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UNIVERSITY OF JAMMU
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B.A. / B.COM SEMESTER - IV

Subject : Environmental Science | **Unit I to III**
Course No. : ES-401 | **Lesson No. 1 to 12**

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ENVIRONMENTAL STUDIES

IV - SEMESTER

Examination to be held in the year 2019, 2020 and 2021 onwards

(B.A. / B.Sc. / B.Com. / BBA / BCA)

C. No.: ES 401 (Theory) **Title : Environmental Science**

Duration : 45 minutes **Max.Marks : 50**

Theory Examination : 35

Sessional Assessment : 15

DETAILED SYLLABUS

UNIT 1 **BIODIVERSITY AND ITS CONSERVATION**

L. No. 1 **Biodiversity :**

a) Definition, genetic, species and ecosystem diversity.

b) Values of biodiversity (consumptive, productive, social, ethical and aesthetic values)

L.No. 2 Biodiversity of India; India as a mega diversity nation, hotspots of biodiversity, concept of Bio-geographic regions of India.

L.No. 3 Threats to Biodiversity (habitat loss, poaching of wildlife, man wildlife conflicts) & Conservation of Biodiversity (*Insitu* and *Exsitu* conservation of biodiversity, endemic and endangered species of India.

L.No. 4 Ecotourism, Eco-marketing

UNIT II **NATURAL RESOURCES AND THEIR MANAGEMENT**

L.No. 5 Forest Resources : Uses of Forests, Causes of over-exploitation (deforestation, timber extraction) mining and its effects on forests and tribal people

L.No. 6 Water Resources : Uses & over-utilization of surface and ground water & effects; conflicts over water, dams-benefits & problems; water conservation, rainwater harvesting.

L.No. 7 Food Resources : World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture (fertilizer-pesticide problems, water logging and salinity).

L.No. 8 Energy Resources : Growing energy needs, renewable & non-renewable energy sources, use of alternate energy resources; urban problems related to energy.

L.No. 9 Land Resources : Land as a resource, land degradation, man-induced landslides, soil erosion and desertification.

UNIT III POPULATION AND HUMAN HEALTH

L.No. 10 Population growth, variation among nation, Family Welfare Programs.

L.No. 11 Common diseases : communicable and non-communicable

i) Water borne diseases
ii) Air borne diseases
iii) Food borne diseases

L.No. 12 HIV/AIDS, Drug Addiction, Nuclear Hazards, Role of Information Technology in Environment & human health.

Field / Practical Work

All the students are required to undertake the following field/ practical work based on which they will be assessed for their Internal Assessment Test.

i) To record the biodiversity of the any visited area
ii) Identify the natural resources of your area
iii) Identify the sources of energy used in your area
iv) Visit to a health center for recording of common water/air/ food borne diseases of your area.

Note :

The seasonal assessment of 15 marks will be distributed as follows :

Attendance in Theory and Practical	-	05
Test based on field work	-	10

For Theory Paper Setter

The question paper of 35 marks will consists of 35 multiple choice questions based on above topics. Questions should be equally distributed from all the units. Each question would be of ONE mark.

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BIODIVERSITY

1.1 INTRODUCTION

One of the most fascinating facts about planet earth is the presence of life. Life originated on this planet about 3 billion years ago in the form of very simple cells. Since that time diverse forms of living organisms have evolved from the simpler ones and a large diversity of living organisms is present at this time. Some of the species have become extinct and newer ones have evolved. The diversity of life on this planet can be gauged from the fact that there are about 1.9 million species of organisms known to scientists till now. Every organism is unique. It is estimated that the actual number of species may be about 13 million species and in some estimates may reach up to 100 million.

Biodiversity is very important for the survival of planet earth as a support system for life and for the ecological balance. Humans owe their healthy lives to biodiversity as biodiversity has provided various cures to diseases and continue to be the source of future medicines. The food which we eat has its origin in biodiversity. Without a diversity of pollinators, plants, and soils, our supermarkets would have a lot less produce. Our economies are dependent on biodiversity for a range of raw products. Besides these direct benefits which biodiversity provides various indirect benefits which we term as ecological services is also provided by biodiversity. Ecological services include oxygen production, chemical absorption, water supply and an array of other benefits. Biodiversity allows for ecosystems to adjust to disturbances like extreme fires and floods. Genetic diversity prevents diseases and helps species adjust to changes in their environment.

1.2 OBJECTIVES

After reading this lesson the students will be able to know what biodiversity is and various aspects of biodiversity like

i) Definition of Biodiversity

ii) Different levels of Biodiversity

   a) Genetic Diversity

   b) Species Diversity

   c) Ecosystem Diversity

iii) Values associated with Biodiversity like

   a) Consumptive values

   b) Productive values

   c) Social values

   d) Ethical values and

   e) Aesthetic values

1.3 DEFINITION OF BIODIVERSITY

The term biodiversity is compact form of the term Biological Diversity coined by E. O. Wilson in 1985. "Biological diversity" or Biodiversity is the variety and variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems. According to Convention on Biodiversity (1992), "Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD,1992). Biodiversity comprises of the millions of different species that live on our planet, including the genetic differences within species. Biodiversity, therefore is the assemblage of the whole of 'Life on Earth'.

TABLE 1.1: THE COMPOSITION AND LEVELS OF BIODIVERSITY (AFTER HAYWOOD,1995).

Ecological Diversity		**Organismal Diversity**
Biomes		Kingdoms
Bioregions		Phyla
Landscapes	**Genetic Diversity**	Families
Ecosystem	Populations	Genera
Habitats	Individuals	Species
Niche	Chromosomes	Sub Species
Populations	Genes	Population
	Nucleotides	

1.4 LEVELS OF BIODIVERSITY

Norse *et al*. (1986) explained biodiversity as genetic diversity (variation within species), species diversity (species number) and ecological diversity or ecosystem diversity. Sandlund *et al.* (1992), described biodiversity as the structural and functional variety of life forms at genetic, population, community and ecosystem levels.

(I) GENETIC DIVERSITY

Genes contain the information necessary for all the life on Earth. Genes are passed on from parents to offspring, and contain the information that builds and maintains cells and determines the essential physical and biochemical characteristics of each organism.

Genetic diversity is the sum total of all the genetic information contained in the genes of individuals of plants, animals and micro organisms of the planet earth. Each species is made up of individuals that have their own particular genetic composition. Within a species there may also be some isolated populations which have their own distinctiveness. Each species is the repository of an immense amount of genetic information. The number of genes range from about 1000 in bacteria, up to 400 000 or more in many flowering plants. Each species is made up of many organisms, and virtually no two members of the same species are genetically identical. This means for example that even if an endangered species is saved from extinction, it will probably have lost much of its internal diversity. When the populations are allowed to expand again, they will be more genetically uniform than their

ancestral populations. For example, the bison herds of today are biologically not the same in terms of their genetic diversity as the bison herds of the early 18th century (McClenagham *et al,* 1990). To conserve the genetic diversity within a species, different populations must be conserved. This protects the genetic diversity that allows for adaptability to environmental changes and is therefore vital to species survival.

The significance of genetic diversity is often highlighted with reference to global agriculture and food security. This stresses the reliance of the majority of the world's human population on a small number of staple food species, which in turn rely on supply of genes from their wild relatives to supply new characteristics, for example to improve resistance to pests and diseases (Cooper *et al,* 1992)

(II) SPECIES DIVERSITY

Species is a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. The species is the principal natural taxonomic unit, ranking below a genus. Species are also regarded as populations within which gene flow occurs under natural conditions. Within a species, all normal individuals are capable of breeding with the other individuals of the opposite sex belonging to the same species, or at least they are capable of being genetically linked with them through chains of other breeding individuals. By definition, members of one species do not breed freely with members of other species.

At present approximately 1.9 million living species of all kinds of organisms have been described. Most of the species belong to the groups like vertebrates and flowering plants, while other groups are relatively less numbered, such as lichens, bacteria, fungi and roundworms (Pearce and Moron, 1994).

Likewise, some habitats are better researched than others, and coral reefs, deep ocean floor and tropical soils are not well studied. This lack of knowledge has considerable implications for the economics of biodiversity conservation, particularly in defining priorities for cost-effective conservation interventions.

Species diversity is the variety of species within a region in specific period of time. This region may range from small areas like a forest or a pond to whole of the biosphere. Species diversity is not evenly distributed around the world or across continents. Some regions have high species diversity while others have very less. Thirty-four biodiversity

hotspots have been identified comprising just 2.3% of the Earth's land surface yet hold especially high numbers of species that occur nowhere else – half the world's plant species and 42% of all terrestrial vertebrate species. They are also home to 75% of the planet's most threatened mammals, birds and amphibians.

The single most obvious pattern in the global distribution of species is that overall species richness increases with decreasing latitude. Not only does this apply as a general rule, it also holds within, the great majority of higher taxa, at order level or higher. However, this overall pattern masks a large number of minor trends. Species richness in particular taxonomic groups, or in particular habitats, may show no significant latitudinal variation, or may actually decrease with decreasing latitudes. In addition, in terrestrial ecosystems, diversity generally decreases with increasing altitude. This phenomenon is most apparent at extremes of altitude, with the highest regions at all latitudes having very low species diversity (although these areas also tend to be of limited size, which may be one factor resulting in lower species numbers). In terms of marine systems, depth is the analogue of altitude in terrestrial systems and biodiversity tends to be negatively correlated with depth. Gradients and changes in species richness are also noticeably correlated to precipitation, nutrient levels and salinity, as well as other climatic variations and available energy (Pearce and Moron, 1994).

Species diversity can be depicted as alpha diversity, beta diversity and gamma diversity.

a) **Alpha Diversity:** It is the presence of different species within a habitat or ecosystem. In simple terms alpha diversity is the species richness of a region.

b) **Beta Diversity:** Beta diversity is the rate of change of species diversity of different communities. This is the change in species diversity along an environmental gradient like altitude, slope, latitude etc.

c) **Gamma Diversity:** Gamma diversity is the species diversity in a larger landscape like a biome or whole of biosphere.

(III) ECOSYSTEM DIVERSITY

Ecosystem diversity encompasses the overall variety and variability of all the habitats, biotic communities and ecological processes in the biosphere along with the diversity within ecosystems.

Ecosytem diversity can be described at a number of different levels and scales:

a) **Functional diversity:** It is the relative abundance of functionally different kinds of organisms like producers, consumers, scavengers *etc.* and the processes of energy flow and material cycling in the ecosystem.

b) **Community diversity:** Community diversity is the different number, size and spatial distribution of different communities in various ecosystems.

c) **Landscape diversity:** It is the diversity of scales of different landscapes and communities associated with them.

No simple relationship exists between the diversity of an ecosystem and ecological processes such as productivity, hydrology, and soil generation. Neither does diversity correlate neatly with ecosystem stability, its resistance to disturbance and its speed of recovery. There is no simple relationship within any ecosystem between a change in its diversity and the resulting change in the system's processes.

1.5 Values of Biodiversity :

Biodiversity includes all the variety and variability among organisms and includes man as an important part of biodiversity. Man is a part of biodiversity as well takes benefit of the various values of biodiversity.

The value of biodiversity and the services provided by the biodiversity to mankind and to the ecosystem as a whole are very important when we have to formulate strategies for the conservation of biodiversity. On a broad basis there are three reasons to evaluate the biodiversity:

- Values associated with use.
- Values associated with pleasure, appreciation, or aesthetics.
- Values associated with ethics or morality.
- Values of biodiversity are generally classified into two major classes i.e. **direct use value of biodiversity** and **indirect use value of biodiversity**.

A) Direct use value of Biodiversity : Direct use value of biodiversity are those benefits which are obtained through direct interaction with the biodiversity. These are further classified as consumptive use values or non-consumptive use values of biodiversity.

I) **Consumptive use value of biodiversity or productive use value of biodiversity:** Biodiversity provides a lot of natural products that are used directly for food, fodder, timber, fuel wood etc. Humans use at least 40,000 species of plants and animals on a daily basis. Many people around the world still depend on wild species for most of their needs like food, shelter and clothing. The tribal people are completely dependent on the forests for their daily needs. Biodiversity is also the source of products that are commercially harvested and marketed. The biotechnologists continuously use the wild species of plants for developing new, better yielding and disease resistant varieties. Biodiversity represents the original stock from which new varieties are being developed. Various productive use values of biodiversity are as follows

a) **Food:** Humans obtain their food sources like grains, fruits, tubers, vegetables, meat, milk, honey etc. from biodiversity. Except salt every food is obtained from biodiversity. The food resources ranges from forest products to marine produce to crop land etc.

b) **Medicinal Values:** Most of medicines which human uses have their origin from biodiversity. Around 20,000 plant species in the world have medicinal values and, many are still unexplored. For example ***Cinchona*** *officinalis* is used for the production of quinine which is a anti-malarial drug. Some other medicinal plants include *Rauvolfia serpentine, Aconitum, Ocimum sanctum* etc.

TABLE 1.2 SOME MEDICINAL PLANTS OF JAMMU AND KASHMIR

S.No.	Plant name	Medicinal Use
1	*Aconitum heterophyllum*	Used against diarrhoea, general weakness, impotency and fever
2	*Artemisia brevifolia*	Stomach-ache, intestinal worms, appetite stimulant, Used against diarrhoea, generalweakness, impotency and fever
3	*Berberis lycium*	Fruit extract against stomachache and diarrhoea.
4	*Bunium persicum*	Seed as spice, appetiser, reduces cholesterol, anxiety and depression, indigestion and dysentery.
5	*Colchicum leutum*	Rheumatism, gout, diseases of liver and spleen
6	*Ephedra gegardiana*	Asthma, cardiac stimulant, hay fever.
7	*Gentiana kurroo*	Blood purifier, fever, cough, liver ailments and headache.
8	*Taraxacum officinale*	Tonic, stimulant, laxative, stomach disorders, indigestion and intestinal worms.
9	*Thymus serphyllum*	Whooping cough, epilepsy, suppression of urine.
10	*Viola serpens*	Cough and cold

a) **Industrial Values:** Biodiversity is the backbone of some of the industries like paper and pulp industry, lac industry, cotton industry, gum, rubber and other industries. A range of raw material is provided for industries by biodiversity.

b) **Ecotourism:** Ecotourism is related to tourism to a natural landscapes like forests, lakes, grasslands and is directly depends upon the biodiversity of the region. In this modern era most of the tourism is ecotourism as people want to get rid of their busy urban life and want to stay at natural pollution free environs.

B) **Indirect Use Values of Biodiversity:** The indirect uses of biodiversity are various ecological functions which indirectly provide welfare to humans. These values include social value of biodiversity, aesthetic value, ethical value etc.

a) **Social value of biodiversity**: The social value of biodiversity includes, recreational, cultural and spiritual values. Biodiversity tends to increase the standards of living of humans. Ancient societies always valued the biodiversity and treated it as a part of their social life. Hindus still worship plants as sacred. Tribal societies in these times also have the social rituals attached to nature and biodiversity. Nature has always remained a part and parcel of human civilization.

b) **Ecosystem services** : The ecosystem services provided by biodiversity are given below (Table 1.3) :

Oxygen production by plants: The production of oxygen by plants and marine algae helps to maintain the balance of oxygen on this planet and hence life.

Water conservation: Vegetation slows run off, traps sediment and removes nutrients from the run off. Thus, producing the natural sources of water.

***Soil*:** Soil is produced and maintained as fertile soil through many interacting processes of which biological one is the most important. Lichens are pioneers in soil formation.

***Pollination Services*:** Pollination of agricultural crops, forest trees and native flowering plants by native insects, birds and other creatures is an important service provided by biodiversity. Without pollination there would not be any life possible on earth for long period.

Biological control of pests: Pest control in agricultural land by beneficial native predators and other biological methods helps to reduce chemical use and hence control pollution.

Habitat: Biodiversity in the form of forests and other ecosystems provide a very important natural habitat for various organisms.

Nutrient recycling: One of the most important service provided by nature is the cycling of nutrients in an ecosystem.

Table 1.3: Organisms as ecosystem engineers and ecosystem service provider.

Engineers	**Ecosystem Service**
Green Plants / Algae	Oxygen production
Soil organisms	Nutrient cycling
Beavers	Hydrology of water bodies
Coral reef	Island , Unique ecosystem
Trees	Control soil erosion/ Habitat
Earthworms	Nutrients/ soil aeration

c) Ethical value: It is based on the principle of 'live and let others live'. Ethical values related to biodiversity conservation are based on the importance of protecting all forms of life. All forms of life have the right to exist on earth. Man is only a small part of the Earth's great family of species. Morality and ethics teach us to preserve all forms of life and not to harm any organism unnecessarily. Some people take pleasure in the hunting of animals. People also sometimes degrade and pollute the environment by their unethical actions. Through proper education and awareness, the people's conscience against such practices must be raised.

d) **Aesthetic Value**: Planet earth is beautiful because of the rich biodiversity, which otherwise would have been barren and resembled other planets of the universe. Biological diversity adds to the quality of life and provides some of the most beautiful aspects of our existence. Biodiversity is responsible for the beauty of a landscape. People go far off places to enjoy the natural surroundings and wildlife. This type of tourism is referred to as eco-tourism, which has now become a major source of income in many countries. In many societies, the diversity of flora and fauna has become a part of the traditions and culture of the region and has added to the aesthetic values of the place.

1.6 SUMMARY

Biological diversity is the contracted term for biodiversity and is the variety and variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems. Biodiversity is also described as the structural and functional variety of life forms at genetic, population, community and ecosystem levels. Man is a part of biodiversity as well takes benefit of the various values of biodiversity. The value of biodiversity and the services provided by the biodiversity to mankind and to the ecosystem as a whole are very important when we have to formulate strategies for the conservation of biodiversity. Values of biodiversity are classified into two major classes i.e. direct use value of biodiversity and indirect use value of biodiversity.

1.7 GLOSSARY

Biological diversity: The variety and variability among organisms and ecosystems.

Gene: A basic unit of heredity.

Species: A taxonomic unit members of which can interbreed and produce fertile young ones.

Population: A group of organisms belonging to same species.

Ecosystem: A unit of ecology with a boundary having flow of energy and material.

1.8 SHORT ANSWER TYPE QUESTIONS

Q. 1 Who coined the term Biodiversity

a) E.O.Wilson

b) A. G. Tansley

c) E.P. Odum

d) None of these

Q.2 What does CBD stands for

a. Clean biological design

b. Convention on Biological Diversity

c. Centre for Biological Disasters

d. All of these

Q.3 Which of the following is not a level of biodiversity

a. Genetic Diversity

b. Species Diversity

c. Natural Diversity

d. Ecosystem Diversity

Q.4 Which of the following services is not provided by biodiversity

a. Habitat for organisms

b. Nutrient Cycling

c. Pollination

d. None of these

Q. 5 Alpha diversity denotes what type of diversity

a. Diversity of a region

b. Interrelated diversity of two different regions

c. Diversity of whole biosphere

d. Diversity of Earth.

Answers:

1-a; 2-b; 3- c; 4-d; 5- a.

1.9 EXAMINATION ORIENTED QUESTIONS

Q.1 Define the following :

a. Biodiversity

b. Alpha diversity

c. Gamma diversity

d. Aesthetic value of biodiversity

Q.2 Explain different levels of biodiversity

Q.3 How biodiversity plays a role in human life ?

Q.4 Explain the direct use values of biodiversity.

Q.5 What are different ecosystem services provided by biodiversity ?

1.10 Suggested readings and References

- https://www.cbd.int/convention/text.

- K. Maiti P. and Maiti P. (2011). Biodiversity: Perception, Peril and Preservation, PHI Learning Private Limited, New Delhi.
- Pandey S. N. and Misra S. P. (2011). Environment and Ecology, Ane Books Private Limited, New Delhi.
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BIODIVERSITY OF INDIA

2.1 INTRODUCTION

Majority of the scientific fraternity agrees that the life on this planet first originated around 3.6 billion years ago, a mega event that marked the transformation of the inorganic to the organic realm. The subsequent developments led to the progressive changes of the original life forms from unicellular to the multi-cellular, from very primitive simple life forms to the highly complex and functionally developed life forms termed as organisms. This resulted in a great variety of organisms from the micro to the macro organisms with highly specialized functions. The whole process was spanned to billions of years. The other most prominent feature of this development was their growth and life cycles of innumerable shapes and equally varied physical and biological conditions and environs and ecosystems.

The concept of Biodiversity was first recognized in 1986 and the term was coined by the bio-scientist Walter and Rosen, which got immediate recognition and currency, a short form for biological and diversity, derived from the Greek Bios meaning thereby life and Diversity as variation of life forms. The Biodiversity can, therefore, be defined as "A vast array of life forms, species of unicellular to multicellular plant and animals, occurring on this earth in various environs from aquatic to terrestrial and the ecological complexes of which these are the part. The biodiversity differs from place to place as the environmental conditions of a particular area as well as the degree of tolerance of the species determine whether a species can occur in that particular area. The biodiversity is the variety and variability of organisms and ecosystems of more precisely it is the sum total of the species richness on this earth. "Since it refers to the number, variety and variability of life forms, such as the micro-organisms, higher plants and animals wild as well as cultivated/

domesticated, their occurrence is not uniform, not located at one place, the occurrence being determined by the environmental conditions". Another definition as coined by Convention on Biodiversity, Article 2 is "Biodiversity is the variability among the living organisms from all sources including, terrestrial, marine and other ecosystems, the ecology complexes of which are the part, including variation and variability within species, between the species and the ecosystem". As far as the exact number of flora and fauna present and flourishing on this earth, there are only wild guesses of 10 to 80 million of which only 1.4 million stands identified / enlisted so far.

A very simple question can be asked "Why study Biodiversity"? Even a very shallow knowledge of the subject will answer this question. The life on this earth is interdependent upon space chain and food chain, though influenced by other external factors also. Any small tilt of any of these two will demolish the balance with ensuing catastrophic results. In simple words, no life form, be it plant or animal including the humans, can exist independently. Human beings had recognized this fact even before the advent of civilization and all societies advocated least disturbance to the biodiversity. The seers of the past were the aggressive votaries of this concept.

2.2 OBJECTIVES

The objective of this chapter is to gather knowledge about India's biodiversity, its preservation, various regions recognised as hot spots and bio-geographical regions.

2.3 BIODIVERSITY IN INDIA

In the Indian context, the biodiversity has a very special significance. A very vast country with region specific weather and climate conditions prevailing; it is house to a very diverse and vast variety of flora and fauna. From tropical to sub-temperate to temperate to hot and cold deserts, varied soil conditions, the species of plants and animals also carry very diverse and distinctive characteristic, habits and life cycles. In this back ground, it can be said that India is a very rich repository of flora and fauna on the global scale. While it has only 2.9% of the global land mass, the biodiversity coverage is 8%. As per satellite imagery, 19% of India's land mass is covered under forests of different kinds. There are 6 wetlands of significance having been declared as Ramsar sites under Ramsar Convention, while natural sites as World Heritage Sites by World Heritage Convention to which India is a part to the convention on biodiversity since 1994. May it be noted that this international

body has a legal personality established for the conservation and sustainable use of biodiversity with fair and equitable sharing of the benefits arising from commercial and other utilization of genetic resources. There are ample factors to place it at a unique pedestal of biodiversity, one among the 21 mega biological diversity countries of the world.

2.4 INDIA AS A MEGA BIODIVERSITY NATION

The biotic or the living status of a place is subservient to and influenced by a number of factors viz. climatic, edaphic i.e. soil types and the geographical. A place with high to very high temperatures, low precipitation, poor soil will invariably host and nurture a very specific xerophytic flora population and equally sturdy faunal populations. On the other end of the landscape, a place with very fertile soils, adequate rainfall and tropical temperatures will be a fertile ground for the establishment of luxuriant vegetative populations of large number of species of plants and animals, with wide diversity and equally diverse faunal species. It is a rare distinction for India to have such diverse factors which are responsible for housing large number of plant and animal species. India is one country that is bestowed with rich biodiversity of multitude of flora and fauna both cultivated/domesticated and their ancestral wild counterparts. Comprising of both the endemic and the exotics i.e. those which are found only in exclusive environs of India and no other place and those that have migrated from other places and have acclimatized in Indian conditions. Justifiably, India has been named as the Mega Biodiversity Nation of the world. It makes interesting reading to know that India has wide variations in temperatures from minus 60 to plus 50 odd degrees from the cold deserts of Ladakh in J&K and Uttarakhand to parts of Rajasthan. Again rainfall variations from scanty to profuse, erratic to heavy and of long durations are the case with Rajasthan to North East. India's coastal line of 7500 km covering the Western Ghats and the Eastern Ghats, have very wide, varied and endemic biotic populations of terrestrial to aquatic nature. The mighty Himalayas have their own and very specific biotic populations while the North East have their endemic and exotic share in the flora and fauna. The central India is also very rich in endemic species of flora and fauna. Indo- Gangetic plains have been the rich repository of both wild and cultivated plant species and varieties.

India has three well marked seasons namely, winter, summer and the rainy season. The great variations in ecological conditions prevailing therein, tropical location, climate and physical features all are the factors that aid in supporting an enormous diversity of wild life, including hot desert forms, like wild ass to cold desert forms like the Tibetan Antelope,

animals inhabiting the open scrub lands like black buck, Grassy swamps like Rhinoceros, of deciduous forests like wild gaur and the lion tailed macaque. Another important feature of India is its unique bio- geographical composition as it combines living forms of three major bio-geographical realms viz. Eurasian, Agro tropical and the Indo-Malayan. India lies at the confluence / trijunction of Ethopian, Palaearctic and Indo-Malayan with interesting features. The Chinkara, the Hyena and the rat represent the Ethopian element. The Lynx, the wolf and the Hangul represent the Palaearctic and The Hoolock Gibbon, the goat antelope and the mouse deer are the Indo-Malayan representatives. The endemic varieties include Sloth Bear, the Black Buck, four horned antelope and the Nilgai.

So far in India, a large number of plants and animals, both at the macro and the micro level have been identified till date. 15,000 flowering plants, 5,430 insects spp., 5,050 Mollusks, 6,500 spp. of other invertebrates, 2,546 spp. of fishes, 1,228 spp. of birds, 446 spp. of reptiles, 372 spp. of mammals, and 204 spp. of amphibians have been identified, enlisted and classified so far but these figures are deficient as a very vast majority of the biotic life in India awaits action of identification, as India's biodiversity is estimated to be over 45,000 plant spp., a 7% of world's total and 10th place in the world's 25 most plant rich countries. On the faunal front, it has 6.5% of the world fauna. On the Agriculture front, India is bestowed with 166 spp. of crop and horticulture plants with 320 wild relative, forming a very potential and rich repository / gene bank. India's contribution to crop biodiversity has been impressive with repositories of over 50,000 varieties of rice, 5,000 of sorghum, 1,000 varieties of mango, etc. Here vegetation ranges from xerophytes to evergreens to deciduous to mangroves to conifers to alpine pastures of high reaches of the Himalayan regions. Floral diversity not only serves the food front but also the industry and the pharmaceutical fronts. On the other hand, the marine biodiversity of India's 7,500 km long coastline has the near shore rich fishing grounds and supports the coral reefs of Gulf of Kutch etc. The ocean forming coast line have rich resources in coral reef debris and sands which are highly exploited. Ornamental shells, pearl oysters are also a major source of commercial products.

India has four world recognized biodiversity hot spots viz. Western Ghats, North East States, the Indo-Burma and Sundaland, where the Indo-Burma covers only a miniscule part of North East India and the Sundaland hotspot consists of Nicobar Islands, therefore,

only the first two are the major hot spots of consequence. These two hot spots house endemic flora and fauna which is under threat. Western Ghats have moist deciduous forests and rain forests. This region shows high species diversity as well as high level of endemism i.e. the species found here are found nowhere else on this planet. About 62% of reptiles and 77% of amphibians are found here. In the extreme, North East states depict altitudinal variations. This area has at least 163 globally threatened species like the one horned Rhinoceros, wild Asian water buffalo, The Relict dragonfly is found here and is an endangered spp. Also this zone has the Himalayan new, the only Salamander spp. found within the Indian limits.

2.4.1 PRESERVING THE INDIAN BIODIVERSITY

For preserving the Indian biodiversity, 9 biosphere reserves have been set up in specific bio-geographic zones, the biggest being in the Deccan Peninsula in the Nilgiris, covering Tamil Nadu, Andhra Pradesh and Karnataka. Other biosphere reserves are Nanda Devi in Uttarakhand in the Western Himalayas, the Nokreh in Meghalaya, Manas and Saikhowa in Assam, the Sunderbans in West Bengal, Odisha, Great Nicobar and Gulf of Mannar in Tamil Nadu. This country has 103 National Parks housing large populations of tigers, one horned Rhinoceros, Asiatic lions and elephants.

Since the very survival of Indians and India is dependent upon the biodiversity, it becomes imperative to ensure that the biodiversity of the country is ferociously protected, allowed self regeneration and preserved on war footing, in all earnestness and by every citizen of the country.

2.5 HOT SPOTS OF BIODIVERSITY

A biodiversity hotspot first came into existence in 1988 when an English biologist Norman Myers projected the concept in the Conservation International (CI) Organization, a pioneer in the field, which not only accepted but also promoted the idea for a longtime exclusively. The CI adopted the idea of protecting those incredible places which were marked as hot spots and this became a loadstar for CI for nearly two decades. However, as on date the CI's mission has expanded beyond the ambit of protection of hotspots, as it has recognized that protection of species and places is not enough, as far as the human race on this planet to survive and thrive. Protection has to be holistic as far as the nature is concerned and it must form a fundamental part of every human society. Still the conservation / protection

remain the main goal of every human activity, also a basic and most important work for the CI for the following reasons.

A. Biodiversity is the base for the existence and proliferation of all life on this planet. Without species there would be no life supporting factors like the air, water, food. No human society can exist without these basic factors. All the places on the face of the earth, where biodiversity is under most threat, the hot spots are critical for the survival of the mankind.

B. The maps of hot spots overlap in most extraordinary manner with the maps of the natural places that are most beneficial to the mankind. So the hot spots are the richest and most important ecosystems in the world and are home to many vulnerable populations which are directly dependent upon nature to survive. As per an estimate while only 2.3% of the earth's surface houses forests, wetlands, other ecosystems in the hot spots, these account for 35% of all the ecosystem services that are the basic human need satisfiers and the human being depend upon.

2.5.1 HOT SPOT

As defined by Norman Myers, a hot spot is an area where:

1. at least 1500 vascular plant species are endemic i.e. growing exclusively in that habitat and nowhere else on this earth and in other words, a hot spot is irreplaceable;

2. there has been a loss of 70% or more of these species and must be under constant threat of further degradation and extinction.

In other words, there should be at least 30% or less of its original (endemic) natural vegetation and this must be under constant threat of further degradation and extinction.

There are about 35-36 places on this earth which meet the strict criterion of hot spots and are enlisted as the global biodiversity hot spots. These represent 2.3% of the earth's surface but support more than 50% of world's plant species as endemic and nearly 43% of bird, mammals, reptiles and amphibian spp. as endemic to these hot spots.

2.5.2 BIODIVERSITY HOT SPOTS IN INDIA

Some proclaim four hot spots in India that meet the strict criterion of hot spot while others are of the opinion that in reality only two hot spots exist in India. Four hot spots are in the region are:

1. Eastern Himalayan
2. Western Ghats
3. Indo Burma
4. Sundaland

1. EASTERN HIMALAYAS

This block encompasses Bhutan, North Eastern states, South Central and Eastern Nepal ranging from <500 meters to >8,000 meters above mean sea level and result in wide diversity of ecosystems from alluvial grasslands and sub-tropical broad leaved tree forests along the foot hills to temperate broad leaved forests in the mid hills, mixed conifers and conifer forests in the higher hill and the alpine meadows above the tree lines. These spots are a house to163 globally threatened plant and animal species including one horned rhinoceros (vulnerable) and wild Asian water buffalo (endangered). Of the 10,000 sp. of plants, 1/3rd are endemic, found at no other place on this planet. Endemic avians like the Himalayan quail, cheer pheasant and western trogopan are found here which are endemic and endangered and also houses Asia's largest and most endangered birds like Himalayan vulture and white billed Heron. Mammals like Golden Langur, Himalayan Tahr, Pygmy hog, Samber, langurs, snow leopard, black bear, blue sheep, Gangetic Dolphins, Swamp deer also inhabit this region.

Many varieties of orchids are found exclusively in this region and many such varieties are endangered and at the brink of extinction.

2. WESTERN GHATS

This hot spot consists of the South Western parts of India and the south Western high lands of Sri Lanka. These are also called Sahyadri Hills. Of the 1,90,000 sq. km. original area only 43,000 sq. km., is now available in its original pristine condition, because of extreme population pressure and it comprises of mountain forests. Wide variation in rainfall coupled with region's complex geography, there exists a great variety of vegetation types. There are low lying rain shadow areas, with scrub forests i.e. forest of under developed

trees and shrubs. The plains are covered with the deciduous and rain forests up to about 1,500 mts. above mean sea level and unique mosaic of mountain forests and rolling grasslands above 1,500 mts. heights. These areas are house to Asian elephants, Nilgiri Tahr, Indian Tiger, lion tailed Macaque (all endangered) and the Indian giant squirrel (least concerned). There are over 6,000 vascular plants belonging to 2,500 genera of which 3,000 are endemic to the Ghats. Black pepper and cardamom are having their origin in the Western Ghats. Highest concentration of flora and fauna in these Ghats is on Agasthyamalai Hills in Deep South. 450 bird spp., 140 mammal spp., 260 reptile spp., 175 amphibian spp. are found here. It has, therefore, been classified as one of the richest repositories of flora and fauna in the world.

3. INDO-BURMA

Geographically, Indo-Burma compartment covers only a very small part of the Indian territory and thus, does not qualify as even a minor hot spot as far as India is concerned. The Indo-Burma region encompasses several countries. It is spread out from Eastern Bangladesh to Malaysia and includes North-Eastern India south of Brahmaputra river, Myanmar, the southern part of China's Yunnan province, Lao People's Democratic Republic, Cambodia, Vietnam and Thailand. Much of this region has been deteriorating rapidly in the past few decades. This region is home to several primate species such as monkeys, langurs and gibbons with populations numbering only in hundreds. Many of the species, especially some freshwater turtle species, are endemic. Almost 1,300 bird species exist in this region. It is estimated that there are about 13,500 plant species in this hotspot, with over half of them endemic. Ginger, for example, is native to this region.

4. SUNDALAND

Sundaland is a region in South-East Asia that covers the western part of the Indo-Malayan archipelago. It includes Thailand, Malaysia, Singapore, Brunei and Indonesia. India is represented by the Nicobar Islands. The United Nations declared the islands a World Biosphere Reserve in 2013. The islands have a rich terrestrial and marine ecosystem that includes mangroves, coral reefs and sea grass beds. The marine biodiversity includes several species such as whales, dolphins, dugong, turtles, crocodiles, fishes, prawns, lobsters, corals and sea shells. The primary threat to this biodiversity comes from over exploitation of marine resources. In addition, the forests on the island also need to be protected. The

spectacular flora and fauna of the Sundaland Hotspot are succumbing to the explosive growth of industrial forestry in these islands.

2.6 BIO-GEOGRAPHIC REGIONS OF INDIA

India is a vast country with land, mountain and sea frontiers, wide variations in agro climatic and environmental conditions make it very rich house of diverse biotic material. The flora and fauna of the country is not only very large as far as its numbers are concerned but also in terms of variety species and genera of multitude of families. The range of the biota spreads from the deserts - hot and cold. Alluvial plains to the most rugged barren landscapes, from mountains and sub-mountains to the water bodies including marshes, rivers, lakes to sea shores to the seas. Scientific community, in order to study and document the biodiversity, must divide the whole country into specific zones, based on the geographical features and parameters.

Bio-geographical division of India can be defined as "A division of India according to bio-geographic characteristics, where biogeography is the study of distribution of species of flora and fauna and ecosystems in geographic space and through the geological times". The classification work has been done by the Wildlife Institute of India, an ace institute in this field having kept a bench mark of the rich genetic diversity of flora and fauna of the zones so identified. The bio-geographical zones are:

1. Trans-Himalayan zone
2. Himalayan zone
3. Desert zone
4. Semi-Arid zone
5. Western Ghats
6. The Deccan plateau
7. The Gangetic zone
8. North East zone
9. Coastal zone
10. Islands near shore line

These are the ten zones which cover the biodiversity of the country. The brief description of these zones is:

1. TRANS-HIMALAYAN

This falls in the North of the Great Himalayas and extends from Ladakh in J&K to Lahul and Sipiti of HP. It has sparse vegetation but has the richest wild sheep and goat community in the world. The snow leopard and the migratory black necked cranes are found here. It represents an extremely fragile ecosystem.

2. HIMALAYAN ZONE

It consists of the youngest and the loftiest mountain chain in the world. It has unique distinction owing to its high altitude, steep gradient and rich temperate flora. The forests are very dense with extensive growth of grasses and evergreen tall trees like oak, chestnut conifers i.e. pine and deodars. Above the snow line, there is no vegetation except the meadows. Wild sheep, mountain goat, ibex, panda, markhor, snow leopard, hangul and the musk deer are the faunal population found here. This region is one of the richest areas in terms of habitat and species.

3. SEMI-ARID ZONE

This is located as a transitional zone between the desert and the denser forests of the Western Ghats, has by and large thorny vegetation which is discontinuous with open areas of bare and water deficit soils, throughout the year. Thorny shrubs, grasses and some species of bamboo are the main ground cover. Birds, jackals, leopards, eagles, snakes, foxes, samber, chital, wolf and the lions are also found here.

4. WESTERN GHATS

One of the unique biological regions, a biodiversity hot spot, is the mountains along the west coast of the peninsular India. Varied climate and the diverse topography create a wide array of habitat which supports a unique set of flora and fauna species. Wide cultural diversity also exists due to the presence of indigenous human populations here. Western Ghats are one of the world's 25 biodiversity hot spots. The hills are the fertile ground for the high level of endemic species of flora and fauna of higher and micro level species. Nilgiri Langur, lion tailed macaque, Malabar grey hornbills are found exclusively here.

5. NORTH WEST DESERT

With less than 70 cm rain fall, this zone comprises of parts of Rajasthan, Kutch, Gujarat and Delhi with climate very hot and dry in summer and cold winter, this zone supports mostly the xerophytic plant species like kikar, wild palms, etc., highly endangered Indian Bustard, camel, wild ass, fox and snakes.

6. DECCAN PLATEAU

A semi arid region lying in the rain shadow of the Western Ghats way beyond the ghats is the Deccan Plateau. This is the largest part of the peninsular plateau of India. The high land of this zone is house to different types of the forests, majority being the deciduous ones, which give a vast variety of forest products. This region consists of the regions lying south of the Satpura range, extending up to the southern tip of India. Species found here include chital, nilgai, chousingha, barking deer, elephant, wild buffalo. Swamp deer is restricted to only a single location of Madhya Pardesh.

7. GANGETIC PLAINS

Descending from the Himalayan foot hills, the Gangetic plains, in the North, are the largest unit of the great plains of India. The Ganges is the main river passing through this region. These plains are a rich centre of biodiversity. The forests are by and large of sal, teak, sheeshum, mahua, kher and among the animal spp. Rhino, elephant, swamp deer, hog deer, wild buffalo and hispid hare are found here.

8. NORTH EAST INDIA

It is a treasure house of biodiversity in the country. This is also a biodiversity hot spot on the world map on biodiversity. It has many wild ancestors of the cultivated plants like banana, mango, citrus, pepper, also a fountainhead of orchids, bamboo, ferns etc.

9. COASTS

India's coastline varies in characteristics and structures giving a wide scope for the housing of great variety of flora and fauna, including the deltas mangroves. The soil are very rich for agro horticulture, mostly coconut and rubber plantation.

10. ISLANDS

There are two groups of islands, Arabian Sea islands and Bay islands, which differ significantly in origin and physical characteristics. Best preserved evergreen forests of Lakshadweep are unique in India. Some islands are having coral reefs at their periphery and the tropical moist and evergreen forests with majority of the endemic flora and fauna found only here.

2.7 SUMMARY

The biodiversity in India has a very special and important status on the world map of biodiversity. Because of its long frontiers and coastal line as well as the North West to North East Himalayan ranges, with vast range of agro climatic, environmental ecosystems, the natural occurrence of flora and fauna, both endemic and exotic, makes the country rich in biodiversity. However, there is dire need to preserve and conserve these rich resources for the generations to come. Any deviation in approach to protection of the flora and fauna will have consequences of colossal dimensions and the generation will have to face the consequences of our laxity.

2.8 GLOSSARY

Arid Zone	A desert zone with very low rainfall.
Biodiversity	Varietal forms of living organisms.
Biotic	Pertaining to life.
Coastal Zone	Area that extends from the high tide mark on land to the edge of the continental shelf, which is the submerged part of the continent.
Ecosystem	Complete ecological system of an area including living and non-living components.
Endangered	Species threatened or at the verge of extinction due to survival of only few members.

Endemism	Restricted distribution of species to an isolated region.
Flora	Pertaining to plants.
Fauna	Pertaining to animals.
Mangrove Vegetation	Plants with salt tolerant trees characterized by stilt roots and shallow marine sediments.
National Park	Well demarcated and protected area of natural landscape.
Species Diversity	Number of plant and animal species found in a community or ecosystem.
Swamp	Wetland dominated by trees and shrubs.
Temperate Forest	Forest found in region with freezing winter and warm and humid summer.
Wetlands	Area which is saturated by surface or ground water with vegetation adapted for life under those soil conditions as swamps, bogs, marshes and estuaries.

2.9 SUGGESTED QUESTIONS

2.9.1 Multiple Choice Questions

1. How many bio-geographical regions are present in India?

   a. 3 b. 4 c. 7 d. 10

2. Which one of the following areas in India, is a hotspot of biodiversity?

   a. Sunderbans b. Western Ghats

   c. Eastern Ghats d. Gangetic Plain

3. Which one of the following is not observed in biodiversity hotspots?

a. Species richness b. Endemism

c. Accelerated species loss d. Lesser inter- specific competition

4. Select the correct statement about biodiversity

   a. The desert areas of Rajasthan and Gujarat have a very high level of desert animal species as well as numerous rare animals

   b. Large scale planting of BT cotton has no adverse effect on biodiversity

   c. Western Ghats have a very high degree of species richness and endemism

   d. Conservation of biodiversity in just a fad pursued by the developed countries

5. Biodiversity of a geographical region represents

   a. Genetic diversity present in the dominant species of the region

   b. Species endemic to the region

   c. Endangered species found in the region

   d. The diversity in the organisms living in the region

Answers

1. d 2. b 3. d 4. c 5. d

2.9.2 Short Answer Questions

1. Define biodiversity.
2. When was the term Biodiversity coined and by whom?
3. What do you understand by the term Biodiversity Hotspot?
4. Name the two conditions required to declare a place as a hotspot?
5. How many hotspots exist in India and where?
6. Who coined the term Biodiversity Hotspot and when?
7. What type of vegetation is found above the tree line in higher reaches of the Himalayas?

8. What do you understand by the term Bio-geographic region?

9. Name any five Bio-geographic regions of India?

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BIODIVERSITY: THREATS AND CONSERVATION

3.1 INTRODUCTION

Biodiversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels; the genetic variability within a species, the variety of species within a community, and the organization of species in an area into distinctive plant and animal communities constitutes ecosystem diversity. Numerous resources are present which are very useful for our healthy survival. But to our great disappointment, biodiversity is currently being lost at an unprecedented rate globally. The decline in biodiversity has been more rapid in the past fifty years than ever before in human history and human activities are causing increased extinction rates. One eighth of known plant species are threatened with extinction which indicates unsustainable ecological practices.

3.2 OBJECTIVES

In this lesson, we will study various threats to biodiversity e.g. habitat loss, poaching of wildlife, and man wildlife conflicts; conservation of biodiversity, *In-situ* and *Ex-situ* conservation of biodiversity; and endemic and endangered species of India.

3.3 THREATS TO BIODIVERSITY

Biodiversity loss is caused mainly by :

- Habitat destruction (for example through construction and wetland drainage or infilling)
- Invasive alien species (such as Japanese Knott Weed and Zebra Mussel)

- Pollution (for example from use of excess fertilizer leading to excessive levels of nutrients in soil and water)
- Land use change (such as conversion of land to plantation forestry or agriculture)
- Climate Change
- The unsustainable harvesting of natural resources, including plants and animals i.e. overgrazing and overhunting
- The loss, degradation or fragmentation of ecosystems through land conversion for agriculture, forest clearing etc.

3.3.1 HABITAT LOSS

Habitat loss is the process in which natural habitat is unable to support the species present. In this process, the organisms that previously used the site are displaced or destroyed, reducing biodiversity. This occurs when a particular area is converted from usable to unusable habitat. Most of the species extinctions from 1000 AD to 2000 AD were due to human activities, in particular destruction of plant and animal habitats. Raised rates of extinction are being driven by human consumption of organic resources, especially related to tropical forest destruction. Habitat fragmentation is a further aspect of habitat loss which is defined as a decrease in some or all types of natural habitats in a landscape, and the dividing of the landscape into smaller and more isolated pieces. Fragmentation can be caused by natural processes such as fires, floods, and volcanic activity, but is more commonly caused by human impacts. It often starts with some small and harmless impacts and with the increase in human activities, the influence of fragmentation becomes greater. In the end, it leads to devastating effects on native species and total change in the landscape. Any species that requires a large home range, such as a grizzly bear will not survive if the area is too small.

3.3.1.1 FACTORS CONTRIBUTING TO HABITAT LOSS

Overpopulation, deforestation, air pollution, water pollution, soil contamination, global warming, climate change, industrial activities, agriculture, aquaculture, mining, and water extraction are all central causes of habitat loss.

3.3.1.2 IMPACTS OF HABITAT LOSS

- Many endemic organisms have very specific requirements for their survival that can only be found within a certain ecosystem, resulting in their extinction.
- Habitat destruction can also decrease the range of certain organism populations. This can result in the reduction of genetic diversity and perhaps the production of infertile youths, as these organisms would have a higher possibility of mating with related organisms within their population, or different species.
- Habitat destruction vastly increases an area's vulnerability to natural disasters like flood and drought, crop failure, spread of disease, and water contamination.
- Humans also lose direct uses of natural habitat when habitat is destroyed such as aesthetic uses e.g. bird watching, recreational uses like hunting and fishing, and ecotourism.
- Habitat destruction has altered nitrogen, phosphorus, sulfur, and carbon cycles, which has increased the frequency and severity of acid rain, algal blooms, and fish kills in rivers and oceans and contributed tremendously to global climate change.

SOLUTIONS

- Protecting remaining intact sections of natural habitat.
- Educating the public about the importance of natural habitat and biodiversity.
- Finding ecological ways to increase agricultural output without increasing the total land in production.
- Preserving habitat corridors to minimize prior damage from fragmented habitats.
- Reduction in human population expansion.

3.3.2 POACHING OF WILDLIFE

Poaching has traditionally been defined as the illegal hunting or capturing of wild animals. Since the 1980s, the term "poaching" has also referred to the illegal harvesting of wild plant species. In agricultural terms, the term 'poaching' is also applied to the loss of soils or grass by the damaging action of feet of livestock which can affect availability of productive land, water pollution through increased runoff and welfare issues for cattle.

In other words, Poaching is the illegal taking of wild plants or animals contrary to local and international conservation and wildlife management laws. Violations of hunting laws and regulations are normally punishable by law and, collectively, such violations are known as poaching.

3.3.2.1 LEVELS OF POACHING

- Subsistence Poaching: In this, a person usually hunts/traps for himself and his family. This individual is often driven by poverty at first but can quickly cross over to becoming a commercial poacher. He will use whatever he has available to get his food.
- Commercial Poaching: Poaching for bush meat, traditional medicine and narcotic sales.
- Syndicate Poaching: This is sophisticated organized crime, well funded, well networked and internationally orchestrated. Large networks of individuals are recruited to do the poaching. They always operate in groups, often very large groups of between 5 and 25 members. They are driven by a significant monetary motive.

3.3.2.2 EFFECTS OF POACHING

- Defaunation of forests: predators, herbivores and fruit-eating vertebrates cannot recover as fast as they are removed from a forest, the pattern of seed predation and dispersal is altered; tree species with large seeds progressively dominate a forest, while small-seeded plant species become locally extinct.
- Reduction of animal populations in the wild and possible extinction.
- The effective size of protected areas is reduced as poachers use the edges of these areas as open-access resources.
- Many tribal people rely on hunting for food and have become victims of the fallout from poaching.

3.3.3 MAN AND ANIMAL CONFLICT

Human wildlife conflict is defined by the World Wide Fund for Nature (WWF) as "any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, on the conservation of wildlife populations, or on the environment". Human and wildlife conflict is the most deliberated topic in the recent times. The conflict takes many forms ranging from loss of life or injury to humans, and animals both wild and domesticated, to competition for scarce resources to loss and degradation of habitat. Due to the rapid increase in urbanization, there has been drastic depletion in the forest and grassland cover with diminishing natural resources. Continuous growth of human activities in the corridors of the forest, has posed a serious threat to the survival of many wild animals.

The instances of man-animal interface have grown in recent years, particularly in respect of wild elephants and bear. There are cases of human kill, human injury, cattle kill, house damage and crop damage by wild animals; and also penalizing killing of wild animals.

3.3.3.1 CAUSES OF CONFLICTS

Increased fragmentation, increasing conflicts: The gradual loss of habitats has led to increasing conflict between the humans and wildlife. As wildlife range has become more and more fragmented and wildlife is confined into smaller pockets of suitable habitat, humans and wildlife are increasingly coming into contact and in conflict with each other.

Impact of human activities: Human activities such as animal husbandry, agriculture, development of infrastructure, tourism have modified wildlife habitat. With extensions of human activities, especially animal husbandry, it has become common for livestock and wild ungulates to share the same grazing fields. Also in recent years the successful recovery of the declining or near extinct species through wildlife management and protection from poaching and overexploitation has created new conflicts.

Natural factors: Droughts, bush fires, climatic changes and other unpredictable natural hazards also contribute to the decrease in suitable wildlife habitat and therefore affect the occurrence and extent of human-wildlife conflicts. Similarly, the seasonal modification of habitats due to rainfall can also have an impact on human-wildlife conflict.

3.3.3.2 EFFECTS OF CONFLICTS

- Injury and loss of life of humans and wildlife.
- Crop damage, livestock depredation, predation of managed wildlife stock.
- Damage to human property.
- Trophic cascades (Trophic cascades occur when predators limit the density and/ or behaviour of their prey and thereby enhance survival of the next lower trophic level).
- Destruction of habitat.
- Collapse of wildlife populations and reduction of geographic ranges.

3.4 BIODIVERSITY CONSERVATION

Biodiversity conservation focuses on the sustainable management of wealth of biological diversity, comprising land and marine ecosystem, agroecosystems and production areas and *ex-situ* conservation. These conservation efforts must safegaurd traditional knowledge system and develop biodiversity utilization systems based on equitable sharing of benefits. The growing concern over the mass extinction of biodiversity has galvanized much theoretical and empirical research to improve the efficacy of conservation efforts.

Conservation of biodiversity can be achieved in a number of ways. These methods can be broadly classified as *in-situ* and *ex-situ* conservation. *In-situ* conservation includes conservation of plants and animals in their native ecosystems or in man-made ecosystems, where they naturally occur. *Ex-situ* conservation is the conservation of samples of genetic diversity (particularly representing endangered species) away from their natural habitats.

NEED TO CONSERVE BIODIVERSITY:

It is important to conserve biodiversity for the sake of our own curiosity and aesthetic appreciation. About 40% of all prescriptions are for medicines that originated from plants and animals. Edible plant species offer a tremendous resource of possibilities that could greatly add to the security of our food. Biodiversity is the life support system of our planet. We depend on it for the air we breathe, the food we eat, and the water we drink. Wetlands

filter pollutants from water, trees and plants reduce global warming by absorbing carbon, and bacteria and fungi break down organic material and fertilize the soil. It has been empirically shown that native species richness is linked to the health of ecosystems, as is the quality of life for humans. The connections between biodiversity and our sustainable future appear closer and closer the more we look. Therefore, we need to conserve biodiversity as our lives depend on it.

3.4.2 BENEFITS OF BIODIVERSITY CONSERVATION

- Conservation of biological diversity leads to conservation of essential ecological diversity to preserve the continuity of food chains.
- The genetic diversity of plants and animals is preserved.
- It ensures the sustainable utilization of life support systems on earth.
- It provides a vast knowledge of potential use of plant and animal resources to the community.
- A reservoir of wild animals and plants is preserved, thus enabling them to be introduced, if need arises, in the surrounding areas.
- Biodiversity conservation assures sustainable exploitation of potential resources.

3.5 *IN-SITU* AND *EX-SITU* CONSERVATION

3.5.1 *IN-SITU* CONSERVATION

The word *in-situ* refers for 'on-site conservation'. *In-situ* conservation aims to enable biodiversity to maintain itself within the context of the ecosystem in which it is found. It is the process of protecting an endangered plant or animal species in their natural habitat, either by protecting or cleaning up the habitat or by defending the species from predators. The *in-situ* conservation maintains recovering populations in the surroundings where they have developed their distinctive properties and helps to ensure the ongoing processes of evolution and adaptation within their environments. Wildlife and livestock conservation is mostly based on *in-situ* conservation. Sufficiently large reserves are

maintained to enable the target species to exist in large numbers. The main examples of such reserves are national parks, biosphere reserves and wild life centuries.

3.5.1.1 NATIONAL PARKS

A national park is a park in use for conservation purposes. A national park is a large reserve of natural or semi-natural land, declared by a national government, set aside for its features of predominantly unspoiled landscape, flora and fauna protected from all interferences other than essential management practices, so that its natural attributes are preserved. A national park has the following defining characteristics.

- One or several ecosystems not materially altered by human exploitation and occupation, where plant and animal species, geomorphological sites and habitats are of special scientific, educational, and recreational interest.
- Visitors are allowed to enter, under special conditions, for inspirational, educative, cultural, and recreative purposes.
- Minimum size of 1,000 hectares within zones in which protection of nature takes precedence.
- Statutory legal protection.
- Prohibition of exploitation of natural resources qualified by such activities as sport, fishing, the need for management, facilities, etc.

The wildlife national parks in India spread across the country offer a fascinating diversity of terrain, flora and fauna, e.g. Kaziranga national park in east famous for one horned rhino, Kanha national park in the centre, Nagarhole national park in south, Corbett national park in north and Sundarbans national park in the west part of India.

India's first national park was established in 1935 as Hailey National Park, presently known as Corbett National Park, Uttarakhand. By 1970, India had only five national parks. India enacted the Wildlife Protection Act and Project Tiger to safeguard the habitats of conservation dependent species in 1972. As of July 2017, there are 103 national parks encompassing an area of 40,500 km^2 (15,600 sq mi), comprising 1.23% of India's total surface area. A few main national parks are listed in Table 3.1 alongside their state.

Table 3.1 : Important national parks in India.

National Park	State	Important wildlife	Started
Kaziranga	Assam	One horned Rhino	1974
Gir	Gujarat	Indian Lion	1975
Dachigam	J&K	Hangul	1981
Bandipur	Karnataka	Elephant	1974
Periyar	Kerala	Elephant, Tiger	1982
Kanha	M.P	Tiger	1955
Corbett	Uttarakhand	Tiger	1935
Dudhwa	U.P	Tiger	1977
Ranthambore	Rajasthan	Tiger	1980
Sariska	Rajasthan	Tiger	1982
The Great Himalaya	Himachal Pradesh	Snow Leopord	1984
Sundarban	West Bengal	Royal Bengal Tiger	1984
Nagarhole	Karnataka	Elephant, Jackal, Tiger	1988

3.5.1.2 BIOSPHERE RESERVES (BR)

Biosphere reserves (BR) are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Program to promote sustainable development based on local community efforts and sound science. The program of Biosphere Reserve was initiated by UNESCO in 1971. The purpose of the formation of the biosphere reserve is to conserve *in-situ* all forms of life, alongwith its support system, in its totality, so that it could serve as a referral system for monitoring and evaluating changes in natural ecosystems. Biosphere reserves are areas of prevented ecosystems promoting solutions to reunite the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under independent jurisdiction of the located states. Biosphere reserves serve as living laboratories for testing out and demonstrating integrated management of land, water and biodiversity.

3.5.1.2.1 CRITERIA FOR DESIGNATION OF BR

- A site must contain an effectively protected and minimally disturbed core area of value of nature conservation.

- The core area should be typical of a bio-geographical unit and large enough to sustain viable populations representing all trophic levels in the ecosystem.
- Areas having potential for preservation of traditional tribal or rural modes of living for harmonious use of environment.

3.5.1.2.2 STRUCTURE AND FUNCTIONS OF BR

Biosphere reserves are demarcated into following 3 inter-related zones:

Core Zone : Core zone contains suitable habitat for numerous plant and animal species and may contain centres of endemism (a localised area which has a high occurrence of endemic species). Core areas often conserve the wild relatives of economic species and also represent important genetic reservoirs having exceptional scientific interest. The core zone is to be kept free from human pressures external to the system.

Buffer Zone : The buffer zone adjoins or surrounds core zone, uses and activities are managed in this area in such ways that help in protection of core zone in its natural condition. Human activities are likely to continue if these do not adversely affect the ecological diversity.

Transition Zone : The transition area is the outermost part of a biosphere reserve. This is usually not delimited one and is a zone of cooperation where conservation knowledge and management skills are applied and uses are managed in harmony with the purpose of the biosphere reserve. This includes settlements, crop lands, managed forests and area for intensive recreation and other economic uses characteristics of the region.

Collectively, biosphere reserves form a world network and known as the World Network of Biosphere Reserves (WNBR). The first biosphere reserve of the world was established in 1979, since then the network of biosphere reserves has increased to 669 in 120 countries across the world in the year 2016. The Indian government has established 18 Biosphere Reserves of India, which protect larger areas of natural habitat than a national park and often include one or more national parks along buffer zones that are open to some economic uses (Table 3.2).

Table 3.2: Some of the biosphere reserves in India

Name	Location	State	Type	Year	Area (km)
Gulf of Mannar	Indian part of Gulf of Mannar between India and Sri Lanka	Tamil Nadu	Coasts	1989	10500
Sunderbans	Part of delta of Ganges and Barahamaputra river system	West Bengal	Gangetic Delta	1989	9630
Nanda Devi	Parts of Chamoli District, Pithoragarh District & Almora District	Uttarakhand	West Himalayas	1988	5860
Nilgiri	Part of Wynad, Nagarhole, Bandipur and Mudumalai, Nilambur, Silent Valley and Siruvani Hills	Tamil Nadu, Kerala and Karnataka	Western Ghats	1986	5520
Simlipal	Part of Mayurbhanj district	Orissa	Deccan Peninsula	1994	4374
Pachmarhi	Parts of Betul, Hoshangabad and Chhindwara district	M.P.	Semi-arid	1999	4926
Nokrek	Part of Garo Hills	Meghalaya	East Himalayas	1988	820
Gyan Bharti	Part of Kuchh, Rajkot and Surendra nagar district	Gujarat	Semi-arid	2008	12454
Manas	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamrup and Darrang District	Assam	East Himalayas	1989	2837
Great Nicobar	Southern most islands of Andaman and Nicobar Islands	Andaman and Nicobar Islands	Islands	1989	885
Dehang Debang	Parts of Siang and Debang valley	Arunachal Pradesh	East Himalaya	1998	5112
Achana-kamar	Part of Annupur, Dindori and Bilaspur district	MP, Chhattishgarh		2005	3835
Kanchan-junga	Part of Kanchanjunga hills	Sikkim	East Himalaya	2000	2620
Agasthaya-malai	Neyyar, Peppara and Shenduruny wildlife sanctury and adjoining areas	Kerala	Western Ghats	2001	1828
Dibru Saikhowa	Part of Dibrugarh and Tinsukia district	Assam	East Himalaya	1997	765

3.5.1.3 WILDLIFE SANCTUARIES

Wildlife sanctuary is a protected area which is reserved for the conservation of only animal and human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not interfere with well-being of animals. Sanctuary is an area which is of adequate ecological, faunal, floral, Geo-morphological, natural or zoological significance. The Sanctuary is declared for the purpose of protecting, propagating or developing wildlife or its environment.

In India, 543 wildlife sanctuaries are established, which are scattered all across the country. These sanctuaries attract the tourists with their beautiful landscapes, amazing rock formation and diverse range of flora and fauna. Most of these sanctuaries were originally private hunting grounds of the former Indian aristocratic families. These sanctuaries are home to several endangered species of animals and birds. Many of the forest reserves and wildlife sanctuaries of India are famous for some particular species of animals.

The wildlife sanctuaries of India also include the bird sanctuaries. Some important wildlife sancturies are listed in Table 3.3.

Table 3.3 Some Important wild life sanctuaries of India

Name of sanctuary	State	Important wildlife
Ghana Bird Sanctuary	Rajasthan	300 species of birds
Hazaribagh Sanctuary	Bihar	Tiger, Leopard
Sultanpur Bird Sanctuary	Haryana	Migratory birds
NalSarovar Bird Sanctuary	Gujrat	Water birds
Abohar Wildlife sanctuary	Punjab	Black Duck
Mudanmalai Wildlife Sanctuary	Tamilnadu	Tiger, Elephant, Leopard
Vedanthangal Bird Sanctuary	Tamilnadu	Water birds
Jaldapara Wild life sanctuary	W. Bengal	Rhinoceros, elephant, Tiger
Wild Ass Sanctuary	Gujarat	Wild ass, wolf, nilgain, Chikara

3.5.2 *EX-SITU* CONSERVATION

Ex-situ conservation refers to 'off-site conservation'. It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location. It is a technique of conservation of biological diversity outside its natural habitats. Its concept was developed earlier before its official adoption under the Convention on Biological Diversity signed in 1992 in Rio de Janeiro. *Ex-situ* conservation is applied as an additional measure to supplement *in-situ* conservation. *Ex-situ* conservation includes a variety of activities, from managing captive populations, education and raising awareness, supporting research initiatives and collaborating with *in-situ* efforts. It is used as a valuable tool in studying and conserving biological resources for different purposes through different techniques such as zoos, captive breeding, aquarium, colony relocation, botanical gardens, gene banks etc.

3.5.2.1 COLONY RELOCATION : In *ex-situ* conservation techniques, the best method of maximizing a species chance of survival is by relocating part of the population to a less threatened location.

3.5.2.2 SEED BANKS : These are protected houses of specimens for breeding and reintroduction into the wild. Endangered plants may also be preserved in part through seed banks or germplasm banks. The term seed bank sometimes refers to a cryogenic laboratory facility in which the seeds of certain species can be preserved at very low temperature for upto a century or more without losing their fertility.

3.5.2.3 ZOOS: Zoos are zoological parks in which animals are confined within enclosures or semi-natural and open areas, displayed to the public, and in which they may also breed. Zoos breed many endangered species to increase their numbers. Such captive breeding in zoos has helped to save several species from extinction.

3.5.2.4 AQUARIA: An aquarium is an artificial habitat for water-dwelling animals. The aquaria have largely been used for display and educational facilities. However, they are assuming new importance in captive breeding programs. Growing threats to freshwater species in particular are leading to the development of aquaria based *ex-situ* breeding programs.

3.5.2.5 CAPTIVE BREEDING : Captive breeding is the process of breeding animals

in controlled environments within well-defined settings, such as wildlife reserves, zoos and other commercial and non-commercial conservation facilities. Sometimes the process includes the release of individual organisms to the wild, when there is sufficient natural habitat to support new individuals or when the threat to the species in the wild is lessened. While captive breeding programs may save species from extinction, release programs have the potential for diluting genetic diversity and fitness.

3.5.2.6 BOTANICAL GARDENS : Botanical gardens are used to grow and display plants primarily for scientific and educational purposes. They provide different services like conservation of plant diversity, forestry, pharmaceutical and biofuel industries, protected area management, ecotourism etc. They have a unique opportunity for conservation of plant diversity by shaping and mobilizing citizens to the current environmental challenges. Botanical gardens give opportunity for arable plants (plants that are naturally present on arable farmland which refers to fields that are used to grow crops) to be grown under relatively modified environmental conditions.

3.5.2.7 CRYOPRESERVATION: Cryopreservation is the process of freezing biological material at extreme low temperatures; most common at -196 °C/-321 °F in liquid nitrogen. At these low temperatures, all biological activity stops, including the biochemical reactions that lead to cell death and DNA degradation. This preservation method in theory makes it possible to store living cells as well as other biological material unchanged for centuries and hence helps in conservation.

3.6 Endemic and Endangered species of India

Endemic species are plants or animals exist in some particular regions and nowhere else in the world. Endemic species are plants and animals that exist only in one geographic region. Species can be endemic to large or small areas of the earth. Some are endemic to a particular continent, some to part of a continent, and others to a single island. Unless conserved, these will disappear from earth. Endangered species are animals or plants that have become so rare that they are in danger of becoming extinct and if not conserved properly, will ultimately extinct.

3.6.1 ENDEMIC SPECIES

Endemic species are plants and animals that exist only in one geographic region and no-

where else in the world. In India, endemic species are mostly in Himalaya and Western Ghats. Some of the endemic animals in India are:

1. Lion tailed Macaque

2. Nilgiri Langur

3. Brown Palm Civet

4. Nilgiri Tahr

3.6.2 ENDANGERED SPECIES

In India, around 450 plant species, 100 mammals and around 150 types of birds are considered as endangered. Unless we take immediate actions for protecting these species, all these species will be extinct from earth. More species are coming under the endangered category every year due to reasons like over-exploitation of resources and habitat destruction.

Critically Endangered animals :

1. Jenkin's Shrew

2. Malabar Large Spotted Civet

3. Namdapha Flying Squirrel

4. Pygmy Hog

5. Salim Ali's Fruit Bat

6. Sumatran Rhinoceros

7. Wroughton's Free Tailed Bat

Endangered animals :

1. Asiatic Lion

2. Asiatic Black Bear

3. Desert Cat

4. Great Indian Rhinoceros

5. Indian Elephant or Asian Elephant

6. Blue Whale

7. Capped Leaf Monkey

8. Fin Whale

9. Ganges River Dolphin

10. Hispid Hare

11. Indus River Dolphin

12. Red Panda

3.7 SUMMARY

During the last century, biodiversity loss has been increasingly observed. One eighth of known plant species are threatened with extinction. Edward O. Wilson prefers the acronym HIPPO, standing for Habitat destruction, Invasive species, Pollution, Human Over population, and Overharvesting. The most authoritative classification in use today is that of IUCN's Classification of Direct Threats adopted by most major international conservation organizations such as the US Nature Conservancy, the World Wildlife Fund, Conservation International, and Birdlife International. The main causes of threats to biodiversity includes over-hunting, destruction of habitat, introduction of exotic species, genetic and environmental pollution, climate change and some times man-animal conflict. Biodiversity conservation focuses on the sustainable management of wealth of biological diversity, comprising land and marine ecosystem, agroecosystems and production areas and *ex-situ* conservation. Prof. Michael E. Soulé, a US biologist distinguishes eight different tactics for conserving biodiversity including the use of large protected reserves, unprotected but largely undeveloped lands, extractive reserves with limited sustainable harvest, restoration projects, zooparks for both indigenous and non-indigenous species, agroecosystem and agroforestry lands, living *ex-situ* preserves such as zoos, aquaria or gardens and germplasm banks. *In-situ* conservation includes conservation of plants and animals in their native ecosystems or in man-made ecosystems, where they naturally occur. *Ex-situ* conservation is the conservation of samples of genetic diversity (particularly representing endangered species) away from their natural habitats. India's first national park was established in 1935 as Hailey National Park, presently known as Corbett National Park, Uttarakhand.

A total of 103 national parks have been authorized. Biosphere reserves are areas of prevented ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. The Indian government has established 18 Biosphere Reserves of India, which protect larger areas of natural habitat than a national park and often include one or more national parks along buffer zones that are open to some economic uses. Wildlife Sanctuary refers to the zoned area set aside by law for the preservation of wildlife where hunting is strictly prohibited and wildlife to be reproduced naturally. In India over 543 wildlife sanctuaries are established, which are scattered all across the country. *Ex-situ* conservation refers to 'off-site conservation'. It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location, e.g. Zoos, botanical gardens and seed banks. Endemic species are plants and animals that exist only in one geographic region. Species can be endemic to large or small areas of the earth. Unless conserved, these will disappear from earth. Endangered species are animals or plants that have become so rare that they are in danger of becoming extinct and if not conserved properly, will ultimately extinct.

3.8 GLOSSARY

Captive breeding : It is the process of breeding animals in controlled environments within well-defined settings, such as wildlife reserves, zoos and other commercial and non-commercial conservation facilities.

Endangered Species : These are animals or plants that have become so rare that they are in danger of becoming extinct and if not conserved properly, will ultimately extinct.

Endemic Species : Endemic species are plants and animals that exist only in one geographic region. Unless conserved, these will disappear from earth.

***Ex-situ* Conservation :** It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location. It is the conservation of biological diversity outside its natural habitats.

***In-situ* Conservation :** It is the process of protecting an endangered plant or animal species in their natural habitat, either by protecting or cleaning up the habitat or by defending the species from predators.

3.9 QUESTIONS

Descriptive type/Short answers questions

1. Write an explanatory note on threats to biodiversity with the suitable example; explain how poaching and human wildlife conflicts are responsible for biodiversity loss.
2. What are endemic and endangered species? Give examples for each.
3. Explain *'in-situ'* and *'ex-situ'* approaches of conservation of biodiversity.
4. Write short notes on

· Habitat loss

· Poaching of wildlife

· Man-wildlife conflict

· Biodiversity treaty

MULTIPLE CHOICE QUESTIONS

1. Which of the following is an endemic species of India

   a) Asian elephant b) Lion-tailed macaque

   c) Whales d) Panda

2. Which of the following is a cause of loss of biodiversity

   a) Habitat degradation and loss b) Invasion of non native species

   c) Pollution d) all of the above

3. Kaziranga National Park is famous for

   a) Rhinoceros b) Tiger

   c) Elephant d) Musk deer

4. In India, number of Biosphere Reserves are

   a) 12 b) 18

c) 15 d) 13

5. Dachigam National Park is famous for conservation of

a) Rhinoceros b) Asiatic Lion

c) Tiger d) Hangul

6. If a person hunts/traps the wildlife for himself and his family, it is called as

a) Subsistence Poaching b) Commercial Poaching

c) Syndicate Poaching d) None of the above

Answers

Multiple choice questions

1.b 2.c 3.c 4.b 5.d 6.a

3.10 SUGGESTED READINGS AND REFERENCES

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ECOTOURISM AND GREEN MARKETING

4.1 INTRODUCTION

People are gaining environmental consciousness. Due to the pressures of growing population our planet's natural communities are shrinking rapidly all over, because of the expansion of agriculture, urbanization, damming, forest fragmentation, contaminants of underground water, building of roads, etc. Tourism is one of the world's fastest growing industries and an important source of foreign exchange and employment for developing countries.

Tourism has the potential to increase public appreciation of the environment and to spread awareness of environmental problems when it brings people into closer contact with nature and the environment. This contact may improve awareness of people about the value of nature and lead to environmentally conscious behavior and activities for the preservation of the environment. Uncontrolled conventional tourism poses potential threats to many natural areas around the world. It can put pressure on an area and lead to impacts such as soil erosion, increased pollution, effluent discharge in the water bodies, habitat loss, increased vulnerability to forest fires, etc. There is also pressure on water resources and it makes the local population to compete for resources. The sustainability in tourism for the long run can be achieved by incorporating the principles and practices of sustainable development that too to increase the benefits from tourism resources for the population in host communities,while maintaining the cultural and environmental integrity of the host communities and enhancing the protection of ecologically sensitive areas and natural heritages is necessary.

The concept of eco tourism was developed in 1980's as a combination of preservation or conservation of natural areas and tourism. It was coined by a Mexican ecology-economist Hector Ceballos Lascuria. The term is referred to a travel which is ecologically and culturally

sensitive, combining the understanding of flora, fauna and their ecological interactions with the opportunity to contribute to their ongoing and future protection.

Ecotourism probably had its foundations in the ethics of conservation, but its recent surge has certainly been due to its economic benefits as developing countries begin to recognize that nature-based tourism offers a means of earning money with relatively little exploitation or extraction of resources. It is this economic incentive, perhaps more than the consciousness of human ethics that has given rise to the global expansion of environmentally responsible tourism activities.

Eco tourism is a simple concept where tourists are drawn to areas that are ecologically significant and which are preserved and protected and the money that is spent by tourists for food, lodging, transport, guide service, park fees, etc. will support the local economy by providing jobs and creating a sustainable economic infrastructure. Ecotourism is loosely defined as nature-based tourist experiences, whereby visitors travel to regions for the sole purpose of appreciating their natural beauty.

4.2 CONCEPT AND DEFINITIONS OF ECOTOURISM

The term "Ecotourism" was coined by Mexican environmentalist Hector Cebellos Lascurian in 1983 and was brought to light in 1996 through his paper "Tourism, ecotourism and protected areas". It is also argued that the term was in use earlier also. The term ecotourism involves travel to the areas of natural or ecological importance for the purpose of observing wildlife and learning about the environment. Principally ecotourism means making a little environmental impact as possible and helping to sustain the indigenous population, thereby encouraging the conservation of wildlife and habitats when visiting a place. The ecotourism encourages going back to natural products in every aspect of life.

4.2.1 DEFINITIONS

The first formal definition, coining the term "ecotourism, was published in 1987 stating "traveling to relatively undisturbed or uncontaminated natural areas with the specific objective of studying, admiring, and enjoying the scenery and its wild plants and animals, as well as any existing cultural manifestations (both past and present) found in these areas." Subsequently, many other definitions have come up which include:

ENVIRONMENT-CENTERED DEFINITIONS : The US-based Ecotourism

Society defines ecotourism as "responsible travel to natural areas that conserves the environment and improves the well-being of local people." It is usually understood as involving small-group travel.

SUSTAINABLE TOURISM: It is a broader concept than ecotourism. It means any tourism - including urban tourism and mainstream (resort) tourism - that does not degrade the environment.

PEOPLE CENTERED DEFINITIONS: Pro-poor tourism (www.propoortourism.org.uk) means tourism that benefits poor people in tourist destinations. The UK-based NGO Tourism Concern is working towards a definition of fair-trade tourism that applies the precepts of fair trade (fair wages, shares of profits) to tourism.

COMMUNITY TOURISM (or community-based tourism) denotes tourism where small local communities - typically rural villages in the South - benefit and are involved in the management and decision-making process.

SOME MORE DEFINITIONS

- According to **The International Ecotourism Society (TIES)** in 1991 "Ecotourism is responsible travel to natural areas that conserves the environment and sustains the well being of local people".
- According to the **World Tourism Organization (WTO)** "Tourism that involves travelling to relatively undisturbed natural areas with the specified object of studying, admiring and enjoying the scenery and its wild plants and animals as well as any existing cultural aspects (both of the past and present) found in these areas is Ecotourism".
- **K. Lindberg and B. Mckercher** defined Ecotourism as a tourism and recreation that is both nature based and sustainable.
- **Herald Goodwin** called ecotourism a purposeful travel to natural areas to understand the culture and natural history of the environment taking care not to alter the integrity of the ecosystem, while producing economic opportunities that make the conservation of natural resources beneficial to local people.

4.3 CHARACTERISTICS OF ECOTOURISM

Martha Honey expanded on the definition given by TIES describing the seven characteristics of ecotourism, which are:

1. Involves travel to natural destinations.
2. Minimizes environmental impact.
3. Builds environmental awareness.
4. Provides direct financial benefits for conservation.
5. Provides financial benefits and empowerment for local people.
6. Respects local culture.
7. Supports human rights and democratic movements

4.4 PRINCIPLES OF ECOTOURISM

The International Ecotourism Society has expanded the concept of ecotourism by six basic principles of ecotourism:

i) It avoids negative impacts that can damage or destroy the natural and cultural environments of the area being visited.

ii) It is a mode of educating the travelers about the importance of conservation.

iii) Realisation of revenue for the conservation of natural areas and management of protected areas.

iv) It becomes a source of economic benefits and revenues to the local people.

v) It emphasizes the need for the planning and sustainable growth of tourism industry and seeks to ensure that the tourism development doesn't exceed the social and environmental capacity.

vi) It retains high percentage of revenues in the host countries by stressing the use of locally owned facilities and services.

In most cases, ecotourism follows the important principles of sustainability i.e.:

- To promote conservation of the natural ecosystems,
- To support local economies
- To respect local culture,
- Optimizes benefits to local people and
- Minimize environmental impacts

4.5 OBJECTIVES OF ECOTOURISM

Ideally, ecotourism should satisfy several criteria, Which include :

a. Conservation of biological diversity and cultural diversity through ecosystem protection.

b. Promotion of sustainable use of biodiversity, by providing jobs to the local populations.

c. Sharing of socio-economic benefits with local communities and indigenous peoples by involving them and their participation in the management of ecotourism enterprises.

d. Tourism to untouched natural resources, with minimal impact on the environment should be a primary concern.

e. Minimization of tourism's own environmental impact.

f. Affordability and lack of waste in the form of luxury.

g. Showcasing the local culture, flora and fauna should be the main attractions.

The Ecotourism Society of India dedicated to the promotion of sustainable tourism has laid down various objectives which are:

a. Identify eco-sensitive areas where tourism will have an impact on social, cultural and natural environment.

b. Make strategy and efforts to ensure long term sustenance of environment.

c. Work with empowered bodies to establish carrying capacity and sustainable tourism practices which include conservation of nature and wildlife and allow local

communities to benefit from tourism.

d. Regulate number of tourists and visitors so that tourism practices allow nature to re-generate itself.

e. To work with government bodies to develop policies and code of conduct for promotion of sustainable tourism, and help implement the same. To work towards certification of tourism service providers.

f. To act as watchdog for excessive consumption of natural resources and any negative impact in the tourism sector.

g. To support research in tourism environment related areas.

h. Work with service providers to enhance quality of their product and services to a level so they can be sustainable and eco-friendly.

i. Encourage use of appropriate local practices, materials, art, craft, architecture, food.

j. To work towards certification of tourist service providers.

k. Encourage use of appropriate local practices, matierials, art, craft, architecture, food, etc.

l. Encourage minimal conspicuous consumption and prevent excessive consumption of energy.

m. Encourage energy saving practices, water harvesting, use of solar and other natural energy sources.

n. Encourage good waste management practices especially non-biodegradable materials.

o. Encourage low pollution-generating practices to minimize carbon footprint.

p. Organise training and other activities to create awareness on ecotourism, sustainable and responsible tourism.

q. To collaborate with like-minded bodies and implement ecotourism objectives in India and abroad.

r. To continually identify new ecotourism destinations.

4.6 IMPACTS OF ECOTOURISM

Impacts of ecotourism can be positive as well as negative which can further be classified as direct (caused by tourists) and indirect (effects of the infrastructure or activities necessary to provide the visitor experience) or "on-site" and "off-site". Using the latter groups, some on-site impacts include:

4.6.1 POSITIVE IMPACTS OF ECOTOURISM:

Ecotourism may have some positive impacts such as

- Ensuring natural resources are conserved and managed properly so that they could be used by present and future generation,
- Providing employment to local people.
- Educating the tourists making them more enthusiastic and effective agents of conservation.
- Providing opportunity for long term protection to biodiversity.

4.6.2 NEGATIVE IMPACTS OF ECOTOURISM

If ecotourism is not monitored regularly it can be as damaging as mass tourism

- Ecotourism is the major threat to the rich biodiversity and natural habitats of the wilderness.
- Competition for ecotourism income between various groups leads to social disharmony.
- Increased use of resources by human population may cause problem to the environment.
- Threat to the environment is the production of waste and effluent pollution (e.g., rubbish/garbage) and Water and air pollution (e.g., effluent in rivers);
- Reclamation of land for infrastructure (e.g., clearing of forests for hotel)
- It may result in land degradation by trampling of vegetation and soil by tourists which include:

- Breakage and burning of stems.
- Reduction in regeneration ability.
- Reduction in plant vigour.
- Species composition change.
- Loss of ground cover, organic matter and accelerated erosion.
- Reduction in soil porosity.
- Increase in runoff
- soil erosion and compaction;
- trampling of vegetation;
- removal of vegetation (e.g., collection of plants or firewood);
- accidental introduction of exotic species;
- increased frequency of fire

4.7 ROLE OF ECOTOURISM TOWARDS SUSTAINABLE ENVIRONMENT MANAGEMENT

While promoting the development of ecotourism one may perceive many difficulties. Hence, some guidelines have to be formulated to achieve sustainable ecotourism. The objective pertinent to conservation should be as follows:

a. A database should be developed on the existing ecological resources of an area. The carrying capacity of the habitat should be evaluated and assessed.

b. The baseline environmental status should be established.

c. Negative impact on the environment, especially degradation and pollution should be assessed.

d. Development of a source of long -term financial stability for the conservation of protected areas. Maintenance of biological diversity should be given prime importance.

e. Identification of tourism activities which are compatible with the area and establishment of standards for quality. The activities should cause least damage to the ecosystem

f. Integrated approaches should be emphasized which place great emphasis on building local capacity.

g. Ecotourism should surely support a wide range of local economic activities.

h. Development of partnerships with NGO, especially local communities. This will help to strategize community based ecotourism enterprise.

i. Involvement of local people in planning, management and development programs. Local people are able to provide authentic information about nature, culture and their ethnic traditions.

j. Visitor's needs and tourist markets should be analyzed. The marketing should focus on environmental, social, cultural, and economic sustainability criteria. Basic amenities availability to visitors should be ensured. Over visitation should be avoided.

k. Establishment of education, training and research programs for the staff as well as tourists associated with ecotourism.

l. Management polices should be established which should help to minimize environmental degradation, such as waste management, zoning for transportation etc.

m. Government should enforce a legislative framework to regulate tourism trade and industry, create basic infrastructure and health facilities, and ensure safety and security of the tourists.

n. Promotion of equity in the distribution of both the economic costs and the benefits of the activity among tourism developers and hosts.

o. Establishment of a program for monitoring and reviewing the ecotourism activities.

4.8 GREEN MARKETING

4.8.1 INTRODUCTION

It is known that due to increasing production and business activities the natural environment is being polluted. The damage caused to people, crops, and wildlife has been reported from different parts of the world. As resources are limited and human wants are unlimited, it is necessary for marketers to use resources efficiently, so that organizational objectives are achieved without waste of resources. So green marketing is inevitable. There is growing interest among people around the world regarding protection of natural environment. People are getting more concerned for environment and changing their behaviour for the protection of environment. As a result of this, the term "Green Marketing" has emerged. Hence, marketers are feeling their responsibility towards environment and giving importance to green marketing. Not only marketers but consumers are also concerned about the environment, and consumers are also changing their behaviour pattern. Now, individual as well as industrial consumers are becoming more concerned about environment-friendly products.

The awareness in the developing countries about various global environmental issues is less as compared to consumers in the developed countries. Green is slowly and steadily gaining ground on eco-consciousness in India. The growing consumer awareness about the origin of products and the concern over impending global environmental crisis, there are increasing opportunities to marketers to convince consumers. The firms have increasingly introduced GPIs (Green Product Innovations) into their product developments over a period of time.

Defining environmental friendly product or green product is complex. In a strict sense, there is no such thing as a truly green product, as all products found in the market or we buy, own, use and discard in our everyday life has negative environmental impacts at some stage of their lifecycles.

Today, "Green" marketing has moved from a trend to a way of doing business and businesses that sell and should recognize:

(a) The value of going green and

(b) Incorporating this message into their marketing program and communicating the green concept to their consumers.

If a product has a less environmental impact, it is regarded as environmental friendly or environmentally sustainable or green product. The producers/ firms who produce various consumer goods adopt Environmental Management Systems (EMS) focusing on the environmental impacts of production and establish management frameworks that achieve continuous improvement in natural resource management by integrating best available management practices and relevant codes of practice. These products which we purchase and are supplied by suppliers with a reputation for reducing environmental impacts from their manufacturing processes are included as green products.

4.8.1 WHY GREEN MARKETING IS IMPORTANT

Basically, green marketing concerns with three aspects:

1. Promotion of production and consummation of pure / quality products,
2. Fair and just dealing with customers and society, and
3. Protection of ecological environment.

4.8.2 GREEN MARKETING: MEANING AND DEFINITIONS

Green marketing involves marketing issues within an environmental framework. The term marketing is used to describe activities that create value through voluntary exchange between parties. Within the marketing framework this involves an organization designing an output comprising a range of characteristics i.e. Product, Price, Place, Promotion. These characteristics can be combined in many ways to meet the needs of consumers or customers, seen in the form of the diverse range of products available within a product category.

Definition according to American Marketing Association "Green marketing is the marketing of products that are presumed to be environmentally safe".

According to Polonsky 1994 "Green or Environmental Marketing consists of all activities designed to generate and facilitate any exchanges intended to satisfy human needs or wants, such that the satisfaction of these needs and wants occurs, with minimal detrimental impact on the natural environment.

According to Pride and Ferrell (1993) Green marketing, also alternatively known as environmental marketing and sustainable marketing, refers to an organization's efforts at

designing, promoting, pricing and distributing products that will not harm the environment.

4.8.3 GREEN CONSUMER

Elkington (1994) defined green consumer as one who avoids products that are likely to endanger the health of the consumer or others; cause significant damage to the environment during manufacture, use or disposal; consume a disproportionate amount of energy; cause unnecessary waste; use materials derived from threatened species or environments; involve unnecessary use of, or cruelty to animals; adversely affect other countries.

Green Marketing incorporates broad range of activities including:

a. Product modification,

b. Changes to the production process,

b. Packaging changes, and

c. Modifying advertising.

Green marketing focuses on

♦ satisfaction of customer needs and wants with no or minimum harm to the natural environment.

♦ The marketing or promotion of a product based on its environmental performance or an improvement there off.

♦ The holistic management process responsible for identifying, anticipating and satisfying the requirements of customers and society, in a profitable and sustainable way.

♦ Holistic and responsible strategic management process that identifies, anticipates, satisfies and fulfils stakeholder needs, for a reasonable reward, that does not adversely affect human or natural environmental well-being.

4.8.4 IMPACTS OF GREEN MARKETING

The environmental awareness among the people and more stress on green products and green marketing, etc. has created some beneficial and positive impacts and some of these are:

- Establishment of several national and international agencies to monitor efforts and activities of business firms in relation to pollution control and production of eco-friendly products.
- Increased emphasis on social and environmental accountability of producers.
- Efforts to recycle wastes
- Imposition of strict norms for pollution control.
- Consideration of pollution control efforts and eco-technology in awarding ISO 9000 or ISO 14000 certification.
- Increased use of bio-fertilizers and manures replacing use of chemical fertilizers i.e. organic farming
- There is reduction in use of plastic products.
- Initiatives for the protection of forests, flora, fauna, rivers, lakes, etc.
- People are in demand for pure products such as edible items, fruits, and vegetables produced through organic farming.
- Increase in consumption of herbal products instead of processed products.

4.9 SUMMARY

Ecotourism is generally travelling to undisturbed natural areas with the objectives of recreation, studying and admiring the flora and fauna of the area. Sustainable ecotourism aids in promoting conservation, sustenance of the well being of humans and helps in the maintenance of a balanced relationship between humanity and the environment. Ecotourism also enhances the international cooperation, foreign direct investment and partnerships with both private and public sectors. There is need to develop education and training programmes to encourage people to participate in eco-tourism, enable indigenous and local communities to develop and benefit from ecotourism, and enhance stakeholder cooperation in tourism development and heritage preservation, in order to improve the protection of the environment, natural resources and cultural heritage. The ecotourism is primarily to benefit society and not damage the environment or deplete the natural resources. it has to recognize the carrying capacity of the habitat and its environment and not expand

beyond the threshold. Above all, there is a requirement on the part of people to imbibe good civic sense among the people. Ecotourism can live up to its promise if it follows the principles of sustainable development, adequately monitors and protects its resources.

In recent past many companies have accepted their responsibility not to harm the environment by producing products and following production processes which are cleaner and environmental friendly or "go green" with the understanding that they can reduce pollution and increase profits at the same time. The business activities cause many environmental problems and there is an increasing recognition that business is vital in the process of a more ecological sustainable society. Green marketing is a creative opportunity to innovate in ways that make a difference and at the same time achieve business success. Companies, especially multinationals, play an essential role in the world economy, and they have also the resources and capacity to put ecological solutions into practice. Sustainable production and consumption includes companies to have a responsibility to drive the development towards greater sustainability and become greener, with company's aim is to create markets for more environmentally friendly products and services and on the other hand educate and influence customers or consumers to change. This is building consumer demand for products that have been made using cleaner production techniques and for services - including tourism services - that are provided in a way that minimizes environmental impacts.

4.10. GLOSSARY

Cultural Tourism: Cultural Tourism is travel for the purpose of learning about cultures or aspects of cultures.

Ecosystem: A dynamic complex of plant, animal, fungal and microorganism communities and their associated non-living environment interacting as an ecological unit.

Ecotourism: Responsible travel to natural areas which conserves the environment and sustains the livelihood of local people.

Green advertising: It means the advertising without adverse impact on society.

Green message: means matured and neutral facts, free from exaggeration or ambiguity.

Green travel: It Green travel involves selecting travel options that have positive environmental impact.

Green: Green is indicative of purity. Green means pure in quality and fair or just in dealing.

Sustainable Development: Development that meets the needs and aspirations of the current generation without compromising the ability to meet those of future generations.

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4.12 SAMPLE QUESTIONS

1. Which of the following groups does NOT typically benefit from ecotourism?

    a. Tourists

    b. Hospitality providers

    c. The local community

d. Large hotel chains

Ans. d

2. What does TIES stand for?

a. The International Ecology Society

b. Tourism International Environment Society

c. Tourism International Ecotourism Seminar

d. The International Ecotourism Society

Ans. d.

3. What is Carrying Capacity in relation to tourism?

a. Refers to how much a destination has changed in development

b. Refers to the ability of a destination to take tourism use without deteriorating in some way

c. Refers to Accommodation Capacity

d. The number of attractions in a destination

Ans. b.

4. Green marketing is a part of

a. Social marketing

b. Service marketing

c. Relationship marketing

d. Rural marketing

Ans. c

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FOREST RESOURCES

5.1 INTRODUCTION

The word 'forest' is derived from the Latin word 'foris' means 'outside' (may be the reference was to a village boundary or fence separating the village and the forest land). A forest is a natural, self-sustaining, tree dominated community having association with variety of other living organisms i.e. animals, shrubs, herbs, etc and abiotic conditions. The forest is a natural community and no forest is static in time because they respond to outside influences.

One third of the total earth's area is occupied by forests, out of which, about fifty percent is under tropical forests. As per the State of forest report 2013, forest cover of country is 6, 97, 898 sq. km or 69.79 million hectare, which is 21.23 percent of the total geographical area of the country. The tree cover of the country is estimated to be 9.13 million hectare which is 2.78 percent of the total geographical area. The total forest and tree cover of the country as per 2013 assessment is 78.92 million hectare, which is 24.01 percent of the total geographical area of the country. There is an increase of 5871 sq. km in the forest cover of the country in comparison to 2011 assessment (Table 5.1).

Table 5.1 ♦FOREST COVER OF INDIA

Years	Forest and Tree Cover (percent)	Forest area (sq km)
2005	23.41	769,621
2009	21.02	690,899
2011	21.05	691,969
2013	24.01	789,164

5.2 OBJECTIVES

The main objective of this lesson is to understand forests, their uses and types, various factors responsible for deforestation, impact of deforestation. The special emphasis has been given to mining activities and its impact on forests and tribal.

5.3 USES OF FORESTS

Forest not only provide us with fuel wood, timber, fodder and non forest products but also provide us a wide range of environmental and economic goods and services supporting industrial and commercial activities and maintain ecological balance. These goods and services provided by forests can be categorised as

5.3.1 CONSUMPTIVE DIRECT USE SERVICES WHICH INCLUDE:

a) FUEL WOOD: Wood is used as a source of energy for cooking purpose and for keeping warm.

(b) TIMBER: Wood is used for making furniture, tool-handles, railway sleepers, matches, ploughs, bridges, boats etc.

(c) BAMBOOS: These are used for matting, flooring, baskets, ropes, rafts, cots etc.

(d) FOOD: Fruits, leaves, roots and tubers of plants and meat of forest animals form the food of forest tribes.

(e) SHELTER: Forests provide shelter for various insects, birds, reptiles, mammals, micro-organisms etc.

(f) PAPER: Wood and Bamboo pulp are used for manufacturing paper which is used for making various products such as Newsprint, stationery, packing paper, sanitary paper, etc.

(g) RAYON: Bamboo and wood are used in the manufacture of rayon (yarns, artificial silk-fibres)

(h) FOREST PRODUCTS : Tannins, gums, drugs, spices, insecticides, waxes, honey, horns, musk, ivory, hides etc. are all provided by the flora and

fauna of forests.

5.3.2 THE SERVICES THAT HAVE OPTION VALUES as natural habitat. Forests are the homes of millions of wild animals and plants and a repository of genetic wealth. About 7 million species are found in the tropical forests alone.

5.3.3 THE SERVICES OF NON- CONSUMPTIVE USE VALUES which include recreation and ecotourism'

5.3.4 SERVICES OF INDIRECT USE VALUE

(a) PRODUCTION OF OXYGEN: The trees produce oxygen by photosynthesis which is vital for life on this earth.

(b) REGULATION OF HYDROLOGICAL CYCLE: Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff and slowly releasing the water for recharge of springs. About 50-80% of the moisture in the air above tropical forests comes from their transpiration which helps in bringing rains.

(c) CONSERVATION OF SOIL: Forests prevent soil erosion by binding the soil with the network of roots of the different plants and reduce the velocity of wind and rain, which are the chief agents causing erosion.

(d) SOIL-IMPROVEMENT: The fertility of the soil increases due to the humus which is formed by the decay of forest litter.

(e) REDUCTION OF ATMOSPHERIC POLLUTION: By using up carbon dioxide and giving off oxygen during the process of photosynthesis, forests reduce pollution and purify the environment.

(f) CONTROL OF CLIMATE: Transpiration of plants increases the atmospheric humidity which affects rainfall and cools the atmosphere.

(g) CONTROL OF WATER FLOW: In the forests, the thick layer of humus acts like a big sponge and soaks rain water preventing run-off, thereby preventing flash-floods. Humus prevents quick evaporation of water,

thereby ensuring a perennial supply of water to streams, springs and wells.

5.4 TYPES OF FORESTS

The forests can be of different types and can be categorised on the basis of altitude, climate which include rainfall, temperature, etc. According to Champion and Seth the forests of India can be classified into four major types i.e. Tropical, Subtropical, Temperate and alpine. These four major types have been further divided into sixteen types which are as follows :

i. Tropical wet evergreen
ii. Tropical semi evergreen
iii. Tropical moist deciduous
iv. Tropical dry deciduous
v. Tropical thorn
vi. Tropical dry evergreen
vii. Subtropical pine
viii. Subtropical broadleaved hill
ix. Subtropical dry evergreen
x. Subalpine
xi. Moist alpine scrub
xii. Dry alpine scrub
xiii. Himalayan moist temperate
xiv. Montane wet temperate
xv. Himalayan dry evergreen
xvi. Himalayan dry temperate
xvii. Littoral and swamp forests

5.4.1 TROPICAL WET EVERGREEN

Wet evergreen forests are found in the south along the Western Ghats and the Nicobar and Andaman Islands and all along the north-eastern region. It is characterized by tall, straight evergreen trees. The more common trees that are found here are the jackfruit, betel nut palm, jamun, mango, etc. The trees in this forest form a tier pattern: shrubs cover the layer closer to the ground, followed by the short structured trees and then the tall variety.

5.4.2 TROPICAL SEMI-EVERGREEN

Semi-evergreen forests are found in the Western Ghats, Andaman and Nicobar Islands, and the Eastern Himalayas. Such forests have a mixture of the wet evergreen trees and the moist deciduous trees. The forest is dense and is filled with a large variety of trees of both types.

5.4.3 TROPICAL MOIST DECIDUOUS

Moist deciduous forests are found throughout India except in the western and the north-western regions. The trees have broad trunks, are tall and have branching trunks and roots to hold them firmly to the ground. Some of the taller trees shed their leaves in the dry season. There is a layer of shorter trees and evergreen shrubs in the undergrowth. These forests are dominated by Sal and Teak, along with mango, bamboo, and rosewood.

5.4.4 TROPICAL DRY DRY DECIDUOUS FOREST

Dry deciduous forests are found throughout the northern part of the country except in the North-East. They are also found in Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka, and Tamil Nadu. The canopy of the trees does not normally exceed 25 metres. The common trees found are the sal, Acacia, and bamboo.

5.4.5 TROPICAL THORN

This type of vegetation is found in areas with black soil: North, West, Central, and South India. The trees do not grow beyond 10 metres. Spurge, caper, and cacti are typical of this region.

5.4.6 TROPICAL DRY EVERGREEN

Dry evergreens are found along the Andhra Pradesh and Karnataka coast. It has mainly

hard leaved evergreen trees with fragrant flowers, along with a few deciduous trees.

5.4.7 SUB TROPICAL BROAD-LEAVED FORESTS

Broad-leaved forests are found in the Eastern Himalayas and the Western Ghats, along the Silent Valley. There is a marked difference in the form of the vegetation in the two areas. In the Silent Valley, cinnamon, rhododendron, and fragrant grass are predominant. In the Eastern Himalayas, the flora has been badly affected by the shifting cultivation and forest fires. These wet forests consist mainly of evergreen trees with a sprinkling of deciduous here and there. There are oak, alder, chestnut, birch, and cherry trees. There are a large variety of orchids, bamboo and creepers.

5.4.8 SUB TROPICAL PINE FORESTS

These are found in the steep dry slopes of the Shivalik Hills, Western and Central Himalayas, Khasi, Naga, and Manipur Hills. The trees predominantly found in these areas are the chir, oak, rhododendron, and pine. In the lower regions sal, sandan, amla, and laburnum are found.

5.4.9 SUBTROPICAL DRY EVERGREEN

Dry evergreen forests normally have a prolonged hot and dry season and a cold winter. It generally has evergreen trees with shining leaves that have a varnished look. Some of the more common ones are the pomegranate, olive, and oleander. These forests are found in the Shivalik Hills and foothills of the Himalayas up to a height of 1000 metres.

5.4.10 MONTANE WET TEMPERATE FORESTS

Montane Wet temperate forests are found in North and Southern parts of India. In the North, they are found in the region between east of Nepal into Arunachal Pradesh, at an elevation of 1800-3000 metres, receiving a minimum rainfall of 2000 mm. In the South, they are found in parts of Niligiri Hills, the higher reaches of Kerala. The forests in the northern region are denser than in the South.

5.4.11 HIMALAYAN MOIST TEMPERATE

This type of forest spreads from the Western Himalayas to the Eastern Himalayas. The trees found in the western section are broad-leaved oak, brown oak, walnut, rhododendron, etc. In the Eastern Himalayas, the rainfall is much heavier and therefore the vegetation is also more lush and dense. There are a large variety of broad-leaved trees, ferns,

and bamboo. Coniferous trees are also found here, some of the varieties being different from the ones found in the South.

5.4.12 HIMALAYAN DRY TEMPERATE

This type is found mainly in Lahul, Kinnaur, Sikkim, and other parts of the Himalayas. There are predominantly coniferous trees that are not too tall, along with broad-leaved trees such as the oak, maple, and ash. At higher elevation, fir, juniper, deodar and chilgoza can be found.

5.4.13 SUBALPINE FORESTS

Sub alpine forests extend from Kashmir to Arunachal Pradesh between altitudes of 2900 to 3500 metres. In the Western Himalayas, the vegetation consists mainly of juniper, rhododendron, willow, and black currant. In the eastern parts, red fir, black juniper, birch, and larch are the common trees. Due to heavy rainfall and high humidity the timberline in this part is higher than that in the West. Rhododendron of many species covers the hills in these parts.

5.4.14 MOIST ALPINE SCRUB

These forests are found all along the Himalayas and on the higher hills near the Myanmar border. It has a low scrub, dense evergreen forest, consisting mainly of rhododendron and birch. Mosses and ferns cover the ground in patches. This region receives heavy snowfall.

5.4.15 DRY ALPINE SCRUB

These are found from about 3000 metres to about 4900 metres. Dwarf plants predominate, mainly the black juniper, the drooping juniper, honeysuckle, and willow.

5.4.16 LITTORAL AND SWAMP

Littoral and swamp forests are found along the Andaman and Nicobar Islands and the delta area of the Ganga and the Brahmaputra. The forests occupy mainly tree species like whistling pines, mangrove dates, palms and bullet wood. These trees have roots that consist of soft tissue so that the plant can breathe in the water.

5.5 OVER EXPLOITATION OF FORESTS

All forests present on Earth today have been influenced by human beings for thousands of years. Since pre-history, human beings have realized benefits from forested lands in the

form of spiritual values, medicines, shelter, food, materials, fuel and more. Often, humans have sought to manipulate natural processes and have overexploited forest systems of goods and services desired by people. The demand for forest products also increased with growing population. Deforestation is perceived to be the culprit behind a number of environmental problems ranging from floods, to soil erosion, to desertification.

5.5.1 DEFORESTATION

Deforestation is the permanent destruction of indigenous forests and woodlands. The term does not include the removal of industrial forests such as plantations. Deforestation has resulted in the reduction of indigenous forests. Indigenous forests now cover 21% of the earth's land surface. The World Resources Institute regards deforestation as one of the world's most pressing land-use problems. The rate at which deforestation is occurring is a great matter of concern. The destruction of forests due to unscrupulous and indiscriminate felling of trees has led to an overall deterioration of our environment and is posing a serious threat to the quality of "life in future.

5.5.2 CAUSES OF DEFORESTATION / FOREST DEGRADATION

Anthropogenic activities have brought significant changes in Indian forests in the form of

I. DEFORESTATION AND DEGRADATION OF FORESTS

The process of deforestation and degradation (Degradation of forests means the reduction in productivity and diversity of the forests) by conversion of forests to non forest uses. Population explosion poses a great threat to the environment in general and forests in particular. Vast areas of forest land are cleared of trees to reclaim land for human settlements (factories, agriculture, housing, roads, railway tracks etc.). Growth of population increases the demand for forest products like timber, firewood, paper and other valuable products of industrial importance, all necessitating felling of trees. The forests are also removed for the increased demand of land for river valley projects, mining and quarrying, etc.

II. FOREST FIRES

Fires in the forests may occur due to natural calamities or human activities. The reasons for occurrence of fire are dependent on various factors which include:

(a) Smouldering of the humus and organic matter forming a thick cover over the

forest floor (i.e. ground fires).

(b) Dried twigs and leaves may catch fire (i.e. surface fires).

(c) In densely populated forests, tree tops may catch fire by heat produced by constant rubbing against each other (i.e. crown fires).

(d) Human activities like clearing forests for habitation, agriculture, firewood, construction of roads, railway tracks and carelessness (throwing burning cigarette stubs on dried foliage). Fires destroy fully grown trees, resulting in killing and scorching of the seeds, humus, ground flora and animal life.

III. GRAZING ANIMALS

The increase in livestock population directly dependent on forests for fodder is also responsible for deforestation and forest degradation. Trampling of the forest soil in the course of overgrazing by livestock has far reaching effects such as loss of porosity of soil, soil erosion and desertification of the previously fertile forest area in turn reducing the regeneration of new plants.

IV. PEST ATTACKS

Forest pests like insects, diseases, etc. destroy trees by eating up the leaves, boring into shoots and by spreading diseases.

V. NATURAL FORCES

The hazards like floods, storms, snow, lightening etc. are the natural forces which damage forests.

VI. SHIFTING CULTIVATION:

Shifting cultivation or Jhum is a common practice in north eastern states of India and along Eastern Ghats having great population of tribal. The practice of shifting cultivation has been reported from about 13 states of the country. Jhum system in India is practised by tribal and it varies according to different ecological regions, topography and socio-economic and cultural environment of the tribals.

The process of Jhum consists of three basic steps i.e.

1. Slashing of vegetation: The trees in the area are either clear felled and crops are cultivated there or in areas where sparse trees are there only the lower branches

are removed.

2. Burning of the slashed trees and branches on the spot

3. Cultivation of crops.

5.6 EFFECTS OF DEFORESTATION

Forests are closely related with climatic change, biological diversity, wild animals, crops, medicinal plants etc. Large scale deforestation has many detrimental impacts on environment by:

a. Habitat destruction of wild animals (tree-using animals are deprived of food and shelter) resulting in competition for food and space among the animals resulting in extinction of species.

b. Increased soil erosion due to reduction of vegetation cover as the trees and bushes act as ground cover which bind the soil particles together.

c. Reduction in the oxygen liberated by plants through photosynthesis.

d. The forests act as sink for carbon dioxide. The reduction in forests will cause increase in Carbon dioxide fixation by plants.

e. Decrease in availability of forest products.

f. Loss of Biodiversity: The biological diversity which include millions of plants, animals and micro-organisms is under threat of extinction from overexploitation of forests which may result in risks to the future of humanity.

g. Scarcity of fuel wood and deterioration in economy and quality of life of people residing near forests.

h. Lowering of the water table due to more run-off and thereby increased use of the underground water increases the frequency of droughts.

i. Rise in Carbon dioxide level has resulted in increased thermal level of earth which in turn results in melting of ice caps and glaciers and consequent flooding of coastal areas.

5.7 TIMBER EXTRACTION

Overexploitation in the form of removal of trees and other vegetation without replacing it has caused quantitative loss of biomass, productivity and density of forests. The timber is extracted from forests for commercial purposes by clear felling, which results in complete destruction of trees and modification of the forests. Logging for valuable timber such as teak, deodar and other important tree species, not only involves a few large trees but also involve destruction or felling of other non targeted trees in the process due to heavy machines working. Also road construction for making approach to the trees causes further damage to the forests. In India, firewood demand would continue to rise in future mostly consumed in rural areas, where alternative sources of energy are yet to reach.

The forests are also being affected by developmental activities such as construction of roads, dams, railways and mining. These activities cause erosion of natural vegetation.

5.8 DAMS

The dams and river valley projects have multi-purpose uses. India has more than 1550 large dams, the maximum being in the state of Maharashtra (more than 600) followed by Gujarat (more than 250) and Madhya Pradesh (130). The highest dam is Tehri dam constructed on river Bhagirathi in Uttarakhand, whereas, the largest in terms of capacity is Bhakra dam on river Sutlej. There are numerous environmental consequences of large dams which include direct impacts to the biological, chemical and physical environment especially rivers and riparian environment. The permanent inundation is one of the effects of the dams on the forests. The big dams are usually occupying large area of land, where clearing of a forest has to be done and ultimately that area comes under water. Thousands of hectares of forests have been cleared for executing river valley projects, which breaks the natural ecological balance of the region. Floods, landslides become more prevalent in such areas. The Tehri dam submerged 1000 hectares of forest, affecting about 430 species of plants according to the survey carried out by the Botanical Survey of India.

5.9 MINING

India has a lot of mineral wealth in the ground. Iron, bauxite, gold, lead, zinc, manganese, coal and copper are some of the dozens of minerals found in almost half of its landmass. Mining is the process of removing deposits of ores from substantially very well below the ground level. Mining is carried out to remove several minerals including coal. Mining from

shallow deposits is done by surface mining or opencast mining, while that from deep deposits is done by sub-surface mining.

5.9.1 IMPACT OF MINING ON FOREST:

These mineral deposits invariably found in the forest region, and any operation of mining will naturally affect the forests. Right from the first stage of mineral extraction, the environmental degradation of land, addition of pollutants to air, water and deforestation occur, and remain unchecked.

Mining is always accompanied with environmental disturbances more so, in opencast mining or surface mining. Surface mining of coal results in huge removal of overburden and mineral waste, which are dumped into nearby fertile soil which in turn contribute towards land degradation, vegetation degradation destruction of productive land in addition to effecting river flow, siltation, water pollution, deforestation, etc. Large excavations and denudation of vegetation in the coalfields is commonly observed. One inch of fertile topsoil takes 500-1000 years for formation but unfortunately in mining areas no one bothers about this topsoil, which is thrown or mingled casually. More than 80,000 ha of land of the country are presently under the stress of mining activities.

Mining operation require removal of vegetation along with underlying soil mantle and overlying rock masses. This results in destruction of landscape of the mining area. Large scale deforestation has been reported in Mussorie and Dehradun valley due to mining of various areas. Indiscriminate mining in Goa, since 1961, has destroyed more than 50,000 ha of forest land. Mining of radioactive mineral in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation. This is true in Karnataka and Bellary, Sandur, Chikkanayakanahalli (Tumkur) in particular open cast mining amounts to deforestation in a big way. The coal fields in J&K mainly in inner Shivaliks are located in moderately sloped hills at Mahogala, Mehtka, Kalakote and Tatapani. Builtup of infrastructural facilities on surface for mining, beneficiation, housing and other activities take heavy toll of forest bearing areas in sites around the coal mines. Development of infrastructural facilities for any type of mining results in destruction of trees and vegetation.

5.9.2. MINING IMPACT ON TRIBAL

It is estimated that there are over 67 million tribal people in India, with the majority of them

living in forested and hilly areas. Tribes are among the poorest and most marginalised sections of Indian society, and majority of tribal population is illiterate and suffer from extreme poor physical health and living conditions.

Most of the valuable mineral resources lie in the areas that are either ecologically precarious or heavily populated areas with indigenous peoples such as south, central and north eastern states of Orissa, Madhya Pradesh, Chattisgarh and Jharkhand, areas that are home to a majority of India's 90 million tribal peoples.

The tribal communities are worst affected by mining activities. Some of the direct as well as indirect impacts are discussed below.

5.9.2.1 IMPACT ON PHYSICAL ENVIRONMENT

- One of the most severe impacts of mining are the changes it has brought to the local land use patterns and landscape. It has been found out that maximum land diverted for mining activity is either forest land, agriculture fields or common grazing land. Forests have especially borne the brunt of mining. Illegal mining in the remote areas inhabited by tribal is a big problem. In spite of Environmental Impact Assessment made compulsory for mining projects, the rules and regulation set under Environmental protection act are flaunted, causing huge environmental impacts such as land degradation, air, water and noise pollution, etc. by exploitation of mineral resources through surface and underground mining The effect of mining has direct and indirect bearing on the tribal areas.
- **LAND DEGRADATION :** Large-scale mining and allied activities have caused severe damage to the land resources of the tribal areas. The forests and agricultural lands belonging to the tribal people have been laid waste because of haphazard mining. Underground mining operations, especially of coal, have created unsafe surface conditions in many areas warranting diversion of roads, railway lines, etc, and severely damaged due to subsidence, abandoned quarries and dumps.
- **POLLUTION :** Large-scale mining operations in tribal areas have adversely affected the ground water table in many areas with the result that the yield of water from the wells of adjoining areas has drastically reduced. Further, effluents discharged from mine sites have seriously polluted the streams and underground waters of the area. Acid mine drainage, liquid effluents from coal handling plants, and

mine sites as well as suspended solids from coal washing have all caused serious water pollution, adversely affecting fish and aquatic life and creating health problems for the tribal.

- **THE ACQUISITION OF LAND:** The indigenous people have a special relationship with their land. To them land is not simply a factor of production. It has a spiritual significance as well. The tribe is the trustee of the land it occupies. Their society, culture, religion, identity and their very existence are intimately linked to the land they hold.
- **MIGRATION OF TRIBAL:** The rapid expansion of mines in tribal areas is followed by a phenomenal growth in urbanisation and a large-scale influx of outsiders to the area. This in turn has resulted in alienation and displacement of indigenous people further resulting in migration of tribal people to outside regions in search of livelihood. This amount loosing of home. Moreover they get disassociated from the control over common property resources i.e. the rights held by tribal on land and other natural resources (e.g., pastures) that they can use independently of one another are lost when the area is brought under mining activity. The influx of outsiders in the mining areas also cause exploitation of the tribal population.
- **DESTRUCTION OF SOCIAL SYSTEM:** One of the major risks of forced displacement is the fracture of the social fabric. Communities are isolated and family members can be separated from each other. The tribal's religious and cultural identity is lost. The aesthetic cultural practices of the tribal community are completely threatened as they are dependent on forests especially sacred groves for their festivals, ceremonies and social celebrations. The deities of the tribal, sacred groves, hills and caves, traditional forms of tribal folklore and wisdom are also greatly affected.
- **EXPLOITATION :** When outsiders exploit the tribe's land and its resources the natural life cycle of tribal ecology and tribal life is greatly disturbed.
- **REHABILIATION AND SETTLEMENT PROBLEMS :** The tribal communities once evacuated have to be rehabilitated to suitable areas but their rehabilitation always remains a matter of concern. It is reported that about 40 per cent of all people displaced in India, due to developmental activities, are tribal and

out of these only about 21 per cent of them have been resettled.

- **LOSS OF LIVELIHOOD:** It has been found out that majority of the area presently used for mines were previously used for cultivation of various types of crops or were under forests.

5.10 SUMMARY

India's current forest and tree cover is estimated to be 78.29 million ha, constituting 23.81% of the geographical area of the country. The National Forest Commission report 2006 indicated that around 41 per cent of total forest in the country is already degraded, 70 per cent of the forests have no natural regeneration, and 55 per cent of the forests are prone to fire. The livelihoods of the people, especially the indigenous communities, living close to forest and within the forests are dependent on forests for variety of goods and services which include fodder, agriculture, firewood for cooking, housing, and an array of marketable minor forest produces. The indiscriminate exploitation of forest resources can potentially degrade forests. Large scale unauthorised and indiscriminate felling of forests have been taking place in forests for commercial purposes. The area under forests is shrinking due to encroachment for agriculture, habitation, developmental projects (including mining, river valley projects, etc.) and overexploitation of forest resources. This increasing degradation of forest is hampering the basic human right to life and livelihood of the local communities, especially the indigenous community whose life is closely linked with the resources and environment amidst which they live.

5.11 GLOSSARY

Common Property Resources: The land and other natural resources (e.g., pastures) to which the rights are held by members of a community to use them independently of one another.

Biodiversity: The variety of life forms in a given area. Diversity can be categorized in terms of the number of species, the variety in the area's plant and animal communities, the genetic variability of the animals, or a combination of these elements.

Conservation: The protection, improvement, and wise use of natural resources for present

and future generations.

Forest degradation: Degradation of forests means reduction in productivity and diversity of the forests.

Habitat: An area in which a specific plant or animal can naturally live, grow, and reproduce.

Jhum: The sequential system of shifting cultivation where an area of forest is cleared for cultivation by burning to allow the ash to enrich nutrient-poor soils.

Reforestation: Re-establishing a forest by planting or seeding an area from which forest vegetation has been removed.

Sacred groves: The sites still exist in many states, which have preserved remnant populations of rare and endemic species, sometimes in their original and undisturbed form, which have been wiped out elsewhere. Such areas are quite small (sometimes only a handful of trees) to very large.

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5.13 SELFASSESSMENT QUESTIONS

1. Area of land, water and air where the life exists is called

   (a) Biosphere (b) Lithosphere

   (c) Atmosphere (d) Hydrosphere

   Ans: a

2. India has a forest cover of around:

a. 30 percent b. 10 percent

c. 24 percent d. 33 percent

Ans: c

3. Forests are not responsible for which of the following

a. Maintaining water flow b Landslides

c. Medicinal plants d. Absorbing rain water

Ans: b

4. Jhum is:

a. Method of cultivation b. Method of forest conservation

c. Method of soil conservation d. An animal species

Ans: a

5. Reduction in the productivity and diversity of the forests is:

a. Deforestation b. Forest Destruction

c. Forest Eco- restoration d. Forest degradation

Ans: d

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WATER RESOURCES

6.1 INTRODUCTION

Water is a common chemical substance that is essential for the survival of all known life forms. In typical usage, water refers only to its liquid form or state, but the substance also has a solid state, ice, and a gaseous state, water vapour or steam. Water covers about 71% of the Earth's surface. On Earth, water is found in oceans and other large water bodies, with 1.6% of water below ground in aquifers and 0.001% in the air as water vapour and clouds and precipitation. Oceans hold 97% of surface water, glaciers and polar ice caps 2.4% and other surface water such as rivers, lakes and ponds 0.6%. A very small amount of the Earth's water is contained within biological bodies.

The sun causes liquid water to warm and evaporate (liquid form to gaseous form as vapour) and rise up into the sky. The water vapours are cooled during evaporation. These cooled water vapours form clouds. The transformation of the vapour into clouds (gaseous state to liquid) is condensation. When these clouds get heavy enough, the water falls back to the ground in the form of rain, snow, or hail. This is called as precipitation. Plants in our environment contain water in a liquid form. They release water vapour into the atmosphere, this is called as transpiration. When transpiration takes place along with evaporation then it is called as evapo-transpiration. The water resources are broadly classified into following types:

Surface water

Surface water is water available in rivers, lakes or wetlands. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, and sub-surface percolation.

Ground water

Groundwater is the water located in the pore space of soil and rocks. The natural input to ground water is seepage from surface water. The natural outputs from ground water are springs. Water below the ground is stored in sections called aquifers. The water content of an aquifer normally depends on the soil particle size.

Frozen water

Water stored in iceberg is called frozen water. Several schemes have been proposed to make use of icebergs as a water source; however, to date this has only been done for novelty purposes. Glacier runoff is also considered as surface water.

6.2 OBJECTIVES

The objectives of this lesson include making the students aware of various uses and overutilization of surface and ground water and its effects; conflicts over water; benefits and problems of dams; water conservation and rainwater harvesting.

6.3 Uses and overutilization of surface and ground water and effects

6.3.1 Uses of fresh water: surface water and ground water

Uses of fresh water can be categorized as consumptive and non-consumptive.

CONSUMPTIVE

Use of water is consumptive if that water is not immediately available for another use. Losses to sub-surface seepage and evaporation are considered consumptive.

Agricultural use: Approximately 69% of world-wide water is used for irrigation purposes, with 15-35% of irrigation withdrawals being unsustainable. Irrigation methods such as furrow and overhead sprinkler irrigation are usually less expensive but also less efficient, because much of the water evaporates or runs off. More efficient irrigation methods include drip or trickle irrigation, surge irrigation, and some types of sprinkler systems where the sprinklers are operated near ground level. These types of systems, while more expensive can minimize runoff and evaporation.

Industrial use: It is estimated that 15% of world-wide consumptive water use is industrial. Major industrial users include power plants, pulp and paper industries, distilleries, tannery, ore and oil refineries etc.

Household use: It is estimated that 15% of world-wide water use is for household purposes. These include drinking, bathing, cooking, sanitation and gardening.

NON-CONSUMPTIVE

Water that can be treated and returned as surface water, such as sewage, is generally considered non-consumptive if that water can be put to additional use.

Recreational use: Recreational water use is non-consumptive, usually a very small but growing percentage of total water use. Recreational water use is mostly tied to reservoirs. Release of water from a few reservoirs is also used to enhance whitewater boating, water skiers, nature enthusiasts and swimmers.

Environmental use: Environmental water usage includes artificial wetlands, artificial lakes intended to create wildlife habitat, and water release from reservoirs to help fish spawn.

6.3.2 OVERUTILIZATION OF SURFACE AND GROUND WATER: CAUSES

Industrialization: Exploding industrialization increases water consumption at very high rate that leads to more pressure on water resources and natural ecosystems.

Rapid urbanization: The accelerated urbanization requires significant investment in infrastructure in order to supply fresh and clean water to individuals and to treat wastewater.

Climate change: Climate change could have significant impacts on water resources around the world because of the close connections between the climate and water cycle. Rising temperatures will increase evaporation of water and lead to increase in precipitation, though there will be regional variations in precipitation. Both droughts and floods may become more frequent in various regions at different times, and dramatic changes in snowfall and snowmelt are expected in mountainous areas.

Population: Food and water are the basic necessity of human life. Human population appears to have innate drive to use maximum water. Therefore, growing population is the

major factor responsible for the overutilization of water. For example, human population uses the water for domestic, agriculture, industrial and infrastructure purpose.

Commercialization of agriculture: farmers are producing commercial crops after the success of green revolution. It is estimated that agriculture sector currently uses three-quarters of the world's fresh water. Its run-off has degraded the earth's major water resources.

Industrial sector: Industrial sector makes extensive use of water primarily for cooling soft drinks and power generation purposes. However, the inefficient use of water by industries is a matter of concern.

Reckless mining operations in the catchment: Reckless mining operations in the catchment areas have polluted surface water and groundwater.

6.3.3 EFFECTS OF OVERUTILIZATION OF SURFACE AND GROUNDWATER

(i) Loss of integrity of freshwater ecosystems :

Human activities for infrastructure development like creation of dams, land conversion, etc. are responsible for the loss of integrity of freshwater ecosystems. Water quality and quantity, fisheries, habitats, etc. are at risk due to this loss of integrity.

(ii) Risk to ecosystem functions :

Population and consumption growth increases water extraction and acquisition of cultivated land. Virtually all ecosystem functions including habitat, production and regulation functions are at risk.

(iii) Depletion of aquifers, living resources and biodiversity :

Due to the growing population, overharvesting and overconsumption of water is increased and hence, many of the world's major aquifers are becoming depleted. This is due to direct human consumption as well as extensive consumption in agriculture, industries, etc. Production of food, quality and quantity of water and

supply of water gets badly affected by these depletions of living resources and biodiversity.

(iv) Pollution of water bodies:

Release of pollutants to land, air or water alters chemistry and ecology of water bodies. Greenhouse gas emissions produce significant changes in runoff and rainfall patterns. Because of water pollution, water supply, habitat, water quality, food production, etc. are at risk.

(v) Other impacts related to groundwater depletion include

- drying up of wells,
- increased cost of pumping and well infrastructure,
- land subsidence
- salt-water intrusion, and
- changes in surface albedo and related climate change

6.4 CONFLICTS OVER WATER

Water conflict is a term describing a conflict between countries, states, or groups over an access to water resources. The United Nations recognizes that water disputes result from opposing interests of water users, public or private. These conflicts occur over both freshwater and saltwater, and both between and within nations. However, conflicts occur mostly over freshwater. Since, freshwater resources are necessary for all ecological and societal activities, including food and energy production, transportation, waste disposal, industrial development, and human health, but are limited, unevenly and irregularly distributed; they are, therefore, the center of water disputes arising out of need for potable water and irrigation. As we approach the twenty-first century, improving standards of living increase the demand for fresh water, and global climatic changes make water supply and demand more problematic and uncertain. The potential risk of conflict arising over utilization of water resources has become a key topic in development over the past few decades.

Despite the lack of evidence of international wars being fought over water alone, water has been the source of various conflicts throughout the history. The only known example of an actual inter-state conflict over water took place between 2500 and 2350 BC between the Sumerian states of Lagash and Umma. Water stress has led most often to conflicts and political tensions at local, regional, and international levels.

6.4.1 TYPES OF CONFLICTS

- Control of Water Resources (state and non-state actors): where water supplies or access to water is at the root of tensions.
- Military Tool (state actors): where water resources, or water systems themselves, are used by a nation or state as a weapon during a military action.
- Political Tool (state and non-state actors): where water resources, or water systems themselves, are used by a nation, state, or non-state actor for a political goal.
- Terrorism (non-state actors): where water resources, or water systems, are either targets or tools of violence or compulsion by non-state actors.
- Military Target (state actors): where water resource systems are targets of military actions by nations or states.
- Development Disputes (state and non-state actors): where water resources or water systems are a major source of contention and dispute in the context of economic and social development.

6.4.2 REASONS OF CONFLICTS

- Conflict through use: Unequal distribution of water leads to inter-state or international disputes. Some examples are given below:

International conflicts

- ✓ Conflict over water from the Indus between India and Pakistan
- ✓ Conflict over water from the Colorado river between Mexico and USA
- ✓ Conflict over water from the Shatt-al-Arab between Iran and Iraq
- ✓ Conflict over water from the Bhramaputra between India and Bangladesh

National conflicts

- ✓ Sharing of Cauvery water between Karnataka and Tamilnadu
- ✓ Sharing of Krishna water between Karnataka and Andhra Pradesh
- ✓ Sharing of Siruveni water between Tamilnadu and Kerala
- ♦ Construction of dams or power stations: For hydroelectric power generation, dams are built across the rivers, and this initiates conflicts between the states.
- ♦ Conflict through pollution: Rivers are also used for industrial purposes. They act as reservoirs for supply of fresh water and also a receptor of waste water and rubbish from the industry. Water crossing borders that has been polluted by wastes from one country develops into an international conflict.

6.4.3 MANAGEMENT OF WATER CONFLICTS

- ♦ Concerted efforts are required to enforce laws that check the practices to control water pollution.
- ♦ In order to overcome the problem of sharing river water in a country, the concept of interlinking of rivers can also be utilized.
- ♦ Rivers should be nationalized; the National Water Authority and River Basin Authority should be given powers to ensure equitable distribution of basin water.

6.5 DAMS: BENEFITS AND PROBLEMS

A dam is a barrier that stops or restricts the flow of water upstream or underground streams. The big dams have usually been considered to play a key role in the development process due to their multiple uses. These dams are often regarded as a symbol of national development. There are hopes all over from every corner of the region where such dam is planned to be constructed.

6.5.1 BENEFITS

Dams provide a range of economic, environmental, and social benefits which are discussed as under:

Recreation: Dams provide prime recreational facilities like boating, water skiing, camping, picnic areas, and many other water sports.

Flood Control: In addition to helping farmers, dams help in preventing the loss of life and property caused by flooding. Flood control dams hold floodwaters and then either release them under control to the river below the dam or store or divert the water for other uses. For centuries, people have built dams to help control devastating floods.

Water Storage: Dams create reservoirs which stores enormous volume of water that can be supplied for many uses, including industrial, municipal, and agricultural.

Irrigation: Dams provide irrigation and drinking water in remote areas and bring out overall development of the region.

Electricity Generation: The most important function of dam is generation of hydroelectricity.

Debris Control: In some instances, dams provide enhanced environmental protection, such as the retention of hazardous materials and detrimental sedimentation.

Navigation: Dams provide a stable system of inland river transportation throughout the heartland of the Nation.

Employment opportunities: The dam projects generated much employment opportunities, raised the standard of living and improvement in quality of life and thus have tremendous potential for economic upliftment.

Control famines: The occurrence of drought and famine can also be reduced by construction of dams.

Reduce water and power shortage: Through generation of electricity and storage of water, dams help in reducing the water and power shortage.

Helpful in fishery and aquaculture: The water reservoirs of dams can be used for fisheries and aquaculture. The planned, integrated development of fisheries ecosystems in reservoirs not only can mitigate the negative social consequences on dam construction, but also can enhance the economic benefits from hydropower and irrigation projects in many developing countries.

6.5.2 PROBLEMS

The environmental impacts of big dams are also too many due to which very often big dams become an issue of controversy. The dams are built to serve the society with multiple uses, but it has several serious side-effects. That is why now there is a shift towards construction of small dams or mini-hydel projects. The impacts can be at the upstream as well as downstream levels.

UPSTREAM PROBLEMS

- Displacement of tribal people
- Loss of forests, flora and fauna
- Loss of non-forest land
- Siltation and sedimentation of reservoirs
- Stagnation and water logging near reservoir
- Microclimatic changes
- Breeding of vectors and spread of vector-borne diseases
- Changes in fisheries and the spawning grounds
- Growth of aquatic weeds

DOWNSTREAM PROBLEMS

- Loss of land fertility along the river since the sediments carrying nutrients get deposited in the reservoir
- Reduced water flow and silt deposition in the river
- Salt water intrusion at river mouth
- Water logging and salinity due to over irrigation
- Flash floods
- Micro-climatic changes
- Outbreak of vector-borne diseases like malaria

BARRIER AS A PROBLEM

- blocks fish migration
- disrupts flow of sediments and water
- hazards from ageing dams

RESERVOIR AS A PROBLEM

- contributes to global warming
- displaces communities and raises resettlement, compensation, and development problems associated with those disturbed communities.
- increases waterborne illness
- triggers earthquakes
- Archaeological and historical places along with geological and topographical places that are rare with their exceptional beauties, disappear after lying under the reservoir.

6.6 WATER CONSERVATION

- Water conservation implies improving the availability of water through augmenting of water storage in surface reservoirs, tanks, etc. Efforts have been made to collect

water by building dams and reservoirs e.g. digging wells, ponds etc. Some countries have also tried to recycle and desalinate water to fulfill the demand of water. Water conservation has become the need of the day. The idea of ground water recharging by harvesting rainwater is gaining importance. The goals of water conservation efforts include:

- Ensuring availability of water for future generations where the withdrawal of freshwater from an ecosystem does not exceed its natural replacement rate.
- Energy conservation as water pumping, delivery and wastewater treatment facilities consume a significant amount of energy. In some regions of the world over 15% of total electricity consumption is devoted to water management.
- Habitat conservation where minimizing human water use helps to preserve freshwater habitats for local wildlife and migrating waterfowl, and also the water quality.

6.6.1 WATER CONSERVATION METHODS

- Some ancient methods of water conservation are given below

1 The Indus Valley Civilization, had one of the most sophisticated urban water supply and sewage systems in the world. The fact that the people were well acquainted with hygiene can be seen from the covered drains running beneath the streets of the ruins at both Mohenjodaro and Harappa.

2 One of the oldest water harvesting systems is found about 130 km from Pune along Naneghat in the Western Ghats. A large number of tanks were cut in the rocks to provide drinking water to tradesmen who used to travel along this ancient trade route. Each fort in the area had its own water harvesting and storage system in the form of rock-cut cisterns, ponds, tanks and wells that are still in use today. A large number of forts like Raigarh had tanks that supplied water.

3 Underground baked earthen pipes and tunnels to maintain the flow of water and to transport it to distant places, are still functional at Burhanpur in Madhya Pradesh, Golkunda and Bijapur in Karnataka, and Aurangabad in Maharashtra.

- Water conservation in agricultural sector: Simple techniques can be used to reduce the demand for water in agricultural sector. Some of them are listed below.

1. Mulching is the application of organic or inorganic material such as plant debris, compost, etc., that slows down the surface run-off, improves the soil moisture, reduces evaporation losses and improves soil fertility.
2. Ploughing helps to move the soil around that breaks soil capillaries. As a consequence it retains more water thereby reducing evaporation.
3. Shelter belts of trees and bushes along the edge of agricultural fields slow down the wind speed and reduce evaporation and erosion.
4. Contour farming is adopted in hilly areas and in lowland areas for paddy fields. Farmers recognize the efficiency of contour-based systems for conserving soil and water.
5. Transfer of water from surplus areas to deficit areas by inter-linking water systems through canals, etc.
6. Use of efficient watering systems such as drip irrigation and sprinklers will reduce the water consumption.

- Rain water harvesting is a very popular method of conserving water especially in the urban areas. It means collecting rainwater on the roofs of building and storing it into surface or underground tanks for later use. This helps in recharging the groundwater, raises the declining water table and can augment water supply.

- Water conservation in commercial sector:

1 Waterless urinals

2 Waterless car washes

3 Infrared or foot-operated taps, which can save water by using short bursts of water for rinsing in a kitchen or bathroom.

4 Water-saving steam sterilizers, for use in hospitals and health care facilities

5 Water to Water heat exchangers.

♦ Water-saving technology for the home includes:

1 Check faucets and pipes for leaks.

2 Check your toilets for leaks

3 Install water-saving shower heads and low-flow faucet aerators

4 Insulate your water pipes: It's easy and inexpensive to insulate your water pipes with pre-slit foam pipe insulation. You'll get hot water faster plus avoid wasting water while it heats up.

5 Take shorter showers.

6 Turn off the water after you wet your toothbrush

7 Use your dishwasher and clothes washer for only full loads

6.7 RAINWATER HARVESTING

Water is one of the five basic elements viz., Earth, Water, Fire, Air and Sky and no creature can survive without it. Despite having a great regard for water, we seem to have failed to address this sector seriously. This irresponsible attitude resulted in deterioration of water bodies with respect to quantity and quality both. Now, situation has arrived when even a single drop of water matters. As the water crisis continues to become severe, there is a dire need of reform in water management system and revival of traditional systems.

The traditional systems were time-tested wisdom of not only appropriate technology of rainwater harvesting, but also water management systems, where conservation of water was the prime concern. Traditional water harvesting systems were Bawalies, step wells, jhiries, lakes, tanks etc. These were the water storage bodies to domestic and irrigation demands. People were themselves responsible for maintenance to water sources and optimal use of water that could fulfill their needs.

6.7.1 DEFINITION

"Conscious collection and storage of rainwater to cater to demands of water, for drinking, domestic purpose & irrigation is termed as Rainwater Harvesting."

Simply, Rainwater harvesting is a technique of collection and storage of rainwater into natural or artificial reservoirs or tanks, or the infiltration of surface water into subsurface aquifers.

In other words, we can say that the harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. Normally water is collected from the roofs of buildings and stored in rainwater tanks. However, the concepts of rainwater harvesting are not only applied to roof catchments. Ground runoff can be modelled and used as input to overall water balance calculations.

6.7.2 NEED OF RAINWATER HARVESTING

There are many reasons but following are some of the important ones:

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

6.7.3 BENEFITS IN RAINWATER HARVESTING

- By capturing water directly, we can significantly reduce our reliance on water storage dams. This places less stress on these dams and can potentially reduce the need to expand these dams or build new ones.
- Collecting and using your own water can also significantly reduce your water bills.
- By capturing water, the flow of stormwater is also reduced and this minimizes the likelihood of overloading the stormwater systems in our neighbourhoods.

6.7.4 METHODS OF RAINWATER HARVESTING

Broadly there are two ways of harvesting rainwater:

(i) Surface runoff harvesting

(ii) Roof top rainwater harvesting

Surface runoff harvesting:

In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

Roof top rainwater harvesting (RTRWH):

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

6.7.5 COMPONENTS OF THE ROOF TOP RAINWATER HARVESTING SYSTEM

The design of the basic components of roof top rainwater harvesting system mainly constitutes of sub components in the following sequence: Catchment, Transportation, First flush and Filter.

Catchment: The surface that receives rainfall directly is the catchment of rainwater harvesting system. It may be terrace, courtyard, or paved or unpaved open ground.

Transportation: Rainwater from rooftop should be carried down through water pipes or drains to storage/harvesting system. At terraces, mouth of the each drain should have wire mesh to restrict floating material.

First Flush: First flush is a device used to flush off the water received in first shower. The first shower of rains needs to be flushed-off to avoid contaminating storable/rechargeable water by the probable contaminants of the atmosphere and the catchment roof.

Filter: Filters are used for treatment of water to effectively remove turbidity, colour and microorganisms. After first flushing of rainfall, water should pass through filters. There are different types of filters in practice, but basic function is to purify water like Sand Gravel Filters, Charcoal Filters, PVC- Pipe filters, Sponge Filters etc.

6.7.6 PRECAUTIONS TO BE TAKEN DURING RAINWATER HARVESTING

Harvested rainwater is used for direct usage or for recharging aquifers. It is most important to ensure that the rainwater caught is free from pollutants. Following precautionary measures should be taken while harvesting rainwater.

- Roof should be clean, free from dust, algal plants etc.
- Roof should not be painted.
- Do not store chemicals, rusting iron, manure or detergent on the roof.
- Nesting of birds on the roof should be prevented.
- Provide gratings at mouth of each drainpipe on terraces to trap leaves, debris and floating materials.
- Filter media should be cleaned before every monsoon season.
- At the end of the dry season and just before the first shower of rain is anticipated, the storage tank should be scrubbed and flushed off all sediments and debris.

6.7 SUMMARY

The water cycle is the movement of water in the environment by evaporation, condensation, and precipitation. Uses of fresh water can be categorized as consumptive and non-consumptive. Use of water is consumptive if that water is not immediately available for another use. Losses to sub-surface seepage and evaporation are considered consumptive. Water that can be treated and returned as surface water, such as sewage, is generally considered non-consumptive if that water can be put to additional use. Effects of overutilization of surface and groundwater include loss of integrity of freshwater ecosystems, risk to ecosystem functions, depletion of aquifers, living resources and biodiversity, pollution of water bodies etc. Water conflict is a term describing a conflict between countries, states, or groups over an access to water resources. The water disputes result from opposing interests of water users, public or private. These conflicts occur over both freshwater and saltwater, and both between and within nations. However, conflicts occur mostly over freshwater. A dam is a barrier that stops or restricts the flow of water upstream or underground streams. The big dams have usually been considered to play a key role in the development process due to their multiple uses. Water conservation implies improving

the availability of water through augmenting of water storage in surface reservoirs, tanks, etc. Efforts have been made to collect water by building dams and reservoirs e.g. digging wells, ponds etc. Some countries have also tried to recycle and desalinate water to fulfill the demand of water. Water conservation has become the need of the day. The idea of ground water recharging by harvesting rainwater is gaining importance. Rainwater harvesting is a technique of collection and storage of rainwater into natural or artificial reservoirs or tanks, or the infiltration of surface water into subsurface aquifers.

6.8 GLOSSARY

Rainwater harvesting : It is a technique of collection and storage of rainwater into natural or artificial reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff).

Roof top rainwater harvesting (RTRWH) : In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system.

Water conflict : Water conflict is a term describing a conflict between countries, states, or groups over an access to water resources.

Water cycle : The water cycle is the movement of water in the environment by evaporation, condensation, and precipitation.

6.9 QUESTIONS

Descriptive type/Short answers questions

1. Discuss the benefits and problems associated with constructing dams.
2. Write an essay on rainwater harvesting.
3. What are the consequences of overutilization of surface and groundwater?
4. Write a detailed note on water conflict.

Multiple choice questions

1. How much percentage of earth's surface is covered with water?
   (a) 29%
   (b) 71%
   (c) 79%
   (d) 21%

2. Which of the following impact is not related to groundwater depletion?
   (a) land subsidence
   (b) salt-water intrusion
   (c) Risk to ecosystem functions
   (d) Landsliding

3. Conflict on sharing of Krishna river water is between:
   (a) Karnataka and Andhra Pradesh
   (b) Kerala and tamil nadu
   (c) Karnataka and tamil nadu
   (d) Karnataka and kerala

4. Which of the following problems are associated with dams downstream?
   (a) Siltation and sedimentation
   (b) Flash floods
   (c) Loss of non-forest land
   (d) Growth of aquatic weeds

5. Water conservation in agricultural sector can be done by:

   (a) Application of organic or inorganic material such as plant debris, compost etc

   (b) Contour farming

   (c) Drip irrigation and sprinklers

   (d) All of the above

6. Rainwater harvesting is a technique of:

   (a) Collection and storage of rainwater into natural or artificial reservoirs or tanks

   (b) The infiltration of surface water into subsurface aquifers

   (c) Both a and b

   (d) None of the above

7. The correct sequence of sub components in the design of roof top rainwater harvesting system is:

   (a) Catchment, Transportation, First flush and Filter

   (b) Catchment, First flush, Filter and Transportation

   (c) First flush, Filter, Catchment and Transportation

   (d) Filter, Catchment, Transportation, First flush

8. Water Conflict between India and Pakistan is over river:

   (a) Brahmaputra

   (b) Indus

   (c) Jhelum

   (d) Ravi

Answers

1(b) 2(d) 3(a) 4(b) 5(d) 6(c) 7(a) 8(b)

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FOOD RESOURCES

7.1 INTRODUCTION

There are thousands of edible plants and animals and out of which only about three dozen types constitute the major food of humans. The main food resources include wheat, rice, pulses, sorghum, maize, millet, barley, oats, cassava, potato, sweet potato, sugarcane, and common fruits and vegetables comprise mango, papaya, banana, pea, cucumbers, tomato, and animal products include milk, meat, fish and seafood. Amongst these rice, wheat and maize are the major grains, about 1500 million metric tons of which are grown each year, which is about half of all agricultural crops. In developing countries people largely depend on wheat and rice. Meat and milk are mainly consumed by developed nations like USA, Europe and Japan, which constitute about 80% of their total food. Fish and sea food contribute about 70 million metric tons of high quality protein to the world's diet. The food and Agricultural Organization (FAO) of United Nations estimated that on an average the minimum caloric intake on a global scale is 2500 calories/day. The food scarcity can affect the health. Food security depends on available food supplies, accessibility to the available supplies, income, life style, the consumption rate of food, and the amount that can be set aside for future use.

7.2 OBJECTIVES

The objectives of this lesson comprise to study various world food problems; the changes caused by agriculture and over-grazing; and effects of modern agriculture e.g. fertilizer based problem, water logging and salinity.

7.3 WORLD FOOD PROBLEMS

The world produces enough food and agricultural products that are more than sufficient to satisfy the great demand at least for a number of decades ahead of it. However, people all over the world have been affected in one way or the other by shortage of food resulting into a situation called food crises. The world food problems concern regarding world food supplies and prices along with the problem of hunger and unavailability of the food to each individual. All of those factors which influence the system of production, consumption, and division of foodstuffs among world population are the cause of world food problems.

There are a number of reasons for worldwide food problems, e.g.

1. The slowdown in the rate of increase in yields of staple food crops
2. Scarcity of arable land
3. Natural catastrophes, e.g. drought, heavy rain and flooding, crop failures
4. Improper food production technologies
5. Inadequate food reserves
6. Food prices
7. Increasing urbanization
8. Population growth
9. Import-export balance
10. Food supply-and-demand imbalances
11. Warfare and civil disturbances
12. Culturally-based food prejudices
13. Environmental degradation (soil erosion and inadequate water resources).
14. Declining ecological conditions in agricultural regions
15. Lack of enough water on the agricultural land that is needed for producing enough food in order to feed the world population
16. Poor methods of consumption

17. The improper distribution of food stuffs also causes food problems
18. Gap between the rich and poor, developed countries and developing countries
19. Food wastage at homes, restaurants, social occasions etc.

Some problems are unique for developing world, which include,

1. Underdevelopment
2. Excessive population growth
3. Parents lacking knowledge of basic nutrition for their children
4. Lack of economic incentives
5. Insufficient government attention to the rural sector

Some problems are unique for industrialized world, which include,

1. Excessive use of natural resources
2. Pollution
3. Loss of farmland to competing uses
4. Inefficient, animal-protein diets
5. Inadequate research in science and technology
6. Excessive government bureaucracy

Some problems are common for both industrialized and developing world, which include,

1. Unequal access to resources creates sustainability issues
2. Lack of development planning
3. Insufficient emphasis on agricultural development for self-sufficiency
4. Inappropriate technological research
5. Insufficient food aid
6. Inadequate transfer of research and technology

7. Politics of food aid and nutrition education

8. Inappropriate role of multinational corporations

Many organizations like FAO (Food and Agriculture Organization), WHO (World Health Organization), International Food Policy Research Institute, etc. are involved to get rid off from these problems. There is a great need to get attention on food supply along with the food production. A clear understanding of reasons behind hunger and malnutrition is imperative to enable the policy makers to prepare the basic work at the grass-root level for appropriate policy measures and the development of programs designed to alleviate hunger and its consequences.

7.4 CHANGES CAUSED BY AGRICULTURE AND OVERGRAZING

7.4.1 CHANGES CAUSED BY AGRICULTURE

Agriculture is the world's oldest and largest industry; more than half of all the people in the world still survive on farms. The word agriculture comes from the Latin words ager, referring to the soil and cultura, to its cultivation. Agriculture can be defined as the cultivation and/or production of crop plants or livestock products. With the modernization in agriculture, there is tremendous increase in the food production, especially in developing countries. But this increase will not be sufficient for the future as population is growing much faster and the land is limited. To meet the world food demand, the farmers need to get more crop yield per unit area by using chemical fertilizers, hybrid varieties, and by increasing the cultivated area (by reclaiming the waste land) which would ultimately result in unavoidable changes and larger impacts on the environment.

The changes in environment caused by man through his agro-pastoral activities can be divided into two types:

(a) Changes brought about by traditional agriculture: It includes,

- Defacement of land,
- Deforestation coupled with loss of soil structure,

- Soil erosion and depletion of soil nutrients.

(b) Changes brought about by modern agriculture:

- Excessive irrigation causes twin problems of Salinization and water logging resulting from rise in water table. It also causes depletion of ground water resources.
- Addition of chemical fertilizers increases the rate of depletion of micronutrients from soils, eutrophication of water bodies and biomagnification.
- Use of plant protection chemicals poisons the food products, sometimes kills non-target friendly organisms and helps target organisms to develop immunity.
- The use of high yielding varieties makes the agriculture market-oriented and ultimately causing depletion of genetic diversity.

The effects of agriculture on the environment can also be broadly classified into three groups, viz. global, regional and local:

(1) **Global Effects:** These include climate changes as well as potentially extensive changes in chemical cycles.

(2) **Regional Effects:** These include deforestation, desertification, large-scale pollution, increase in sedimentation in major rivers and in the estuaries and changes in the chemical fertility of soils over large areas. In tropical waters, sediments entering the ocean can destroy coral reefs.

(3) Local Effects: These occur at or near the site of farming. These changes/effects include soil erosion and increase in sedimentation downstream in local rivers. Fertilizers carried by sediments can also transport toxins and destroy local fisheries.

7.4.2 CHANGES CAUSED BY OVERGRAZING

Overgrazing results from grazing too many livestock for too long period on the land, due to which the vegetation is unable to recover after grazing. In another case, overgrazing can be defined as grazing too many animals on land not suitable for grazing. Overgrazing implies that the number of animals exceeds the productive capacity of the grazing land or pasture. Overgrazing can cause following changes in the environment.

- Soil compaction and erosion.
- Reduces soil fertility, organic matter content, water infiltration and water holding capacity.
- Leads to land degradation.
- In arid regions, vegetation cover on the ground is very important to protect soils. Overgrazing removes this protective vegetation. These soils are then vulnerable to wind and water erosion, and remove fertile layer of the soil.
- Overgrazing may result in weed invasion and an overall decrease in forage availability by preferential removal of more palatable species and by the consumption of the majority of the more desirable plant species before they have had a chance to set seed.
- Reduction in the growth of vegetation.
- Reduction in the diversity of plant species.
- Dominance of plant species that is relatively undesirable to the cattle.

7.5 EFFECTS OF MODERN AGRICULTURE

Most food in the world was produced organically using organic manure and human and animal power before 19th century. The agricultural revolution began in England in the early 19th century with a horse-drawn hoe and a seed drill. After that, in middle of the 19th century, manufacturing of super phosphate fertilizer, nitrogen fertilizer, DDT, herbicides etc were started and by the middle of the 20th century, most of the components of modern agriculture were in use on agricultural farms, especially in the developed countries. Modern agriculture has been of great help in alleviating hunger, because the world population more than doubled itself during the last half of the 20th century.

However, unsustainable use of pesticides and fertilizers resulted in their residues in the produce above safety levels which ultimately cause ill-effects on the consumption of produce. The main effects of modern agriculture are presented below.

1. The constant use of chemical fertilizer, together with lack of crop rotation, reduces the soil fertility.
2. The repeated deep ploughing is used to turn over the ground, heavy rains can carry away the topsoil and make the soil less fertile.
3. Damage to the soil structure by compression due to high tillage is a serious problem in areas that are intensively farmed.
4. High yield levels are produced by applying large quantities of chemical fertilizers, instead of by maintaining the natural fertility of the soil, which causes soil, water and air pollution including their residual effects on the produce.
5. About half of the nitrate in the chemical fertilizer applied is not used by plants and this unused nitrate runs off the fields to contaminate water.
6. The chemicals used for the control of pest and diseases are accumulating in the crops and cause health problems on the consumption.
7. Native cultivars and animal breeds lose out to exotic species and hybrids, and are threatened to extinction.

7.5.1 FERTILIZER-PESTICIDE PROBLEMS

7.5.1.1 ENVIRONMENTAL EFFECTS OF FERTILIZERS

A fertilizer is any material of natural or synthetic origin that is applied to soils or to plant tissues to supply one or more plant nutrients essential to the growth of plants. Various environmental effects of fertilizers are discussed below.

Eutrophication: Run off of phosphate fertilizers from agricultural land to water leads to Eutrophication. It is the enrichment of a water body with excess of nutrients. This process induces growth of plants and algae, causing algal blooms and this biomass load results in oxygen depletion of the water body making water body unsuitable for other aquatic or-

ganisms to survive. Algal blooms produce harmful toxins that can accumulate in the food chain, and can be harmful to humans.

Nitrate pollution: Only a fraction of the nitrogen-based fertilizers is converted to produce available nitrogen to the plants. The remainder accumulates in the soil or lost as runoff. High application rates of nitrogen-containing fertilizers combined with the high water solubility of nitrate leads to increased runoff into surface water as well as leaching into groundwater, thereby causing groundwater pollution. Nitrate levels above 10 mg/L (10 ppm) in groundwater can cause 'blue baby syndrome'.

Soil acidification: Nitrogen-containing fertilizers can cause soil acidification when added to the soil. This may lead to decrease in nutrient availability which may be offset by liming.

Changes in soil biology: High levels of fertilizer may cause the breakdown of the symbiotic relationships between plant roots and mycorrhizal fungi.

ACCUMULATION OF TOXIC ELEMENTS:

Cadmium: The concentration of cadmium in phosphorus-containing fertilizers varies considerably and can be problematic.

Fluoride: The widespread use of phosphate fertilizers has increased soil fluoride concentrations. It has been found that food contamination from fertilizer is of little concern as plants accumulate little fluoride from the soil; of greater concern is the possibility of fluoride toxicity to livestock that ingest contaminated soils. Also of possible concern are the effects of fluoride on soil microorganisms.

Contribution to climate change: The greenhouse gases e.g. carbon dioxide, methane and nitrous oxide are produced during the manufacture of nitrogen fertilizers and hence contribute to global warming.

7.5.1.2 ENVIRONMENTAL EFFECTS OF PESTICIDES

Pesticides are substances which prevent, destroy, repel or moderate pests. Examples of pesticides include herbicides, insecticides, nematicides, molluscicides, and fungicides. These pesticides are used to control the pest in the agricultural fields so that these pests should not harm the crop and can get a higher yield. Various environmental effects of pesticides are given below.

Soil pollution: Due to retained pesticides in the soil, the biodiversity of the soil might reduce greatly. Also, the pesticides can obstruct chemical signals which facilitate functioning of nitrogen-fixing bacteria in soil and reduce the soil fertility.

Water pollution: Pesticides generally reach water sources through four main ways, i.e. percolation in soil, drifting outside the intended area, surface run off and accidental spills. Once water is contaminated, it may be unsafe for drinking and may cause adverse health effects.

Air pollution: The pesticide use can have an impact on air quality. These pesticides can cause serious effects on humans, when inhaled as fumes via air, such as damage to the kidneys and nervous system. The unsustainable utilization of pesticides can cause death of bees and hoverflies. These insects are essential in the process of pollination, and any impact on their populations may affect crop productivity.

Effect on plants and animals: In plants, the pesticides which affect nitrogen-fixing bacteria can cause death of higher plants such as legumes. Pesticides can have neurological impacts, hormonal impacts and impact on immune system. The apparent influence of pesticide and fertilizer mixtures on the endocrine system may have a cascade effect, attesting the immune system and affecting fetal brain development.

7.5.2 WATER LOGGING

Water logging refers to the saturation of soil with water. Soil may be regarded as waterlogged when it is nearly saturated with water much of the time such that its air phase is restricted and anaerobic conditions prevail. Waterlogged/critically waterlogged areas may be defined where water table is within 2 m from the surface (Table 7.1).

Table 7.1: The criteria adopted by different agencies for waterlogging

Water logging	National Commission on Agriculture (1976)	Ministry of Water Resources, Govt. of India (1991)
Waterlogged/Critical	Water table < 1.5 m	Water table < 2 m
Potentially waterlogged		Water table 2-3 m
Safe area		Water table > 3 m

For getting higher yield from agricultural fields, farmers provide more water by employing canal irrigation as well as tube wells for drawing water from within the earth. Excessive irrigation without proper drainage affects the soil-liquid-air ratio and also raises the water table. As a result, soil becomes drenched with water and thus become water logged. Water logged soils cannot support good plant growth because they lack in air which is very essential for root respiration, causing congestion of roots. Water logged soils also lack in mechanical strength and cannot physically support the weight of plants. This causes the plants to submerge in mud. As a result, the yield is reduced.

7.5.2.2 FACTORS RESPONSIBLE FOR THE FORMATION OF WATER-LOGGED SOIL

- Drainage: poor drainage system is responsible for water-logging in the field.
- Flood: Flood water is usually causing water-logged situation in the field.
- Land shape: Saucer-shaped land gets water from high-lands which results into water-logging.
- Climatological factor: due to high rainfall water accumulates on the soil surface.
- Seepage from canal: Ground water levels are closer to the surface due to seepage from canal.
- Uncontrolled and unwanted irrigation: excess irrigation may cause accumulation of water on the soil surface.

7.5.2.2 EFFECTS OF WATER LOGGING

- Damage to the soil structure
- Suffocation of plant roots
- Erosion in higher rainfall areas
- Reduced soil fertility
- Fungal disease
- Nitrogen deficiency
- Reduced yield
- Pasture loss through drowning
- Access problems for machinery/stock

7.5.2.3 MANAGEMENT OF WATER-LOGGED SOILS

Farmers need to manage and plan irrigations properly, so that they do not over water the soil.

- Leveling of land: Leveling of land in many wetlands removes water by runoff.
- Drainage: Drainage removes excess water from the root zone that is harmful for plant growth. Land can be drained by surface drainage, sub-surface drainage and drainage well methods.
- Controlled irrigation: Excess use of water in the irrigation results in water-logged area.
- Flood control measures: Construction of bunds may check water flow from the rivers to the cultivable lands.
- Plantation of tree having high transpiration rate: Transpiration rate in certain tree like Eucalyptus, Acacia, Zyzyphus is very high. They can be planted in waterlogged soils.
- Selection of crops and their proper varieties: Certain crops like rice,

waternut, jute and sesbania can tolerate water-logging upto some extent. In rice crop submergence tolerance varies from one variety to another.

7.5.3 SALINITY

Soil salinity is the salt content present in the soils. Salts occur naturally within soils and water. Salination can be caused by natural processes such as mineral weathering or by the gradual withdrawal of an ocean. It can also be caused through artificial processes such as irrigation. Soils that contain excess soluble salts and affect plant growth adversely are called salt affected soils. These soils are mainly divided in to two major categories.

Saline soil

Saline soils are those which contain sufficient soluble salts (chlorides and sulphates of sodium) to interfere with the growth of plants. These soils are locally called as Reh. The six classes of saline soils found in India are (1) saline soils of semiarid regions with highly saline ground water (2) saline soils of sub humid region with moderately saline groundwater (3) saline soils of sub humid region (4) saline soils of semi arid delta region (5) saline acid sulfate soils of humid region and (6) saline marsh of arid region.

Alkali soils

These are also called as sodic soils and these soils contain excessive exchangeable sodium to adversely affect crop production and locally called as Usar. The alkali soils found in India fall under three classes, viz. (1) alkali soils of Indo Gangatic plain with sweet ground water, (2) alkali soils of Indo Gangatic plain with sodic ground water and (3) alkali soils of deccan plateaus with sodic or saline ground water. In general, pH and Electrical Connectivity(EC of saline soil is more than the normal soil due to presence of more sodium salts and alkali soils have more pH and sodium adsorption ratio (SAR) than the normal soils due to presence of excessive exchangeable sodium salts in the soil. Properties of these problematic soils are summarized in Table 7.2.

Table 7.2 Some of the properties of saline and alkali soils

Properties	Saline soil	Alkali soil
1. Chemistry of soil solution	Dominated by chlorides and sulphides of sodium, calcium and magnesium.	Dominated by sodium carbonate or sodium bicarbonate or both.
2. Major effect on plants	High osmotic pressure of soil solution.	Alkalinity of soil solution and resultant corrosive effect on plant roots.
3. Mode of reclamation	Removal of excessive electrolytes through leaching.	Lowering or neutralizing high pH through chemic al amelioration.

7.5.3.1 FACTORS RESPONSIBLE FOR FORMATION OF SALINE AND ALKALI SOILS

1. Arid and semiarid climate: In these climatic regions annual evaporation is more than the annual rainfall, due to which salts present in the lower strata come on the surface with evaporating water and accumulated on the surface.

2. Poor drainage of soil: Due to evaporation of stagnated water in poor drainage areas salts are accumulated on the surface of soil.

3. High water table: In high water table areas submerged conditions prevail and after evaporation of water such soil become saline.

4. Over flow of seawater over lands: Seawater is brackish in nature and when it over flows on land, it ultimately increases the concentration of salts.

5. Bad quality of irrigation water: Soils become saline when farmers use bad quality water in irrigation, which contains salts in higher concentrations.

6. Salts blown by wind: In highly arid regions like Rajasthan, salts are present on the soil surface and blown by high velocity wind, which are deposited on another place.

7. Saline nature of parent rock material: When parent rock is saline, soil formed from these rocks is naturally saline.

8. Low permeability of soil to water: Continuous ploughing at a certain depth forms a hard layer, which restricts the downward movement of water due to which salts are accumulated on surface by evaporation.

9. Undulated land: In undulated region salt containing water flows down from upper areas to lower areas, which increases more salts in lower areas.

10. Presence of hard kanker pan in lower surface: Due to presence of hard kanker pan in lower surface downward movement of water is reduced resulting which salts are accumulated on surface by evaporation.

7.5.3.2 EFFECTS OF SALINITY

- Effects of salts on soil

When salts are accumulated in the soil (surface and/subsurface), they reduce the availability of nutrients to plants, as they bind with them. Salts also decrease the activity of microorganisms. Salts are accumulated in subsurface soil and form hard pan, which restrict water to percolate at lower strata. As salts enriches the soil, the physical properties (texture, porosity, bulk density, etc.) and chemical properties (pH, EC, SAR, etc.) also adversely affected.

- Effects of salts on plants

As salts enter in the soil, the osmotic pressure of soil water increases, and when this osmotic pressure is more than the osmotic pressure of roots, then plant is unable to absorb nutrients. Germination of seeds also reduces in salt affected soil because as radicle and plumule emerges, they injured with salts. Availability of some elements (Ca, Mg etc.)

decreases and few elements (Na etc.) increases up to toxic levels.

7.5.3.3 METHODS OF RECLAMATION

The term reclamation of saline soils refers to the methods used to remove soluble salts from the root zone. Reclamation methods are mainly divided into three categories viz. Physical, chemical and biological. Physical methods are crude and time consuming but these are most suitable for the reclamation of saline soils while chemical methods give quick response and suitable for reclamation of alkali soils. Biological methods are ecofriendly and reclaim both type of soils but they are time consuming.

PHYSICAL METHODS

The following methods are found suitable to reclaim these problematic soils.

Scraping of salts: We scrape the salts and dump them elsewhere.

Leaching of the salts: In this method fields filled with water and salts are leached with water.

Drainage: In drainage huge amount of water is left in the field for a short period after that it is drained out in which salts are dissolved.

Trenching: We dig a trench and when we dig another trench, the soil of this trench is filled in the first trench resulting which the lower soil becomes upper soil and vice versa.

Breaking of hard kanker pan: The downward movement of water along with salts is allowed by the breaking of hard kanker pan.

Deep ploughing: Deep ploughing breaks subsurface layer, by which downward movement of water along with salts is possible.

CHEMICAL METHODS

Reclamation of salt affected soils can be done by using chemicals (e.g. gypsum, pyrite, sulphur, ferrous sulphate, etc.). Each chemical firstly forms calcium sulphate ($CaSO_4$), and then this $CaSO_4$ react with sodium bound clay particles and replace Na+ with Ca++ and form sodium sulphate ($Na2SO_4$), which percolates in lower strata with water and/or drained

out from the field by facilitating drainage.

The optimum doses of chemicals depend upon three factors (i) Nature and degree of soil deterioration, (ii) Soil texture and (iii) Type of crop to be grown.

BIOLOGICAL METHODS

Use of organic manure: After decomposition of organic manure like farm yard manure and compost, humic and fulvic acids are formed which reclaim soil.

Use of green manure: By the use of green manure, chemical and physical properties of soil are improved and also increase microbial activity.

Use of molasses: By the addition of molasses organic acids are formed which reclaim the soil.

Mulching: Mulching directly reduces evaporation rate and also adds organic matter after decomposition.

Use of crop residue: Soil can also be reclaimed by use of crop residues directly or in the form of mulching, organic manure etc.

Growing of weeds: The roots of weeds like *Argemone maxicana* secret some chemicals, which reclaim soil.

Growing of salt tolerant plants: Soil can also be reclaimed by growing salt tolerant plants but it takes long time. Some salt tolerant plants are given below.

Trees	Grasses and forage crops	Cereal Crops	Vegetable Crops	Fruit Crops
Babool	Alfa-alfa	Barley	Carrot	Ber
Jhau	Karnal grass	Rice	Lettuce	Aonla
Black Siris	Bermuda grass	Sorghum	Potato	Guava
Arjun	Para grass	Wheat	Onion	Phalsa

7.5.3.4 MANAGEMENT OF SALINE SOILS

Proper management is essential after reclamation of such problematic soils; therefore, by adopting following techniques, soils can be managed successfully.

Ploughing: Ploughing should be avoided at same depth.

Puddling: Excessive puddling should be avoided.

Light and frequent irrigation: Irrigation should be applied lightly at frequent interval, which reduces evaporation.

Regular cultivation: Regular foliage cover achieved by adopting intensive crop rotation, thus reducing the rate of evaporation.

Method of irrigation: It is beneficial to provide minimum water for irrigating the crops. For this drip and sprinkler irrigation methods can be used.

Drainage: Regular drainage is essential to avoid stagnation of excessive water in the field.

Fertilizers: Use of basic fertilizers like $CaCO_3$, basic slag etc should not be applied continuously.

7.6 SUMMARY

The world food problems are related to world food supplies and prices along with the problem of hunger and unavailability of the food to each individual. All of those factors which influence the system of production, consumption, and division of foodstuffs among world population are the cause of world food problems. There is a great need to get attention on food supply along with the food production. A clear understanding of reasons behind hunger and malnutrition is imperative to enable the policy makers to prepare the basic work at the grass-root level for appropriate policy measures and the development of programs designed to alleviate hunger and its consequences. To meet the world food demand, the farmers need to get more crop yield per unit area by using chemical fertilizers, hybrid varieties, and by increasing the cultivated area (by reclaiming the waste land) which would ultimately result in unavoidable changes and larger impacts on the environment. Overgrazing results from grazing too many livestock for too long period on the land, due to which the vegetation is unable to recover after grazing. Overgrazing implies that the number of animals exceeds the productive capacity of the grazing land or pasture. Over-grazing can cause changes like soil compaction and erosion, reduce soil fertility, organic matter content, water infiltration and water holding capacity. Modern agriculture has been of great help in alleviating hunger, because the world population more than doubled itself during the last half of the 20th century. However, unsustainable use of pesticides and fertilizers resulted in their residues in the produce above safety levels which ultimately cause ill-effects on the consumption of produce. A fertilizer is any material of natural or

synthetic origin that is applied to soils or to plant tissues to supply one or more plant nutrients essential to the growth of plants. Various environmental effects of fertilizers are eutrophication, nitrate pollution, soil acidification, changes in soil biology, accumulation of toxic elements etc. Pesticides are substances which prevent, destroy, repel or moderate pests. Various environmental effects of pesticides are soil pollution, water pollution, air pollution and effects on plants and animals. Water logging refers to the saturation of soil with water. Soil may be regarded as waterlogged when it is nearly saturated with water much of the time such that its air phase is restricted and anaerobic conditions prevail. Water logged soils cannot support good plant growth because they lack in air which is very essential for root respiration, causing congestion of roots. Water logged soils also lack in mechanical strength and cannot physically support the weight of plants. This causes the plants to submerge in mud resulting in reduced yield. Salination can be caused by natural processes such as mineral weathering or by the gradual withdrawal of an ocean. It can also come about through artificial processes such as irrigation. Soils that contain excess soluble salts and affect plant growth adversely are called salt affected soils. The term reclamation of saline soils refers to the methods used to remove soluble salts from the root zone. Reclamation methods are mainly divided into three categories viz. physical, chemical and biological. Physical methods are crude and time consuming but these are most suitable for the reclamation of saline soils while chemical methods give quick response and suitable for reclamation of alkali soils. Biological methods are ecofriendly and reclaim both type of soils but they are time consuming.

7.7 GLOSSARY

Alkali soils : These are also called as sodic soils and they contain excessive exchangeable sodium to adversely affect crop production.

Overgrazing : It results from grazing too many livestock for too long period on the land, due to which the vegetation is unable to recover after grazing. It can also be defined as grazing too many animals on land not suitable for grazing. Overgrazing simply implies that the number of animals exceeds the productive capacity of the grazing land or pasture.

Saline soils : Saline soils are those which contain sufficient soluble salts (chlorides and sulphates of sodium) to interfere with the growth of plants.

Water logging : It refers to the saturation of soil with water. Soil may be regarded as waterlogged when it is nearly saturated with water most of the time such that its air phase is restricted and anaerobic conditions prevail.

7.8 QUESTIONS

Descriptive type/Short answers questions

1. Discuss in detail various changes caused by agriculture and overgrazing.
2. Elaborate upon various methods for reclamation of saline soils.
3. Write a detailed note on soil water logging and its management.
4. Discuss various reasons responsible for world's food problem.

Multiple choice questions

1. Algal blooms are result of:
   (a) Biomagnification
   (b) Radioactive pollution
   (c) Eutrophication
   (d) Air pollution

2. Nitrate pollution is known to cause:
   (a) Blue baby syndrome
   (b) AIDS
   (c) Down's syndrome
   (d) All of the above

3. Water logged areas may be defined as areas where water table is:
   (a) < 3m
   (b) < 5m

(c) < 4m

(d) < 2m

4. Alkaline soils are also known as:

(a) Nitrate soils

(b) Sodic soils

(c) Potassium soils

(d) Sulphur soils

5. Normal soil have pH:

(a) 5.5

(b) 6.5

(c) 7.5

(d) 8.5

6. Saline soils are dominated by

(a) Chlorides and sulphides of sodium, calcium and magnesium

(b) Chlorides and carbonates of sodium, calcium and magnesium

(c) Carbonates and bicarbonates of sodium and calcium

(d) Carbonates and bicarbonates of sodium only

7. The optimum doses of chemicals for reclamation of saline soils does not depend upon

(a) Nature and degree of soil deterioration

(b) Water table of that area

(c) Soil texture

(d) Type of crop to be grown.

8. Overgrazing can cause

(a) Soil compaction and erosion

(b) Reduce organic matter content and water holding capacity of soil.

(c) Salinity of soil

(d) Both a and b

Answers

1(c) 2(a) 3(d) 4(b) 5(b) 6(a) 7(b) 8(d)

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ENERGY RESOURCES

8.1 INTRODUCTON

The effect of energy in our life and society is enormous and it controls everyday aspects of our lives. Energy is the lifeline of the economy for any country. Energy can be found in a number of different forms viz. heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy. There are two types of energy i.e. potential or stored energy and kinetic or moving or working energy. The potential energy is the energy of position and kinetic energy is energy of motion. Energy can be transformed into another sort of energy. But it cannot be created and nor be destroyed. Energy has always existed in one form or another. The energy sources are divided mainly into two groups: renewable and non-renewable. Renewable and non-renewable energy sources can be used to produce secondary energy sources including electricity and heat. There are several units to measure energy viz. British thermal unit (Btu), joules, calories, kilo watt hour (kWh).

8.2 OBJECTIVES

The objectives of this lesson include studying the growing energy needs; various renewable and non-renewable energy sources; use of alternate energy resources; and different urban problems related to energy consumption.

8.3 GROWING ENERGY NEEDS

Energy is essential to the existence of mankind. All industrial processes like mining, transport, lighting, heating and cooling in buildings need energy. With the growing population,

the world is facing an energy deficit. Lifestyle change from simple to a complex and luxurious lifestyle adds to this energy deficit. As per International Energy Agency (IEA), a 37% increase in global primary energy demand is expected by 2040. Electricity demand is increasing twice as fast as overall energy use and is likely to rise by more than two-thirds from 2011 to 2035. Almost 95% of commercial energy is available from fossil fuels like coal and natural gas. These fossil fuels will not last for more than a few years as is the scenario of growing energy utilization. Hence, we must explore alternative fuel/energy options.

8.3.1 CAUSES OF GROWING ENERGY NEEDS

1. Urbanization: Developing countries are also being confronted with the global problem of rapid urbanization, as most of their rural populations flock to cities. Urbanization implies much higher energy intensity.
2. Population explosion: Due to population explosion, the demand for energy has increased many folds.
3. Industrialization: Businesses and factories in particular, require significant amounts of energy in the form of both electricity and petroleum-based fuels in order to operate. As economies industrialize, energy demand increases.
4. Increasing wealth in emerging markets: When economies grow, their energy needs also grow. Consumers want cars, air conditioners, refrigerators, and other energy consuming devices.
5. Globalization: As we move more often, and with greater speed, the energy we use in transportation will inevitably increase. Air travel in particular is a heavy user of fuel.

8.3.2 WAYS TO MITIGATE GROWING ENERGY DEMANDS

The worldwide increase in demand for energy has put ever-increasing pressure on identifying and implementing ways to save energy. In fact, the world has consistently

improved its energy efficiency. However, going forward the world will need even more improved energy efficiency measures. These are mentioned below.

1. More efficient buildings : Reflective roofing, better use of daylight, and other green and energy-friendly improvements can drastically reduce energy demands from electricity-guzzling commercial buildings.
2. Energy efficient light bulbs: Each $2 spent on new compact fluorescent lamps (CFLs) can save more than $30 in power and replacement costs. Use of LED (light-emitting diode) bulbs can further reduce the power and replacement expenditures.
3. Demand-side management (DSM): As electricity becomes more expensive, consumers and utilities will have a mutual interest in finding new ways to manage demand for electricity so as to reduce the cost to the end-user. For example, programs to turn off idle appliances, rather than let them "sleep" in low-power mode, or to automatically turn off the heat or air conditioner during the wee hours of the night in corporate headquarters.
4. Fuel efficiency: There are many other ways to improve fuel efficiency. One of the most evident involves ensuring proper inflation of tires of the vehicles. Another method is to limit frequent and intense stopping and starting, and other fuel-intensive driving activities.

8.4 RENEWABLE AND NON-RENEWABLE SOURCES OF ENERGY

8.4.1 NON-RENEWABLE ENERGY RESOURCES

Non-renewable energy resources have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted e.g. coal, petroleum, natural gas and nuclear fuels like uranium and thorium. Coal, oil and natural gas are called "fossil fuels".

8.4.1.1 COAL

Coal was formed 255-350 million years ago when the ancient plants were buried after the death into the soil and due to heat and pressure gradually got converted into peat and coal

over millions of years. Coal is a hard, black coloured rock-like substance. There are three main types of coal : anthracite, bituminous and lignite. Anthracite coal is the hardest and has more carbon, which gives it higher energy content. Coal is most abundant fossil fuel in the world. Major coal fields in India are Ranighanj, Jharia, Bokaro, Singrauli and Godavari valley. Anthracite coal occurs only in Jammu and Kashmir.

Following are the most significant uses of coal.

1. Electricity generation, steel production, cement manufacturing and as a liquid fuel.

2. Steam coal - also known as thermal coal - is mainly used in power generation.

3. Coking coal - also known as metallurgical coal - is mainly used in steel production.

8.4.1.2 PETROLEUM

Petroleum is often called as crude oil or oil. It was formed when the plants and animals died, sank to the bottom of the oceans and were buried by thousands of feet of sand and silt. The heat and pressure changed the remains, and eventually, petroleum was formed. Petroleum deposits are locked in porous rocks almost like water is trapped in a wet sponge. When crude oil comes out of the ground, it can be as thin as gasoline or as thick as tar. Hence it has to be purified and refined by the process of fractional distillation, during the process different constituents separate out at different temperatures. Large varieties of products obtained from the process are petroleum gas, paraffin wax, kerosene, petrol, diesel, fuel oil, lubricating oil, asphalt, plastic etc. Oil fields in India are located at Digboi (Assam), Gujarat Plains and Bombay high, offshore areas in deltaic coasts of Godavari, Krishna, Kaveri, and Mahanadi.

Petroleum is used widely in:

1. Transportation for running the vehicles,

2. In power stations where diesel is used to produce electricity,

3. For domestic and lightning purposes in which kerosene is used,

4. For the construction of metal roads, in which tar is used,

5. For the manufacturing of candles and pharmaceuticals in which paraffin and vaseline are used.

8.4.1.3 NATURAL GAS

Raw natural gas is a mixture of different gases. Natural gas can be hard to find since it is usually trapped in porous rocks deep underground. Natural gas is highly flammable. It is mainly composed of methane (95%) with small amount of propane and ethane. Methane is odourless, colourless and tasteless. As a safety measure, natural gas companies add a chemical odourant called mercaptan to detect escaping of gas. Natural gas deposits mostly accompany oil deposits. It can be easily transported through pipelines. It has high calorific value of about 50 KJ/g. In India, natural gas reserves have been found in the eastern coast (Tamil Nadu, Orissa and Andhra Pradesh), as well as in Tripura, Rajasthan and off-shore wells in Gujarat and Maharashtra. Various uses of natural gas are as follows.

1. It is commonly used to heat and cool homes and businesses worldwide.

2. It is also used as a fuel in Thermal power plants for generating electricity.

3. It is used as a source of hydrogen gas in fertilizer industry and as a source of carbon in tire industry.

8.4.2 RENEWABLE ENERGY RESOURCES

Renewable energy resources can be replenished in a short period of time, can be generated continuously in nature and are inexhaustible e.g. solar energy, wind energy, tidal energy, hydropower, biomass energy, biofuels, geothermal energy and hydrogen. They are also known as non-conventional source of energy and they can be used again and again in an endless manner.

8.4.2.1 SOLAR ENERGY

Solar energy is radiant energy that is produced by the Sun. Every day sun radiates enormous amount of energy. The solar energy comes from within the Sun. The hydrogen atoms in the Sun's core form helium by nuclear fusion and generate enormous energy. Traditionally, solar energy was used as energy source for drying clothes and food grain, preservation of eatables and for obtaining salt from sea water for thousands of years, but recent development in technology made possible to use it for generating power. Some important solar energy harvesting devices are solar cell, solar cooker, solar water heater, etc.

Solar cells: They are also known as photovoltaic cells or PV cells that convert light directly into electricity. Solar cells are made of thin wafer of semi conducting materials like silicon and gallium. When solar radiation falls on them, a potential difference is produced which causes flow of electron, thus produces electricity.

Solar cooker: A solar cooker is a device which uses sunlight as its energy source to generate sufficient temperature to cook food. Electromagnetic radiation from the Sun, including visible and infrared wavelengths, penetrates into the collector that is absorbed by the surfaces inside the collector. Once the radiation is absorbed by the surfaces within the collector, the temperature rises. This increase in temperature can be used to cook food.

Solar water heater: A solar heat collector is mounted on the roof or in an open area. It collects solar light and converts to heat. When collector is hot enough, a thermostat starts the pump and circulates a heat transfer fluid, through the collector for heating. The heating fluid then goes to storage tank and heats water.

Solar power plant: The power station uses the Sun's heat to make steam, and drive a generator to make electricity. The station looks like the solar furnace, except that the mirrors are arranged in circles around the "power tower". As the Sun moves across the sky, the mirrors turn to keep the rays focused on the tower, where oil is heated upto 3,000 degree Celsius. The heat from the oil is used to generate steam, which then drives a turbine, which in turn drives a generator to provide of electrical power.

Advantages of Solar Energy

- It is a source of free energy, needs no fuel and produces no waste or pollution.
- In sunny countries, solar power can be used and is a boon for those regions where electricity supply does not exist.
- Solar energy is handy for low-power uses such as solar powered garden lights and battery chargers, and reduces energy bills.

Disadvantages of Solar Energy

- It doesn't work at night and during cloudy weather.

- Solar power stations are very expensive to build. Solar cells cost a great deal compared to the amount of electricity they will produce in their lifetime.
- It can be reliable only in a very sunny climate.

8.4.2.2 WIND ENERGY

Wind energy is the kinetic energy associated with the movement of atmospheric air. Wind energy has been used for hundreds of years for sailing, grinding grain, and for irrigation. Wind energy systems convert this kinetic energy to more useful forms of power. Wind energy continues to be the fastest growing renewable energy source with worldwide wind power installed capacity reaching 14,000 MW. In India, the states of Tamilnadu and Gujarat lead in the field of wind energy. There are about a dozen wind pumps of various designs providing water for agriculture, afforestation, and domestic purposes, all scattered over the country. Some of the gadgets are Windmills, and Wind turbines.

Wind mills: The Sun heats the atmosphere unevenly, so some patches become warmer than others. These warm patches of air rise and other air patch blows to fill the space. The energy in the wind can be used by building a tall tower, with a large blade/propeller on the top. The wind blows the propeller in a circle, which turns the generator to produce electricity.

Wind turbines: These transform the wind energy into mechanical power, which can then be used directly for grinding etc. or further converting to electric power to generate electricity. Today's wind machines use blades to collect the wind's kinetic energy. The wind flows over the airfoil shaped blades causing lift, like the effect on airplane wings, causing them to turn. The blades are connected to a drive shaft that turns an electric generator to produce electricity.

Advantages of wind energy

- Wind is free, wind farms need no fuel.
- Produces no waste and greenhouse gases.
- The land beneath can still be used for farming.
- Wind farms can be tourist attractions.
- Good method of supplying energy to remote areas.

Disadvantages of wind energy

- The wind is not always predictable.
- Suitable areas for wind farms are often near the coast, where land is expensive.
- Some people feel that covering the landscape with these towers is unattractive.
- It can kill birds; migrating flocks tend to like strong winds.
- It can affect television reception.
- It can be noisy. Wind generators have a reputation for making a constant, low, "swooshing" noise day and night.

8.4.2.3 HYDROELECTRIC ENERGY

The name comes from "hydro", the Greek word for water. Hydroelectricity is electricity generated by hydropower, i.e., the production of power through use of the gravitational force of falling or flowing water. For production of electricity from water, a dam is built to trap water, usually in a valley where there is an existing lake. When water fall from a great height at the turbines, it drives turbine and the connecting generator start the electricity generation.

Advantages of hydroelectric energy

- Once the dam is built, the energy is virtually free.
- No waste or pollution produced.
- Much more reliable than wind, solar or wave power.
- Electricity can be generated constantly.

Disadvantages of hydroelectric energy

- The dams are very expensive to build. However, many dams are also used for flood control or irrigation, so building costs can be shared.
- Building a large dam will flood a very large area upstream, causing problems for animals that used to live there.

- Finding a suitable site can be difficult, sometimes the impact on residents and the environment may be unacceptable.
- Water quality and quantity downstream can be affected, which can have an impact on aquatic and terrestrial life.

8.4.2.4 TIDAL ENERGY

The tide moves a huge amount of water twice each day, and harnessing it could provide a great deal of energy. Tidal energy is the utilization of the Sun and Moon's gravitational forces - as tides are formed by the gravitational pull of the Sun and Moon on the oceans of the rotating earth. Tides can be found with varying degrees of strength on any coastline, and sometimes even at sea, although these are better known as currents.

When the tide comes in, water flows through a sluice (a sliding gate or other device for controlling the flow of water) into a storage pond. When the tides go back out, the water flows back into the sea. The difference between the tide mill and today's tidal power plant lies in the size of the unit and the amount of energy generated. Another method of utilizing tidal energy is to build a barrage or barrier with gates of some kind at the opening of a bay or a river system to create an estuary or a big basin. The gates create differences in the water levels between the estuary and the ocean, thus enabling the generation of electricity.

Globally, only four countries are generating power through tidal energy. The first country to start generating electricity using tidal energy was France (La Rance Tidal plant in 1966). The Shiwa Lake Tidal plant in South Korea is the largest tidal power plant in operation with a capacity of 254 MW. The other places where tidal power is used to generate electricity include Canada (20 MW), China (3.2 MW) and Russia (0.4 MW).

Advantages of Tidal energy

- Once power plant built, tidal power is free.
- It produces no greenhouse gas and other waste.
- It needs no fuel.

- It produces electricity reliably.
- Not expensive to maintain.
- Tides are totally predictable.

Disadvantages of Tidal energy

- A barrage across an estuary is very expensive to build, and affects a very wide area. Only provides power for around 10 hours each day, when the tide is actually moving in or out.
- Damages like reduced flushing and erosion can change the vegetation of the area and disrupt the balance.
- The alteration of tidal currents affects the habitat of the seabirds and the fish.
- Tidal energy is only available in a small number of regions. This depends on local features.

8.4.2.5 GEOTHERMAL ENERGY

The word geothermal comes from the Greek words geo (earth) and therme (heat). Geothermal energy is a renewable energy source and refers to heat energy generated and stored inside the Earth. Most of this heat is provided from the decay of radioactive isotopes. This deep geothermal energy can only be accessed when it arrives at the Earth's surface through geological processes such as through fault lines on the Earth's crust (or areas of volcanic activity) or by drilling through the surface to access it. Geothermal energy can sometimes find its way to the surface in the form of volcanoes, hot springs and geysers. The first geothermal power station was built at Landrello, in Italy, and the second was at Wairekei in New Zealand.

Advantages of Geothermal energy

- Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.

- The power stations do not cover much area, so there is not much impact on the environment.
- No fuel is needed.
- Once a geothermal power station built, the energy is almost free. It may need a little energy to run a pump, but this can be taken from the energy being generated.

Disadvantages of Geothermal energy

- There are not many places to build a geothermal power station.
- The type of rock above is also important; it must be of a type that can be drilled easily.
- Sometimes a geothermal site may "run out of steam", perhaps for decades.
- Hazardous gases and minerals may come up from underground, and can be difficult to safely dispose off.

8.4.2.6 BIOMASS ENERGY

Biomass is the organic matter produced by the plants or animals which include wood, crop residues, cattle dung, manure, slaughterhouse waste, sewage, agricultural waste etc. "Bioconversion" uses plant and animal wastes to produce "biofuels" such as ethanol, biogas and oil.

Types of Biomass Energy

(a) **Energy Plantation**

Solar energy is trapped by green plants through photosynthesis and converted into biomass. They may produce energy either by burning directly or by getting converted into biogas or may be converted into ethanol by fermentation.

(b) **Petro crops**

Petro crops are those plants which are used for production of biodiesel from their fruits/seeds e.g. jatropha, pongamia and oil palms.

(c) **Agriculture and urban waste biomass**

Crop residues, wheat and rice straw, bagasse (sugarcane residues), coconut shells, peanut hulls, cotton stalks etc. are some of the agricultural wastes which can be used to produce energy by burning or fermenting. Animal dung, fishery, poultry waste and even human refuse are examples of biomass energy.

(d) **Biogas**

Biogas is a clean fuel produced through anaerobic digestion of several organic wastes like agricultural, animal, domestic and industrial. It is relatively clean burning and colourless gas, and composed of methane (CH_4), carbon dioxide (CO_2), and some traces of nitrogen (N_2), ammonia (NH_3), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), and hydrogen (H_2), depending on the feedstock used. The popularization of biogas has produced beneficial effects on exploration of energy, fertilizers and improvement of hygiene, farming and ecological environment.

Biogas is produced in the anaerobic environment, where certain bacteria decompose organic material. The whole process is referred as anaerobic digestion (AD). AD effectively treats the organic fraction of waste. The process not only leads to a healthy and clean environment, but also produces a renewable energy like methane. The by-product produced during the process is high-grade manure. In a biogas plant, biomass like vegetable wastes, animal excreta, and weeds undergo decomposition in the absence of oxygen and form a mixture of gases.

Benefits of Biogas Plants

- A non-polluting and renewable source of energy is created in biogas plants.
- It is an excellent way of energy conversion.
- Biogas plants produce enriched organic manure which can be used as fertilizers.
- Biogas generated from organic waste provides improvement in the environment, sanitation and hygiene.
- The biogas plants provide a source for decentralized power generation.

Disadvantages of biogas plants

- Low production during winter months
- Low methane content
- High retention time

8.5 USE OF ALTERNATE ENERGY SOURCES

All fossil fuels are non-renewable energy sources and as such they will eventually be depleted because their generation rates are much lower than the utilization. Fossil fuels are based on finite resources and their distributions are heavily localized in certain areas of the world, they will become expensive with the increasing demand and reducing the availability. Further, energy generation from fossil fuels requires combustion and during combustion they release vast amount of greenhouse gases and pollutants thus damaging the environment. In order to sustain the future of the world with a clean environment and non-depletive energy resources, alternate energy source that must be renewable in nature is the obvious choice. Renewable energy sources include: wind energy, solar energy, geothermal energy, biomass, biogas, bioethanol, biodiesel, algal biofuels, and hydrogen. Most renewable energy, except geothermal energy, comes directly or indirectly from the Sun.

Benefits of alternate / renewable energy resources

- Environmental cleanness without pollutant emission
- Non-depletive or renewable in nature
- Availability throughout the world, provides energy security
- Do not cause global warming
- Waste reduction and also reduces the demand of land-fill sites
- Stabilization of energy costs
- Provide stability in oil price

Keeping in view the advantages of the alternate or renewable energy sources, most of the countries have made policies to encourage the production of alternate energy by providing subsidy in various forms. Also they are making some mandatory policies to adopt these

alternative energy sources. The ethanol blending in petrol is an example of such mandatory policies. Most of the countries are focusing on the solar and wind energy sources to fulfill the residential and industrial energy demand and biofuels for the transport and agricultural energy demands. Most of the European countries have made it mandatory to replace about 20% of the energy consumption by renewable energy sources by 2020 and also 20% transport energy demand by biofuels.

8.6 URBAN PROBLEMS RELATED TO ENERGY

Urbanization is a global phenomenon. Cities are the main centres of economic growth, trade, education, innovations and employment. Urban centers use enormous quantities of energy. It was some two hundred years ago with the dawn of industrial era the cities showed rapid development. Now about 50% of the world population lives in urban areas and there is increasing movement of rural population to cities in search of employment. The urban growth is so fast that it is becoming difficult to accommodate all the industrial, commercial and residential facilities within a limited municipal boundary. As a result there is spreading of the cities into the sub-urban or rural areas too, this phenomenon is known as "urban sprawl". The urban set up is densely populated, consumes a lot of energy and materials and generates a lot of waste. The management of urbanization involves management of diverse range of problems and thus effecting all aspects of social life.

Energy demanding activities in urban areas: Residential and commercial lighting (Malls, offices, hotels), private and public transport, modern life style e.g. excess use of electronic gadgets, industrial activities etc.

Problems related to urbanization: Problems related to energy, power cuts and load, hampered economic development, unemployment, pollution, social problems, sanitation problems etc. Various urban problems related to energy consumption are listed below.

- Embodied energy materials like iron, glass, aluminium, steel, cement, marble and burnt bricks, which are used in urban housing, are very energy intensive. The process of extraction, refinement, fabrication and delivery are all energy consuming and add to pollution of earth, air and water.
- Kerosene is a urban fuel which produces smoke that is harmful.
- Urban centers in hot climates need energy for cooling. The early systems of fans

are changed into air-conditioning, which consumes enormous quantities of energy.

- High rise buildings in urban centers also depend on energy to operate lifts and a huge number of lights.
- Urban transport depends on energy mainly from fossil fuels. Most urban people use their own individual transport rather than public transport systems and put pressure on non-renewable sources of energy.
- The people in urban areas use more electricity for computers and High definition (HD) televisions. These all take more energy than was used before and the power grid cannot cope with the extra demands.
- More and more power cuts and load shedding and hence arises problem related to electrical energy.

8.7 SUMMARY

Energy is essential to the existence of mankind. All industrial processes like mining, transport, lighting, heating and cooling in buildings need energy. With the growing population, the world is facing an energy deficit. There are various causes of growing energy needs such as urbanization, population explosion, industrialization, and consumerism. By constructing energy efficient buildings and using energy efficient devices, we can mitigate the growing energy requirements. The energy sources are divided mainly into two groups: non-renewable and renewable. Non-renewable energy resources have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted e.g. coal, petroleum, natural gas and nuclear fuels like uranium and thorium. Renewable energy resources can be replenished in a short period of time, can be generated continuously in nature and are inexhaustible e.g. solar energy, wind energy, tidal energy, hydropower, biomass energy, biofuels, geothermal energy and hydrogen. They are also known as non-conventional sources of energy. In order to sustain the future of the world with a clean environment and non-depletive energy resources, alternate energy source that must be renewable in nature is the obvious choice. There are many urban problems related to energy. Urban centers in hot climates need energy for cooling in the form of air-conditioning, which consumes enormous quantities of energy. Urban transport depends on energy mainly from fossil fuels. Most urban people use their own individual transport rather than public

transport systems and put pressure on non-renewable sources of energy.

8.8 GLOSSARY

Geothermal energy: It is a renewable energy source and refers to heat energy generated and stored inside the Earth.

Non-renewable energy resources: These have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted e.g. coal, petroleum, natural gas and nuclear fuels like uranium and thorium.

Petro crops: The plants which are used for production of biodiesel from their fruits/ seeds.

Renewable energy resources: The energy resources which can be replenished in a short period of time, can be generated continuously in nature and are inexhaustible.

8.9 QUESTIONS

Descriptive type/Short answers questions

1. Discuss in detail various sources of non-renewable energy.

2. Write a detailed note on solar energy.

3. Elaborate upon how use of alternate energy sources can mitigate urban problems related to energy consumption.

4. Write notes on the following.

a) Wind energy

b) Geothermal energy

c) Biomass energy

d) Petroleum and Natural gas

Multiple choice questions

1. Which of the following is non renewable source of energy?

   (a) Solar energy

   (b) Wind energy

   (c) Petroleum

   (d) Biogas

2. Which of the following is renewable source of energy?

   (a) Petroleum, natural gas

   (b) Solar energy, wind energy, coal

   (c) Hydel energy, petroleum

   (d) Geothermal energy, tidal energy, solar energy

3. Which of the following is the cleanest fuel?

   (a) Coal

   (b) Solar energy

   (c) Natural gas

   (d) Petroleum

4. Major composition of biogas is of

   (a) CH_4

   (b) CO_2

   (c) NOx

   (d) SOx

5. Petro crops are those plants which are used for production of

(a) Biodiesel from their fruits/seeds

(b) Edible grains

(c) Fodder

(d) None of the above

6. Major source of geothermal energy is

(a) Hot water springs

(b) Decay of radioactive isotopes

(c) Chemical reactions being carried out in rock strata

(d) All of the above

7. Solar cells are made of thin wafer of semi conducting materials like

(a) Silicon and chromium

(b) Mercury and gallium

(c) Silicon and mercury

(d) Silicon and gallium

8. Which of the following is not the unit of energy?

(a) British thermal unit (Btu)

(b) Kelvin

(c) Calories

(d) Kilo watt hour (kWh)

9. Best form of coal is

(a) Anthracite

(b) Bituminous

(c) Lignite

(d) Peat

Answers

1(c) 2(d) 3(b) 4(a) 5(a) 6(b) 7(d) 8(b) 9(a)

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LAND RESOURCES

9.1 INTRODUCTION

According to UN (1994) Land is a defined area of the earth's terrestrial surface, comprising of biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology including shallow lakes, rivers, marshes, and swamps, the near-surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activities including terracing, water storage or drainage structures, roads, buildings, etc. It is a physical entity in terms of its topography and spatial nature. Land in a broader and integrative view; also include natural resources i.e. the soils, minerals, water and biota that the land acquires.

Its nature, extent and capabilities greatly influence the socioeconomic status and development of a nation. Land cover has gone under continuous change right since hundreds of years. This change has occurred through the use of fire for game hunting and clearance of patches of land for agriculture and livestock production, since the start of plant and animal domestication. In the past two centuries, the impact of human activities on land has increased because of population increase, technological development and the requirements thereafter, changing the landscapes, and ultimately impacting the biological diversity, nutrient and hydrological cycles as well as climate especially in the developing world. Land-cover change is very intense in the developing countries which have agriculture based economies and increasing human populations. It is estimated that 39 to 50 percent of the earth's surface has been transformed or degraded by us.

Land is required for the functioning of organisms, population and ecosystem. Although land appears to be unlimited resource, yet its exploitation would limit the availability of

their indispensable life support system. The land can be classified into various types according to their natural ecological features such as soil, slope and natural biotic communities.

The main component of land is soil. Soil is one of the most precious natural resource for human life and social development. The world soil derived from Latin word "Solum" means material in which plants grow. Soil is defined as "the weathered (or broken particles) surface of the earth's crust which is associated with living organisms and the products of their decomposition".

The soil is recognized as one of the most valuable life supporting natural resources since it produces food that is basic to man's existence. A clear knowledge of the kind of soils and the extent of their distribution are essential pre-requisites in developing rational land use plans for agriculture, forestry, irrigation, drainage etc., and for maximizing agricultural production to meet the ever-increasing needs for food, fiber, etc. The variability in soil influences the use of different soils for different purposes which is known as land use. The land use pattern of an area is directly dependent on the level of development and economic growth. Growth of population and its dynamics are some of the fundamental drivers of changing land use pattern.

India has a total area of about 329 million hectares. Out of the total of 329 million hectare of geographical area of India about around 162 million hectare of land is under agriculture cover. About 46 million hectare is under real forest as shown by satellites. Rest of the land is occupied housing, industry and other non-agricultural uses including land which is snow bound.

9.2 OBJECETIVES

The main objective of this lesson is to

- Acquaint you with importance of land/ soil,
- How this precious resource is deteriorating due to negligence of human.
- The various processes involved in degradation of land will also be understood, especially man induced landslides, soil erosion and desertification.

9.3 LAND DEGRADATION

Over a period of time, there has been rapid degradation of land resources all over arising from faulty land use practices, resulting in deforestation associated with depletion of biodiversity, leading to desertification of the landscape. Three main land uses responsible for changes in the earth's land cover are:

a. Agriculture which include cultivation, grazing, irrigation and drainage;

b. Extraction of natural resources, primarily forestry and energy production; and

c. Settlements, which we define loosely to include use of land for human settlements ranging from rural villages to cities. The clearing of native land cover for human settlements are the most permanent forms of land conversion.

Land degradation making the land unsuitable for habitat construction and agriculture has become a major problem in recent times. It is often related to decline in soil quality, caused through its misuse by human. This has threatened the world food production as soil quality degradation results in severe reduction in crop yield. It refers to a decline in the soils productivity through adverse changes in nutrient status and soil organic matter, structural attributes, and concentration of toxic chemicals.

According to UNEP the land degradation can be defined as the rate of adverse changes in soil quality resulting in decline in productive capacity of land due to processes induced mainly by human intervention. Land degradation is a result of adverse human activities. The processes leading to land degradation are generally triggered by excessive pressure on land to meet the demands of the rapidly growing population for food, fodder and fiber. This leads to overexploitation of natural resources with little consideration for maintaining the eco-balance sustainability. Various anthropogenic activities, such as the introduction of large scale irrigation, canals, deforestation lead to accelerated soil degradation through salinization, flooding, drought, erosion, water-logging, etc. Soil degradation and its impact is a complex consequence of physical, chemical, social, political and economic circumstances.

It is estimated that 15 percent of the world's total land area has not maintained its quality due to a number of problems that include erosion, nutrient decline, salinization and physical compaction. The countries which are mainly dependent on agriculture as a national resource suffer more from the effects of land degradation. According to some estimates around 188

million ha of total geographical area of India, is degraded.

9.4 CATEGORIES OF DEGRADED LAND

Following are the major categories of wasteland (degraded land)

1. Gullied and/or ravenous (eroded) lands
2. Undulating uplands with or without scrub
3. Water-logged and marshy land
4. Land affected by salinity/alkalinity (coastal or inland)
5. Shifting cultivation area
6. Degraded notified forest land
7. Degraded pastures/grazing land
8. Degraded non forest plantation land
9. Sandy areas (desert or coastal)
10. Mining/industrial wasteland
11. Barren rocky/stony waste/sheet-rock area
12. Steep sloping areas.
13. Snow covered and/or glacial areas.

9.5 CAUSES OF LAND DEGRADATION

9.5.1 LAND OR SOIL DEGRADATION:

It can be said that there are four main types of soil degradation :

i. Water erosion,

ii. Wind erosion,

iii. Chemical degradation and

iv. Physical degradation.

These soil degradation processes may occur due to natural processes enhanced by direct/ indirect human interventions. These are:

a. Deforestation and removal of the natural vegetation ,

b. Overgrazing,

c. Agriculture-related practices and

d. Overexploitation of vegetation for domestic use

9.5.2 SOME OF THE MAJOR SOIL DEGRADATION PROCESSES AND THEIR CAUSES

9.5.2.1 LOSS OF TOPSOIL BY EROSION

Of the total land area of India 162 million ha of land is suffering from soil erosion due to water and wind. This results in a decrease in depth of the topsoil layer due to more or less uniform removal of soil material by run-off water (water erosion) or due to winds (wind erosion). The possible causes are inappropriate land management especially in agriculture (insufficient soil cover, unobstructed flow of run-off water, deteriorating soil structure) leading to excessive surface run-off and sediment transport.

9.5.2.2 TERRAIN DEFORMATION

Terrain deformation is an irregular displacement of soil material (by linear erosion or mass movement) causing clearly visible scars in the terrain. The possible causes are faulty land management in agriculture, forestry or construction activities, allowing excessive amounts of run-off water to concentrate and flow unobstructed.

9.5.2.3 FERTILITY DECLINE

Fertility decline and reduced organic matter content resulting in net decrease of available nutrients and organic matter in the soil is due to imbalance between output (through harvesting, burning, leaching, etc.) and input (through manure/fertilizers, returned crop residues, flooding) of nutrients and organic matter.

9.5.2.4 SOIL POLLUTION

It indicates the presence of a substance in the soil with high concentration of adverse biological or toxic effects. The source of pollution may be waste dumps, spills, factory wasted, etc. The source can also be airborne (atmospheric deposition of acidifying compounds and/or heavy metals.

9.5.2.5 SOIL EUTROPHICATION

The presence of an excess of certain soil nutrients, cause impaired plant growth. The possible causes are imbalanced application of organic and chemical fertilizer resulting in excess nitrogen, phosphorus; liming.

9.5.2.6 OVERGRAZING AND USE OF HEAVY MACHINERY

Compaction of soil is caused due to overgrazing resulting in alteration of soil structure by trampling caused by cattle or frequent use of machinery. The repeated use of heavy machinery on land and overgrazing, have create cumulative effect by compacting the soil.

9.5.2.7 SEALING AND CRUSTING

This is caused by clogging of soil pores with fine soil material and development of a thin impervious layer at the soil surface, obstructing the infiltration of rainwater. The possible causes are poor soil cover, allowing a maximum splash effect of raindrops; destruction of soil structure and low organic matter.

9.5.2.8 WATER LOGGING

Water logging is result of human induced high water levels in the soil excluding paddy fields. The possible causes of water logging are rising water table due to construction of reservoirs/irrigation and/or increased flooding caused by higher peak-flows.

9.5.2.9 SOIL SUBSIDENCE

The soil subsidence or settling of soil is possibly caused by oxidation of peat and settling of soils in general due to lowering of the water table; solution of gypsum in the sub-soil (human-induced) or lowering of soil surface due to extraction of gas or water.

9.5.2.10 LAND USE CHANGE

Loss of productive land due to diversion of land to non-bio-productive activities is a big problem faced at present. The possible reasons for diversion of productive land are urbanization, industrial activities, infrastructure, mining, quarrying, etc.

9.5.2.11 ARIDIFICATION

This is a process in which there is decrease in average soil moisture content. The possible causes are lowering of groundwater tables for agricultural purposes or drinking water extraction; decreased soil cover and reduced organic matter content.

9.5.2.12 SALINISATION/ALKALINISATION OF SOILS

Soil salinisation and alkalinisation is a net increase of the salt content of the (top) soil leading decline productivity of soils. The possible reasons for salinity problems are due to intrusion of seawater (which may occur under all climate conditions) and inland salinisation caused by improper irrigation methods and/or evaporation of saline groundwater.

9.6 DESERTIFICATION

Desertification is a type of land degradation. Desertification as a process has generally been viewed as a series of incremental changes in biological productivity in arid, semi arid and sub humid ecosystems. According to United Nations Conference on Desertification (UNCOD, 1977) it is "the reduction or destruction of the biological potential of the earth which can create the conditions analogues to a natural desert.

Land degradation and desertification both terms used interchangeably many times. It is a term which is generally understood to refer to degradation in arid, semi-arid and dry sub-humid climatic zones. The most critical and increasing threat to sustainable land use is desertification. It is estimated that desertification affects one-quarter of the total land area of the world, or about 70 percent of all dry lands, and threatens the livelihoods of over 1 billion people in more than 100 countries. Desertification is closely linked with rural poverty and hunger. It exacerbates conditions leading to famine, migration, internal displacement, political instability and conflict. Desertification is the degradation of land in arid, semi-arid and dry sub-humid areas resulting from various climatic variations, but primarily from human activities. Desertification is mainly due to human mismanagement of land resources with drought and other natural events enhancing the effect of human action.

9.6.1 THE TYPES OF DESERTIFICATION PROCESSES

9.6.1.1 VEGETATIVE DEGRADATION

The depletion of vegetation from the slopes due to deforestation, overgrazing, removal of grasses, fuelwood, etc. reduce or eliminate plants that help to bind the soil inducing increased runoff of water falling on the slopes as precipitation, giving rise to soil erosion. The removal of vegetation also exposes the soil to wind erosion. The removal of top soil due to erosion

causes loss of biological productivity.

9.6.1.2 WATER EROSION AND WIND EROSION

As discussed above the processes of soil erosion deplete the biological potential of land through removal of top fertile soil leading to desertification.

9.6.1.3 DROUGHTS

Droughts by themselves cannot cause desertification but it is just a contributing factor. The causes are social and economic, having to do with access to resources, power and economics. Droughts are common in arid and semiarid lands, and well-managed lands can recover from drought when the rains return.

9.6.1.4 WATERLOGGING AND SALINISATION

The process of water logging makes the land unfit for cultivation. Water-logging also leads to salinisation and alkalinisation, both resulting in loss of biological and economic potential of land.

9.6.1.5 SOIL CRUSTING AND COMPACTION

By pounding the soil with their hooves, livestock compact the substrate, increase the proportion of fine material, and reduce the percolation rate of the soil, thus encouraging erosion by wind and water.

9.6.1.6 HUMAN OVERPOPULATION

Human Overpopulation is leading to destruction of tropical wet and dry forests, due to widening practices of zoom cultivation. Deforestation has led to large scale erosion, loss of soil nutrients and sometimes total desertification.

9.6.1.7 OTHERS

The other important, but non-extensive degradation processes include several kinds of soil pollution from pesticides, heavy metals, acid forming fertilizers, and industrial waste.

9.6.2 IMPACTS OF DESERTIFICATION

The desertification reduces biological productivity, diversity loss, loss of agriculture potential low food serenity and reduced carrying capacity for humans and livestock. This also increases incidences of drought, flooding. The major impacts of desertification are :

- A major impact of desertification is loss of biodiversity and productive capacity. The change in vegetation induces desertification which usually arises from the demands of increasing population that settle on the land in order to grow crops and graze animals.
- In large desert areas, sand dunes can encroach on human habitats. Sand dunes move through wind. And like snow, sand avalanches, falling down the steep slopes of the dunes that face away from the winds, move the dunes forward.
- Some arid and semi-arid lands can support crops, but additional pressure from greater population or decreases in rainfall can lead to the disappearance of the few plants present. The soil becomes exposed to wind, causing soil particles to be deposited elsewhere. The top layer becomes eroded.
- With the removal of shade, rates of evaporation increase and salts become drawn up to the surface. This is salinisation, which inhibits plant growth. The loss of plants causes less moisture to be retained in the area, which may change the climate pattern leading to lower rainfall.

9.6.3 MANAGEMENT OF DESERTIFICATION

Combating desertification is a complex issue because overexploitation of land and climatic variations can have similar impacts. This makes it very difficult to follow a particular mitigation strategy. Even mitigation measures like reforestation cannot yield results if global warming continues. For management of desertification many steps can be followed such as Green manuring i.e. growing of leguminous crops in agriculture fields to increase fertility through atmospheric nitrogen fixation and adding organic manure to soil; creation of tree barriers; regulate cattle grazing; growing of multipurpose tree species in agriculture fields or in vacant lands to cater to the demand of fuelwood and fodder; judicious use of water; rain water harvesting, crop rotation; etc.

9.7 LANDSLIDES

Landslides are simply defined as down slope movement of rock, debris and / or earth under the influence of gravity. This sudden movement of material causes extensive damage

to life, economy and environment. It is the most common and universally accepted collective term for most slope movements of massive nature. Other names which are used in place of landslides are mass wasting, mass movements, slope failures, etc. The term sliding generally used sometimes been considered unsuitable it also involves movements other than sliding like fall, topple, flow etc. In a landslide, masses of rock, earth, or debris move down a slope. Landslides may be small or large, slow or rapid. They are activated by Natural phenomenon and human activities. More than 5000 people are buried alive under landslides and economic losses of greater than 4 billion USD worth is suffered every year globally. Among South Asian countries, India is one of the worse affected by landslides. In India, according to Geological Survey of India, nearly 15 percent of its geography (covering about 0.49 million sq.km) is prone to various degrees of landslide hazard frequently affecting the human life, livelihood, livestock, living places, structures, infrastructure, and natural resources in a big way. In addition to direct and indirect losses, landslides cause environmental damage, disruptions in society, etc.

Landslides are spread over 22 States and 2 Union territories including J&K, Himachal, Uttarakhand, Arunachal, Assam, Meghalaya, Mizoram, Manipur, Nagaland, Sikkim, Tripura, Kerala, Karnataka, Tamilnadu, Andhra Pradesh, Goa, Maharashtra, Madhya Pradesh, Chhatisgarh, Andeman and Nicobar and Puducherry. The most sensitive areas are Himalayan belt, Nilgiris, Western and Eastern Ghats. Landslides constitute a serious hazard that causes substantial human and financial losses in the country. With growing population and human interventions in terms of developmental activities over unstable slopes, landslides pose increasing risk to human life, buildings, structures, infrastructures and environment.

9.7.1 TYPES OF LANDSLIDE BASED ON PROCESS

Based on process types, there are five types of landslides i.e. Fall, Topple, Slide, Spread, Flow and Subsidence.

a. FALl : It is a very rapid to extremely rapid movement which starts with detachment of material from steep slopes such as cliffs, along a surface. The material then comes down through the air by free falling, bouncing or rolling onto the slopes below.

b. TOPPLE : It involves overturning of material. Topples range from extremely slow to extremely rapid movements.

c. SLIDE : The movement of material in this type is along a surface. The slides are translational and rotational slides. The down slope movement of the soil or mass, occur dominantly on the surface.

d. FLOW : is a landslide in which the individual particles travel separately within a moving mass.

e. CREEP : This type of land slide has very slow rate of slope movements, usually a few millimeters per year, which is imperceptible in nature.

9.7.2 THE CAUSAL FACTORS OF LANDSLIDES

There are various causal factors responsible for landslides. These include natural as well as manmade processes which are briefly discussed below.

9.7.2.1 NATURE INDUCED LANDSLIDES

a. GROUND BORNE

This includes the natural material existing on the slopes such as plastic weak material, sensitive material, collapsible material, weathered material, etc.

b. GEOMORPHOLOGICAL PROCESSES

There are various processes which take place in and above the surface earth which are responsible for creating landslides. Some of these are tectonic, volcanic, erosion of base of the slopes, glacial erosion, vegetation removal, ground cracks, subsidence, etc.

c. PHYSICAL PROCESSES

The physical processes responsible for triggering landslides are intense rainfall over a short period, rapid melt of deep snow, prolonged heavy precipitation, high tides or breaching of natural dam, earthquakes, volcanic activity.

9.7.2.2 MAN MADE CAUSES

The incidence of landslides is on increase because of human interference with nature. Various developmental activities such as construction of roads, river valley projects, settlements and creation of other infrastructure in mountainous areas are causes of landslides. The various factors involved in above mentioned activities are Excavation of the slope, loading of the slope or its crest, drawdown of reservoir, Irrigation, defective maintenance of drainage system, vegetation removal (deforestation), mining and quarrying, creation of dumps of very loose waste, artificial vibration including traffic, pile driving, heavy machinery, blasting and explosion.

9.7.3 IMPACT OF LANDSLIDES

The landslide disasters have both short term and long term impacts on society and environment. The former account for the loss of life and property at the site and the latter include landscape changes that can be permanent, including loss of cultivable land and environmental impacts in terms of erosion and soil loss, leading to population shift and relocation of establishments. Like in any other disasters the landslides also reduce the capacity and effective life of hydroelectric and multipurpose projects by adding enormous amount of silt load to the reservoirs. Landslide in dams result in flooding of large upstream areas. Further, if the dam fails, it causes flooding and large scale devastation in downstream areas.

9.8 SOIL EROSION

Soil erosion is generally refers to detachment and transportation of soil and soil material by water, wind, ice or gravity, etc., water and wind being the major factors. In other words erosion is defined as the wearing away of topsoil. Topsoil is the top layer of soil and is the most fertile and comprises of the most organic, nutrient-rich materials. Therefore, this is the layer that farmers want to protect for growing their crops and ranchers want to protect for growing grasses for their cattle to graze on. The soils are made due to wearing of rocks in mountains in the form of a non destructive slow natural process known as natural erosion or geological erosion, which is beyond the control of human. On the other hand, when nature's balance is disturbed by human activities i.e. large scale cutting of trees in forests,

preparation of land for cultivation, etc., the erosional activity increases manifolds. This rapid erosion, triggered by human activity, is known as accelerated erosion.

9.8.1 THE PROCESS OF EROSION COMPRISES OF:

i. Detachment of soil particles from the land surface

ii. Transportation, which requires a mode of transportation to carry the detached particles. No substantial erosion can take place unless there is detachment of particles from there mass before they are carried.

9.8.2 TYPES OF SOIL EROSION

1. Normal erosion: This is caused by the gradual removal of topsoil by natural processes. The rate of erosion is slow.
2. Accelerated erosion: This is caused by man-made activities. In this case, the rate of erosion is much faster than the rate of formation of soil.

9.8.3 FACTORS AFFECTING SOIL EROSION

The major factors affecting soil erosion are given below

9.8.3.1 CLIMATE:

The various climate parameters such as temperature, rainfall and snowfall (precipitation), wind velocity, humidity and sunshine are responsible for erosion.

Water in the form of precipitation is most important factor that affects soil erosion through splash and runoff. Water drops which fall on the soil surface with force depending upon the size of drop, detaches and splashes the soil particles. These detached particles are then transported through water runoff.

Strong wind mainly in dry areas is an important climate agent that carries away the fine particles of soil thereby contributing to soil erosion. Similarly the climate is defined in terms of temperature such as temperate, tropical, subtropical, etc. The temperature along with rainfall, humidity, topography (which include slopes, aspect, etc.) are responsible for erosion.

Slopes accelerate soil erosion. Glaciers also cause soil erosion in higher altitudes. There advancement causes destruction of vegetation, exposing the soil surface to direct impact of rainfall.

9.8.3.2 BIOLOGICAL FACTORS

The biological factors responsible for soil erosion include vegetation, overgrazing, deforestation, shifting cultivation practices undertaken by the tribals, are the major biotic agents causing soil erosion. These processes disturb the top soil thereby exposing the soil to various physical forces inducing erosion. The lack of vegetation gives rise to water runoff as presence of vegetation retards the erosional activity by binding the soil. The vegetation also intercepts rain drops thereby reducing their impact.

Grazing of animals is also a very important reason of soil erosion in India as india has a huge livestock population. The livestock with their hooves destroy vegetation cover through treading on the soil. Mice, ants, earthworms, rabbits, mongoose, etc. are also responsible for soil erosion.

Other factors such as construction of dams, buildings and roads remove the protective vegetation cover leading to soil erosion

9.8.4 EFFECTS OF SOIL EROSION

Soil erosion which is also called "creeping death" of the soil is worldwide phenomenon.

1. LOSS OF SOIL: The eroded soil particles may travel from few centimetres to hundreds of kilometres. The fine soil particles from agriculture fields are also washed away and only heavy sand particles are retained in the fields. The soil loss in unprotected areas is high as compared to soils covered by some ground cover.
2. LOSS OF NUTRIENTS: The erosion of top soil removes nutrients which are existing in the top layer of the soil thereby soil fertility is lost.
3. CHANGE OF SOIL TEXTURE: The sand, clay, silt and organic matter are washed away as sediment with water runoff and deposited down slopes. The combination of erosion and sedimentation causes textural separation of soil which was eroded from its actual site. This may also result in ability of soil to hold water.

4. SILTING OF WATER BODIES: The silt load carried by water results in silting of reservoirs that fall in the course of rivers or streams. The silt settles down in the reservoirs and ultimately with due course of time their existence is also jeopardised. The life span of various hydro electric projects is reduced by siltation of reservoirs.

5. FLOODS: The incidence of floods also increases by increased sedimentation which fills the river bed in turn reducing the water carrying capacity of the rivers and streams. The water in streams and rivers spills over the banks with increased rains.

6. WATER POLLUTION: The sediment runoff can pollute water courses and water bodies due to nutrient built up. The concentration of nutrients in water bodies kill or affect aquatic life. The process is also called as Eutrophication.

9.8.5 SOIL / LAND CONSERVATION

1. Conservational till farming or no-till farming: Traditionally, land is ploughed to make a planting surface. This disturbs the soil and makes it susceptible to erosion. The no-till farming method makes minimum disturbance to the top soil by making slits in the unploughed soil. Seeds, fertilizers and water are injected in these slits.

2. Contour farming: In this method, crops are planted in rows along contours of gently sloped land. Each row acts as a small dam to hold soil thereby slowing water runoff.

3. Terracing: In this method, steep slopes are converted into a series of broad terraces that run across the contour. This practice retains water for crops and reduces soil erosion by controlling runoff.

4. Alley cropping or Agro forestry: This method involves planting crops in strips or alleys between rows of trees or shrubs that provide fruits and fuel wood. Hence, when the crop is harvested, the soil will not be eroded as the trees and shrubs remain on ground holding the soil particles.

5. Wind breaks or shelter belts: In this technique, trees are planted in long rows along the boundary of cultivated land which block the wind and reduce soil erosion. Wind breaks help in retaining soil moisture, supply wood for fuel and provide

habitat for birds.

6. Judicious use of water: The water for irrigation in the fields should be used economically. Excessive use of water causes water logging and in turn salinity and alkalinity.

7. Integrated Watershed Management: This includes an integrated development and management of a unit of land, which is here a hydrologic unit.

8. Increase of vegetative cover: The increase in vegetative or ground cover will decrease the runoff which in turn improves the water percolation and ground water recharging.

9. Crop suitability analysis: The crop suitability analysis will ascertain that which crop is suitable to be grown in the area depending on the slope, soil, and water requirement of the crop to be planted.

9.9 SUMMARY

Land is a physical entity in terms of its topography and spatial nature which includes natural resources such as soils, minerals, water and biological material. Land is important for all living organisms including man as it provides us food, fodder, water, shelter, and other products and services. The indiscriminate use of land resource by human has resulted in land degradation. The faulty land use practices, deforestation, indiscriminate use of irrigation, use of marginal lands for agriculture, pollution and other man induced disasters, etc. are some of the important factors for land degradation.

The removal of trees and other vegetation cover from forests and other lands for timber, shifting cultivation, river valley projects and other developmental activities exposing the land surface to winds and water runoff after rains causing soil erosion. The removal of fertile topsoil reduces the economic and biological potential of soils leading to desertification. Implementation of some control and conservation measures such as proper land use planning, afforestation, channelization of rain water, watershed management, etc are essential.

9.10 GLOSSARY

Crop rotation : The growing of different crops in recurring succession on the same land.

Desertification: Loss of biological or economic potential of soil or land making it unfit for cultivation.

Dune : A mound or ridge of loose sand piled up by wind.

Land degradation: area of land surface that is potentially available for agricultural use declines from year to year. The burning of forest removes particularly the entire nitrogen supply for vegetation.

Landscape : All the natural features such as fields, hills, forests, water, etc. which distinguishes one part of earth's surface from another part.

Landslides : The downwards sliding, falling, flowing of soil, rock, debris. This may occur due to fall, slides, flows and man induced.

Run off : That portion of the precipitation on an area which is discharged from the area through stream channels. The portion of water that get lost without entering the soil is called surface runoff.

Soil erosion : The rock fragments and soil are detached from the original site, transported and then eventually deposited at the some new locality.

Watershed : The total land area or hydrologic unit, regardless of size, which drains water through a common point.

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9.12 SELF ASSESSMENT QUESTIONS

1. The thin layer of grainy substance covering the surface of the earth is called .....

   (a) Soil

   (b) Land

   (c) Minerals

   (d) Humus

   Ans: a

2. It is the uppermost layer, Rich in humus & minerals and Consists of Sand, Silt & Clay.

   (a) Sub Soil

   (b) Top Soil

   (c) Alluvial Soil

   (d) Black Soil

   Ans: b

3. Natural Vegetation and wildlife exist only in the narrow zone called .....

   (a) Lithosphere

   (b) Hydrosphere

   (c) Atmosphere

   (d) Biosphere

   Ans. d

4. Sliding of huge debris, rocks and other material down the slope is know as .....

   (a) Volcanic Eruptions

   (b) Landslides

   (c) Earthquakes

   (d) Tsunami

   Ans. b

5. ..... is the decline in the productive capacity of land for some time or permanently.

(a) Land Reclamation

(b) Land Degradation

(c) Land use

(d) Land Profile

Ans: b

6. The breaking up of rocks is known as .....

(a) Erosion

(b) Reclamation

(c) Degradation

(d) Weathering

Ans : d

7. What can be some of the common methods to conserve land resources

(i) Afforestation

(ii) Land Reclamation

(iii) Regulated use of chemical pesticide and fertilizers

(iv) Check on overgrazing

(a) Only (i) is correct

(b) (i) and (iv) are correct

(c) (i), (ii) and (iii) are correct

(d) All are correct

Ans : d

8. What do you mean by Conservation?

(a) It means the use of resources till they are finished

(b) Wise use of resources in order to avoid misuse and wastage

(c) It means the extensive use of resources

(d) Misuse of resources

Ans : b

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10.1 INTRODUCTION

World population has continued to grow from 1 billion around 1800 to 7.5 billion through 2017, an increase of 6.5 billion. The last 100 years have seen a massive fourfold increase in the population due to medical advances, lower mortality rates, and an increase in agricultural productivity. The first section of this chapter illustrates the concept of population growth and discusses the causes, consequences and control measures. The second section dealswith variations in population among nations and its impact. The third section elaborates various family welfare programmes and their role in controlling the population with particular reference to India.

10.2 OBJECTIVES

The chapter has been devised with following learning objectives for the students

- Population Growth
- Variation among nations
- Family welfare programs

10.3 POPULATION GROWTH: AN OVERVIEW

Human evolution dates back to 3 million years ago. Homo sapiens, the species to which we belong is only about 40,000 years old. In the past, total human population on earth was small, probably less than 10 million. However, as agriculture was introduced, communities evolved that could support more people. According to United Nations, 200 years ago, human population which numbered less than 1 billion has now grown to more than7 billion. For thousands of years, population grew only slowly, but it has jumped dramatically in the last 50 years.

Population Growth Rate. The average annual percent change in the population, resulting from a surplus (or deficit) of births over deaths and the balance of migrants entering and leaving a country is called population growth. The rate may be positive or negative. The growth rate determines how great a burden would be imposed on a country by the changing needs of its people for infrastructure (e.g., schools, hospitals, housing, roads), resources (e.g., food, water, electricity), and jobs.

10.3.1 HISTORY OF GLOBAL POPULATION GROWTH

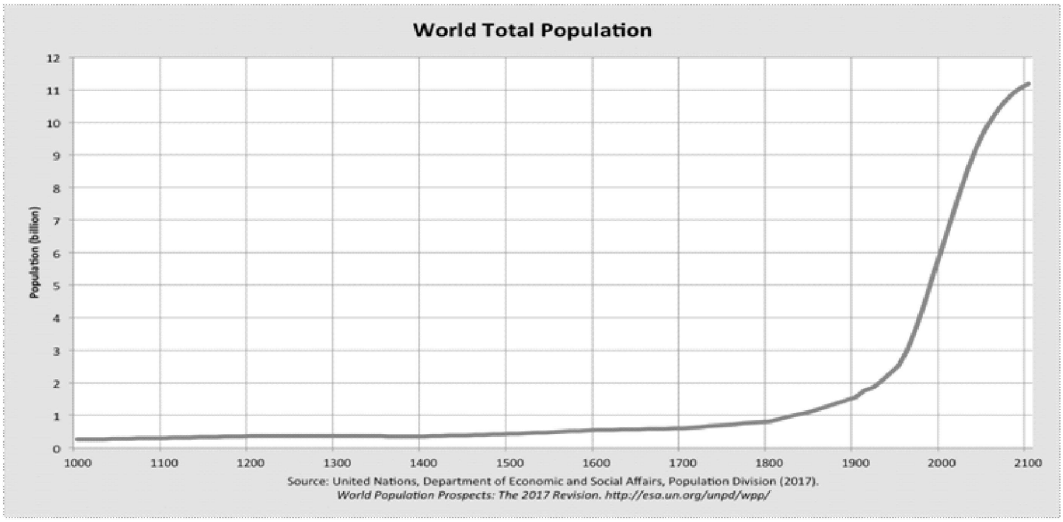

Fig 10.1. World population growth

As can be seen in Figure 10.1, the world's population grew very slowly until about 1750. There was a long period of stationary growth (no growth) until 10th century BC and world's population was approximately 300 million which was followed by a period of slow growth from 10th Century BC to approximately 1750, during which global population increase was estimated as 800 million. The world's population, during this period was kept in check by high death rates resulting from combined effects of plagues, famines, unsanitary living conditions, and general poverty. After 1750, the world's population grew substantially; by 1800 it was 1 billion and by 1950 it had tripled to around 2.5 billion. The doubling time of population was almost 122 years in this 200-year period. Population growth from 1950 to 1985 was even more erratic; by 1985, the human population was 5 billion. World population had doubled in thirty-five years. By 2000, global population was 6 billion and is projected to be approximately 9 billion by the year 2050.

Population growth patterns in different countries vary based on their birth rate and mortality rate along with the migration status which arethe deciding factors for population variations among nations.Population growth rate in world as well as different countries cycles through different stages based on two important demographic characteristics: birth rates and death/ mortality rates. As these characteristics change in relation to each other, their produced impact greatly affects a country's total population. This is termed as demographic transition.

Demographic transition occurs in four phases. In the first phase, there is a fall in death rate and improvement in longevity; this leads to population growth. In the second phase, there is a fall in birth rate but fall is less steep than fall in death rates and consequently there is population growth. In the third phase, death rates plateau and replacement level of fertility is attained but the population growth continues because of the large size of population in reproductive age group.The fourth phase is characterized by fall in birth rate to below replacement level and reduction in the proportion of the population in reproductive age group; as a result of these changes population growth ceases and population stabilizes.

- **Population growth (1750-1950)**. In the middle of the eighteenth century, the mortality rate began to decline particularly in the Western countries. However, this decline in less developed countries followed a different path. Mortality decline in western countrieswas because of improvements in food availability, housing, water cleanliness, personal hygiene, and public sanitation.

  Mortality decline in less developed countries did not begin until around 1950, much later than in the West. In many less developed countries, substantial mortality reductions occurred in a short period of time as compared to western countries. So the demographic transition that took two centuries to unfold in the West occurred (or is occurring) within the span of a single life in developing nations.

- **Population growth (1950-2050)**

  The world witnessed unprecedented population growth between 1950 and 1985 particularly due to third world increases. This increase in human population was largely the consequence of mortality declines. The rate of global population growth has declined significantly from its 1970s highs. Current estimates anticipate a continued decline to about 0.5 percent in 2050. This corresponds to a doubling

time of 140 years with more population growth projections in the less developed countries in the twenty-first century.

10.3.2 CAUSES OF POPULATION GROWTH

Among various reasons for population growth, the most obvious one was more births than deaths. This is called natural increase. The global total fertility rate or TFR is 2.5 against the replacement level of TFR 2.1 which would lead to a stable population. Besides reduced death rates and increased fertility rates, other factors responsible for population growth are:

i. **Food Production :** In the last century, agricultural practices adopted by farmershave increased food production geometrically in some places. Much of the world experienced agricultural success, especially in the last 50 years.

ii. **Improvement in Public Health :** Improvement in public health (water and sanitation), and medical technology (vaccines and antibiotics), along with gains in education and standards of living within many developing nations have helped in lowering the mortality rate.

iii. **Prevention of Disease :** Scientists have learned a great deal about the ways to prevent and cure many types of disease. The most effective tools in the conquest of disease have been improved knowledge about nutrition, vaccinations, better public health practices and the development of new medicines.

10.3.3 CONSEQUENCES OF RAPID POPULATION GROWTH

Rapid human population growth has a variety of consequences like

i. **Environmental and ecological consequences :** Densely populated developing countries contribute to over 95% of the population growth. Rapid population growth has put pressure on environmental components and has led to environmental problems like fragmentation of land holding, collapsing resources, shrinking forests, rising temperatures, loss of plant and animal species.

ii. **Urbanization :** The proportion of people in developing countries who live in

cities has almost doubled since 1960 (from less than 22 per cent to more than 40 per cent), while in more developed regions the urban share has grown from 61 per cent to 76 per cent. By 1999, the number of megacities had grown to 17(13 in developing countries) and presently there are 37 megacities in the world.

iii. **Poverty :** Poverty is a condition of chronic deprivation and need at the family level. Poverty have long been associated with increased death, and disease.

iv. **Food security and nutrition :** Technological innovations in agriculture and increase in area under cultivation have ensured food production to keep pace with the population growth. But in the next five decades, the food and nutrition could become critical in many parts of the world.

10.3.4 STRATEGIESFORCONTROLLING POPULATION GROWTH

Over-population and continuing population growth are making substantial contributions to the destruction of Earth's life support systems. Some of the measures to control population growth are:

i. **Availability and use of Contraceptives :** Access to safe and effective contraceptive options for both sexes along with choice of good family planning. Ensuring that people have easy and cheap access to contraception tools will help avoiding cases of unwanted pregnancies and births.

ii. **Proper Medical Facilities :** Proper medical facilities ensure healthy children and low mortality rate. If provided with optimum medical facilities population rate will almost certainly decline.

iii. **Delayed Marriages :** Child marriage is highly prominent in certain countries like India, Pakistan or Bangladesh. A marriage at a tender age leads to a long span for giving birth and hence more children. UN report has suggested that there would be a significant decline in world population if the legal age for marriage is made 20 years.

iv. **Providing Incentives :** Incentives have proved to be an efficient policy measure in combating most development issues including population.

v. **Women Empowerment :** Girl education and eradication of gender bias from

law, economic opportunity, health, and culture. Empowering woman will ensure a healthy and aware society.

vi. **Poverty Eradication :** Concrete measures should be taken for poverty eradication.

vii. **Legislative Actions** Strict legal steps are required for child marriage, education, abolition of child labour and beggary, and family planning.

viii. **Education and awareness :** More public education is needed to develop more awareness about population issues.

10.4 VARIATIONS AMONG NATIONS

The relatively high rate of world population growth is not shared equally by all nations. Rather, there are considerable variations among countries in their annual rates of growth. The highest growth rates accompanied by most pressing social and economic problems, are faced by the least developed nations. The population growth rates vary from nation to nation, some nation show very high growth rates above 3 per cent. On the other hand some nations are not growing at all and few have declining population.

Low population growth in developed nations of Europe and North America are due to long history of very slow population growth over thousands of years, and almost equal ratio of birth rates to death rates due to better healthcare and sanitation.

However, the less Developed countries did not begin to benefit from better health care and sanitation until after the Second World War. Since then the death rates have sharply declined but their birth rates have not decreased. Accordingly the growth rates have increased to above 2% and 3% in some cases.

At present the world's population has crossed 7.5 billion. The existing population is unevenly distributed with less developed countries having 90% of the total population while the developed countries having only 10%. Asia is the largest and the most populated continent (4.5 billion) with 60% of the total population and 30% of the total land area. Asia is densely populated with population density of 145 persons per square km. India and China together have 40% of the world's population. Africa with 16% of world population (1.2 billion) and population density of 145 persons per square km has high population growth rate due to increased birth rate and decreasing death rate. In Europe, population growth

rate is either steady or declining with total population of 742 million (9.8% of world population) and population density of 34 persons per square km. America (North America, Central America and South America) with a quarter of the total land area is having total population of 1.3 billion. Population may increase in these countries due to migration. Oceania is thinly populated with total population of 40.6 million and population density of 5 persons per square km.

10.4.1 POPULATION GROWTH STATUS OF INDIA

Indian population crossed one billion mark in 1990 with present population of 1.3 billion. This mark may cross 1.63 billion by 2050 at current growth rates. While some believe that increasing welfare and its additional measure such as birth control may solve the problems occurring in future India, many state that only governments aggressively reducing births may make a difference.

10.5 FAMILY WELFARE PROGRAMME IN INDIA

India launched a nationwide Family Planning Programme in 1952. India is the first country in the world to launch such a programme. India with 2.4 percent of the total land area is the second most populous country having total population of 1.3 billion (hosts 1/6th of the total world's population). Therefore, high maternal, infant, childhood morbidity and mortality; low life expectancy and high fertility; and associated high morbidity had been a major concerns for public health professionals right from the pre-independence period.

10.5.1 OBJECTIVES OF FAMILY WELFARE PROGRAMME

The prime objective for the initiation of this programme was to reduce birth rate to the extent necessary to stabilize the population at a level consistent with requirement of national economy. Later, it also aimed to improve the quality of life of the people including education, nutrition, health, employment, shelter, women's and child welfare, safe drinking water, and all other factors associated with the concept of welfare. Other objectives of Family Welfare Programme are:

i. To promote the adoption of small family size norm, on the basis of voluntary acceptance.

ii. To promote the use of spacing methods.

iii. To ensure adequate supply of contraceptives to all eligible couples within easy reach.

iv. To arrange for clinical and surgical services so as to achieve the set targets.

v. Participation of voluntary organizations/local leaders/local self-government in family welfare programme at various levels.

vi. Using the means of mass communication and interpersonal communication to overcome the social and cultural hindrances in adopting the programme.

10.5.2 FAMILY WELFARE APPROACHES IN THE FIVE YEAR PLANS

Population Control as national priority was reflected in the five year plans well before the formal adoption of either the Health Policy or the National Population Policy. This evolution of the Family Welfare Programme in India over the twelve five year plans starting from the first (1951-1956) upto twelveth (2012-2017) has been discussed here.

During the first five year plan(1951-1956) : the planners recognized the potential threat posed by population explosion and need to take steps to avert it. The utmost importance was given to family limitation or spacing of children in order to secure better health for the mother and better care and upbringing of children.

The Second Five Year Plan (1956-1961) : Stressed upon the fact that a high rate of population growth was bound to adversely affect the rate of economic advancement and per capita standards of living. In 1956, Central Board for Family Planning was established along with establishment of Central training and clinical institute and rural training units.

Third Five Year Plan (1961-1966) : On the basis of 1961 census data, clinical approach adopted in the first two plans was replaced by "Extension and Education Approach" which envisaged expansion of services facilities along with spread of message of small family norm. More emphasis was laid on education and motivation for family planning, provision of services, supplies and research.

Fourth Five Year Plan (1969-1974) : Family Planning found its place in fourth five year plan as a programme of the highest priority. This plan aimed at reduction of birth rate from 39 per thousand to 32 per 1,000 by the end of the fourth plan and to 25 per 1000 by1981.

During the Fifth Five Year Plan (1974-1978) : the National Population Policy was announced in April 1976 with a target of reduction of birth rate of 25 per thousand, and a population growth rate of 1.4 per cent by 1980. The legal minimum age at marriage from 15 to 18 for females and from 18 to 21 for males was fixed.

Sixth Five-year Plan (1980-85) : Aimed at the long-term demographic goal of reducing the net reproduction rate (NRR) to one by 1995 for the country as a whole and by 2000 in all the States from the NRR of 1.67 that prevailed at that time.

Seventh Five Year Plan (1985 to 1990) : Focussed on promoting spacing methods, removal of bias against girl children through Information, Education and Communication (IEC) campaigns, enforcement of the law relating to the minimum age of marriage, securing maximum community participation and involving Village Health Committees and Mahila Mandals in family planning programmes in all the villages.

Eight five Year Plan (1992-1997) : Human development and population control were listed as two of the six priority objectives of the Eight Plan. The Health for All (HFA) initiative took into account not only the high risk vulnerable groups, i.e., mothers and children, but also others like underprivileged segments within the vulnerable groups.

Ninth Five year Plan (1997-2002) : During this plan,the earlier approach of using NRR (Net Reproduction Rate) of 1.0 was changed to a Total Fertility Rate (TFR) of 2.1which was to be achieved by 2026.

The Tenth Five-year Plan (2002-2007) : Called for the integration of numerous vertical programmes for family planning and maternal and child health into integrated programme of health care for women and children. The National Rural Health Mission to provide accessible, affordable and quality health care to the rural population, especially the vulnerable groups, was launched in 2005 and the Department of Family Welfare was merged with the Department of Health.

The Eleventh Five-year Plan (2007-2012) : Reiterated the goals and objectives of the National Rural Health Mission which also included reduction in total fertility rate to the replacement level. However, at the policy level, the focus explicitly shifted towards universal access to health care rather than universal access to family planning.

Twelfth Five-year Plan (2012-2017) : Stresses the urgent need for population stabilisation and recommends dedicated funding for family planning services in high fertility States, bundled with reproductive and child health care services under the National Rural Health Mission.

10.5.3 METHODS FOR CONTRACEPTION UNDER FAMILY WELFARE PROGRAMME

In order to control population, Family Welfare Programme (FWP) aims at spacing between child birth and reduction in number of Children per family. For spacing Births NFP provides the following contraceptive services to public under free distribution scheme:

a. Condoms

b. Oral Contraceptive Pill

c. Intra Uterine Devices (IUD) like Copper-T

Surgical methods known as Sterlisation are applied as permanent methods of contraception. The surgery done on males is vasectomy and on females is tubectomy.

a. **Male Sterilisation :** Sterilisation in males is done by vasectomy. It is a permanent sterilisation done in males where a segment of vas deferens of both the sides is cut and the cut ends are ligated. The technique is simple and can be performed even in primary health centres by trained doctors under local anesthesia.

b. **Female Sterilisation :** Occlusion of the fallopian tubes is the underlying principle to achieve female sterilisation. This is known as tubectomy.

10.5.4 STRATEGIES FOR THE SUCCESSFUL IMPLEMENTATION OF THE FAMILY WELFARE PROGRAMME.

The following strategies have been adopted during different five year plans for the successful implementation of the family welfare programme :

i. **Integration with health services :** Family Welfare Programme has been integrated with other health services instead of being a separate service.

ii. **Integration with maternity and child health :** FWP has been integrated with

maternity and child health (MCH). Public are motivated for post-delivery sterilization, abortion and use of contraceptives.

iii. **Concentration in rural areas :** FWP are concentrated more in rural areas at the level of sub entries and Primary Health Centres. This is in addition to hospitals at district, state and central levels.

iv. **Literacy :** There is a direct correlation between illiteracy and fertility so priority is given to Girl education.

v. **Breast feeding :** Breast feeding is encouraged. It is estimated that about 5 million births per annum can be prevented through breast feeding.

vi. **Raising the age for marriage :** The age of marriage has been raised to 21 years for males and 18 years for females.

vii. **Minimum needs Programme :** It was launched with an aim to raise the economic standards. Fertility is low in higher income groups. So fertility rate can be lowered by increasing economic standards.

viii. **Incentives :** Monetary incentives have been given in family planning programmes, especially for poor classes.

ix. **Awareness through mass media :** Motivation through radio, television, cinemas, newspapers, puppet shows and folk dances is an important aspect of this programme.

10.6 SUMMARY

- Population growth is one of the major problems of world. The present population of world consists of over 7.5 billion people.The abnormal population growth is commonly believed to be one of the principal causes of poverty and very low standard of living of people. Population growth has serious effects on the environment. Overpopulation weakens the economy in many respects. The world's current and projected population growth calls for an increase in efforts to meet the needs for food, water, health care, technology and education.

- In most countries growth rates have been going down since the 1960s. Yet substantial differences remain across countries and regions. In the last century

developed countries have had lower growth rates than developing countries.

- Family planning efforts in India were conceived to accelerate the 'normal' process of population transition through reducing birth rate under the assumption that social and economic development processes would automatically induce an accelerated decrease in the death rate. Greater education, awareness and better standard of living among the growing younger age group population would create the required consciousness among them that smaller families are desirable; if all the felt needs for health and family welfare services are fully met, it will be possible to enable them to attain their reproductive goals, achieve substantial decline in the family size and improve quality of life.

10.7 GLOSSARY

Crude Birth rate: It is the number of live births occurring among the population of a given geographical area during a given year, per 1,000 mid-year total population of the given geographical area during the same year.

Contraceptives: It is a device or drug serving to prevent pregnancy.

Death rate(Crude Death rate): It is the number of deaths occurring among the population of a given geographical area during a given year, per 1,000 mid-year total population of the given geographical area during the same year.

Doubling time: The number of years required for the population of an area to double its present size, given the current rate of population growth.

Exponential growth: Development at an increasingly rapid rate in proportion to the growing total number or size, or a constant rate of growth applied to a continuously growing base over a period of time

Family Planning: The practice of controlling the number of children one has and the intervals between their births, particularly by means of contraception such as abstinence, natural planning, or hormonal, birth control or voluntary sterilisation. Couples decide how many children to have and when.

Less developed countries(LDC): Less developed countries include all countries in Africa,

Asia (excluding Japan), and Latin America and the Caribbean, and the regions of Melanesia, Micronesia, and Polynesia.

Life expectancy: It is a statistical measure of the average time an organism is expected to live, based on the year of their birth, their current age and other demographic factors including sex.

Megacities: A megacity is usually defined as a metropolitan area with a total population in excess of ten million people.

Migration: It is the movement of people from one permanent home to another. This movement changes the population of a place. International migration is the movement from one country to another.

More developed countries: More developed countries include all countries in Europe, North America, Australia, New Zealand, and Japan.

Population growth: An increase in the number of people that reside in a country, state, county, or city. To determine whether there has been population growth, the following formula is used: (birth rate + immigration) - (death rate + emigration).

Stationary phase: When birthrates and death rates are equal or population is stable.

Total Fertility Rate (TFR): The number of children a woman is expected to have in her reproductive years.

Welfare: Statutory procedure or social effort designed to promote the basic physical and material well-being of people in need.

10.8 SQ/POSSIBLE ANSWERS

Q.1. Indicate whether the statement is true or false.

A. Since the 1960s, the human population growth rate has increased.

B. Population was stationary in the mid 18th century

C. A population with many young people compared to older people will

likely experience slow population growth as the young people mature and have children.

D. The population growth of developing nations as a whole surpasses population growth in developed nations.

Ans.1 A. True

B. False

C. False

D. True

Q.2 Describe four negative impact of the concentration of people in cities.

Ans.2 Negative impacts due to concentration of population growth in cities are:

i. Lack of infrastructure like housing and other facilities

ii. Lack of basic amenities like food, water supply etc.

iii. Increase in waste generation and waste disposal problem

iv. Lack of employment opportunities.

Q.3 Match the following

i. 1891-1921 ---------- a. period of stagnant population

ii. 1921-1951 ---------- b. period of steady growth

iii. 1951-1981 ---------- c. period of high growth

iv. 1981-2011 ---------- d. period of declining growth rate

Identify the correct sequence

a. ia, iib, iiic, ivd

b. ic, iib, iiia, ivd

c. ib, iic, iiia, ivd

d. ia, iib, iiid, ivc

Ans.3 a.(ia, iib, iiic, ivd is the correct sequence)

Q.4 Consider the following statement regarding Demographic transition

i. In the first phase, there is a fall in death rate and improvement in longevity; this leads to population growth.

ii. The fourth phase population growth increases to the maximum

Which of the above given statement(s) is/are correct?

a. i. is correct

b. ii. is correct

c. i and ii are correct

d. none of the above

Ans.4 a.(i is correct)

Q.5. Consider the following statements:

i. Birth rate is the number of live births per lakh persons in a year.

ii. The India, sex ratio is defined as the number of females per 1000 males in the population.

Which of the above given statement(s) is/are correct?

a. Only i

b. Only ii

c. Both i and ii

d. Neither i nor ii

Ans.5 b.(only ii)

10.9 LESSON END EXERCISE, EXAM ORIENTED QUESTIONS

Q.1 Write short notes on

i. Global population growth

ii. Family welfare Programme of India

Q.2. How Education and awareness can help in reducing population?

Q.3 Give three strategies adopted for the successful implementation of Family welfare programme in India.

Q.4 Explain the trend of population increase/decrease in the world since the 18th Century.

Q.5 Give two reasons for variation of population among developed and developing countries.

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10.12 MODEL TEST PAPER

1. Number of births that take place per 1000 people is classified as

   a. birth rate

b. death rate

c. population density

d. housing density

2. If number of deaths are less than number of births then the

a. population unchanged

b. population increases

c. population decreases

d. none of the above

3. If number of births are equal to number of deaths then the

a. areas become less denser

b. population unchanged

c. population increases

d. population decreases

4. If number of deaths are more than number of births then the

a. population unchanged

b. population increases

c. population decreases

d. both a and c

5. Overpopulation is equated:

a. in the first stage of the demographic cycle with high fertility rates.

b. with high birth rates.

c. with imbalanced fertility rates and dependency ratios.

d. with a continuing imbalance between numbers of people and carrying capacity.

6. Which of the following is not relevant when projecting a country's population?

a. education and literacy rates

b. government policies regarding population growth

c. stage of demographic transition

d. the status of women

7. Continued high birth rates and rapidly declining death rates describe which stage of the demographic cycle?

a. Stage 1

b. Stage 2

c. Stage 3

d. Stage 4

8. As of 2017, the world's population stands at approximately:

a. 7 billion persons.

b. 6.7 billion persons.

c. 8 billion persons.

d. 7.5 billion persons.

9. The continent with the highest birth rates is:

a. Africa.

b. Europe.

c. North America.

d. South America.

10. Proportionately, the greatest decreases in infant mortality rates have occurred in:

a. developing rural nations.

b. South and Central America.

c. the urbanized areas of South Asia.

d. urbanized industrial nations.

11. The region of the world that contributes the most to world population growth is:

a. Africa.

b. Asia

c. America

d. China

12. For a long time the world's population stayed the same because

a. people died at an early age

b. the birth rate was too low

c. people only ate berries and wild plants

d. death rate was low

13. What event in the mid-1700s significantly changed human population growth?

a. Industrial Revolution

b. development of agriculture

c. bubonic plague

d. human settlement began

14. Which combination of factors will produce the highest rate of population growth?

a. high life expectancy and high infant mortality

b. low life expectancy and low infant mortality

c. low life expectancy and high infant mortality

d. high life expectancy and low infant mortality

15. What is a population's total fertility rate?

a. the number of births needed to keep a nation's population stable

b. the average number of children a male member of a population has each year

c. the average number of children a female member of the population has during her lifetime

d. the total number of babies born in a population each generation

16. What is average birth rate in developing countries

a. 26 or 29 per 1000

b. 25 or 27 per 1000

c. 26 or 28 per 1000

d. 26 or 27 per 1000

17. What does census provides us?

a. Information regarding population

b. Information regarding resources

c. Information regarding agricultural income

d. Information regarding crops

18. How much percentages of world population inhabit India?

a. 2.4%

b. 3.28%

c. 16.7%

d. None of these

19. Which of the following statements defines the density of population1?

a. Number of persons living per unit area

b. Number of persons living in a country

c. Change in the number of inhabitants of a country during a specific period of time

d. Absolute numbers added every year

20. Population theory was given by

a. Malthus

b. James Princep

c. Keynes

d. Frank Notenstein

21. Consider the following statements and identify the right ones.

i. In the second stage of demographic transition, death rates declines.

ii. The difference between birth rate and death rate decreases

a. I only

b. ii only

c. both

d. none

22. National Rural Health Mission (NRHM) was launched in which year?

a. 2005

b. 2002

c. 1998

d. 1992

23. World Development Report has projected that population of India will touch 1,350 million by

a. 2020

b. 2025

c. 2030

d. 2035

24. Most cost effective family planning method is

a. vasectomy

b. Tubectomy

c. copper T

d. oral pills

25. Best contraceptive for newly married couple

a. barrier method

b. IUCD

c. oral contraceptive pills

d. natural methods

Answers

1a	2b	3b	4c	5d	6c	7b	8d	9a	10c
11b	12a	13a	14d	15c	16c	17a	18c	19a	20a
21a	22a	23b	24a	25c					

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11.1 INTRODUCTION

There are countless diseases, each with its own unique and characteristic cause. Understanding how pathogens are spread is critical to preventing disease. Many pathogens require a living host to survive, while others may be able to persist in a dormant state outside of a living host. But all pathogens must also have a mechanism of transfer from one host to another or they will die when their host dies. This chapter will explore various modes of transmission of pathogens. The first section covers the waterborne infections; the main waterborne pathogens, types of diseases and how these can be controlled.The second section discusses airborne infection transmission and the types of diseases associated with airborne transmissions. The symptoms and the pathogens that cause many waterborne infections resemble those of food borne infections. But water gets contaminated in a way that is different from food contamination. The third section deals with the principles of food borne infections, types of diseases that can happen by eating contaminated food and how these can be prevented.

11.2 OBJECTIVES

The chapter has been planned with following learning objectives for the students

- Common types of diseases, their classification and mode of transmission
- Introduction, transmission, symptoms and prevention of Water borne diseases
- Introduction, transmission, symptoms and prevention of Air borne diseases
- Introduction, transmission, symptoms and prevention of Food borne diseases

11.3 COMMON DISEASES AND THEIR TYPES

A disease is a condition that impairs normal functioning in living beings. It is considered to

be harmful deviation from the normal structural or functional state of an organism, generally associated with certain signs and symptoms and differing in nature from a physical injury. Disease generally results from a complex interaction between host, an agent (or cause) and the environmental factors.The most common diseases prevalent in various parts of India are malaria, typhoid, hepatitis, jaundice, tuberculosis, diarrhoeal diseases, dengue etc.

There are certain diseases which spread easily from one person to other, but some do not. The former are called communicable diseases and the latter non-communicable diseases.

11.3.1 COMMUNICABLE DISEASES (CD)

It may be defined as illness due to a specific infectious agent or its toxic products capable of being directly or indirectly transmitted from man to man, animal to animal, or from the environment (through air, dust, soil, water, food etc.) to man or animal. Communicable disease is transmitted through direct contact with an infected individual or indirectly through a vector. These can be infectious or contagious like the common cold, chicken pox, and strep throat. The spread or transfer can happen through the air, through contact with contaminated surfaces, or through direct contact with blood, faeces, or other bodily fluids.

11.3.2 NON-COMMUNICABLE DISEASES (NCD)

It is also known as chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behaviour factors. In low-and middle-income countries, NCDs disproportionately affect people and account for more than three quarters of global NCD deaths (31million). The main types of NCDs are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (asthma) and diabetes. According to World Health Organization, NCDs kill 40 million people each year, equivalent to 70% of all deaths globally. Pathogens like virus, bacteria, fungi or protozoa spread through a community using different modes of travel called methods of transmission. Diseases in which method of transmission is, water are called water borne disease; air are called air borne disease and food are called as food borne disease.

11.4 WATERBORNE DISEASES

Waterborne diseases are caused by pathogenic microorganisms that most commonly are

transmitted in contaminated fresh water. Infection commonly results during bathing, washing, drinking, in the preparation of food, or the consumption of food thus infected. Various forms of waterborne diarrheal disease probably are the most prominent examples, and affect mainly children in developing countries.

> In Bangladesh alone, around 35 million people are exposed on a daily basis to elevated levels of arsenic in the water they drink, which will eventually threaten their health while shortening their life expectancy.

According to the World Health Organization, such diseases account for 1.8 million human deaths annually. In developing countries, four-fifths of all illnesses are caused by water-borne diseases, with diarrhea being the leading cause of death among children.

11.4.1 WATERBORNE DISEASE VECTORS AND TRANSMISSION ROUTE

Waterborne organisms range from viruses to fungi, bacteria and intestinal parasites (helminthes) that pass in the faeces from an infected host to a susceptible host and are facilitated by waterborne transmission. Waterborne diseases are spread by drinking water contaminated with faeces and urine of infected animals or people.

The common water borne diseases based on type of pathogen that causes infection along with general symptoms are tabulated in table 11.1.

Table 11.1 Waterborne diseases based on the type of pathogen that causes infection

Disease	**Microbial Agent**	**Mode of Transmission**	**Sources of Agent in Water Supply**	**General Symptoms**
Protozoan/ parasitic Infections				
Amoebiasis (Amoebic dysentery)	*Entamoebahistolytica* (protozoan)	Water/food borne (Hand→ mouth) by Ingestion	Sewage, non - treated drinking water, flies in water supply	Abdominal discomfort, fatigue, weight loss, bloody diarrhea, gas pains, Fever, Life threatening if untreated
Giardiasis	*Giardia lamblia* (protozoan parasite)	Water borne Faecal→ oral route(hand→ m outh) from person to person By Ingestion	Untreated water, poor disinfection, pipe breaks, leaks, groundwater contamination	Diarrhea, abdominal discomfort, bloating, gas and gas pains
Schistosomiasis	*Schistosoma (S. mansoni, S. haematobium, and S. japonicum)* (parasitic flukes)	Waterborne-Faecal snail→water→ person(skin)	Contaminated fresh water with certain types of snails that carry schistosomes eggs	Rash or itchy skin. Fever, chills, cough, and muscle aches

Schistosomiasis	*Schistosoma (S. mansoni, S. haematobium, and S. japonicum)* (parasitic flukes)	Waterborne-Faecal snail→water→ person(skin)	Contaminated fresh water with certain types of snails that carry schistosomes eggs	Rash or itchy skin. Fever, chills, cough, and muscle aches
Taeniasis	*Taeniasolium* (tapeworm)	Waterborne/foodborne Person→water → Person by Ingestion	Raw meat/ contaminated water with eggs released with human faeces	Intestinal disturbances, neurologic manifestations, loss of weight
Fascioliasis	*Fasciola hepatica* (parasitic flukes)	Waterborne animal→snail →water→ person By Ingestion	Contaminated drinking water with encysted metacercaria	GIT disturbance, diarrhea, liver enlargement, cholangitis, cholecystitis, obstructive jaundice.
Coenurosis	*Taeniamulticeps (tapeworm)*	Dogs faeces→ rodents, rabbits →human By Ingestion	Contaminated drinking water/food with eggs (coenurus)	Increases intracranial tension
Bacterial Infections				
Cholera	*Vibrio cholerae*	Faecal→ oral By Ingestion	Inadequate water treatment, poor sanitation, and inadequate hygiene	Acute, profuse watery rice like diarrhea, dehydration, muscle cramps and extreme fatigue
Typhoid	*Salmonella typhi*	Faecal→ oral By Ingestion	Water/food borne	Fever, headache, nausea, loss of appetite, constipation or diarrhea
Bacillary Dysentery	*Shigelladysenteriae*	Faecal→ oral route From person to person, or animal to person by Ingestion	Food/water borne	Watery or loose stools, stomach cramps
Leptospirosis	*Leptrospirainterrogans*	Urine→ oral route From animal to person By Ingestion	Urine or urine contaminated water	Fever, headache, muscle pain and also causes hepatitis and jaundice
Viral Infections				
Hepatitis A	Hepatitis A	Fecal→oral, person→ person By Ingestion	Contaminated water and food	Jaundice, fatigue, abdominal pain, loss of apetite, nausea, diarrhea, fever
Polio – polio virus	poliovirus	person→ person By Ingestion	Contaminated water and food	Sore throat , fever, tiredness, nausea, headache, stomach pain, meningitis andparalysis at advance stages
Viral Gastroenteritis	Rotavirus	Faecal→ oral, person→ person, animal→ person By Ingestion	Faeces and contaminated water	Watery diarrhea, vomiting, death due to dehydration at later stage

11.4.2 PREVENTING WATER-BORNE DISEASES

Following measures can be taken to prevent water borne diseases:

a. Treatment of water: Water treatment includes following methods

- Filtration: Removes particles, including microbes
- Flocculation: Adds chemicals that make little particles aggregate into bigger particles. This helps them to settle down faster and take more microbes with them.
- Disinfection: Removes all bacteria using chemicals like chlorine, gas like ozone or UV irradiation or reverse osmosis.

b. Keeping Reservoirs safe: The water storage reservoirs should be kept clean and away from biotic interference so that there is less contamination of water.

c. Regular monitoring of Water distribution system: Periodical monitoring and maintenance of the water treatment unit and the distribution system lowers the chances of water contamination.

d. Interruption of routes of transmission: Spreading of pathogenic microorganisms can be avoided by interrupting the routes of transmission such as protecting food from flies, chlorination of water, and maintaining proper sanitation, etc.

11.5 AIR BORNE DISEASES

Diseases which are spread through air are called air borne diseases. When droplets of the foreign entities enter our body through the process of breathing, they disturb our basic body metabolism. Air borne diseases are caused by exposure to some source of infection which can be an infected patient or an animal.

11.5.1 AIR BORNE DISEASE VECTORS AND MODE OF TRANSMISSION

Pathogens use airborne transmission to infect hosts far away from pathogen's source. These pathogens are viruses, bacteria or fungi. In addition, several microbial toxins move through the air. The air just acts as mode of transmission for these pathogens.Air borne diseases are

> Chlorine is the most effective disinfectant. It kills most of the infectious agents in water. Chlorine also kills the resistant spore form of Bacillus and Clostridium, provided the contact time is upto one hour

classified on the basis of the type of pathogens (Table 11.2).

Table 11.2 Air borne diseases based on the type of pathogen that causes infection

Disease	Microbial Agent	Mode of Transmission	Route of Exposure	General Symptoms
Fungal Infections				
Aspergillosis	*Aspergillus spp.*	Inhalation of spores/ contaminated soil, hay, decaying vegetation	Inhalation	Fever, Chest pain, Cough, Coughing up blood, Fatigue. Shortness of breath
Cryptococcosis	*Cryptococcus neoformans*	Inhalation of spores/ contaminated soil/bird droppings (pigeon)	Inhalation	Blurred vision, headache, chest pain, Confusion, Altered mental status, Coma, Seizures, Neurological signs start slowly
Bacterial Infections				
Whooping cough	*Bordetella pertussis*	in airborne droplets or by direct contact with infected throat or nasal discharges.	Inhalation	Mild coughing, sneezing, runny nose, low fever, diarrhea
Meningitis (Meningococcal disease)	*Neisseria meningitidis*	person to person, sharing respiratory or throat secretions	Inhalation	Early meningitis symptoms may mimic the flu (influenza). The symptoms come on incredibly fast and include fever, headache, delirium, a stiff neck, nausea and even seizures.
Diphtheria	*Corynebacteriumdiphtheriae*	Person to person usually through respiratory droplets like from coughing or sneezing	Inhalation	fever, chills, thick, gray membrane covering your throat and tonsils, swollen glands in the neck, a loud, barking cough, a sore throat, bluish skin, drooling, a general feeling of uneasiness or discomfort
Pneumonia	*Klebsiellapneumoniae Streptococcus pneumoniae Legionella pneumophila*	air-borne droplets from a cough or sneeze	Inhalation	Chest pain on breathing or cough, Confusion or changes in mental awareness, Cough which may produce phlegm, fever, fatigue, sweating and shaking chills, , nausea, vomiting or diarrhea, shortness of breath

Tuberculosis	*Mycobacterium tuberculosis*	Infected person to a susceptible person in airborne particles, called droplet nuclei, from sneeze	Inhalation	Coughing up blood and phlegm, difficulty breathing, wheezing, fever, fatigue, sweating, chest pain, weight loss and breathing issues
Viral Infections				
Chickenpox	*Varicella zoste*r virus	Person to person by direct contact (touching the rash), droplet or air born spread	Inhalation, contact	The most common symptom is an itchy, blister-like rash. Fever and sore throats can also accompany this disease.
Influenza	Influenza virus es of the group RNA viruses under the family Orthomyxoviridae	Transmitted among humans either by direct contact with infected individuals; by contact with contaminated objects (called fomites, such as toys, doorknobs); and by inhalation	Inhalation	Fever over 100.4^0 F, Aching muscles, especially in your back, arms and legs, Chills and sweats, Headache, Dry, persistent cough, Fatigue and weakness, Nasal congestion, Sore throat
Measles	Paramyxovirus belonging to the genus Morbillivirus	Coughing and sneezing as virus can live for up to 2hrs in an airspace	Inhalation	Coughing, fever, muscle pain, skin sensitivity, sore throat, red eyes, white bumps in the mouth and rashes all over the skin.
Smallpox	Variola virus (smallpox virus)	Person to person via direct deposition of large, infective airborne droplets of saliva onto the nasal, oral or pharyngeal mucosal membranes, during contact with susceptible individual orscabs or fluid found in the patient's sores	Inhalation	high fever, chills, he adache, severe back pain, abdominal pain, vomiting followed by a rash on the face which spreads to the hands, forearms, and the main part of the body, the rash would develop into abscesses filled with fluid and pus

11.5.2 PREVENTING AIRBORNE DISEASES

a. Vaccination: Some airborne diseases can be avoided and prevented by getting vaccinated.

b. Avoiding Contact:Avoiding contact with an infected persons. Those who are infected can take precaution and isolate themselves until they are well.

c. Air Purification: UV air purification devices can be used in homes and offices to reduce air pollution load in the air.

d. Careful hygiene and sanitation protocols: Proper hygiene and sanitation protocols should be followed to prevent exposure to pathogens.

11.6 FOOD BORNE DISEASES

Foodborne diseases are the result of ingestion of foodstuffs contaminated with microorganisms or chemicals. The contamination of food may occur at any stage in the process from food production to consumption ("farm to fork") and can result from environmental contamination, including pollution of water, soil or air.The most common clinical presentation of foodborne disease takes the form of gastrointestinal symptoms; however, such diseases can also have neurological, gynaecological, immunological and other symptoms.

11.6.1 CAUSES OF FOOD-BORNE DISEASES AND MODE OF TRANSMISSION

Food-borne infections are caused by pathogens (biological agents) like bacteria, viruses, fungi and various parasites in food. Food poisoning, in contrast, comes from unwanted chemicals in food. Chemical that spoil food and cause disease include natural toxins and chemical contaminants. Some natural toxins are associated with the food itself, some are made by pathogens in the food when it is time/temperature abused. Food toxicities and food spoilage also result from microbes. Another group, food allergens cause allergies like some people are sensitive to proteins in foods. Major food allergens include milk, eggs, fish, wheat, soy, peanuts and tree nuts.

Table 11.3 Food-borne diseases based on the type of pathogen that causes infection

Disease	Microbial Agent	Mode of Transmission	Route of Exposure	General Symptoms
Parasitic Infections				
Toxoplasmosis	*Toxoplasma gondii*	undercooked or raw meat and fresh produce, exposure from infected cat faeces	Ingestion	Body aches, swollen lymph nodes, fever, fatigue, poor coordination and seizures
Cysticercosis	*Taeniasolium*	Raw or uncooked pork	Ingestion	Headache, confusion, vision change and seizures.
Chlonorchiasis or Chinese liver fluke	*Clonorchissinensis*	raw and incorrectly processed or cooked fish	Ingestion	Fever, colic pain, bile duct inflammation and cancer.
Ascariasis	*Ascarislumbricoid es*	Foodborne (from raw vegetable to human)	contaminat-ed drinking water/food with eggs	loefflers syndrome in lung, nausea, vomitting, diarrhea, malnutrition underdevelopment
Bacterial Infections				
Listeriosis (food poisoning)	*Listeria monocytogenes*	consuming contaminated raw vegetables, ready-to-eat or processed meats or smoked fish	Ingestion	blood poisoning and meningitis
Botulism	*Clostridium botulinum*	food-person	gastrointesti nal food/water borne	Causes paralysis, life threatening
Intestinal infection	*E. coli* O157:H7	food contaminated by the faeces of an infected person	Ingestion of contaminated food	Diarrhea, abdominal pain, fever, bloody diarrhea. Kidney failure
Viral Infections				
Hepatitis A	hepatitis A virusvirus	food contaminated by the faeces of an infected person	ingestion	Jaundice, n ausea, anorexia, fever and abdominal pain

Most food poisoning is caused by bacteria, viruses, and parasites rather than toxic substances in the food. But, some cases of food poisoning can be linked to toxins (aflatoxin is a toxin released by a mould that grows on grain that has been stored inappropriately and can cause liver cancer if consumed).

11.6.2 PREVENTING FOODBORNE DISEASES

Food preservation:

Food can be preserved inexpensively by using methods such as smoking and curing, preserving food with sugar or honey, fermenting to form acids and drying. These methods work by retarding microbial growth. Following are some of the food preservation methods:

- Canning: Canning is the process of applying heat to food that's sealed in a jar/can in order to destroy any microorganisms that can cause food spoilage.
- Freezing: Freezing helps in keeping the food fresh.
- Drying: Drying is the oldest method known for preserving food.
- Chemical Preservation: Adding chemical preservatives like ascorbic acid, benzoic acid, sorbic acid and sodium benzoate which do not kill microbes but inhibit their growth.
- Food Irradiation:Process of exposing foodstuffs to ionizing radiation like gamma rays. Gamma irradiarion can kill microbes like E.coli, Stahylococcusaureus, and Camplyobacterjejuni in meat and other food products.

11.7 SUMMARY/LET US SUM UP

- Communicable diseases are contagious and are spread from person to person or from animal to person. The spread or transfer can happen through the air, through contact with contaminated surfaces, or through direct contact with blood, faeces, or other bodily fluids. A cold is an example of a communicable disease.
- Non-communicable diseases are not contagious but are the leading cause of death

and disability in the world. Diabetes is a non-communicable disease. NCDs make up a greater percentage of deaths in high-income countries than in low-income countries.

- Waterborne diseases are linked to significant disease burden worldwide. Waterborne diarrhoeal diseases, for example, are responsible for 2 million deaths each year, with the majority occurring in children under 5. Proper household water and sanitation practices can increase resilience to waterborne disease risks.
- Airborne diseases are illnesses spread by tiny pathogens in the air. In most cases, an airborne disease is contracted when someone breathes in infected air. Carrying out good sanitary habits can greatly reduce the risk of transmitting airborne diseases.
- Foodborne diseases are caused by different disease-causing germs which can contaminate foods. Researchers have identified more than 250 foodborne diseases. Foodborne illness can be prevented through four easy steps: Clean, Separate, Cook and Chill food.

11.8 GLOSSARY

Adaptation : A change or the process of change by which an organism or species becomes better suited to its environment.

Anorexia : An eating disorder characterized by an abnormally low body weight, intense fear of gaining weight and a distorted perception of body weight.

Cholangitis : Cholangitis is an infection of the biliary tract with the potential to cause significant morbidity and mortality.

Cholecystitis : Cholecystitis is the inflammation of the gallbladder.

Disease Causative Agent : Disease causative agent usually refers to the biological pathogen that causes a disease, such as a virus, parasite, fungus, bacteriumor a toxin/ toxic chemical that causes illness.

Disease : A disorder of structure or function in a human, animal, or plant, especially one that produces specific signs or symptoms or that affects a specific location and is not simply a direct result of physical injury.

Dormant State : It isthe state of rest or inactivity.

Host : An animal or plant on or in which a parasite or commensal organism lives.

Infectious Agent : An agent like bacteria, virus, fungi or parasites capable of producing infection.

Loefflers syndrome : Löfflers syndrome is a transient respiratory illness associated with blood eosinophilia and radiographic shadowing.

Pathogen : Any disease producing agent, especially a virus, bacterium or other microorganism.

11.9 SAQ / POSSIBLE ANSWERS

Q.1 Which of the following statements is false? Explain what is incorrect.

a. Communicable diseases are more prevalent in developed nations.

b. Food borne diseases are only caused by microbial pathogens.

c. Cholera is only water borne disease.

d. Non communicable diseases spread from person to person contact.

e. Raw water can be disinfected using chlorine.

f. Some foodborne pathogens can also be spread by water, from person-to-person, and from animal-to-person.

Ans.1 a. False. Communicable diseases are more prevalent in developing nations and non-communicable diseases are more prevalent in developed countries.

b. False. Food borne diseases are caused by microbial pathogens and toxins released by these microbial pathogens.

c. False. Cholera is water and food borne disease.

d. False. Non communicable diseases do not spread from person to person contact.

e. True. Chlorine is used as disinfectant for raw water.

f. True. Pathogens associated with food can also be spread through other

modes including by water (drinking or recreational), person-to-person, and animal-to person.

Q.2 What is the difference between communicable and non-communicable diseases?

Ans. 2 Communicable disease refers to diseases that can pass from one person to another. These are also known as infectious diseases. Non-communicable diseases occur in one person and cannot be passed on to another person. These are referred to as chronic.

Q.3 How can someone come into contact with food- or water-borne bacteria?

Ans.3 Food-or water-borne illnesses are not spread from casual contact with another person.

A person can come into contact with food- or water-borne bacteria by eating or drinking something that has bacteria in it.

Q.4 How airborne diseases are caused?

Ans. 4. Airborne diseases occurs when bacteria or viruses travel on dust particles or on small

respiratory droplets that may become aerosolized when people sneeze, cough, laugh, or exhale. When inhaled these infected particles can cause airborne diseases.

Q.5. What are the symptoms of Cholera?

Ans.5 Acute, profuse watery rice like diarrhea, dehydration, muscle cramps and extreme fatigue are some of the symptoms of Cholera.

11.10 LESSON END EXERCISE, EXAM ORIENTED QUESTIONS

Q.1 Write a note onWater borne diseases.

Q.2. How Air borne diseases can be prevented?

Q.3 How Food borne diseases are transmitted?

Q.4 Name five water borne diseases.

Q.5 Name five air borne diseases.

11.11 SUGGESTED READING BOOKS

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11.13 MODEL TEST PAPER

1. An infectious disease that can be transmitted from person to person is known as a
   a. Systemic infection
   b. Communicable disease
   c. Transferable disease
   d. Environmental disease
2. Tuberculosis, or TB, is spread through the air by coughing or sneezing causing tiny droplets that can be breathed in by persons nearby.

a. True

b. False

3. Hepatitis A is not spread through consuming food or water that has been contami nated with infected faeces.

a. True

b. False

4. Annual worldwide incidence of cholera is

a. 1-2 million

b. 1-3 million

c. 1-5 million

d. 3 -5 million

5. Which of the following disease spread through respiratory route?

a. Influenza.

b. Mumps.

c. Chikenpox.

d. All of the above

6. Mumps is an infection of

a. Parotid gland

b. Submandibular gland

c. Sublingual gland

d. Submaxillary gland

7. Which of the following is a communicable disease?

a. Diptheria

b. Diabetes

c. Hypertension

d. Cancer

8. How many people die every year from non communicable diseases (NCDs)?

   a. 10 million people
   b. 25 million people
   c. 40 million people
   d. 80 million people

9. What kind of pathogen causes common cold?

   a. Bacteria
   b. Virus
   c. Fungus
   d. Amoeba

10. What is the difference between Communicable and non-communicable diseases?

   a. NCD can be treated whereas CD cannot
   b. CD can spread to others whereas NCD cannot
   c. CD can be treated whereas NCD cannot
   d. NCD can spread to others whereas CD cannot

11. Water in swimming pools is purified by adding

   a. Sodium
   b. Chlorine
   c. Phosphorus
   d. Potassium

12. Which of the following is a water-borne disease?

   a. influenza
   b. cholera
   c. cancer
   d. heart attack

13. Cryptococcosis is caused by the pathogen

a. Cryptococcus neoformans

b. Clostridium sporogenes

c. Cryptosporidium parvum

d. Cyclospora cayetanensis

14. Following is used as food preservative

a. Chlorine

b. Ice

c. Alum

d. Sodium benzoate

15. Botulism is caused by the presence of toxin developed by

a. Clostridium tyrobutyricum

b. Clostridium sporogenes

c. Clostridium botulinum

d. none of these

Answers

1b 2a 3b 4d 5d 6a 7a 8c 9b 10b

11b 12b 13a 14d 15c

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12.1 INTRODUCTION

While the number of people newly diagnosed with HIV infection in the world has fallen by about a third since 2000, HIV remains a significant health problem. The first section of this chapter provides brief information about HIV and AIDS. Addiction is a growing concern in the developing nations. Drug addiction not only affects a person's health and relationships, but also impacts society and the environment. The second part of this section discusses about drug addiction and various measures to control addiction.

One of the scariest things about nuclear power is when something goes wrong and an accident occurs, the loss becomes irreparable. The second section of this chapter deals with nuclear hazards- sources, effects and control along with case studies of nuclear disasters from various parts of the world.

Information technology has tremendous potential in the field of environment management and human health. The third section of this chapter would help the students understand how information technology can be useful as savior of environment and human health.

12.2 OBJECTIVES

The chapter has been devised with following learning objectives for the students

- Introduction, transmission, symptoms, treatment options and control of AIDS/ HIV
- Examine the cycle of addiction to drugs and what can be done to prevent it
- Introduction to Nuclear hazards with examples from various parts of the world
- What role information technology can play in environment and human health?

12.3 HIV/AIDS

12.3.1 INTRODUCTION TO HIV/AIDS

AIDS is the acronym for Acquired Immunodeficiency Syndrome. The Human Immunodeficiency Virus(HIV) causes Acquired Immunodeficiency Syndrome (AIDS) through contact with the tissue fluids of infected individuals, particularly through sexual contact and attacks, and weakens the body's immune system. As a result, a variety of opportunistic infections (OIs) may cause illness in a person. One of the worst epidemics of all time, AIDS spread around the entire world within twenty years. Isolated cases of AIDS had probably appeared in Central Africa as early as 1970s, but the HIV virus was not identified until 1984. According to the United Nations Programme on HIV/AIDS, an estimated 36.9 million people worldwide are currently living with HIV/AIDS. The spread of HIV encompasses every country, but several sub-Saharan African nations have been the hardest hit.HIV/ AIDS has a serious impact on the socioeconomic fabric of society. India has the third largest HIV epidemic in the world. In 2016, HIV prevalence in India was estimated as 0.3% which equates to 2.1 million people of the total population. Overall, India's HIV epidemic is slowing down, with a 32% decline in new HIV infections, and 54% decline in AIDS-related deaths between 2007 and 2015. The three eastern states with the highest HIV prevalence are Manipur, Mizoram, Nagaland.

12.3.2 MODE OF TRANSMISSION OF HIV

People mostly get or transmit HIV through sexual behaviours and needle or syringe use. Other modes of transmission of HIV are:

i. Certain body fluids like blood, semen, pre-seminal fluid, rectal fluids, vaginal fluids, and breast milk, from a person who has HIV can transmit HIV. These fluids must come in contact with a mucous membrane or damaged tissue for transmission to occur.

ii. By sharing needles or syringes or other drug injecting equipments with someone who has HIV.

iii. HIV can also spread by being stuck/cut with an HIV-contaminated needle or other sharp object. This is a risk mainly for health care workers.

iv. HIV may be transmitted by receiving blood transfusions, blood products, or organ/ tissue transplants that are contaminated with HIV.

v. Less commonly, HIV may also be spread from mother to child during pregnancy, birth, or breastfeeding.

vi. Eating food that has been pre-chewed by an HIV-infected person.

vii. Being bitten by a person with HIV.

12.3.3 SYMPTOMS AND DIAGNOSTIC PATH

HIV is a virus that attacks the body's immune system. Some viruses that cause cold or flu enter the body and attack the respiratory or digestive cells. The immune system which helps to fight infections, has learned to recognize these viruses, and when these viruses enter the body, the human immune system begins producing antibodies to fight them. HIV virus attacks a specific type of immune system cell in the body, known as CD4 helper lymphocyte cells. As the number of HIV in the body increases, more and more CD4 cells die trying to fight the viruses, making it harder for the body to fight off other infections. HIV once enters the body, can remain dormant for upto ten years. However, it remains infectious during entire phase meaning that the virus can be transmitted by a person who feels fine and has no visible signs of being sick. At later stages, a person may begin to feel tired, having difficulty fighting common illnesses, having frequent night sweats and rashes, and having frequent fungal infections of the nails, mouth, and/or vaginal areas.

12.3.4. TESTING FOR HIV AND TREATMENT OPTIONS

HIV can be tested using HIV test called Enzyme-linked Immunosorbent Assay (ELISA)antibody test that looks for viral load or antibodies to the virus to determine whether a person is HIV positive. Currently there is no known cure for AIDS. However, numerous medications can be used to treat HIV and the clinical conditions. If an individual is diagnosed with HIV, then treatment is immediately begun to treat any known infections as well as treatment to stop the virus from reproducing in the body.

12.3.5 RISK FACTORS AND PREVENTIVE MEASURES

The greatest risk factor for AIDS is not being treated after testing positive for HIV. The risk of transmitting or getting infected by HIV can be reduced by

- Abstinence which is the only known sure preventive measure for avoiding sexual exposure to HIV but is rarely practiced.
- Using a condom during sexual intercourse, whether vaginal or anal. Oral sex can also spread HIV if a person has any open cuts or sores on the genitals or mouth and gums.
- Not using dirty or used needles.
- Avoiding direct exposure to blood by health care employees or people who work with people who are bleeding.
- HIV-positive mothers should not breast-feed babies, as HIV is present in mother's milk.
- Staying healthy. Keep healthy after being infected with HIV byexercising regularly, taking good nutrition etc.HIV medication should be taken as directed.
- Health Education and mass awareness. As there is no cure for AIDS, mass awareness and health education can prevent its spread.
- Integration of AIDS control programme. Due to its widespread implications on healthcare like mother and child healthcare, family planning etc. integration of AIDS programme within countries is must.

12.4 DRUG ADDICTION

Drug addiction is the physical and psychological need to continue using a substance/drug, despite its harmful or dangerous effects. It is a serious and expensive societal problem plaguing adolescents, teens, and adults alike. It is chronic, often relapsing brain disease. The initial decision to take drugs is often voluntary for most people, but repeated drug use can lead to brain changes that challenge an addicted person's self-control and interfere with their ability to resist intense urges to take drugs.

Drug Abuse and Addiction

Drug abuse encompasses any use of illicit substances, or inappropriate use of medications (such as taking larger doses than prescribed). Drug abuse might eventually lead to an addiction but not everyone that uses drugs (or abuses them) becomes addicted to them. Drug abuse always precedes addiction.

Drug addiction begins as a result of using a substance (drugs or medications) that have a measurable impact on the brain and the repeated stimulus changes the functionality of the brain. Taking drugs become more important above all other aspects of an otherwise "normal" life. Eating, sleeping, even sexual activity can take a back seat to obtaining and using drugs.

12.4.1 CAUSES OF DRUG ADDICTION

People begin taking drugs for a variety of reasons like to feel good, to do better or sometimes out of Curiosity. It is not always that everyone who uses drugs or alcohol will develop a problem or become addicted. Some of the factors responsible for a person becoming addicted include:

i. **Person's environment :** These include family's beliefs and attitudes and exposure to a peer group that encourages drug use.Drug addiction is more common in environments where drug abuse is seen or where it's seen as permissible.

ii. **Genetics :** Once you start using a drug, the development into addiction may be influenced by inherited (genetic) traits, which may delay or speed up the disease progression. Drug addiction tends to run in families.

iii. **Psychological causes of drug addiction :** Some of the psychological causes of drug addiction appear to stem from trauma, often when the drug addict is young. Sexual or physical abuse, neglect, or chaos in the home can all lead to psychological stress, which people attempt to "self-medicate" which becomes a cause of drug addiction.

12.4.2 SYMPTOMS AND EFFECTS OF DRUG ADDICTION

People of any age, sex or economic status can become addicted to a drug. Certain factors can affect the likelihood and speed of developing an addiction. As a result, it is important to recognize the signs and symptoms of drug addiction early. Some of the signs to look for drug addiction include:

i. **Cravings :** Intense urge to use the drug regularly, daily or even several times a day particularly those that block the thoughts or causes memory losses.

ii. **Physical dependence :** Needing same drug or to get the same effect again and

again also means that one is developing addiction for the drug. Physical dependence to drugs can develop as people grow accustomed to the persistent presence and influence of the substance.

iii. **Tolerance :** Over time and with prolonged use, people can build up a tolerance to the drug, and they need more dosage of the drug to achieve the desired effects.

iv. **Risk Taking .** Doing things to get the drug that you normally wouldn't do, such as stealing, lying, engaging in unsafe sexual activity, selling drugs, or crimes that could land the person in jail.

v. **Financial trouble .** People may spend excessive amounts of time, energy and money finding and getting the drug of their choice. Sudden requests for money without a reasonable explanation also support drug abuse.

vi. **Neglect responsibilities :** People do not meet work responsibilities, and cut back on social or recreational activities. When people choose using or getting the drug over meeting work or personal obligations, this is a classic sign of addiction.

vii. **Physical health issues and visible signs :** Sometimes shakes, tremors, or slurred speech without any medical abnormality may indicate heavy dosage of drugs. Lack of energy and motivation, weight loss or gain, or red eyes also indicate influence of drugs.

viii. **Withdrawal symptoms :** Experience withdrawal symptoms when you attempt to stop taking the drug. Presence of a withdrawal syndrome indicates that physiological dependence is increasing.

Drug use can have significant and damaging short-term and long-term effects. Each drug produces different physical effects but repeated use of all abused substances can alter the way the brain functions. For example, taking a recreational drug causes a rush of the neurotransmitter dopamine in brain, which triggers feelings of pleasure. Methamphetamine, opiates and cocaine are highly addictive and cause psychotic behaviour, seizures or death due to overdose and,Gamma hydroxyl butyrate(GHB) and flunitrazepam may cause sedation, confusion and memory loss. At high doses, they can cause seizures, coma and death.

12.4.3 PREVENTION

Preventing drug addiction improves quality of life, academic performance, work place productivity, reduces crime and criminal justice expenses; reduces motor vehicle crashes and fatalities; and lowers health care costs for acute and chronic conditions.

i. Abstaining/ careful use of drugs

ii. Treatment and behaviour therapy

iii. Preventing drug misuse in children and teenagers.

iv. Preventing a relapse.

v. Through education and awareness programmes.

12.5 NUCLEAR HAZARDS

Nuclear energy gets its name from the nucleus, the central part of the atom. Atoms consists of three different particles: neutrons, protons, and the electrons. The nucleus contains protons and neutrons. Electron circles the nucleus. The number of each particle differs for every element. Most elements are stable and their atoms keep the same balance of these particles. Some elements are unstable. Their atoms continually change by emitting some of their particles. Unstable elements are radioactive in nature. Radioactivity is the phenomenon of emission of energy from radioactive isotopes such as Carbon-14, Uranium-235, Uranium-238, Uranium-239, Radium-226, etc. The emission of energy from radioactive substances in the environment is often called as 'Radioactive Pollution'.

12.5.1 TYPES OF RADIATIONS

Radiation is generally classified as ionizing or non-ionizing, based on the property of ionization which means whether it has enough energy to knock electrons off atoms that it interacts with, as well as being able to do lower-energy damage such as breaking chemical bonds in molecules.

i. Non-ionizing radiation is the term given to radiation in the part of the electromagnetic spectrum where there is insufficient energy to cause ionization like radio waves, microwaves, infrared, ultraviolet, and visible radiation.

ii. Ionizing radiation is radiation with enough energy so that during an interaction with

an atom, it can remove tightly bound electrons from the orbit of an atom, causing the atom to become charged or ionized. These are caused by unstable atoms giving off energy to reach a more stable state and have far reaching effects on human health as compared to non-ionizing radiations.

12.5.2 TYPES OF IONIZING RADIATION

Most atoms are stable, but certain atoms change or disintegrate into totally new atoms and are said to be 'unstable' or 'radioactive'. An unstable atom has excess internal energy, with the result that the nucleus can undergo a spontaneous change. This is called 'radioactive decay'. An unstable nucleus emits excess energy as radiation in the form of fast-moving sub-atomic particles like alpha or beta particle or gamma rays. Primary types of ionizing radiations are:

i. Alpha radiation occurs when an atom undergoes radioactive decay, giving off a particle called as Alpha particles which consist of two protons and two neutrons, the equivalent of the nucleus of a helium atom. Double charge(arising from the charge of the two protons), relatively slow speed and high mass of alpha particles make them interact more readily with matter than beta particles or gamma rays and lose their energy quickly.

ii. Beta radiation takes the form of either an electron or a positron (a particle with the size and mass of an electron, but with a positive charge) being emitted from an atom. Beta particles are fast-moving electrons ejected from the nuclei of many kinds of radioactive atoms. These particles are singly charged (the charge of an electron), are lighter and ejected at a much higher speed than alpha particles.

iii. Gamma radiation, unlike alpha or beta, does not consist of any particles, instead consisting of a photon of energy being emitted from an unstable nucleus. Having no mass or charge, gamma radiation can travel much farther through air than alpha or beta particles, losing (on average) half of its energy for every 500 feet.

iv. X-rays are virtually identical to gamma rays except that X-rays are produced artificially rather than coming from the atomic nucleus. X rays are generally caused by energy changes in an electron, such as moving from a higher energy level to a lower one, causing the excess energy to be released. These are longer-wavelength and (usually) lower energy than gamma radiation, as well.

v. Neutron Radiation.Lastly, Neutron radiation consists of a free neutron, usually emitted as a result of spontaneous or induced nuclear fission. Able to travel hundreds or even thousands of meters in air, they are however able to be effectively stopped if blocked by a hydrogen-rich material, such as concrete or water. Neutrons are, in fact, the only type of radiation that is able to turn other materials radioactive.

12.5.3 SOURCES OF IONIZING RADIATION AND NUCLEAR HAZARDS

Environment has a significant levels of ionizing radiation called Background radiation which occur naturally and are inevitable. Following are some of natural and man-made sources of nuclear pollution/nuclear hazards:

The natural sources include:

i. Cosmic rays from outer space contain high energy particles and cause pollution as they reach on Earth. The quantity depends on altitude and latitude; it is more at higher latitudes and high altitudes.The radio nuclides are present in the atmosphere and further break down into smaller parts, emitting radiation and entering the body of living organisms during breathing.

ii. Emissions from radioactive materials from the Earth's crust.The radioactive minerals contain uranium, thorium or plutonium which emit energetic radiation causing pollution.

Man-made sources include:

i. Nuclear power plants (NPP) produce a lot of waste causing pollution and its disposal poses a global problem. Nuclear reactors in NPP convert energy stored in atoms into heat or electricity. Nuclear power plants (NPPs) use uranium to drive a chain reaction (fission) that produces steam, which in turn drives turbines to produce electricity. Fission takes place when the nucleus of an atom is hit by a fast moving particle called neutron. This collision breaks the nucleus into smaller parts, releasing heat energy and other particles. NPPs release regulated levels of radioactive material which can expose people to low doses of radiation. Mining and processing material in nuclear power plants also contribute to nuclear pollution. Similarly, the radioactive waste facilities release some radioactivity that contributes to the pollution. Uranium, plutonium and other fuels used by nuclear reactors

continue to release radiations even after they have been used. It can also be released into the water, air or soil during the production of nuclear fuel reactor materials.

ii. Radiation has many uses in medicine. The most well-known use is X-ray machines, which use radiation to find broken bones and diagnose diseases. Another example is nuclear medicine, which uses radioactive isotopes to diagnose and treat diseases such as cancer.

iii. Use of radioactive isotopes in research applications is also source of radioactive pollution.

iv. The atmospheric testing of atomic weapons from the end of the Second World War until as late as 1980 released radioactive material, called fallout, into the air. As the fallout settled to the ground, it was incorporated into the environment. Much of the fallout had short half-lives and no longer exists, but some continues to decay to this day. People and the environment receive smaller and smaller doses from the fallout every year. The detonation of the atomic bombs at Hiroshima and Nagasaki, along with the nuclear weapons tests of the 50s and 60s, deposited a certain amount of radioactive fallout into the atmosphere.

v. Radiation has a variety of industrial uses that range from nuclear gauges used to build roads to density gauges that measure the flow of material through pipes in factories. It is also used for smoke detectors, some glow-in-the dark exit signs, and to estimate reserves in oil fields. Radiation is also used for sterilization which is done by using large, heavily shielded irradiators.

Any unwanted leakage/processleading to mass radioactive exposure by any of the above mentioned sourcescan lead to nuclear hazard.Nuclear hazard can be defined as the risk or danger to human health or the environment posed by radiation emanating from the atomic nuclei of a given substance, or the possibility of an uncontrolled explosion originating from a fusion or fission reaction of atomic nuclei. The energy released during a nuclear explosion, which comes from energy released from electron shells around the nuclei, can be more than 1 million times greater than that of a conventional explosion.

12.5.4 EFFECTS OF RADIOACTIVE POLLUTANTS/NUCLEAR HAZARDS

The effects of nuclear hazards depend upon half-life, energy releasing capacity, rate of

diffusion and rate of deposition of the radioactive contaminant. Various atmospheric conditions and climatic conditions such as wind, temperature and rainfall also determine their effects.

All organisms are affected from radiation pollution arising out of nuclear hazard, and the effects are extremely dangerous. Some of the possible effects are as under:

i. Genetic damage: It is caused by radiations which induce mutations in DNA. DNA consists of two long chains of nucleotides twisted together into a double helix; it is the molecular compound in the nucleus of a cell that forms the blueprint for the structure and function of the cell. Radiation is able to break these chains and chemical bonds, thereby affecting genes and chromosomes in turnaffecting the genetic make-up and control mechanisms. The damage is often seen in the offsprings and may be transmitted upto several generations.

ii. Somatic damage occur when cell as a whole is damaged by radiations. This includes burns, miscarriages, eye cataract and cancer of bone, thyroid, breast, lungs and skin.

iii. Epidemiological evidence : Studies on survivors of the atomic bombings of the cities of Hiroshima and Nagasaki in 1945 indicate that the principal long-term effects of radiation exposure have been an increase in the frequency of cancer and leukaemia. Exposure to low doses of radiations (100-250 rads), leads to fatigue, nausea, vomiting and loss of hair and recovery is possible. Exposure at higher doses (400-500 rads), effects the bone marrow, reduces blood cells, and natural resistance and fighting capacity against germs, blood fails to clot, and the irradiated person soon dies of infection and bleeding. Higher irradiation doses (10,000 rads) immediately kills the organisms by damaging the tissues of heart, brain, etc.

iv. Public concerns : A radiation incident can create public panic and potentially result in a large displaced population seeking alternate shelter and health screening for potential exposure, which may create an additional healthcare burden on the local mental health and public health resources. Long-term effects could include ecological damage, loss of food and agricultural production, and human resettlement.

12.5.5 CONTROL OF NUCLEAR HAZARDS

Following measures can help in controlling the radioactive pollution/ nuclear hazards:

i. Provision of nuclear gadgets and safety measures : Workers in nuclear plants should be provided with nuclear gadgets and safety measures against accidents. Appropriate steps should be taken to avoid occupational exposure.

ii. Regular Monitoring.

a. There should be regular monitoring and quantitative analysis through frequent sampling in the risk areas.

b. Leakage of radioactive elements from nuclear reactors, laboratories, transport, careless handling and use of radioactive fuels should be periodically checked and stopped.

iii. Preventive measures should be followed so that background radiation levels do not exceed the permissible limits.

iv. Nuclear waste disposal must be careful, efficient and effective. The nuclear wastes are usually classified as:

a. High Level Wastes (HLW) : High level wastes have a very high-radioactivity per unit volume. For example, spent nuclear fuel. Since these wastes are too dangerous to be released anywhere in the biosphere, therefore, they must be contained either by converting them into inert solids (ceramics) and then buried deep into earth or are stored in deep salt mines.

b. Medium level wastes (MLW) : Medium level wastes (e.g., filters, reactor components, etc.,) are solidified and are mixed with concrete in steel drums before being buried in deep mines or below the sea bed in concrete chambers.

c. Low level wastes (LLW) : Low level wastes (e.g., solids or liquids contaminated with traces of radioactivity) are disposed off in steel drums in concrete-lined trenches in designated sites.

v. Checking radioactive levels at mining sites and rock strata: Periodic and long-term monitoring of areas of naturally occurring uranium rich rocks.

vi. Safety measures should be strengthened against nuclear accidents.

12.5.6 NUCLEAR DISASTERS

Some of the World's worst Nuclear Disasters are discussed as under:

i. Three Mile Island nuclear power plant on March 28, 1979, an uncontrolled nuclear meltdown happened in a reactor accident at Three Mile Island nuclear power plant in Pennsylvania, USA.

ii. Chernobyl nuclear power reactor. The meltdown happened on April 26, 1986, in Ukraine due to human error and poor design of the reactor. Out of the 134 severely exposed workers and firemen, twenty eight of the most heavily exposed died as a result of acute radiation syndrome (ARS) within three months of the accident. Thousands developed thyroid cancer from radiation.

iii. Fukushima Daiichi nuclear power plant In March 2011, a powerful earthquake and tsunami hit the coast of Japan and knocked out the electricity running the cooling system of nuclear reactors in Fukushima. Thus, causing explosions of the reactors. Three of the nuclear reactors melted down and radiation was released in the area.

12.6 ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT PROTECTION AND HEALTH

Successful environmental management and governance can be realized through maximum dissemination of information. Similarly, various health aspects need to be addressed at public forums and information regarding new diseases and their treatments need to be propagated among the masses. Information technology has tremendous potential in the field of environmental management and health as in any other field like business, economics, politics or culture. Development of Internet facilities, worldwide web, geographical information system (GIS) and information through satellites has generated a wealth of up-to-date information on various aspects of environment and health. A number of software have been developed for environment and health studies, which are user friendly.

12.6.1 ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT MANAGEMENT

i. Remote Sensingand GIS :

Remote Sensing is the science and art of acquiring information (spectral, spatial, temporal) about material objects, area, or phenomenon, without coming into physical contact with the objects, area, or phenomenon. It is most useful for natural resource management, sustainable development, environmental degradation, and disaster management.

GIS has proved to be a very effective tool in environmental management and is a technique of superimposing various thematic maps using digital data on a large number of inter-related or inter-dependent aspects like water resources, forest land, soil type, crop land, industrial growth, human settlement etc. in a layered form in computer using softwares.

Applications of Remote sensing and GIS :

a. Useful for future land use planning and for interpreting polluted zones and degraded lands.

b. Provides information of atmospheric phenomenon like approaching of monsoon, ozone layer depletion, smog and inversion phenomenon etc.

c. Planning for locating suitable areas for industrial growth is now being done using GIS by preparing Zoning Atlas.

d. GIS and remote sensing play a key role in resource mapping, environmental conservation and environmental impact assessment.

e. Through remote sensing and GIS we are able to gather digital information on environmental aspects like water logging, desertification, deforestation, urban sprawl, river and canal network, mineral and energy reserves and so on.

f. GIS serves to check unplanned growth and related environmental problems. Our satellite data also helps in providing correct, reliable and verifiable information about forest cover, success of conservation efforts etc.

g. It also helps in identifying several disease-infected areas, which are, prone to some vector-borne diseases like malaria, schistosomiasis etc. based upon mapping of such areas.

ii. Databaseand database management system (DBMS)

Database is the collection of inter-related data on various subjects. It is usually in computerized form and can be retrieved whenever required. In the computer, the information of database is arranged in a systematic manner that is easily manageable and can be very quickly retrieved. There are several Distribution Information Centres (DICs) in our country that are linked with each other and with the central information network having access to international database.

A database management system (DBMS) consists of a collection of interrelated data and a collection of programs to access that data. The primary goal of a DBMS is to provide an environment that is both convenient and efficient for the user to retrieve required information in proper format and to store the information securely and in classified form with minimum storage space. Various computer programming languages can be used for developing suitable software, for various environment related issues. Some of the databases available in India are:

a. The National Science and Technology Management Information System (NSTMIS), a division of Department of Science and Technology (DST) has been entrusted with the task of building the information base on a continuous basis on resources devoted to scientific and technological activities for policy planning in the country.

b. Environmental Information System (ENVIS) : The Ministry of Environment, Forest & Climate Change (MoEF&CC) implemented a Central Sector Scheme entitled Environmental Information System (ENVIS) in December 1982 (Sixth Plan). ENVIS is a decentralized system, a web-based distributed network of subject-specific databases. Its purpose is to integrate country-wide efforts in environmental information collection, collation, storage, retrieval and dissemination to all the concerned.

iii. World Wide Web and online learning centers : World wide web with various search engines containing resource material on every aspect, class-room activities, digital files of photos, power point lecture presentations, animations, web-exercises and quiz has proved to be very important in providing latest and up to date information regarding various facets of environment.

iv. Use of Information Technology in Pollution Monitoring and Control : Advances in information technology have opened up new alternatives for better production and quality control. New micro controller based instruments, gadgets and control units can be used for monitoring pollution and control.

12.6.2 ROLE OF INFORMATION TECHNOLOGY IN HUMAN HEALTH:

Today information technology is used in wide range of fields and one of the upcoming fields is of medical science, which is known as Health Information Technology (HIT). Health information technology (HIT) is the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making.

Following are some of the areas concerning health where information technology can be used:

i. Health Education and Research using internet

a. Rapid communication can be established with the help of e-mails and course details, handouts, and feedbacks can be circulated easily. The Internet provides opportunities to gain up-to-date information on different aspects of health and disease and to discuss with colleagues in different continents via net conferencing. Free access to various medical journals, online textbooks and the latest information on new development in medicine also encourages learning and research

b. Advanced Life Support Simulators (ACLS) are used in medical education in developed nations to develop various clinical skills such as ECG interpretation and appropriate intervention such as drugs, injections, defibrillation without working on a real patient. With new technology, the students can virtually go inside each

and every organ and see how they actually look like from outside as well as from inside.

ii. IT in Healthcare Sector

Information technology has proven to be very helpful in the healthcare sector.

a. Patient administration and clinical services : In metro cities, IT helps to provide electronic medical records (EMR) of the patients and their information such as symptoms, diagnosis, treatment, etc. This technology can convert medical information into a single database.

b. Robotics : The use of robots could eliminate the human physical labor entirely from a system and just be controlled and monitored from a wireless network. In 1997 at the Tripler Army Medical Center in Honolulu, Hawaii, robots were controlled and used to deliver medications as well as nutritional trays to the patients.

c. Use of Remote sensing and GIS can help in identifying several disease-infected areas which are prone to some vector-borne diseases like malaria, schistosomiasis etc. based upon mapping of such areas.

d. Bioinformatics.An emerging field of which is now used in curing severe diseases like osteoporosis and in human genome project (HGP) by developing a computer programme that helps in completing the genome sequencing. The aim of HGP is to create a map of entire set of genes (genome) in the human cell by decoding the three billion units of human DNA.

e. Telemedicine. Telemedicine is essentially an application of information and communication technologies which uses a combination of hardware and software and transmit signals for the exchange of valid information between the care provider and the receiver for diagnosis, treatment and prevention of diseases and injuries, using the internet network.

f. Public Health Informatics. Public Health Informatics has

Information technology in health care dates back to 1973 when Dr. Robert StevenLedley developed the first whole-body computerized tomography (CT/CAT) scanner which allowed capturing of three dimensional images of various parts of body as well as plan radiation therapy for cancer patients.

been defined as the systematic application of information and computer science and technology to public health practice, research, and learning. The scope of public health informatics includes the conceptualization, design, development, deployment, refinement, maintenance, and evaluation of communication, surveillance, and information systems relevant to public health.For example, GRAMSAT (rural satellite) programme of Indian Space Research Organization (ISRO) has been applying its space technology into healthcare. Apollo has been set up Rural Telemedicine Centre in the village of Aragonda of Andhra Pradesh.

12.7 TO SUM UP/SUMMARY

♦ HIV stands for Human Immunodeficiency Virus and is different to AIDS, which is the advanced stage of HIV infection. The HIV virus can be spread through infected blood, breast milk, semen, and anal or vaginal fluids contaminating the blood stream. If HIV is not treated then the body is exposed to opportunistic infections which can cause serious illnesses.

♦ The path to drug addiction begins with the voluntary act of taking drugs but over time, a person becomes addicted to drugs. However just like other chronic diseases, such as diabetes, asthma, or heart disease, drug addiction can be managed effectively.

♦ The degree and the kind of damage from nuclear accidents vary with the kind of radiation, the amount of radiation, the duration of exposure and the types of cells irradiated. Main sources of nuclear hazards range from faulty nuclear reactors, careless handling of radioactive isotopes or radioactive process to exposure due to mining of radioactive material, nuclear weapon testing and disposal of huge amount of nuclear waste. To control nuclear hazards, safety measure against accidental release of radioactive elements must be ensured in nuclear plants.

♦ The understanding of environmental concerns and issues related to human health has exploded during the last few years due to the sudden growth of Information Technology. IT can be quite helpful in environmental as well as health management.

12.8 GLOSSARY

Anabolic / Androgenic steroids : A synthetic steroid hormone that resembles testosterone in promoting the growth of muscle. Such hormones are used medicinally to treat some forms of weight loss and (illegally) by some athletes and others to enhance physical performance.

Disease : Disease is a disorder of structure or function in a human, animal, or plant, especially one that produces specific signs or symptoms or that affects a specific location and is not simply a direct result of physical injury.

Kaposi's sarcoma : Kaposi sarcoma (KS) is a cancer that develops from the cells that line lymph or blood vessels. It usually appears as tumors on the skin or on mucosal surfaces such as inside the mouth, but tumours can also develop in other parts of the body, such as in the lymph nodes (bean-sized collections of immune cells throughout the body), the lungs, or digestive tract.

Lymphocyte : These are type of white blood cell that forms the part of the immune system. There are two main types of lymphocytes: B cells that produce antibodies that are used to attack invading bacteria, viruses, and toxins and the T cells which destroy the body's own cells that have themselves been taken over by viruses or become cancerous.

Nuclear Fission : A nuclear reaction in which a heavy nucleus splits spontaneously or on impact with another particle, with the release of energy.

Nuclear Fusion : A nuclear reaction in which atomic nuclei of low atomic number fuse to form a heavier nucleus with the release of energy.

Nuclear reactor : A device that generates electrical energy by splitting atoms. A nuclear reactor contains and controls sustained nuclear chain reactions.

Opportunistic infection : An opportunistic infection is an infection caused by pathogens (bacteria, viruses, fungi, or protozoa) that take advantage of an opportunity not normally available, such as weakened immune system or an altered microbiota (such as a disrupted gut flora).

Radiation dose : The amount of radiation absorbed by a person is measured in dose. A dose is the amount of radiation energy absorbed by the body.

Radioactivity : It refers to the particles which are emitted from nuclei as a result of nuclear instability.

Syndrome : A Syndrome is a collection of symptoms, characteristics, or phenomena that occur together to make up a particular illness or disease.

12.9 SAQ / POSSIBLE ANSWERS

Q.1 Which of the following statements is false? Explain what is incorrect.

a. AIDS is Auto immune deficiency syndrome.

b. HIV is more prevalent among young sexually active people than among elderly people.

c. An HIV infection can lead to AIDS in a few months in most cases.

d. In the early course of HIV infection, people may not know that they are infected with the virus because they feel healthy (have no symptoms and signs).

e. HIV mostly infects the red blood cells of humans.

f. HIV can only be transmitted through sexual intercourse with an infected person.

g. Eating and shaking hands with HIV infected person cannot transmit HIV to uninfected individuals.

Ans.1

a. False. It is Acquired Immune Deficiency Syndrome

b. True. HIV is more prevalent among young sexually active people than among elderly people.

c. False. In most cases, an HIV infection leads to AIDS in 5-10 years, and only if the person does not get antiretroviral therapy.

d. True. In the early course of HIV infection, people may not know that they are infected with the virus because they feel healthy (have no symptoms and signs).

e. False. HIV mostly infects CD4 lymphocytes, which are a type of white blood cell in humans.

f. False. HIV can be transmitted through sexual intercourse with an infected person,

but also by transfusion of infected blood, or blood products sharing or accidental puncture with sharp objects contaminated by infected blood; and from mother to child.

g. False. HIV can be transmitted through oral sex; the virus can get in through microlesions in the mucosa lining in the mouth.

Q.2 What is a CD4 lymphocyte and what is its role in the human body?

Ans.2 CD4 lymphocyte is a special type of white blood cell in the immune system, which circulates in the body and 'helps' other lymphocytes to function in the immune response, e.g. by making antibodies, or attracting killer cells to destroy virus-infected cells.

Q.3. What is the difference between drug addiction and drug abuse?

Ans.3 Drug abuseen compasses any use of illicit substances, or inappropriate use of medications (such as taking larger doses than prescribed). Drug abuse might eventually lead to an addiction but not everyone that uses drugs (or abuses them) becomes addicted to them. Drug abuse always precedes addiction.

Drug addiction begins as a result of using a substance (drugs or medications) that have a measurable impact on the brain and the repeated stimulus changes the functionality of the brain. Eating, sleeping, even sexual activity can take a back seat to obtaining and using drugs.

Q.4 Define Nuclear Hazard.

Ans.4 Nuclear hazard can be defined as the risk or danger to human health or the environment posed by radiation emanating from the atomic nuclei of a given substance, or the possibility of an uncontrolled explosion originating from a fusion or fission reaction of atomic nuclei.

Q.5 Name two databases management system related to environment in India.

Ans.5 Environment Information System (ENVIS) and National Science and Technology Management Information System (NSTMIS).

12.10 Lesson End Exercise, Exam oriented questions

Q.1 Write short notes on HIV/AIDS.

Q.2. Give five causes of drug addiction.

Q.3 What are nuclear hazards? Support with a case study.

Q.4 Give application of remote sensing and GIS in environmental management.

Q.5 Discuss role of information technology in health.

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12.13 MODEL TEST PAPER

1. Most teenagers with HIV become infected-
    a. From sharing needles and syringes or having sex with an HIV-infected partner.
    b. From blood transfusions.
    c. Through casual contact.
    d. Through piercing body parts and tattooing.
2. HIV may be spread from contaminated needles when-
    a. Piercing ears or other body parts.

b. Injecting steroids.

c. Injecting drugs.

d. All of the above.

3. One HIV prevention strategy is the use of a condom that is-

a. Latex

b. Natural

c. Organic

d. Animal Skin

4. People who are infected with HIV can infect others-

a. Only after they have had a positive HIV-antibody test result.

b. If they have symptoms of AIDS.

c. After they become infected, even if they look and feel healthy.

d. If they develop an opportunistic infection.

5. HIV can be spread through an infected person's-

a. Urine

b. Sweat

c. Blood

d. Tears

6. People who have AIDS get opportunistic infections because

a. When HIV enters the body, it mutates into the disease agents that cause infections.

b. The drugs used to treat HIV cause infections.

c. HIV weakens the immune system and makes it difficult to fight diseases.

d. All of the above.

7. A person is drug addicted if

a. He takes drugs

b. When he shows irresistible urge to take drug and increase the dose

c. When a person gets irritated and emotionally detached

d. None of the above

8. _____ is the common mind-altering substance used during adolescence

a. Cigarette

b. Mushrooms

c. Alcohol

d. Marijuana

9. Heat is generated in a nuclear reactor (thermal) by

a. fusion of atoms of uranium.

b. combustion of a nuclear fuel e.g. uranium

c. fission of U-235 by neutrons

d. absorption of neutrons in uranium atoms.

10. Which of the following is considered to be worst nuclear disaster?

a. Chernobyl disaster

b. Three mile island disaster

c. Cobalt 60 exposure in Delhi

d. All the above

11. Gamma-ray have

a. no mass and no electric charge

b. no mass and an electric charge of +1

c. no mass and an electric charge of +2

d. no mass and an electric charge of -1

12. An alpha particle consists of

a. One proton and two neutrons

b. two protons and one neutron

c. two protons and two neutrons

d. One proton and one neutron

13. The electronic record of patients within the primary care physician's office is known as

a. Electronic Patient Record (EPR)

b. Electronic Health Record (EHR)

c. Electronic Medical Record (EMR)

d. Personal Health Record (PHR)

14. An interdisciplinary field that develops methods and software tools for under `standing biological data is known as

a. Biotechnology

b. Biology

c. Botany

d. Bioinformatics

15. The first whole-body computerized tomography (CT/CAT) scanner was developed by

a. Robert Walsh

b. Robert Steven Ledley

c. Robert Smith

d. Robert Scout

16. GIS stands for

a. Geographic Information System

b. Generic Information System

c. Geological Information System

d. Geographic Information Sharing

17. DBMS stands for

a. Database Management System

b. Database Monitoring System

c. Database Manufacturing System

d. Database Mixing Station

18. Advanced Life Support Simulators (ACLS) are used in

a. to develop various clinical skills such as ECG interpretation

b. To give prescription

c. To scan the body

d. All the above

19. NSTMIS- database of Department of Science and Technology stands for

a. National Science and Technology Management Information System

b. National Science and technology mission in space

c. National Science and technology measuring information system

d. National Science and technology management in science

20. Environmental Information System (ENVIS) was started in the year

a. 1982

b. 1990

c. 1992

d. 1998

Answers:

1a	2d.	3a	4c	5c	6c	7b	8d	9a	10a
11a	12c	13c	14d	15b	16a	17a	18a	19a	20a

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