atmospheric release. In order that a liquid waste may be considered combustible, there are several rules of thumb which should be used. The waste should be pumpable at ambient temperatures or capable of being pumped after heating to some reasonable temperature level. The liquid must be capable of being atomised under these conditions. If it cannot be pumped or atomised it cannot be burned as liquid but must be handled as a sludge or solid. Liquid waste incineration generally involves liquids having viscosities up to approximately 1000 ssu, although lower viscosities are desirable.

Solids incineratoin is not a total disposal method, because most solid materials contain non-combustibles and have residual ash. Many types of conventional incinerators designed for combustion of refuse have been adapted for disposal of chemical process solid wastes. The incinerators have been used for solid chemicals, sludges, filter residues, off-quality product, and tars. The waste must contain a sufficient percentage of combustible material and be physically compatible with the incineration equipment.

As regards to problems or limitations associated with incineration as a method of toxic waste disposal :

i) It is not suitable to noncombustible toxic wastes,

ii) the emissions must be continuously monitored for the presence of toxic intermediate gases,

iii) in certain cases the end produts of combustion are corrosive and

iv) in some instances it has to be supplemented by other methods.

16.6.3. Land Burial and Landfills

Land burial : Land burial is a possible choice for those hazardous materials that require complete containment and permanent disposal. This includes radioactive wastes as well as highly toxic chemical wastes. Disposal can be accomplished by either near-surface or deep burial. Deep burial is more applicable to the highly toxic or dangerous materials since better isolation from the biosphere is afforded.

In near surface burial the material is deposited in stainless steel tanks or concrete lined pits bineath the ground. The standard procedures for deep burial are disposal in salt mines or hard bed-rock or in shale formations by suing hydraulic fracturing.

At the present time near surface burial of both radioactive and chemical wastes is being conducted at several Atomic Energy Commission and commercially operated burial sites. These wastes are buried in unlined trenches approximately 20 feet in depth. The trenches are filled to within 2-5 feet of the surface and are covered with either asphalt or soil and vegetation to reduce infiltration of water. Radioactive wastes are stored in either liquid or solid form in steel tanks enclosed in concrete.

In deep burial the wastes would be buried approximately 1000-1500 feet beneath the ground in unlined tunnels. The wastes are lowered into these tunnels by means of a central access shaft. After the filling operation is complete in a tunnel, it is sealed off by back filling with salt and using a positive seal, for example, concrete.

In these methods of toxic waste disposal proper location of the site is very essential and the various environmental factors of principal concern pertain to meteorology, geology, hydrology and geo-seismology and the criteria for site selection and have to be strictly adhered to provide complete confinement of the waste at the sige with little scope for leakage.

Landfills : There are different types of landfills meant for different wastes. Four types are of interest in the present context: 1) General purpose landfills; 2) General purpose approved lanfills for large volume hazardous wastes, 3) General purpose, secured landfill operations for small volume, extremely hazardous wastes; and 4) Secured landfill for specific wastes for intermediate or large volume extremely hazardous wastes. The potential for environmental damage by landfilled hazardous waste differs depending on both the composition and quantity of that waste. Even general purpose landfills will accept small quantities of toxic wastes, particularly if they are in drums or plsatic containers, but refuse large amounts. Cyanide, arsenic compounds, and some heavy metal compounds are examples of such materials. However, great care must be exercised in choosing suitable type of landfill, Criteria for secured landfills include the following: 1) the composition and volume of each extremely toxic waste is known and approved for site disposal by pertinent regulatory agencies; 2) the site should be geologically and hydrologically approved for extremely toxic wastes: 3) monitoring wells are provided; 4) leachate control and treatment are taken care of; 5) records of burial coordinates to avoid any chemical inter actions are maintained; and 6) registration of the landill site is done for a permanent record of its location once filled.

16.6.4. Ocean Disposal and Other Methods

Ocean Disposal: Until, recently, the disposal of toxic wastes into the oceans was used to be an expedient and economically sound method of disposal. After the episodes like Minamata and the hazards created by bioaccumulation of toxicants, 'Ocean disposal' is being discouraged. EPF of

USA is against ocean disposal of wastes containing more than trace concentrations of certain toxicants.

Chlorinolysis : Destructive chlorination or chlorinolysis can effectively be applied to the disposal of organic compounds. In this process, the undisposables, including DDT and other pesticides and any nondistillable chlorinated residues left over from organic chemical manufacturing, are converted with high yields into a principal product, carbon tetrachloride.

Wet Air Oxidation (WAO) : Wet air oxidation is based on the discovery that any organic material in aqueous solution or suspension can be oxidised to any desired extent by air, under pressure, at temperatures from 350-700° F. The degree of oxidation (0-100%) depends on the temperature and the amount of air supplied. The WAO is being used to detoxify acrylonitrile wastes by destroying cyanide. The WAO is supposed to be the best technology to destroy waste substances, recover valuable inorganic materials from waste streams, and condition sludge solids for easy disposal.

It is clear from the above that the deep well disposal, land burial and landfill methods are based on the principle of "concentrate and contain" while incineration, chlorinolysis and WAO on the principle of "Degradation". The method based on the principle of "Dilute and disperse" namely, 'Ocean disposal', is not favoured because of obvious reasons.

It is not out of context to mention here that India is unable to properly dispose of even its conventional wastes, not to speak of the toxic wastes. In many Indian cities indiscriminate dumping or improper disposal of toxic and hazardous wastes in municipal disposal sites by some small industries is a common site. Liquid wastes find their way into open drains, thus contaminating the environment.

Check Your Progress - 6

6. What is chlorinolysis?

Note : a) Write your answer in the space given below.

b) Compare your answer with one given at the end of this unit

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16.7. COMMUNITY EDUCATION

From the subject matter dealt so far, it is clear that the intenational as well as inadvertent actions of man are the contributors to the problems of toxic wastes. Thanks to the strides made by the advanced countries in the field of environmental toxicology, the developing countries are becoming aware of the hazards of toxic waste genaration. The Scientific community, the administrative machinery, and the voluntary organisations have a great responsibility to educate the community such that biocides and all other toxic substances are used judiciously. The industrial sector must also be forced to realise its accountability to present and future genrations. Further the community must also be made aware of its duties and responsibilities as well as legal provisions and means to fight the problems. Often, there will be considerable time gap between occurrence of a problem and institution of counter measures. Wherever the problems are likely or existing or correct disposal methods are not being adapted and also the Government does not act promptly, mass movements are the only ways to force the Government to impose corrective measures and all this is possible only through community education and awakening.

16.8. CHALLENGES OF FUTURE

The problem of toxic wastes is a common issue of all nations and hence requires common efforts. The developing countries have to utilise the experiences of the developed countries in combating the problem of toxic wastes in all respects, including creation of community awareness. It is necessary to formulate Internationally acceptable definition, classification, and monitoring and impact assessment procedures of toxic wastes. To the extent possible, low toxic low cost technologies as well as better methods of treatment and disposal are to be developed. Careless disposal of toxic wastes is a common practice in developing countries and to correct the erring industries proper legislations, with little scope for litigation, are to be made and the regulations enforced strictly.

Hazards may also arise from already improperly disposed toxic wastes and proper remedies are to be thought of to neutralise, contain or control them. Finally, proper disaster mitigation strategies are to be envisaged to face any untoward eventuality arising out of the toxic wastes.

16.9. SUMMARY

Wastes containing poisonous or toxic substances are known as toxic wastes. Both man and nature contribute to the phenomena of toxic waste generation. The industrial, agricultural and energy utilisation activities of man, besides over indulgence in the useful toxic substances, contribute tremendously to the toxic load of the environment. Though the toxic wastes from only a small fraction of all the wastes generated, their impact can be catastrophic as they affect human health; life on land river and sea; crops and, in-short, the entire food and life cycles.

A toxic waste can be a solid, liquid, gas or sludge and in chemical composition it may be inorganic, organic or both. From the sources the toxic wastes find their way into the environment and affect human and animal health through different mechanisms and routes of exposure. The acute toxic effects may range from minor irritation to death while the chronic effects may manifest in genetic alterations leading to mutagenesis, teratogenesis or carcinogenesis.

The important methods of disposal of toxic wastes appear to be deep well disposal, incineration, and land burial and landfills, provided necessary precautions are also taken. Judicious use of chemical substances, development of low toxic low cost technologies as well as better methods of treatment and disposal and community education will go a long way in combating the problems arising out of toxic wastes.

16.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Wastes are materials which are no longer useful to man, as are by products and residual, as well as liquid and gaseous effluents, including raw sewage.
2. Industrial, agricultural and domestic sources are some of the broad categories of anthropogenic sources of toxic wastes.
3. In its physical nature/state the toxic waste can be a solid, liquid, gas or sludge. It can be inorganic, organic or both depnding upon its chemical composition.
4. A substance like DDT gets accumulated in tissues, if it is more soluble in the tissues than in the surrounding water.
5. Acute toxic effects manifest themselves immediately upon short time exposure at high concentrations and chronic effects become evident only after continuous exposure to low levels. Further, the chronic effects are very difficult to demonstrate and are consequently less obvious.
6. It is a chemical process in which the undisposable organic compounds including nondistillable chlorinated residues are transformed mainly into carbon tetrachloride.

16.11. MODEL EXAMINATION QUESTIONS

I. **Answer the following questions in about 30 lines each.**

1. Write a note on the anthropogenic sources of toxic wastes.
2. What is 'Bioaccumulation'? Discuss giving examples.
3. List out some of the hazards caused by toxic wastes.
4. What methods of ultimate disposal of toxic waste are in vogue presently? Which one of them is better in your opinion and why?
5. Write a note on 'Incineration' as a method of disposal of toxic wastes, highlighting its merits and limitations.

II. **Answer the following questions in about 10 lines each.**

1. Explain the terms "Waste" and "toxic waste" giving suitable examples.
2. Do the terms "toxic waste" and "Hazardous Waste" mean one and the same or different? Explain.
3. Over indulgence in the use of certain substances is one of the contributors towards toxic waste generation. Substantiate giving at least one example.
4. Suggest some ways and means for the control of toxic wastes.
5. Name five toxicants and enumerate their respective toxic effects on man.
6. What are the potential pathways of release and exposure to toxic wastes?

Dr. S.N. Dindi

BLOCK - 5
ENVIRONMENTAL PROTECTION LAWS

UNIT - 17 : ENVIRONMENTAL PROTECTION LAWS : GLOBAL SCENARIO

Contents

17.1. OBJECTIVES

After completing this unit, you will be able to :

* explain the global scenario of the environment, and
* describe the strategies developed for global cooperation at different international conferences and summits organised by governments of different regions and also by United Nations Organisation.

17.2. INTRODUCTION

Maurice Strong, the first head of the U.N. Environment Programme has pointed out that the world faces the challenge of developing effective mechanisms for governance or management of environment at the International level. The looming threats to the world climate and, the undermining of the world's common resources can only be remedied by a global cooperation. Now it is time to take a giant leap forward in the upgrading of civilization, said Prime Minister Brundland of Norway as long back as 1988. Since, there are no shortcuts to remedy the situation on the environmental front, except for international cooperation, strenthening of the UN system, providing it with more reliable sources of revenue and clearer lines of authority will be essential for the global cooperation to take concrete shape. The following pages shall provide information on the various measures being taken nationally and internationally towards this end.

17.3. HELSINKI TO RIO

While attention of the United Nations has been focussed on finding global consensus on matters of environment for quite some time, in 1972 it took a concrete shape in the form of first ever International Conference on Environment at Stockholm from June 5-16, 1972. Since then a series of International Seminars and Conferences have been held in an effort to bind individual nations on a minimum programme on environmental discipline going beyond the principle of patriotism.

17.3.1. UNEP's Regional Seas Conference

Since there are no boundaries for the seas, the pollution caused knowingly or unknowingly by one nation in its own territorial waters or in the internaitonal waters is bound to impinge on the rest of the oceanic life and resources. The matter of protecting the seas from the onslaught of industrial and commercial pollution was discussed at the lengthy Law of the Seas Conference organised under the auspices of the United Nations Environment Programme. Under Part XII of the convention, the signatory States have accepted the obligation to protect and preserve the marine environment through passing relevant laws and enter treaties designed to minimise the release of harmful pollutants into international waters by the citizens of respective countries. The member countries also pledged to cooperate in monitoring the marine environment, to promote research on marine phenomena, to publish findings of such researches for being available to the rest of the world.

Specific Commitments : European countries like the former West Germany have accepted the responsibility for controlling the quality of water in the river Rhine in a bilateral agreement with the Netherlands which shares its waters. The United States also had agreed to limit the amount of salt introduced into the Rio Grande and to have suitable bilateral agreements with Canada over the transport of sulfates and sulfur oxides from the midwest to eastern Canada. However, in practice, things are not simple with divergent interests of individual nations conflicting with one another.

17.3.2. World Soils Policy

To reduce the current damage and prevent further damage to the soils, lands users have to understand the extent of current losses arising out of desertification and erosion and their short-term and long-term consequences. The International Fund for Agricultural Development (IFAD) and the United Nations Conference on Desertification, 1977 (UNCOD) took congnizance of the impending dangers of soil erosion and loss of precious land. A search for solutions to halting desertification is on through spreading information on one hand with a view to create awareness among those responsible for land-use and researching on remedial measures on the other.

In general, much of the degradation is due to the extension of cropping of grazing into marginal land that cannot sustain those activities. Changes in the land used and managed determine the extent of conservation. Fallowing is a simple remedy for restoring the potential of degraded lands. But with the increasing population pressures, it is virtually impossible for government and individual lands users to keep lands fallow for long periods.

The Chinese Model : During the past decade, the Chinese Government's erosion control strategy has turned to sustainable land use. In 1979 with the help of United Nations Development Programme, an experimental station was established in Mizhi, under which the scientists developed a plan for intensifying crop production, planting much of the sloping land with trees and grass and developing animal husbandry as an added source of income for the villagers. The World Food Programme (WFP) provided food as an incentive for farmers to do the work of land reclamation and as a compensation for the cropland that was being converted to trees and grassland. Such experiments have been tried in many other parts such as Ethiopia through bunding hill slopes for preventing soil erosion. It is a matter of pride that between 1976 and 1985, through project sponsored by the UNO in Ethiopia itself the farmers could build 600,000 km of bunds and 470,000 km of terraces. Such simple techniques

of soil and water conservation that add nutrients and moisture to the land in addition to preventing silting should be taken up in India on a larger scale.

Mulching : At the International Institute of Tropical Agriculture, Ibadan, Nigeria, it has been found that applying mulch of crop residues at rates of 6 tons per hectare can provide protection against erosion. It also conserves moisture and improves soil structure. Planting hedges along the contours of sloping land also reduces soil erosion. Nitrogen fixing trees like species of *Acacia, Gliricidia* and Leucaena are also useful since they help improve soil fertility and maintain productivity. *Acacia senegal* planted by sudanese farmers on their crop lands also showed good results in that, the lands could be cultivated continuously for 20 years without soil erosion. The Acacia which drops its leaves into the land provides enough organic matter for the soil to retain its structure and nutrients.

In India land degradation was successfully contained by planting the deep rooted Khus or the vetiver grass (*Vetiveria zizanioides*) on sloping lands, and without making any bunds and thus making the method very economical. The vetiver grass propagates by root division, spreads on its own anchoring soil firmly. Thus the grass forms a vegetative barrier that slows runoff, allowing rainfall to spread out and seep into the soil rather than erode the soil.

Global Goal : Now there is a global goal set to stop desertification by the year 2000, yet we are still loosing more trees, more top soil and more grazing land in favour of industrialisation and modernisation. As such no amount of international pressure can prevent degradation as long as efforts at the village level are lacking. In addition, expanded research into crop verieties and production method appropriate for various categories of lands and people is very crucial.

Finally, with much of the degradation of land coming from excessive human pressure on land, reversing it will require a dramatic slowing of the population growth.

17.3.3. Ozone Layer

The Ozone problem is of special interest because it marks the occurrence of a truly anticipatory response to potential global environmental threat. It is now known to one and all that, the stratospheric ozone is vital for the protection of humanity from the scorching physical effects and the deleterious chemical effects of the solar radiation. There is little doubt that removal of the earth's ozone layer or shield would be biological catastrophe. The effect of the dreaded ultraviolet beams on humans and the altered climatic effects on plant are a matter of concern to the global community today. Ozone like Carbon has a substantial influence on the energy balance of the planet earth.

In 1970 it was realised that hydrogen oxide generated from water vapour emissions could pose a threat to the ozone layer. In 1974 it was further known that a group of compounds called the Chlorofluorocarbons (CFCs) coming out of aerosol spray cans and the refrigeration systems also could be potential threats for the ozone layer. Recognising the seriousness of the threat arising out of ozone depletion and its concomitant possibility of acid rain by 1982 about, 20 countries had taken actions to control CFC emissions. About the same time a Global Framework Convention for Protection of Ozone Layer was also considered. In 1979 a UN sponsored Convention on Long-Range Transboundary Air Pollution was agreed to by 25 countries.

Present State of Knowledge : Ozone, the three-atom form of oxygen, is the only gas in the atmosphere that prevents the harmful solar ultraviolet radiation from reaching the surface of the earth. Most of it is found in altitudes of 12 and 25 km but even there only in few parts per million. The sunlight-triggered chemical reactions constantly replenish ozone naturally. But a scientific report that appeared in 1988 shattered the theory of natural replenishment and established that the ozone layer around the globe was eroding fast. As ozone diminished in the upper atmosphere, the earth receives more ultraviolet radiation which may result in skin cancers and cataracts and also inducing a kind of depression in the human system. Reduced crop yields and depleted marine fisheries, materials damage and increased smog are also attributed to the ozone depletion. Compounds containing chlorine and

bromine which are released from the industrial processes and products that move into the upper atmosphere are considered the main culprits of ozone depletion. The Montreal Protocol of 35 nations called for a drastic reduction in these emissions so as to at least freeze their concentrations at present levels. As per the Montreal protocol, India and other developing countries whose per capita contribution of ozone depleting sources (ODS) is below 300 gms have to phase out the ODS by 2010 AD. In accordance with the United Nations, the first Ozone Day is to be observed on September 16, 1995 to focus global attention on the depletion of the ozone layer and enlisting public support to prevent the threat. It was on September 16 that the Montreal protocol to phase out ODS was signed.

17.3.4. Stockholm Conference

In order to consider the need for a commom outlook and for commom principles to inspire and guide peoples of the world in the preservation and enhancement of the human environment, the United Nations convened a conference on the 'Human Environment at Stockholm (Sweden) from 5 to 16 June 1972. Representatives of 113 countries including India participated. In the conference the Stockholm Declaration is the 'Magna Carta' of our environment and India was a party to the declaration which consists of preamble and 26 principles. The declaration proclaims that :

"Man is both creator and moulder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. In the long and tortuous evoloution of the human race on this planet, a stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an unprecendented scale. Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights - even the right to life itself. The protection and improvement of the human environment are a major issue which affects the well-being of peoples and economic development throughout the world; it is the urgent disire of the peoples of the whole world and the duty of all Governments".

The declaration directed that "the natural resources of the earth must be safeguarded for the benefit of present and future generations through careful planning or management as appropriate and the capacity of the earth to produce vital renewable resources is to be maintained and wherever practicable restored or improved".

The Stockholm Conference calls upon Governments and peoples to exert common efforts for the preservation and improvement of the human environment for the benefit of all the people and for their posterity. The developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. International cooperation is also needed in order to raise resources to support the developing countries in carrying out their responsibilities in this field. The principles of the Stockholm Declaration are as valid today as they were in 1972. They provide a basic code of environmental conduct for the years to come. Our former Prime Minister late Smt. Indira Gandhi chose to end her speech at the Stockholm Conference with the following stanza from the Hymn to Earth in the Atharva Veda which contains the essence of what should guide man's relationship with earth in particular and environment in general.

"What of thee I dig out, Let that quickly grow over, Let me not hit thy vitals, or thy heart"

Since, the Stockholm Conference on the Human Environment, 5th June every year is being observed as "World Environment Day" with a view to increasing public awarness and understanding of the fragility of the human environment.

17.3.5. SACEP

South Asia Cooperative for Environmental Protection (SACEP) comprises the South Asia's poor economies which are also far behind in environment. SACEP is a kind of clearing house to collect, analyse and disseminate environmental laws and related information, a compedium of existing

environmental laws, legal assistance and consultancy to member countries in drafting their environmental laws, orientation workshops/seminars for senior technical personnel and policy makers. The publication of Environmental legislation reports containing new enactments, court decisions on environmental cases and articles from leading environmentalists are also proposed to be included in the scope of its Coordinated Environmental Legislation Programme. According to SACEP many existing laws do not specifically state the social objectives, they aim to achieve and hence the necessity for a cooperative effort. Maldives comprising 2000 small islands has flurishing tourists trade and fisheries as its main stay, but is neglecting its conservation laws and sanitation like India. Nepal which is also a member of this group suffers from extrme soil erosion arising out of deforestation on a large scale, making it vulnerable for further environmental degradation. Afghanistan, another member of SACEP has a very poor sanitation.

17.3.6. I U C N

The International Union for Conservation of Nature and Natural Resources (IUCN) is an autonomous body. It was founded by UNESCO in its first general body meeting in Paris in 1948 with its headquarters at Morzes, Switzerland. It is noteworthy that the 10th general assembly of IUCN was held in New Delhi, India in 1969 and the year 1972 was declared as the year of Nature Conservation. IUCN is the scientific advisor to World Wildlife Fund-International. In cooperation with the WWF, it is engaged in a wide variety of projects related to the classification of the natural regions of the world, the preparation of lists of protected areas, and of endangered species of plants and animals throughout the world in the form of Red Data Book. Its recent publications include Coral Reefs of the World, and the Action Plan for the conservation of Dolphins and Whales. It identified the causes for the disapperance of plants and animals as : 1) Habitat destruction (67%); 2) Over-exploitation (37%); 3) Effect of introduced species (19%) and 4) Other causes (9%). Therefore, IUCN considered that the crucial task in saving wildlife was the creation and maintenance of suitable wildlife habitat, and providing them protection from overexploitation. This has led to the establishment of an international network of nature reserves and biosphere reserves in the context of the MAB programme of UNESCO to protect ecosystems, whether natural or modified by human activity. With the support of WWF and UNEP, IUCN evolved a starategy to conserve the main resources indispensable to humanity. The strategy was published in 1980 as World Conservation Strategy, and several countries including India have adopted the same. This strategy is an action plan to save the world, its people and its species. The principles prescribed in the strategy are :

a) the maintenance of essential ecological processes and life-support systems,

b) the preservation of the genetic diversity on which most of these processes and systems depend for their functioing, and

c) the supervision and control of the long-term exploitation of ecosystems and species.

17.3.7. United Nations Commission on Sustainable Development (CSD)

The first session of the Commission on Sustainable Development was held in June, 1993 at New York and thus opened flood gates for international cooperation. It brought together environment ministers from 40 countries along with officials and experts for two days. Many working groups were constituted on fresh water, health, human settlements and waste control. Further follow-up action shall be taken by respective countries who would be hosting the meetings of the sub-committees. The highlight of the meeting was the involvement of non-governmental agencies in large members.

17.3.8. The Globe 94

In pursuance of the meeting of CSD, a round table at Vancour, Globe-94 was constituted to look into the urban conglomerates and their problems worldwide. Canada as the host for the round table took the lead, and the Institute of Sustainable Development in Winnipeg was also involved. On the

whole the CSD has come to be a forum to translate the agenda of the Rio summit into concrete results through international cooperation.

17.3.9. Global Environmental Monitoring System (GEMS)

GEMS is a UN programme coordinated by UNEP and the UN Earth watch program meant for monitoring global water situation in terms of quality. It is implemented by the World Health Organisation with 57 countries participating. It is trying to strengthen national water quality in member countries and to strengthen the global databases for the purposes of regional and global assessments of water quality.

17.3.10. Review of Current Status

International cooperation has reached a new high in the last decade of this current century, especially after the recent earth summit in June, 1992 and its follow-up measures. A large number of conventions and statues has been brought into force to bind the member nations on a common programme for protecting the globe, cutting across parochial interests. The nuclear non-proliferation that is being actively pursued by the super powers themselves should be viewed a welcome development in this direction. A large number of bilateral agreements in the fields of solar energy and other non-conventional energy systems has been entered into by India with the United States of America recently in this Context. An important shift that occurred worldwide is the stress on the creation of awareness rather than centralised funding and control. The voluntary sector has since been welcomed in a big way both at the national as well as the international levels. Business and Industry have also recognised the vital importance of environmental issues and have come to take responsibility of environmental schemes in today's world.

Check Your Progress

1. The first International conference on Environment was held at.....
.....in the year.....

2 Three examples for nitrogen fixing trees are .....
....., and.....

3. Land degradation was successfully contained by planting deep rooted ..... or.....

4. Third SAARC Summit was held at .....in the year.....

17.4. CONCLUSIONS

It is amply clear after studying the Global scenario that mere laws cannot be effective in the arena of environment without the requisite political will and awareness of the masses. The indications are that an all out effort is being made nationally and internationally to highlight the urgency and importance of examining the environmental angle while taking decisions on any facet of economic and political life of peoples.

17.5. SUMMARY

Unlike the civil and criminal laws of a country, the Environmental Protection Laws cannot be made in isolation of the global concerns. Even the implementation of these laws in each country would depend on the extent of follow-up done by other countries. Issues such as the ozone layer depletion amply show the futility of enforcement of environmental laws by individual countries without a global consensus. Moreover retribution cannot be resorted to easily for enforcing environmental laws because of the peculiar factors involved.

17.6 CHECK YOUR PROGRESS : MODEL ANSWERS

1. Stockholm; 1972
2. *Acacia, Gliricidia* and *Leucaena*
3. Khur or Vetiver grass
4. Kathmandu (Nepal), 1987

17.7. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. List out and explain the various global summits held on environmental issues ?
2. Justify the need to bring all nations on environmental issue and chalk out common laws and statutes for the sustainable earth.

II. Answer the following questions in about 10 lines each.

1. Give in brief about the World Soils Policy.
2. Write about the Chinese Model for controlling soil erosion.

Sri. G. Nageswar Sarma

UNIT - 18 : EINVIRONMENTAL PROTECTION LAWS : INDIAN SCENARIO

Contents

18.1. OBJECTIVES

After going through this unit you will be able to :

* explain the need to make laws for the protection of environement,
* describe the Indian Protection Laws and the need to update these laws keeping in view their present status,
* describe the Insecticide Act and its content,
* expalin Wildlife Protection Act, Water Protection Act and Forest Conservation Act,
* describe the salient features of the Environment Act 1986,
* explain the efforts of the Ministry of Environment and Forests for abatement of environmental Problems.

18.2. INTRODUCTION

It is known to every one - literate or ignorant that, cleanliness is next to godliness. However, filth and unhygienic conditions prevail around us. Hence, the necessity of making law and enforcing

them for ensuring a minimum of standard in public places. Even if laws exist, their effective enforcement can only ensure reasonable living standards in a society supersaturated with greed and lack of concern for the general wellbeing of the society. The simplest and most common example for environmental protection laws is the host of restrictions placed on tribals living traditionally in Jungles for cutting trees for firewood. Declaring certain zones as non-smoking zones and no-horn zones are the common restrictions imposed by laws, though many do not honour them and do not know their significance in terms of environmental protection. While in civil and criminal law, it is the individual that generally seeks a remedy in a court of law, for the transgression of his rights by some one else or the government in the context of environmental protection it is by and large the State that enforces the law against the individual as yet. Wide-spread knowledge of environmental protection laws should prompt the citizen to seek remedies in a court of law either against a local government or an individual. Such a situation is prevailing in many of the more advanced nations. It should be our endeavour to provide the common man with legal remedies for abating pollution and augmenting energy and other resources of the society.

18.3. INDIAN CONSTITUTION ARTICLES 48 & 51-A

Perhaps, India can be said to be one of the few countries in the world whose founding fathers thought it necessary to incorporate guidelines for protecting environment right in the constitution, in the form of Directive Principles of State Policy, in consonance with our tradition that envisaged 'Bahyanbhayantara Suchi' for every devoutly religious person. Article 48A provides : 'Protection and Improvement of environment and safeguarding forests and wildlife. The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country'.

The farmers of our constitution were not content with making provision for the protection of environment by the State machinery, since the State is helpless without the cooperation of the citizens who constitute the state in reality. Thus, another provision enjoins every citizen to ensure protection of nature which has always been considered as the manifestation of the Almighty. Under Article 51A 'It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures'. Apart from these provisions under the Constitution of India, there are more than a couple of hundreds of Central and State legislations which directly or indirectly guide the citizen to protect and preserve nature.

Check Your Progress - 1

What does Article 51-A of Indian Constitution provide ?

Note : a) Write the answer in the space provided below.

b) Compare your answer with the given at the end of this unit.

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18.4. INDIAN PROTECTION LAWS

Even much earlier to the promulgation of the Indian Constitution, the Indian Forest Act of 1927, which inter alia provided for reserving certain forest areas as protected forests stipulating stringent penal measures to deal with those who violated the law. The forest Officers under the

British Regime had enormous powers to arrest people without warrant and try offenders summarily. However, not withstanding the draconian powers vested with the executive, in real practice, precious little has been achieved until after independence when another Law under the Forest Conservation Act 1980 was promulgated. Another important legislation for the student to remember as a forerunner of the laws against pollution and for protecting the environment is the Factories Act of 1948 which provided certain measures with respect to the health of the workers, industrial safety and welfare measures. Though this was a well thought of piece of legislation aimed at the welfare of workers and well-being of the neighbourhood communities, it was observed more in violation. The unfortunate incident of the Bhopal Gas Tragedy is a living evidence of the apathy of the bureaucracy towards the welfare of the workers as well as the general public. Thus, its is to be remembered by the future practitioners of environmental protection that more legislation leads us to nowhere. A third and most important forerunner of the modern legislation on environmental protection is the Indian Explosives Act 1884, which has since been codified in 1908. This was read with the Indian Penal code (relevant provisions thereof) 1860 puts lot of restrictions on manufacture, possession, use, sale and transportation of explosives in public interest and to protect the environment. There is also the Poisons Act of 1919 to contain the menace of pollution.

18.4.1. Necessity of Updating Laws

In spite of the existence of abundant legislation prior to independence it should have become clear to the student that such legislations covering a wide range of subjects such as health, insecticides, explosive drugs, cosmetics, foods, and poisons, have not taken into account the fact that the substances, the handling and production of which were aimed to be controlled could get into the environment and affect the overall health and wellbeing of the society at times even in a remote part of the world. In fact, these Acts, did not provide to contain the short and long range impacts on human habitation and health. Further, most of them were punitive and not preventive and such could only have at the most a firefighting value.

18.4.2. Prevention is Better than Cure

Since none of the Acts stated specified the social objectives to be achieved, the implementation has been tardy resulting in gradual dilution in course of time, making them obsolete at a later date. Thus, there is a total mismatch between the present day high-tech scenario all around and the hackneyed laws lacking the proper teeth to compel the common man and the industrialist alike from indiscriminate destruction of the ecosystem. As such, all the existing legislations needed to be looked into very thoroughly and necessary corrective action taken to provide a stringent regulatory mechanism. It has become essential to come out with a comprehensive legislation covering every facet of human activity, be it industrial production, agriculture or academic pursuits. Such a future legislation was required to provide for control measures right from inception of an idea to its execution and its after-effects.

Check Your Progress - 2

What does the Indian Forest Act of 1927 Provide ?

Note : a) Write the answer in the space provided below.

b) Compare your answer with one given at the end of this unit.

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18.5. THE INSECTICIDES ACT 1968

The Government of India enacted the Insectides Act in line with the Regulatory Policy of the Independent Indian Government in 1968. The Act primarily takes into cognizance for the first time the responsibility of protecting the health of citizens and environment as the broader objectives of the legislation.

The Act was however, enforced from 1971 to regulate import, manufacture, sale, transport, distribution and the use of insecticides with a view to prevent risk to human-beings and animals and for matters related therewith. To ensure effective implementation of the Act, a high level Board, the Central Insecticide Board was constituted to advise the Central and the State Governments on technical matters arising out of administration of this Act and to carryout other functions assigned to the Board under the Act.

Pesticide Registration Committee : To register all the pesticide formulations that are in terms of their short-term and long-term impact on humans and other life forms, an elaborate set has been created under the Act. Pesticide Environment Pollution Advisory Committee set-up in the Ministry of Agriculture reviews from time to time the environmental repercussions and suggest measures wherever necessary. In addition to these two apex bodies, a Central Insecticide Laboratory was established at Faridabad near Delhi, to verify the claims made by different manufacturing agencies regarding the merits of their respective products. Another body, the Committee to ban the use of Pesticides at the National level was constituted to recommend elimination or restriction of the use of hazardous substances on the lines obtaining in the advanced nations. The student, perhaps, is aware of the fact that the most valued pesticide for us in India, the DDT has already been banned in many industrialized nations such as USA. This committee has since banned the highly dangerous chemicals like Endrin and Ethyl Parathian in our country also, with certain restrictions on some other chemicals.

Check Your Progress - 3

Explain the Indian Insecticides Act of 1968

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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18.6. WILDLIFE PROTECTION ACT 1974

Conservation and wise management of wildlife now receives adequate attention in our planning process as well as in our scientific and social endeavours with the motto 'Development without destruction'. The wildlife resource being closely linked with forestry, agriculture, horticulture and fisheries due to its impact on the 'gene pool', the government realised the urgency of procted legislation from time to time of which the Wildlife Protection Act (1972) and its forernner Indian Board of

Wildlife, set-up in 1952 are important landmarks. The Act inter alia provide for the protection of endangered species of plants and animals and protection of endangered species of plant and animals and prohibition dealing with specified plant and animal species without a license form the Government. The Act gives powers to the state governments to declare a particular area as a sanctuary, if it considers that such area is significant for protecting, propagating and developing wildlife or its environment.

Chief Wildlife Warden : Under clause 33 of the Act, the Chief Wildlife Warden shall be the authority who shall control, manage and maintain all sanctuaries. Under clause 28 therein, he is the proper authority to grant permission for a person to enter or reside in a sanctuary for purposes of photography, tourism, scientific research etc. The State Governments may by notification declare any area closed for hunting for such periods may be specified from time to time. Further, under clause 37(2) thereof, no hunting of any wild animal shall be permitted in a closed area specified. Under clause 38 of the Act, the Central Government reserves the right of declaring any area as a Sanctuary or a National Park. Under the provisions of Wildlife (Protection) Act, Cultivation of some species are prohibited. However, such species can be cultivated with a licence from Chief Wildlife Warden.

18.7. WATER POLLUTION ACT 1974

Officially termed the Water (Prevention and Control of Pollution) Act 1974, this legislation is the outcome of continued efforts of voluntary bodies and health activists of the country for many years. Water being the main source of pollution and contamination leading to innumerable diseases which at times prove fatal to the infants, has to be protected at all costs and hence, the necessity of stringent legislation in this regard. However, it has the experience of health educators and social scientists that no significant improvement of the country's aquatic environment was possible since the inception of this piece of legislation with the avowed objective of reducing water-borne infection. Absence of adequate facilities for collection, treatment and disposal of liquid and solid wastes is the biggest limitation in this direction. The slow progress in urban sewage treatment exacerbates the slow progress in the prevention of pollution. It is well-known that the major cause of water pollution in our country is human wastes, discharged drains and sewage in cities and surface leaching in rural areas. The effluents that are being released from hundreds of industries also are increasing the toxic content of river waters and the ground water.

Over and above, the legal definitions provided terms like sewage pollution and other terms, the act provides for constitution of Central Board and State Boards to monitor the pollution levels of streams and rivers and to impose reasonable restrictions on the discharge of effluents into national water-bodies.

The Water (Prevention and Control of Pollution) Cess Act of 1977 has introduced a new dimension i.e. conservation of water by the industry. As every drop of water used by industry is levied a cess, wasteful use of water has been contained to a large extent which in turn lessens the cost of treatment of water.

Check Your Progress - 4 & 5

4. Why is Water Pollution Act (1974) promulgated ?

5. What is the objective of introducing Water Cess Act 1977 ?

Note : a) Write th eanswers in the space provided below.

b) Compare your answers with those given at the end of this unit.

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18.8. FOREST CONSERVATION ACT 1980

This was enacted primarily to check indiscriminate deforestation of vast tracts being converted into crop lands. This was amended in 1988 making it more stringent by incorporating penal provisions for violations. Elaborate guidelines are framed for felling of trees under this Act.

A National Forest Fund has also been created under this Act. State Governments are required to involve voluntary agencies for regeneration of degraded forests.

Though the forest act provides for reserved forests, puts a tab on cutting trees in public places without enumeration and compensatory afforestation in lieu of the trees felled, yet, there is a wide gap between what the legislation seeks to provide for and what actually is practised. Despite the stringent provisions of the Act, there is considerable depletion of forest resources which is likely to affect future generations through increased soil erosion, floods, siltation of water bodies and loss of biological diversity. Of course certain provisions under which the tribal rights and concessions which have to be taken care of act as minor irritants in the scheme of overall conservation. Shifting cultivation and encroachments practised by various tribal communities have to be contained altogether under the provisions of this Act. Clear-felling with artificial regeneration should be avoided or restricted to 25 hectares in plains and 10 hectares in hills.

18.9. AIR POLLUTION ACT

The Air Act as it is popularly called was promulgated in 1981 meant to prevent/control and abatement of air pollution through creating special boards for the purpose. The Act defines Air Pollution as presence in the atmosphere of any solid, liquid or goseous substance in such concentration so as to be injurious to human beings or other living creatures or plants or property or environment.

18.9.1. Powers of Boards

The Central and State Boards for Control and Prevention of Air Pollution have the powers to give instructions to authorities under the Motor Vehicles Act regarding standards for automobile emissions and also to restrict industrial operations in Air Pollution Control areas. They are vested with the powers to take appropriate action (remedial) in case of accidents and unforeseen events.

The boards have extensive powers to invoke penal provisions under the Act and award imprisonment up to three months or fine up to Rs. 10,000 or both. A fine of Rs. 100/- per day may also be levied for continuing offences.

18.9.2. Community Action

Laws become lifeless and ineffective without public participation and cooperation. What ever be the powers wrested with the boards, it is ultimately the community action that matters in protecting environment. Laws are only the last resort when all other alternatives like the individual, community and the voluntary action groups fail in motivating polluters to desist from further degradation of air, water, soil and the surroundings. Community action, thus, is a sine-qua-non for effectively protecting the enviornment from the onslaught of greedy persons and profit-oriented business and industry. Now-a-days, Indian Judiciary have opened up flood gates of public-interest litigation through which

every responsible citizen can play a vital role in protecting environment and conserving precious natural resources with little effort and expense. A series of progressive judgements have been pronounced during the past one year, which should be a harbinger of a new era of environmental enrichment for India.

18.9.3. Voluntary Agencies

It is now clear that there is a plethora of legislation on environmental protection ranging from Acts on Health, Insecticides, Explosives and Conservation. But, legislation does not cure a disease in as much as the provision in the penal code imposing death penalty for homicide by itself has no impact on the crime rate. It is the social pysche that have considerable grip on the behavioural patterns of human beings. As Dr. Anil Agarwal, a leading environmental activist of India holds, 'the best solutions are home made' in so far as the eco-management is concerned.

It is not coersion by the State machinery that really matters but the culture shock that can be brought about by the persuasive tectics of the voluntary worker, who himself sets an example worth emulating to the onlooker. Environment being all pervading in the lives of modern men, there is no place or phase of human life that is insulated from environmental awarness. As such, the crux lies in creating the requisite awareness through creating a new set of values and cultural more than envisage sustainability at every stage of human development, be it economic, social or psychological.

Check Your Progress - 6

6. What is the aim of Air Pollution Act of 1981 ?

Note : a) Write the answer in the space provided below.

b) Compare your answer with the one given at the end of this unit.

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18.10. NEW ACT OF 1986

To create public awareness through legislation, it is essential that there must be sufficient social litigation amongst the society with good number of complaints against the polluters, to keep an effective check against environmental pollution. With this in view the latest Act, the Environment Act 1986 empowers the citizens to file a suit against the polluting units for compensation.

Salient Features of the Act : It recognises the fact that pollution control is different from protection and takes into consideration such vast variety of problems ranging from urbanisation, congestion, housing, growth of slums, sanitation, disposal of garbage and the exhausts arising out of automobiles. The Environment Protection Act even deals with population policy and industrial policy in addition to modes of transport and housing that are inter-twined with environment. Though there is some over-lapping of what has been provided in the Air and Water (Prevention of Pollution) Acts, punishment and retribution have been given a lower profit compared to public participation in raising the awareness of the society and creating the necessary infrastructure to ensure environmental protection. It has broad-based purview of environment including every aspect of modern life such as housing, water-supply, land-use, urban migration and use of fertilizers and psesticides. Thus, for the first time a

comprehensive legislation has been attempted, providing the law-enforcing agencies the necessary clues to succeed in the sphere of environmental enrichment. Mere enforcement through levying fines and jail terms can not go far in the field of protecting the environment. A basic understanding of the average human psyche and an empathetic attitude towards ignorance and compulsions of average citizen are needed. On the other hand it vests such wide powers as closing the industrial units that are harmful to public safety. Certain lacunae left in the act have been rectified in the Tribunals Act of 1992.

18.11. ENVIRONMENT MINISTRY'S EFFORTS

The Ministry of Environment and Forests assists programme which attempt to arrive at appropriate solutions to our environmental problems and to regenerate natural resources. Such assistance is given to relevant areas such as afforestation, soil conservation, land-use planning, preservation of flora and fauna, control of air and water pollution, regeneration of degraded ecosystems, environmental research to evolve strategies to harmonious development of environment alongside economic development, extension, education collation and dissemination of environmental information and creating of environmental awareness at the national level. The Ministry is committed to making the governmental activities more responsive and meaningful to the public needs by involving Non-governmental Organisations throughout the country in implementing these activities.

18.11.1. Review of Current Status

Good work is being done in raising the awareness of the masses through Krishi Vigyan Kendras under the management of various Voluntary Organisations such as the RASS at Tirupathi. The Council for Advancement of People's Action and Rural Technology, (CAPART) at the National level has various programmes and projects to support the voluntary sector in so far as environmental protection is concerned. Agro-forestry schemes that are being encouraged by the District Rural Development Organisations and the Department of Forests at the district level are the immense use in stepping up the environmental literacy level as also to protect the environment physically through creating more green-art in urban areas. Social Forestry schemes and the Joint Forest Management concept floated, of late, by the Ministry of Environment and Forrests in collaboration with the voluntary sector also have immense potential in conserving the precious natural resources and cleaning the urban tracts beset with the automobile exhausts.

18.11.2. Policy Statment for Abatement of Pollution

The commitment of the Government on abatement of pollution for preventing deterioration of the environment seeks to shift emphasis from defining objectives for each problem area towards actual implementation focusing on the long-term aspects. The Government intends to use a mix of instruments in the form of legislation and regulation, fiscal incentives, voluntary agreements, voluntary programmes and information campaigns. The National Environment Tribunal Bill of 1992 which provides for strict liability for damages is also one step in the direction of protecting the environment from the indiscrete use of resources by the greedy.

18.12. SUMMARY

The State has passed some effective Laws for the protection and improvement of the quality of natural environment including forests, lakes, rivers, wildlife, etc. Article 51-A of the Indian Constitution provides that the protection of environment is the duty of every citizen. In the course of time according to the environmental problems as they have arisen from time to time, several Acts have been made to deal with them. They include Indian Forest Act, Factories Act, Insecticides Act, Wildlife Protection Act, Water Pollution Act, Air Pollution Act, etc. The New Environment Act empowers the citizens

to file a suit against the polluting units for compensation. Further, the Ministry of Environment and Forests encourages the programmes projecting at solving the environmental problems submitted either by the governmental or by the non-governmental agencies.

18.13. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Article 51-A in Indian Constitution provides that it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for all living creatures.
2. Indian Forest Act 1927, much earlier to Independence came into existence which provided enormous powers to arrest people without warrant and try offenders who violate the law.
3. Insecticides Act 1968 was promulgated to prevent risks to human beings and animals against the use of insecticides.
4. Water Pollution Act 1974 was promulgated to reduce water contamination and water-borne diseases.
5. Water (Prevention and Control of Pollution) Cess Act 1977 was introduced with the objective of conservation of water by the industry.
6. Air Pollution Act 1981 is aimed at prevention/controlling air pollution through creating special boards for the purpose.

18.14. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write a detailed account of the different Acts that deal with the protection of forests and wildlife.
2. Elaborate the Water Pollution Acts and their objectives.
3. What is Insecticide Act 1968 ? What are the committees that are created under this Act ? Elaborate their functions.

II. Answer the following questions in about 10 lines each.

1. Briefly give the content of Articles 48 and 51-A of the Indian Constitution.
2. Describe the role of community and voluntary organisations in solving environmental problems.
3. Describe the different programmes funded by the Ministry of Environment and Forests in strictly implementing the Laws.

Sri. G. Nageshwar Sharma

UNIT - 19 : POLITICO ADMINISTRATIVE AGENCIES

Contents

19.1. OBJECTIVES

After completing this unit you will be able to :

* explain the need for governmental or private agencies to protect the environment,
* assess the sucess of these agencies in their endeavours, and
* describe further activities in the administrative and political fields for ensuring a clean environment.

19.2. INTRODUCTION

The 1972 United Nations conference on Human Environment at Stockholm was a land mark in world environemnt movement. The member nations and individuals all over the world became conscious of the ecological problems and the urgent need to conserve the eco-system. India has a long cultural tradition of ecological conservation. We also have laws that have an indirect bearing on environmental protection. A special Legislation has been enacted in 1974 to control water pollution. A series of laws have been made since then conferring constitutional status to environmental protection. These have also put environment at the top of our national priorities. Thus legislations covering forest and wild life conservation, air pollution etc., have appeared on the statute book.

In a vast country like ours, which sometimes had different political parties running states and centre a permanent administrative machinery was required to oversee the implementation of the environment laws. Similarly a political mechinery was also required to respond to the environmental concern that come up time and again.

What is perhaps most important to bear in mind is the rapid industrialisation that has been taking place in our country since independence. When progress and development had become synonimous with industrialisation a somewhat lopsided development had come in. With each state in our country competing the other to industrialise, a situation had arisen where an effective control had to be ensured to protect environment. The result was the creation of central and state pollution control Boards.

It is in the background outlined above that the political agencies and the central and state pollution control Boards (PCB) have to be studied.

19.3. POLITICAL AGENCIES

In the strict sense of the term we have no political agencies as far as environment is concerned, till recently. But the union cabinet always had a ministry for forests and wild life. The enormous task of protecting our forests and wild life has been undertaken by the department of forests at the centre and state levels. Also the forest ministry and its departments at different levels have been taking care of wild life habitats and sanctuaries long before a separate Ministry Of Environment (MOE) has been created at one time, words like bio-diversity, ecological balance genetic - pool etc., have not been associated with forestry. The Ministry strictly was a watchman.

The afore mentioned U.N. Conference on Human Environment in 1972 created a new eco-consciousness in India. For the first time a separate ministry for environment has been created in 1989 by government of India. Actually the Jurisdiction of the ministry overlaps into other ministries like irrigation, forests, agriculture, industries etc. Urbanisation, town planning, and education are also within the concern of the environment ministry. So in that sense environment ministry is an effective political agency to protect environment. It is the concern of this ministry to assess and control the damage likely to occur to environment owing to the construction of major dams (Irrigation) or air and water pollution owing to an industrial plant (Industries) or protection of bio-diversity (Forests) or checking the urban environment etc.,

In order to assess the likely impact on environment owing to the development programme a special administrative agency in the shape of a pollution control Board has been created by an act of law.

Governments at the Central and State levels may constitute expert committees to advice them on environmental matters. Although they are not permanent political agencies, these committees function under a political agency.

Tehri Dam and Sardar Sarovar Project are two important issues that got embroiled in environmental controversy. It is the environment ministry that has been responsible. Any damage to environment any where in the country automatically comes under the jurisdiction of the political agency. Ministry of Environment also declares certain lakes (like Kolleru) or wildlife habitats (Forests) as national treasures and conserves them.

In Andhra Pradesh a separate environment ministry has been created in 1992 for the first time by the Government of A.P. But subsequently, the Government has chosen to abolish the same.

Political parties in a democracy usually are most well equipped political agencies to deal with environmental problems, as environmental degradation directly effects the livelihood of the poor. But manifestos of the Political Parties hardly have any agenda for ecological protection or conservation. Hence these problems do not figure in any political compaign. While some parties talk about human rights no political party makes environment a compaign issue.

Check Your Progress - 1 & 2

1. Are there really Political Agencies to protect Natural Environment ?
2. When did a separate ministry of Environment created ? What is the reason for that ?

Note : a) Write the answers in the space provided below

b) Compare your answers with those given at the end of this unit.

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19.4. ADMINISTRATIVE AGENCIES

19.4.1. N E P C

The Government of India constituted a committee on human environment to suggest legislative measures to protect environment in 1972. Consequently the department of environment came into being. The N.E.P.C also suggested setting up of suitable administrative machinery in States to ensure environmental protection. Eventually the states drew-up their own enviornmental protection plans. These plans are:

- Pollution Control
- Research & Development
- Impact Assessment
- Eco-Regeneration
- Environment Education
- Environment Information

As mentioned in the foregoing part, the departments of Forests and Wild life at the Central and State levels may also be referred to as the administrative agenices as they are directly called upon to tackle problems of environmental destruction.

For example massive afforestation (including social and agro-forestry) has been taken up by the department of forest. The department has forest research centres where research is being done in the areas of tissue culture, multiplication of ordinary species for afforestation. The department of wild life conservation besides conserving wild life creates and manages wild life sanctuaries. They also launch programmes like project tiger in order to protect a specific of wild life.

19.4.2. I T D A

The I T D A (Integrated Tribal Development Authority) has been specially constituted in the agency areas to initiate development/welfare programmes for the tribals. The accent is on development and welfare. But the ITDA's in close collaboration with department of wild life and forest conserves the forest eco-systems as these eco-niches have natured tribal culture and way of life.

Check Your Progress - 3 & 4

3. What are the environmental protection plans of the states ?

4. What is the reason for constituting I.T.D.A ?

Note : a) Write the answers in the space provided below.

b) Compare your answers with those given at the end of this unit.

19.4.3. Pollution Control Board (PCB)

A special legislation came into being in 1974 to control water pollution. Consequently some states have established boards for implementation of this law. In A.P such a Board has been created in 1976. When Central Parliament passed the air pollution control Act in 1981, A.P. Government changed the name of the Board into Pollution Control Board. (PCB).

The PCB is the most suitable administrative agency to control and monitor air and water pollution. It is the sole responsibleity of this Board to maintain levels of air and water pollution at non-hazards levels. Hence PCB is the most visible agency that is entrusted with the responsibility and authority to clean the environment. The functions of the PCB are-controlling industrial, automobile and other air pollution.

- Controlling water pollution owing to industrial effluents.
- Advising the erring industries to take up pollution control measures, like establishing effluent treatment plants (ETP's)
- Filling cases on erring industries, in 1st Class magistrate courts in the area.
- Collecting data regarding air, water pollution in different cities which is helful in revising master plans for the cities.
- Importantly the PCB gives no-objection certificate to every new industry after satisfying itself that all measures have been taken to control air and water pollution. Even after the industry began production the PCB monitors air and water pollution.
- Controlling automobile pollution in collaboration with the road transport authority.

19.4.4. Council of Science and Technology

The State Council of Science and Technology also has an environment cell. This cell/committee has representative from PCB, forest, health, meterology, universities etc. It identified specific areas of study which requires immediate attention.

19.4.5. Paryavaran Vahinis

Each district in the state has a paryavarana vahini under the chairmanship of the district collector. The vahini is a semi-official body. Members of this body include all district offcials and social workers. The Vahini meets periodically to discuss specific problems of environment. Strictly this is not an administrative agency although it functions under the district collector.

Check Your Progress - 5 & 6

5. When did A.P Create Pollution Control Board ?

6. Who is the chairman of Paryavarana Vahini ?

Note : a) Write your answers in the space provided below.

b) Compare your answers with those given at the end of this unit.

19.5. SUMMARY

Conference on Human Environment held at Stockholm in 1972 by United Nations was a land mark in world environment movement. India has a long cultural tradition of ecological conservation.

A series of Laws have been made since the enactment of Water Pollution Legislation in 1974 to protect the Environment. These laws relate to forests and wild life conservation, air pollution, water pollution etc., Due to competetive industrialisation processes being taken up different states, a need had arisen to set up administrative agencies by the states as well as by the Centre to protect the Environment. In the strict sense of the term there are no political agencies as far as environment is concerned. The enormous task of protecting our forests and wild life has been undertaken at the centre and at state level. The environmental plans suggested by National Environment Protection Committee include : Pollution Control, Research & Development, Impact Assessment, Eco regenration ,Environment Education and Environment Information.

Integrated Tribal Development Authority (I.T.D.A) was specially constituted to initiate developmental programmes for tribals. Pollution Control Boards (PCB) have been started by the centre as well as by the States immediately after air pollution control act in 1981 by the central government.

PCB is the most visible agency entrusted with the authority and responsibility to clean the environment. PCB prescribes standards for the industries and takes legal actions on those flouting these standards. The state council of science and technology and Paryavarana vahinis in each district under the chairmanship of district collector oversee the environmental protection activities.

19.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1. In a strict sense, there are no political agencies as far as environment is concerned till recently before a separate Ministry of Environment was created. Till then, the department of Forests and wild life at the centre and state levels has been protecting the forests and wild life.
2. A separate Ministry of Environment was created in A.P. for the first time in 1992.
3. The environmental protection plans of the states are pollution control, Research and Development, Impact Assessment, Eco-regeneration, Environment Education and Environment Information.
4. To initiate development and welfere programmes in the Agency areas, the ITDA was specially created.
5. Pollution Control Board was created in A.P. in 1976.
6. The Chairman of Paryavarana Vahini is the District Collector.

19.7. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Name the needs and actions that necessitated the constitution of various political and Administrative Agencies in India to protect and clean the environment.
2. Discuss the responsibilities, authorities and social requirements of the different administrative pollution control agencies in India.

II. Answer the following questions in about 10 lines each.

1. What is the land mark activity in world environment ? Discuss.
2. Why was there a need for legislation to protect environment ?
3. Explain the responsibilities and the authorities of NEPC and I.T.D.A.
4. What are the responsibilities and the authorities of state Pollution Control Boards ?
5. Name the tasks of Paryavarana Vahinis.
6. Name all the environmental protection laws enacted by the Government of India so far.

Dr. T. Patanjali Sastry

UNIT - 20 : LEGAL ASPECTS

Contents

20.1. OBJECTIVES

After completing this unit you will be able to

* assess the need for the legal agencies in environmental protection activities;
* discuss about legal measures provided by the governmental agencies to keep the environment clean;
* describe the role of legal agencies that are helping the Indian citizens, in demanding for clean environment and the right for life.

20.2. INTRODUCTION

After the United Nations Conference on Human Environment held in stockholm in 1972, member nations relised the need to make legislations to ensure clean environment too thier citizens. The stockholm conference declared the right of people to a clean environment. In india, parliament enacted a special legislation to control water pollution in 1974. This may be said as the precursor to later environmental legislations. There have been acts of parliament which could be interpreted to include environmental protection. However the first environmental protection. Inspite of several laws in the statute Book, cases relating to environmental protection are few and far between. It is only very recently that judiciary has been trying to grapple with enviro-legal problems. The Bhopal gas tragedy brought to light certain legal problems, and lacunue in the existing law and its interpretation.

The credit for what little enviro-legal litigation there is should go to the voluntary sector. Different N.G.Os (Non Gevernmental Organisations) occasionally move the high court on cases ranging from tribal rights to cutting trees and industrial pollution.

20.3. RIGHT OF INDIVIDUALS OF COMMUNITIES

The Indian Constitution guarantees fundamental rights to its citizens which are Justiceable. Among them is the right to life which is fundamental to every human being. As mentioned in introduction, irrespective of environment protection laws any interpretation or right to life would include the right to have clean environment. Almost any threat to environment could be met by the above right. Law is kept alive and responsive to changing human needs by its interpretation. Similarly an erring industry could be dealt with by the MRO of the area under nuisance case. It is the most

fundamental right of every citizen and community to have a clean and healthy environment. It is also a most basic condition for human existence. So it may argued that right to clean envrionment is natural right.

There has been increasing global eco-consciousness. Governments over a period of time had to take cognizence of ecological perspective to human life. In India this had led to the water pollution act in 1974 and air pollution act in '76. For the first time in our country an environmental protection legislation has been made in 1986. With the establishment of the Union Ministry for environment the process that began in '74 had been completed.

Rights and duties have a complementary role in our life. As early as in 1976 as part of the 42 Amendement, pertaining to Part IV A (51 A-G) duty to protect and improve the natural environment including forests, lakes, rivers and wild life has been enjoined to the fundamental duties of Indian citizens. From the strict legal point of view it is not Justiceable, like Directive Principles of State Policy. So, the only comprehensive law for protection of environment was the one made in '86.

20.4. PUBLIC INTEREST LITIGATION

In the judicial history of India notwithstanding all the laws and rights of citizens in this country have been quietly empowered by what came to be known as public interest litigation (P.I.L). Obviously it is amenable to widest interpretation. Justice P.N. Bhagavathi, initiated the P.I.L. in India. P.I.L. does not require affidavits or legal procedures to move a court of law for the reddressal of grievances. A mere post card would be accepted as a legal document and a case is deemed filed. It is easy to extend this legal recourse to problems of environment. A citizen can bring to the notice of the court any threat to ecology by writing a post card regarding Water Pollution, Noise Pollution, Public Nuisance, illegal tree-felling, destroying tanks, etc. It is up to the concerned citizens and groups to take advantage of this unique legal recourse to protect and conserve environment. At the moment there is not much on the record to show. It may be interesting to note that the first P.I.L. case was filed against Ratlam (U.P.) municipality for its failure to ensure proper sanitation to its citizens in 1964. The Suprem Court forced the corporation to improve sanitation facilities. Although P.I.L. was unknown in the sixties Ratlam case was perhaps the first P.I.L. on urban environment.

Check Your Progress - 1 & 2

1. Name the important rights of individuals as far as Environment is concerned.
2. What is the first case of public interest litigation ?

Note : a) Write the answers in the space provided below.

b) Compare your answers with those given at the end of this unit.

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20.5. RIGHT TO INFORMATION

Unlike in the U.S. there is no constitutional guarantee in India to this right. Various groups working in the area of environment feel they have been handicapped by the absence of the above right. Like in some other cases the Supreme Court (S.C.) has clarified in several cases that access

to public documents include the right to information. The S.C based its clarifications on Indian Evidence Act of 1872, Act I which provides for making copies of public documents available to the litigants. While saying this the Act itself restricted access to documents. So in effect, one does not get to see the documents one wishes to see. Thus the activists or concerned citizens are genuinely deprived of a most vital source of information. It is customary for the bureaucrats/politicians to take umbrage under the official secrets act. Quite a number of public issues exposed the need for the above provisions.

20.6. FREE LEGAL AID AND ADVICE COMMITTEES

These committees have been formed in 1975. The Free Legal Aid and Advice Committees (FLAC) are appended to every district court with the district judge as the chairman, besides members of the bar F.L.A.C. provides for the inclusion of social workers of whom one should be a women.

The F.L.A.C. goes to villages periodically where it offers legal advice/counselling on matters of property, agriculture, industrial and family problems. Most often the counselling leads to out of court settlements. On the face of it, the F.L.A.C. has nothing to do with environment. But one can easily take advantage of its provisions to seek legal advice on environmental problems. For instance if a particular village had its agricultural drain or fresh water stream polluted by industrial effluents from upstream the villagers can collectively act through F.L.A.C. There have been umpteen such problems through out the state. The F.L.A.C. does not act on its own, but helps people find a legal course. But there has not been a single environmental problem that came before F.L.A.C. As mentioned earlier, it is a matter of interpretation and extension of existing provisions to suit conteporary challenges. This may also be treated as enviro-legal education at the grass-root level.

20.7. LOK ADALATS (L.A.)

Lok Adalat is another innovative experiment initiated in early '80s with a view to making litigation cheaper and mainly to avoid judicial delay. The district Judge is the chairman and a retired Judge is the convenor of L.A. It meets once in 3 months. The L.A. deals with cases already pending in the court, usually consumer issues also figure in the L.A. So far, no environmental problem had come up before the L.A. Like in the case of F.L.A.C. citizens can take advantage of the L.A., as environmental cases are not dissimilar to consumer issues. A number of land acquisition cases connected with the steel plant in vizag have been cleared by the LAs.

Check Your Progress - 3 & 4

3. What is meant by right to information as far as the environment is concerned ?

4. What are the basic functions and responsibilities of free legal and advice committees ?

Note : a) Write the answers in the space provided below.

b) Compare your answers with those given at the end of this unit.

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20.8. SUMMARY

After the United Nations Conference on Human Environment, held in Stockholum in 1972, many nations realised the need for legislations for clean environment. In India, Parliament enacted a special legislation to control water pollution in 1974.

The first environmental act has been made in 1986 with the specific intention of environmental protection. The credit for enviro-legal littigation should go to the voluntary sector namely the Non Governmental Organizations (NGO). The right to life and the right for clean environment are the fundamental rights of all Indian Citizens according to the constitution. An erring industry could be dealt with by the MRO of the area under a nuisance case. Indian Evidence Act of 1872 Act 1 provides for making copies of public documents availabel to the litigants. The very act also prevents access to the documents. Free legal Aid and Advice Committee (FLAC) are formed in 1975. These are appended to district courts. The district Judge is the chairman of the committee. As it stands these FLAC have nothing to do with the environment directly. But its provisions do not prevent it to offer advice on environmental problems too. F.L.A.C does not act on its own but helps people find a legal course. Lok Adalat is an innovative experiment started in early 80's for making litigations chepaer and for avoding judicial delays. The district Judge is the chairman and a retired judge is the convenor of Lok Adalat. Like in the case of FLAC, Citizens can take advantage of L.A for dealing with environmental cases.

20.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Right to life which includes right to have clean environment is the important right of individuals as far as environment is concerned.
2. The first case of public interest litigation was filed against Ratlam Municipality in U.P. in 1964.
3. Right to information is nothing but the access to public documents.
4. The Free Legal and Advice Committees goes to villages periodically and offers legal advice/ counselling on matters of property, agriculture, industrial and family problems.

20.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. What steps are taken by the Governments of India and Andhra Pradesh by way of setting up of statutory bodies to takle the legal aspects of environmental problems ?
2. Explain and discuss the statement 'Right of individuals for life for clean environment and for information'?

II. Answer the following questions in about 10 lines each.

1. The Stockholm Conference in 1972 declared the right of people for clean environment. What is this Conference and what for it was held ?
2. Which environmental case brought to light the legal problems and lacunae in the existing laws?
3. What are the rights of individuals as per the Indian Constitution concerning the environment ?
4. Write briefly about FLAC.
5. What is Lok Adalat ? Write brief account on it.

Dr. T. Patanjali Sastry.

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P.G. DIPLOMA IN ENVIRONMENTAL STUDIES
COURSE-I : ECOLOGY, ENVIRONMENT AND DEVELOPMENT

ASSIGNMENT-2

Time : 2 hours

Note:

1. Do not copy the answer directly from any of the books.
2. As far as possible try to answer the questions independently in your own words.
3. If it is necessary to quote from any source, give the correct reference.
4. Use your own foolscap papers for writing the assignment.
5. Leave sufficient margin for the comments of the evaluator.
6. Completion of this assignment normally should not take more than two hours.

I. Answer the following questions in about 30 lines each.

1. What are the Post-Independence Industrial Policies in India?
2. What are meat-forne diseases? Add a note on the preservation of meat.
3. Explain the process of conversion of energy from sunlight.

II. Answer the following questions in about 10 lines each.

1. Write briefly about podu cultivation.
2. Explain the applications of Coal.
3. What is the role of moderators and Coolant in a nuclear power plant?

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FACULTY OF SCIENCE

P.G. DIPLOMA IN ENVIRONMENTAL STUDIES

COURSE-I : **ECOLOGY, ENVIRONMENT AND DEVELOPMENT**

ASSIGNMENT-3

Time : 2 hours

Note:

1. Do not copy the answer directly from any of the books.
2. As far as possible try to answer the questions independently in your own words.
3. If it is necessary to quote from any source, give the correct reference.
4. Use your own foolscap papers for writing the assignment.
5. Leave sufficient margin for the comments of the evaluator.
6. Completion of this assignment normally should not take more than two hours.

I. Answer the following questions in about 30 lines each.

1. What are the primary and secondary air polluntants? Discuss their sources in detail.
2. What is solid waste and its sources? Describe the disposal methods.
3. List out and explain various global summits held on environmental issues.

II. Answer the following questions in about 10 lines each.

1. Write a brief note on the sources of ground water contamination.
2. Name five toxicants and enumerate their respective toxic effects on man.
3. Describe briefly the role of voluntary organisations in solving environmental problems.

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P.G. DIPLOMA IN ENVIRONMENTAL STUDIES
COURSE-I : ECOLOGY, ENVIRONMENT AND DEVELOPMENT
MODEL EXAMINATION PAPER

Time : 3 Hours | Max. Marks:100

Section-A

Answer any Four of the following questions.

Each question carries 15marks.

Answer the following questions in about 30 lines each.

1. Write an account of energy transfer in ecosystems.
2. What are natural resources? How are they preserved and protected with reference to fores[illegible]ts?
3. What are the post-Independence Industrial Policies in India?
4. What are meat-borne diseases? Add a note on the preservation of meat.
5. Explain the process of conversion of energy from sunlight.
6. What are the primary and secondary air pollutants? Discuss their sources in de[illegible]
7. What is solid waste and its sources? Describe the disposal methods
8. List out and explain various global summits held on environmental issue[illegible]

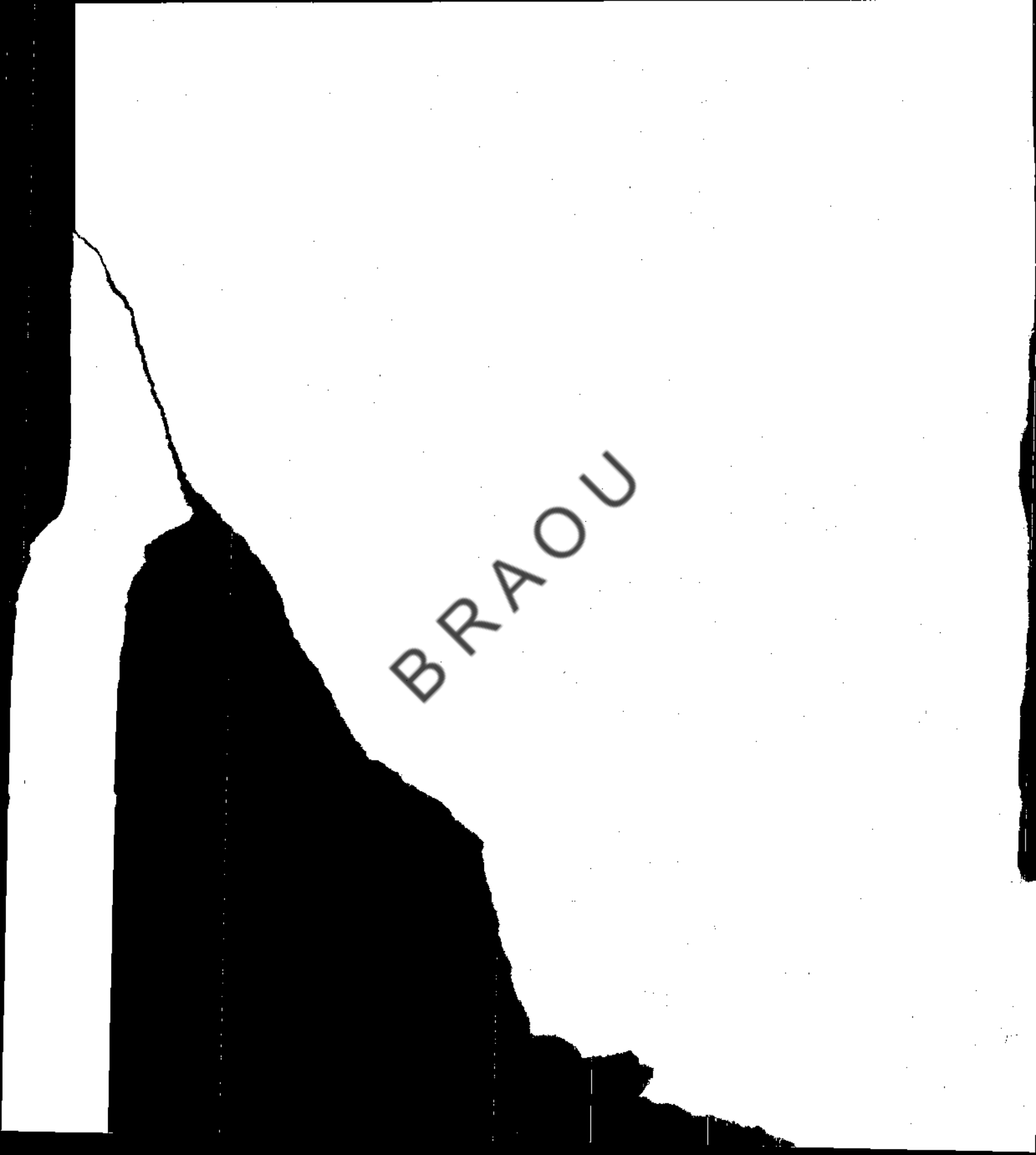
Section-B

Answer any five of the following q[illegible]

Each question carries 8[illegible]

Answer the following questions in [illegible]

9. Give an account on the Modern Synthetic Theory o[illegible]
10. What are the International Agreements made to de[illegible] Seas and Oceans?
11. Describe Chipko Movement.
12. Write briefly about Podu Cultivation.
13. Explain the applications of Coal.
14. What is the role of moderato[illegible]
15. Write a brief note on the sour[illegible]
16. Name five to[illegible]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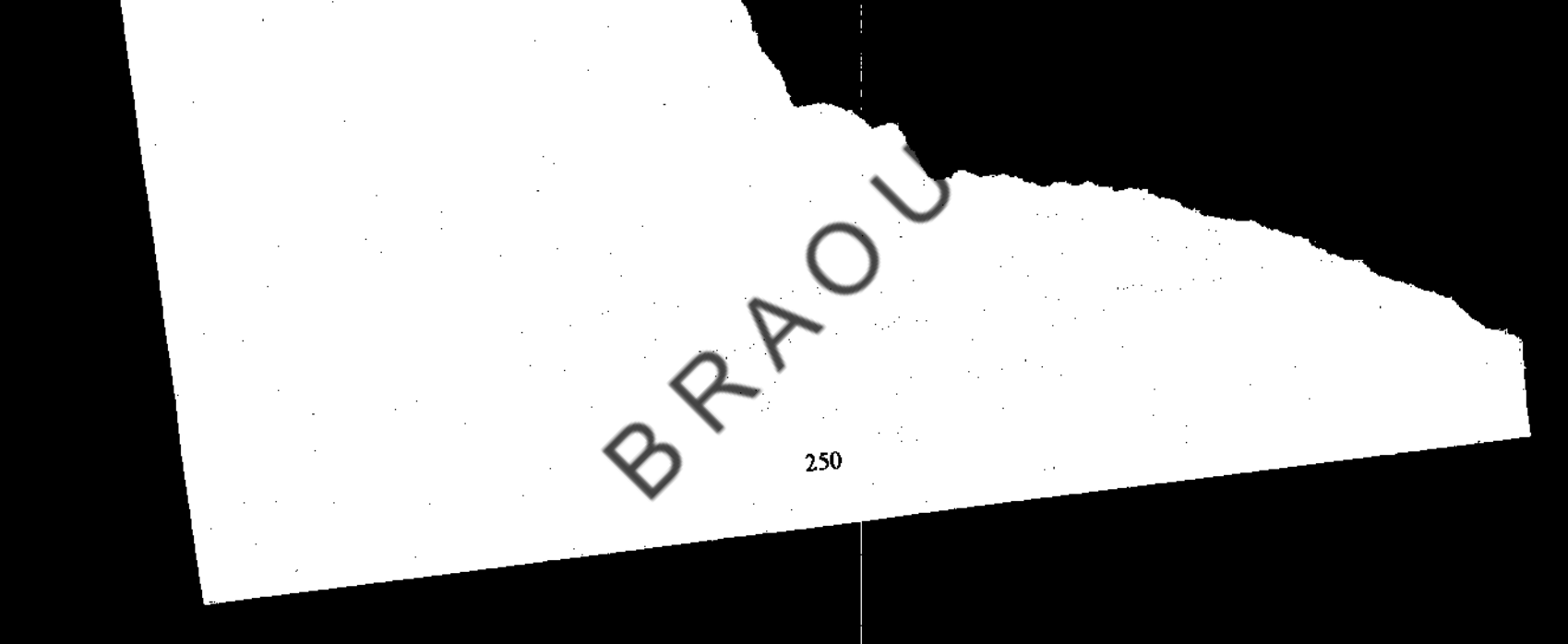
Coolant in a nuclear power plant?

...ces of ground water contamination.

...oxicants and enumerate their respective toxic effects on man.

...escribe briefly the role of voluntary organisations in solving environmental problems.

18. What are the responsibilities of authorities of State Pollution Control Boards?


BRAOU
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Dr. B.R. AMBEDKAR OPEN UNIVERSITY
FACULTY OF SCIENCE

P.G. DIPLOMA IN ENVIRONMENTAL STUDIES

COURSE-I : ECOLOGY, ENVIRONMENT AND DEVELOPMENT

ASSIGNMENT-1

Time : 2 hours

Note:

1. Do not copy the answer directly from any of the books.
2. As far as possible try to answer the questions independently in your own words.
3. If it is necessary to quote from any source, give the correct reference.
4. Use your own foolscap papers for writing the assignment.
5. Leave sufficient margin for the comments of the evaluator.
6. Completion of this assignment normally should not take more than two hours.

I. Answer the following questions in about 30 lines each.

1. How do wind and ice land forms influence the environment?
2. Give an acount of energy transfer in ecosystems.
3. What are natural resources? How are they preserved and protected with reference to forests?

II. Answer the following questions in about 10 lines each.

1. Give an account of the Modern Synthetic Theory on evolution.
2. What are International Agreements made to deal with the pollution of the Seas and Oceans.
3. Describe Chipko Movement.