Unit – I Environment Studies

Environment

INTRODUCTION

The word environment is coined form the French word "Environ" meaning" surround or surroundings" i.e., each and everything surrounding us. **E.g.** Lion in a forest surrounded by living and non-living things like air, water, trees, other animals etc.

DEFINITIONS

1. Environment

Environment is defined as "the sum of total of all the living and the non-living things around us influencing one another." **E.g.** Lion in a jungle surrounded by living and non-living things like air, water, trees, other animals etc.

2. Environmental Science

The study of the environment, its biotic (living) and abiotic (non-living) components and their interrelationship is called environmental science. It includes the basic concepts of physics, chemistry, geography, geology etc., which is used in understanding the structure, function and physical characteristics of environment.

3. Environmental Engineering

Environmental engineering is the application of engineering principles, science, education, ethics and law in the protection and enhancement of the quality of environment, public health and welfare.

4. Environmental Studies

Environmental studies are the process of educating the people for preserving quality environment. It is the multidisciplinary studies of science, engineering, technology and management which shows the impact of human activities on the environment.

TYPES OF ENVIRONMENT

Environment is divided into 2 types:

1. Natural Environment: Natural environment consists of natural components including all biotic (biological) and abiotic (physical) components created through a natural process without any human support.
E.g. Soil, water, air, trees, radiations, noise etc.

2. Man- made environment: Man is most powerful agent who modifies the environment using modern technologies, according to his needs for survival and well-being.
E.g. Houses, parks, hospitals, schools, roads etc.

SCOPE OF ENVIRONMENTAL STUDIES

Environmental Studies is the tool for educating people to preserve environment. Main scope includes:

1. To get awareness and sensitivity of environment and its related problems.

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2. To motivate the active participation of individuals in the protection and improvement of environment.
3. To develop skills for identifying and solving environmental problems.
4. To know the necessity of conservation of natural resources.
5. To conduct environmental programmes in terms of social, economic, ecological and aesthetic factors.

IMPORTANCE/ SIGNIFICANCE/ NEED OF ENVIRONEMNTAL STUDIES

The air we breathe, water we drink, food we eat and the land we live are all polluted. There is no zero pollution.

To solve the above problems, knowledge of environment and its studies are very important.

1. To understand the concept of "need of development without destruction of environment".
2. To gain knowledge of different types of environment their various resources and the effects of different environmental hazards.
3. To inform people about their effective role in protecting the environment by demanding changes in laws and enforcement systems.
4. To develop a concern and respect for the environment.

NEED FOR PUBLIC AWARENESS

1. Necessity to maintain a natural balance, sensible planning of development in order to save humanity from extinction.
2. To check nominal use of natural resources as watch dogs informing government about the degradation of environment.
3. To educate and create awareness through mass media like tv, radio, short films, internet, mobile phones, etc.,
4. To motivate and active participation of individuals in protecting the environment from various types of pollution.

Multidisciplinary Nature of Environmental Studies

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Learning objectives

- *To develop a comprehensive understanding of the concept and scope of environment studies.*
- *To know about the immense importance of environment as a subject.*
- *To develop public awareness about our environment and elicit collective response for its protection.*
- *To gather information about organizations and people relentlessly working in this field.*
- *To know and analyse the types of environment and environmental components and how they affect our survival.*

1.1 Definition and Concept of Environment

fte word environment is derived from the French word *environ*, meaning external conditions or surroundings that favour the growth of flora and fauna, human beings and their properties and protect them from the effects of pollution.

According to Douglas and Holland (1947), environment is '*a word which describes, in the aggregate, all of the extrinsic (external) forces influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms*'.

'*Environment covers all the outside factors that have acted on the individual since he began life*'. (Woodworth and Marques, 1948)

Environment means the aggregate of a complex set of physical, geographical, biological, social, cultural and political conditions that surrounds an individual or organism and eventually determines its appearance as well as nature of its survival.

1.2 Types of Environment

Environment is practically everything that embraces an organism. Out of all the planets comprising the solar system, the only habitable planet to provide all the necessary conditions for existence of life is the Earth. fte physical and chemical environments however varies at places and provides unique conditions for living beings to adapt and survive.

On the basis of human interference, environment can be categorized as natural, semi-synthetic or artificial.

- A **natural environment** is inherent, unaltered and not manipulated by man. Life processes and evolution progresses are unhindered in such an environment. However, one does not oßen find such places in the present day. ft e core areas of the biosphere reserve are examples of natural ecosystems.
- A **semi-synthetic environment** is the natural environment that is modified partially by human intervention, namely development of lakes, aquaculture tanks and so on.
- An **artificial or man-made or synthetic environment** is when the natural environment is deliberately controlled and converted by mankind. For example, aquariums, cities, community parks, paddy fields or the tissue culture laboratories.

Kurt Lewin, a German-American psychologist, emphasized three types of environment that manipulate the persona of an individual.

- **Physical environment** refers to the physical space, the weather and climatic conditions that in2uence the organism. ft e physique and working effi ciency of an individual depends much on the climatic conditions. Short and sturdy build-ups are features of humans in cold climates; their reduced body surface area allows more heat to be retained. In hot regions, a thinner and long limbed structure allows more heat to be lost easily. Races such as Ethiopian or Negroids of Africa, the Caucasians of Europe, Western Asia, Australia and major part of America or Mongolians of East Indies, China, Japan, shows variation in skin colour owing to variation in the level of melanin synthesis. Lighter skin allows more penetration of UV rays to facilitate vitamin D synthesis whereas darker skin prevents the penetration of UV rays. ft e blacks having more dense bones, hence less buoyant but loose less than 1 percent of the bone mass annually after mid-thirties; Whites with less dense bones lose about 2.5 per cent of bone mass annually and is more prone to aging.
- **Social and cultural environment** is made up of moral values, cultural background and emotional drives that modify life and nature of an individual. ft is in turn is dependent on the social, economic and political conditions surrounding an individual.

  Man seems to be the most civilized and skillful of all the organisms. ftis contributes to a highly systemic social organization.
- **Psychological environment** is the physical, social and cultural environment that limits one's activities. ft is sets boundaries for the individual, triggering thought processes and changing behaviours of an individual.

1.3 Multidisciplinary Nature of Environmental Studies

Environmental studies cover every aspect that aRect a living organism, as it interacts with the surroundings in its quest to live. Environmental studies are integrative, but the core of the subject comprises biological sciences like zoology, botany,

microbiology and physiology. Many environmental concerns can be resolved through application of biotechnology and molecular biology, while bioinformatics can serve as a database at molecular level. Environmental studies is therefore multidisciplinary and aims at unraveling the ways in which human beings and nature correlate, sustaining life and man's unquenchable thirst for development with limited and finite resources.

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Physics, chemistry, biology, anthropology, geology, engineering, archaeology, sociology, economics, statistics, political science, law, anthropology, management, technology and health sciences are all its components. Among these physics, chemistry, geography, geology and atmospheric science help us understand the basic concepts of structural and functional organization, as well as the physical characteristics of our environment.

Data simulation and interpretation needs the application of statistics and computer application, while mathematical science is oßen used in environmental modeling. ft e technical solutions for pollution management, waste management, green building and green energy can be found with expertise from the fields of engineering and architecture. ft e achievement of sustainability at all levels is interwoven with and dependant on international cooperation which in turn rests on international relations. Principles of sustainable development determine the draßs and negotiation of international accords and security issues. International cooperation is an indispensible factor in dealing with global environmental issues like climate change, trans-boundary pollution, trade in hazardous substances, ozone layer depletion, biodiversity loss, etc. Economics enables us to gain a bener understanding of the social background needed to achieve growth and development.

Keeping all these in mind, management studies will enable us to formulate policies, followed by legislation for their implementation. ft e study and treatment of environment is very much connected with philosophy, ethics and cultural traditions that help us achieve our goal sustainably. ft e air that we breathe, the water that sustains our lives, the food that gives us energy, the towns and the cities that we live in, in fact everything around us constitute the environment. It is the sum total of all life support systems.

ft e elements that constitute the environment have been revered and worshipped by our ancestors. Our forefathers, in almost all the major civilization around the world, understood the fragile nature of the environmental system. ft ey also discovered the need to lead a lifestyle that was in sync with the environment. It was this basic understanding, profound as it may sound now, led to their worshipping of nature in its various forms.

Box 1.1: Multidisciplinary nature of environmental studies

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Life sciences
Zoology, Botany, Physiology, Biochemistry, Microbiology, Biotechnology, etc.

Basic and applied studies

Mathematics, Computer

Environme

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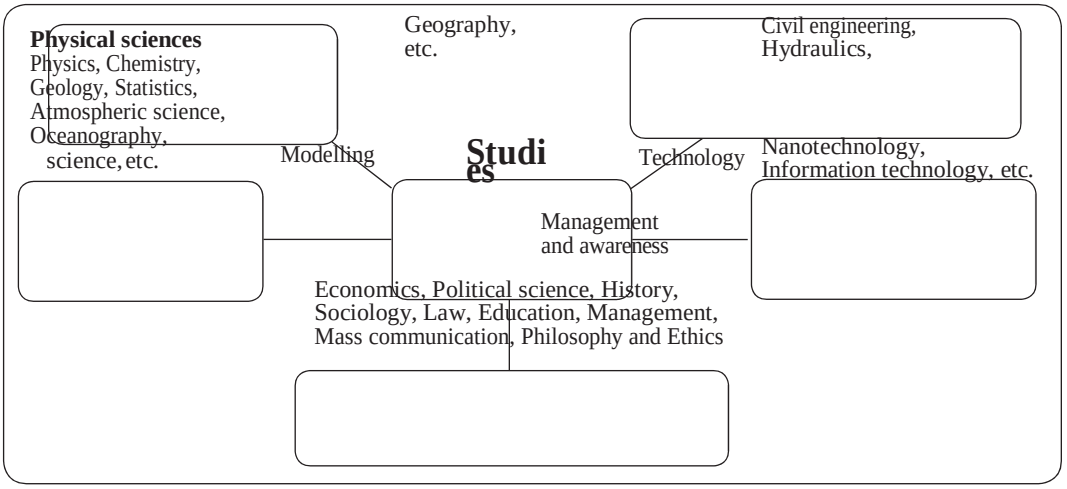
Physical sciences
Physics, Chemistry, Geology, Statistics, Atmospheric science, Oceanography, science, etc.
Geography, etc.
Civil engineering, Hydraulics,
Modelling
Studies
Technology
Nanotechnology, Information technology, etc.
Management and awareness
Economics, Political science, History, Sociology, Law, Education, Management, Mass communication, Philosophy and Ethics

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However, the industrial revolution beginning in 1760 introduced a paradigm shiß in man's interaction with the environment. Rapid industrialization needed huge amounts of resources to feed the wheels of progress. Europe and then America rode the tidal wave of economic development, discarding the frugal and stoic ways of our forefathers and speeding towards hedonistic lifestyles based heavily on a culture of consumption.

Dams were built that harnessed river water to generate electricity and provide water for agriculture. Traditional farming methods were replaced by ones that depended on massive infusion of chemicals in the form of fertilizers and pesticides. Agricultural production boomed, but entire riverine systems were destroyed irretrievably and ecosystems were devastated.

Factories needed to go full thronle to match the increasing demands, as a result nature's womb was pillaged – fossil fuels were extracted and burnt to power the surge of progress. However, in doing so, humans not only pushed the availability of resources towards exhaustion, but also sacrificed myriad life forms by forcing them towards untimely extinction.

A growing population and rapidly incremental demand needed more and more. ft is need led to the destruction of Earth's forest-cover, which in turn led to the loss of habitats for organisms that lived in these forests. Finally, it also added to the process of climate change and global warming.

1.4 Scope of Environmental Studies

ft e last two and a half centuries were most important since the beginning of history in terms of human development. In an all round anempt to control and exploit nature and its services, man has literally whacked up everything in the name of development. However, in doing so we set into motion complex changes that are changing the vary basics of nature and are promising to unleash furies the kind of which have not been witnessed before.

ft e scope of Environmental Studies is not only limited to studying mere concepts, philosophy, ethics, components and the problems associated with resource depletion, pollution and population explosion, but also to find out a practical global solution in the form of raising public awareness – a heart to feel the immediate need for environmental protection leading to increased participation at all levels and a mind to develop scientific and eRective management strategies and solution to all the problems we are currently facing.

Acceptance of human error and the need for immediate steps to reverse the trends, in this context, is a relatively new concept. ft at the resources of the world are finite, that Mother Earth has enough for all of us, but not enough for our greed, too are concepts from the

Expertise in the field of environmental science can be placed as:

- Environment consultant
- Toxicologist
- Environment manager
- Environmental engineer
- Conservation offi cer
- Waste management offi cer
- Scientist in water and air quality

other side of the industrial revolution that are gradually regaining ground. And in their wake, the need to lead environmentally responsible and sustainable lifestyles is gaining currency.

Box 1.2: Scope of environmental studies

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1.4.1 Few applications

1.4.1.1 Green marketing

fte term 'green marketing' signifies an all-inclusive marketing notion in which the manufacturing, marketing, consumption and disposal of goods and services take place in a manner that is less detrimental to the environment with increasing awareness and realization about the bearings of global warming, non-biodegradable solid leftover, dangerous impact of pollutants etc. ftis transference to 'green' sounds costly in the short run; but ultimately in the long term it shall certainly prove to be obligatory, valuable and cost eRective. ft e concept of green marketing received importance in the late 1980s and1990s after the first workshop was organized in Austin, Texas in 1975 on the concept of 'ecological marketing'.

According to Peattie (2001) director, BRASS Research Center, Cardiff, UK, green marketing has three segments of growth.

- **'Ecological' green marketing** whereby all marketing activities were centered on removal of environment glitches and to put forward explanation for ecological
- apprehensions. **'Environmental' green marketing** whereby importance is given to clean technology which will address the issues of pollution
- and waste. **'Sustainable' green marketing** which gained importance in the late 1990s and early 2000 lays stress on sustainability.

Box 1.3: Characteristics of green products

- Products which are originally grown.
- Products which are recyclable, reusable and biodegradable.
- Products constituted with natural components.
- Products comprising recycled and non-toxic chemical substances.
- Products containing permined chemicals.
- Products that will not contaminate the environment.
- Products that are tested on animals.
- Products that are packaged in an eco-friendly way i.e., with reusable and refillable containers etc.

Examples of green marketing in India: case studies

Case Study 1.1: State Bank of India (SBI)

fte SBI is currently utilizing eco-friendly and energy-friendly tools in almost 10,000 new automated teller machines (ATMs). ft is enables SBI to save on power costs and earn carbon credits towards commitment of reducing its carbon footprint. SBI has also launched 'Green Channel Counter' towards green service. It emphasizes on banking

without use of paper which means banking withoutanydepositorwithdrawalslip, cheques or money dealing forms. All these dealings can be completed through SBI shopping and ATM cards. In addition to this, the SBI is the first in India to employ a wind farm of 15 MW capacity that has been developed by Suzlon for the generation of power.

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1.4.1.2 Environmental management system and ISO14000

ft e ISO 14000 series provides the requirements and addresses various aspects of environmental management system. It is one of more than 15,000 voluntary International Standards published by the International Organization for Standardizations (ISO). It provides organizations with practical tools, particularly those looking forward to identify and control their environmental impact, and constantly improve their environmental performance.

ISO 1400 has the following

- benefits: low raw material use;
- reduced energy
- expenditure; enhanced process efficiency;
- decreased waste generation and disposal costs;
- and use of recoverable resources.

ISO 14000 standards series

- ISO 14001: Specifies the actual requirements for an environmental management system.
- ISO 14004: General guidelines on principles and on the development and implementation. of environmental management systems and also their co-ordination with other management systems.
- ISO 14010, 14011 and 14012: Guidelines for environmental auditing.
- ISO 14020, 14021, and 14024: Environmental labeling and
- declarations. ISO 14031 and 14032: Environmental Performance
- Evaluation (EPE). ISO 14040, 14041, 14042, and 14043: Life Cycle Assessment (LCA).
- ISO 14050: Terms and definitions.
- ISO/TR 14061: Information to assist forestry organizations in the use of environmental management system standards.
- ISO 14062: Discusses making improvements to environmental impact
- goals. ISO 14063: Environmental communication – guidelines and examples.
- ISO 14064: Measuring, quantifying, and reducing greenhouse gas emissions (GHGs).
- ISO 19011: Specifies one

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audit protocol for both 14000 and 9000 series standards together.

1.4.1.3 Eco-mark scheme in India

In order to boost customer consciousness or awareness, the Indian government have launched the eco-labeling plan known as 'Eco-mark' in 1991 to facilitate simple recognition of eco-friendly goods.

Figure 1.1: Eco mark logo in India

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ftese standards follow a cradle-to-grave approach, i.e. starting from the extraction of raw materials to production and finally up to disposal. An earthen pot is the logo of Eco-mark scheme in India.

1.5 Components of Environment

ft e components of environment are atmosphere, hydrosphere, lithosphere and biosphere.

1.5.1 Structure of atmosphere

fte layer of air surrounding the Earth is the atmosphere. fte atmospheric mass is about 5×10^{18} kg, 75 per cent of which is limited within about 10 km. fte atmosphere thins out with increasing altitude, with no distinct boundaries. ft e Karman line at 100 km is oßen used as the partition between the atmosphere and outer space. Several layers can be distinguished in the atmosphere, based on composition and temperature variation. Atmospheric science or aerology is the study of Earth's atmosphere and its processes.

Starting from the ground level is the troposphere that varies between 8 and 12 km in thickness. It is thin at the poles (8 km) and thicker at the equator (18 km). Typically air is composed of nitrogen (78.08 per cent), oxygen (20.95 per cent), argon (0.93 per cent), carbon dioxide(0.031 per cent) along with water vapour, neon, helium, krypton, xenon, hydrogen, methane, nitrogen monoxide, ozone, etc. Warm air, being lighter near the surface of the Earth can readily rise above. ft e molecules can travel to and fro in the troposphere in just a few days. Such vertical movement or convection of air produces clouds and rain and gives rise to most of the weather conditions. Temperature decreases with increase in altitude in the troposphere till people reach the topmost layer or tropopause. Temperature decreases at a rate of 6.5°C for every 1 km and this is known as **environmental lapse rate**. Tropopause may reach a temperature of –55°C at the poles. Sometimes the temperature increases with altitude in the troposphere, giving rise to a situation called **temperature inversion**. Such conditions restrict the vertical mixing of air and result in air pollution incidences at ground level.

fte second layer or stratopause extends from tropopause to about 50 km till stratopause. fte region is clear and dry with strong and steady winds. Owing to non-turbulence, presence of steady horizontal winds and being located above stormy weather, jet planes route through stratosphere. Temperature is relatively constant up to 25 km and then increases as one goes up the stratosphere. Top of the stratosphere may attain temperatures close to 0°C. Ozone layer is mostly concentrated between 20–30 km. fte ozone absorbs the UV (Ultraviolet) B radiation in the wavelength of 290– 320 nm. Since ozone is present in this layer it is also called ozonosphere.

Mesosphere lying above the stratosphere extends from above 50 km to about 80 km. It

contains almost 0.1 per cent of the atmospheric mass and is rarified. Mesosphere is highly turbulent and experience waves. ft e excited atoms here absorb a great deal of solar radiation, even then temperature drops to about -100 to -90°C at mesopause. Water vapor freezes into ice clouds which can be seen after sunset if hit by sunlight. ftey are called Noctilucent Clouds (NLC). ftis is the

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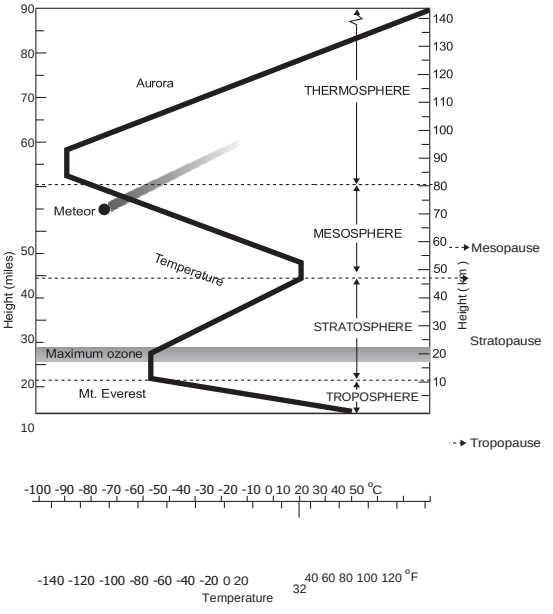
stratum in which many meteors burn up while entering the Earth's atmosphere and are perceived as shooting stars from the Earth's surface.

ft e topmost layer from mesopause is the thermosphere. Temperature increases with increasing altitude and can be more than 1500°C. ft is is due to the absorption of the UV radiation and X rays by the few molecules present there. Nitrogen and oxygen are found mainly in between 100 to 200 km. fte part of the thermosphere (80 km to 500 km) above the Earth's surface is referred to as ionosphere. ft e atoms exist as ions and hence this layer gets its name. Space Shunles, the Hubble Telescope and many Earth observing satellites are stationed in this region. fte ionization process leads to the creation of beautiful illumination; the Aurora Borealis in the northern hemisphere and Aurora Australis in the southern hemisphere. Auroras are usually observable from within the Arctic or Antarctic circles. ft e free electrons present in the ionosphere cause the high frequency waves to be refracted and ultimately re2ected back to earth. ft e more the density of the electrons, the higher will be the frequencies that can be re2ected. During daytime four regions (D from 50–90 kms, E from 90 to 140 kms, F1 from 140–210 kms and F2 above 210 kms) exist. Sometimes F1 and F2 might merge to form F region. During night time D, E and F1 regions become depleted of free electrons leaving only F2 region available for communications. Hence F2 region is the most important for high frequency radio wave propagation as it allows longest communication pathways on account of its highest altitude and that the lifetime of the free electrons is greatest in this region. fte outer most layer above 500 km to about 10,000 km is the exosphere which gradually merges into space. Molecules here have enough kinetic energy to escape the Earth's gravity. Hydrogen and helium are the prime components in this region. fte region between 5,000 km to >> 60,000 km is also referred to as magnetosphere as it is strongly in2uenced by the Earth's magnetic field and the solar wind. ft is region is occupied by Geosynchronous satellites and

Figure 1.2: ft ermal stratification of atmosphere



comprises the Van Allen radiation.

ft e atmosphere is a protective blanket of gases, surrounding the Earth that helps in sustaining life on the Earth. It protects us from the hostile environment of outer space, absorbing most of the cosmic rays and harmful UV radiation. It transmits the visible, near infrared radiation (300 to 2,500 nm), part of UV radiation (mainly UV A) and radio waves.

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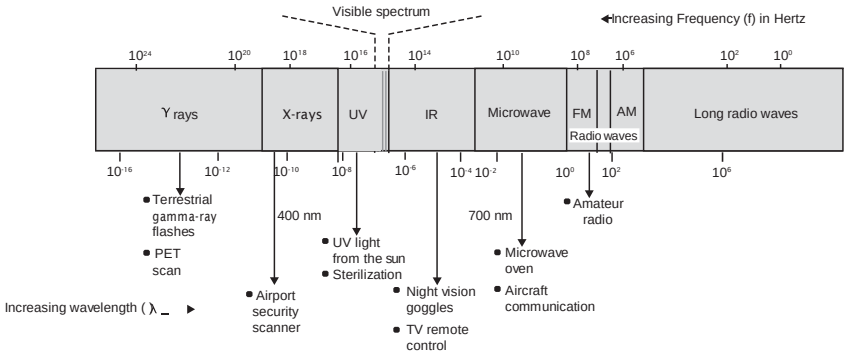
Figure 1.3: Human application of the solar spectrum



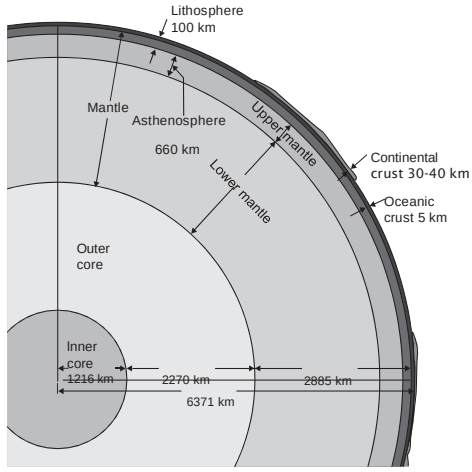
1.5.2 Structure of lithosphere

fte diameter of Earth is about 12,700 km. fte temperature and pressure increases as one penetrates deeper and deeper. fte core temperature is assumed to be 5000–6000°K.

Earth comprises three concentric regions:

- ft e **core** of approximately 7,000 km diameter is divided into inner core and outer core. ft e solid inner core has a radius of 1,216 km and density of 13 grams/cc. ft e liquid outer core has an average thickness of 2,270 km and density of 11 grams/cc. ft e core is supposed to be composed of an iron and nickel alloy. About 10 per cent of the layer is supposed to be composed of sulphur and oxygen as these elements are abundant in the cosmos and dissolve readily in molten iron.
- ft e middle layer is the **mantle** which is about 2,900 km thick. fte upper mantle of 660– 670 km thickness from the base of the crust, mostly contain olivine and pyroxene minerals.

Figure 1.4: A sketch to show the internal structure of the Earth



fte asthenosphere, lying at a depth of 100–200 km from the Earth's surface, is a weak and deformed layer, which acts as a lubricant for the plate tectonics to glide and may extend up to 660 km. fte lower mantle stretches from 670 km to 2,900 km

below the Earth's surface. ft e lower mantle probably comprises silicon, magnesium and oxygen along with some iron, calcium and aluminium.

- ft e outer most part of Earth is the **crust**. Outer crust or continental crust may be 30 to 40 km in thickness containing mostly granite rocks with a density of 2.7grams/cc. fte predominant elements are silicon and aluminium, hence is known as Sial layer. ft e inner crust or oceanic

crust is only 5 to 10 km thick containing basaltic rocks with an average density of 3.0 grams/ cc. ft is layer contains silicon and magnesium and hence is known as Sima layer. Six major plates (Eurasian, American, African, Indo-Australian and Pacific) and twenty minor plates are involved in plate tectonics.

Lithosphere is a 100 km thick layer comprising the crust and the upper part of asthenosphere that can glide over the rest of the mantle. ftis is the region of earthquakes, volcanic eruptions, building of mountains and continental drifts. It exhibits various topographical features like continents, oceans, seas, lakes, mountains, plateau, plains, deltas, beaches, cliffs and dunes. It comprises rocks (igneous, sedimentary and metamorphic rocks) that contain all the minerals (dolomite, magnetite, hematite, etc.) and elements (iron, nickel, nitrogen, hydrogen, oxygen, sulphur, phosphorus, etc.) needed for our survival and prosperity. fte rocks turn into soil by pedogenesis, which sustains the biota. A tabular representation about earth's interior is uploaded on the website.

1.5.3 Structure of hydrosphere

Water is found in hydrosphere, lithosphere and atmosphere and in almost everything including our body cells. It is an oxide of hydrogen and serves as one of the source to hydrogen and oxygen in metabolism. Its physical and chemical properties make it unique. It is present as water vapour in the atmosphere which takes part in the formation of clouds and fogs thus regulating our weather conditions. In the soil, water is usually present in form of gravitational water, capillary water, hygroscopic water and as combined water. ft e water that percolates down under gravitational force until it reaches the saturated zone is the gravitational water. fte part lying above this saturated zone is water table. Such water is used when it comes out naturally as spring or by digging of wells. ft e water retained in the soil against the gravitational pull around the soil particles is capillary water. Capillary water is apprehended by cohesion (anraction between the water molecules to each other) and adhesion (attraction of water molecule with the soil particle). Water remaining in the soil after drying of capillary water is known as hygroscopic water which is lost when the soil is subjected to a temperature of 105°C. Water forms very thin film around soil particles and are not available to the plant. Aßer hygroscopic water is lost, all that remains is known as is combined water. Both combined and hygroscopic water is of no use to plants.

Most of the water found on Earth is marine. ft e oceans and seas contain more than 97 per cent of the hydrosphere. Ice caps and glaciers comprise a slightly more than 2 per cent of all water on Earth. fte groundwater and soil water makes up about 0.63 per cent and 0.005 per cent of freshwater, respectively. Soil water refers to the water arrested in spaces amid soil particles. Of the total water on Earth, freshwater streams, rivers, ponds, lakes, and inlands seas comprise less than 0.03 per cent. ft e water content of the atmosphere is about 0.0001 per cent.

DISASTER

MANAGEMENT;

FLOOD:

Submergence of waste areas of land under water for many days in continuation Causes:

1.Heavy rainfall

2. Sudden Snow melt

3. Clearing of forest for agriculture

4, Industries increase the value and rate of water discharge after a storm Effects:

1. Damage to building and property
2. Soil erosion is the major loss of agriculture
3. Any product submerged by flood water cannot be rescued

Control measures:

1. Building wall prevent spilling out the flood water over flood pains
2. advance meteorological information will prevent flood damage
3. reduction of run off by increasing infiltration through appropriate forestation eg.flood in Bangladesh 1974

EARTHQUAKE:

Earthquake is the motion of the ground surface caused by wave motion starting from a focal point

Causes:

1. Underground nuclear testing
2. Volcanic eruption
3. Pressure of manmade dams, reservoir and lakes
4. movements of plates of earth

Effects:

1. Cause Tsunami
2. Deformation of ground surface
3. In hilly and mountain areas may cause land slides which damage the settlement and transport system
4. Depending on the severity of the quake collapses house and people died in 1000 eg. Earthquake in Bhuj town

Control measures:

1. Government can inform the earthquake prone zone and caution residence
2. building should be designed to withstand tremors

CYCLONE:

Cyclone is meteorological phenomena intense depressions forming over the open oceans and moving towards the land

Effects:

1. Depends on the intensity of the cyclone
2. Damage to human life crops roads, transport, communication could be very heavy

Control measures:

1. planting more trees on hostel areas
2. construction of dams
3. Radar system is used to detect cyclone eg.Cyclone in AP

LANDSLIDES;

The movement of eart materials like coherent rock, mud, soil and debris from higher region to lower due to gravitational pull is called landslide

Causes:

1. Earthquake, shock, vibration
2. Deep water ground mining
3. movement of heavy vehicles on the unstable sleepy region

Effects:

1. Increase erosion of soil
2. block the roads
3. damage the houses, crop yield, life stock

Control measures:

1. Planting of deep rooted vegetation
2. Encouragement for construction of bridges water ways
3. Create national parks, sanctuaries biosphere.e.g.land slides in U.P

UNIT 3:NATURAL RESOURCES

Any component of the env. Which has intrinsic value of its own is called as resource. Any component which can be transferred in a way such that it becomes more valuable and useful is termed as resource.

Resources

Renewable Eg. Clean air, clean water	Non renewable Ground water, minerals	Continuous Solar energy, wind energy	Extrinsic Human skills
Considered to be renewable with considerable life span-as long as they have the capacity to renew – unless they are affected by catastrophes or anthrophogenic activity.	Available only in finite quantity – their rate of renewal is so slow that they are considered as non-renewable	Considered to be available always.	

FOREST RESOURCES:

Forests are one of the most important resources of the world. Apart from having high commercial importance they provide high environmental services also. They act as a blanket on the surface of the earth.

Around $1/3^{rd}$ of world land area was found to be forests. $1/5^{th}$ of world forests were found in Brazil and 6-7% was in Canada and USA. But the matter under high concern is the declination of forest cover year by year.

USES OF FOREST:

Commercial uses: Forests provide timber, fire wood, food material, resin, gum, non edible oils, drugs, medicine, rubber, fibers, bamboo and many other important items.

Ecological uses:

1. Production of Oxygen: Photosynthesis – earth‟s lungs
2. Reducing global warming – sink for carbon di oxide
3. Wild life habitat – 7 million species in tropical forests alone
4. Regulation of hydrological cycle – prevent surface run off – giant sponges – 50-80% moisture

5. Soil conservation – hold solid particles tightly and prevent soil erosion – wind breaks
6. Pollution moderators: absorb toxic gases and purify air reduce noise pollution

OVER EXPLOITATION OF FORESTS:

Human beings depend heavily on forests for food, shelter, wood, fuel and medicine with growing civilization etc. shooted up resulting in large scale mining, road building and clearing of forests.

Excessive use of charcoal, fuel wood, expansion of urban, agricultural and industrial areas and overgrazing have lead to over exploitation and rapid degradation of forests.

DEFORESTATION:

The total forest area of the world in 1900 was 7000 million hectares -1975 – 2900 mha – 2000 – 2300 mha.

Deforestation rate intemperate countries are relatively moderate. But it is alarming in tropical countries. It is estimated that in next 60 years we would lose more than 90% of our tropical forest.

INDIAN STATUS:

Stabilized since 1982, with about 0.04% declaration per year between 1982 - 90. During this period it is estimated that about 1.44 mha land was brought under afforestation. As per our NFP, we have a target of achieving 33% forest area. But we still have only 19.27% of our land area covered by forests(satellite data).

MAJOR CAUSES OF DEFORESTATION:

1. Shifting of Cultivation – 300 million people – 5 lakh hectares of forest for slash and burn culture
2. fuel requirement
3. raw materials for industrial use
4. developmental projects
5. growing food needs
6. overgrazing

CONSEQUENCES OF DEFORESTATION

1. threatens many wild life species due to destruction of natural habitat
2. biodiversity is lost along with that genetic diversity
3. hilly regions are made prone to landslides
4. soil erosion and loss of soil fertility
5. hydrological cycle is affected

(loss of rainfall, flood, drought etc)

TIMBER EXTRACTION AND MINING:

The major activities in forest area are 1. timber extraction 2. mining

The important effects of timber extraction are

i) thinning of forests
ii) loss of biodiversity, particularly tree breading species
iii) soil erosion and loss of soil fertility
iv) migration of tribal people from one place to another in search of new forest
v) extinction of tribal people and their culture

MINING:

Mining is a process of removing ores from area which is very much below the ground level. Mining is done for the extraction of several minerals of metals like Fe, Mn, Au, Ag,etc. The minerals are especially found in thick forests.

Mining can be carried out in two ways

1. Surface mining
2. underground mining or sub-surface mining

The effects of under ground mining on forest reserves is comparatively less than that of surface mining

Relation between forest and climate change:

Forests both influence and influenced by climate change. They play an important role in the carbon cycle and the way we manage forests could significantly affect global warming.

Forests hold more than 50 per cent of the carbon that is stored in terrestrial vegetation and soil organic matter. Hence, deforestation contributes significantly to net emissions of carbon dioxide into the atm.

If the predicted global warming occurs, the impact on forests is likely to be regionally varied, dramatic, and long-lasting. Even now, we can see how any extreme weather has great impact on forests. For example, the 1999 storms in Europe caused heavy damage to forests and also to trees outside forest areas.

The Kyoto Protocol on climate change may have a great impact on forest management. Under the Protocol, a country with forests earns emission credits, since its forests absorb carbon dioxide. These credits are tradable, that is, a developing country can sell its credits to an industrialized country that has exceeded its quota of emissions. The latter would invest in afforestation and reforestation projects in the developing country.

DAMS – BENEFITS AND PROBLEMS

River valley projects with big dams are considered to play a key role in the development of a country. India has large number of river valley projects

1. These dams are regarded as symbol of national development.
2. provides large scale employment of tribal people and increase the std. of living of them
3. contribute for economic uplift and growth
4. help in checking flood
5. generate electricity
6. reduce power and water shortage
7. provide irrigation water
8. provide drinking water to remote areas
9. promote navigation and fishery.

Environmental problems:

The environmental problems can be at upstream as well as downstream

Level

Upstream problems

1. Displacement of tribal people
2. Loss of flora and fauna
3. siltation and sedimentation near reservoir
4. stagnation and water logging near reservoir
5. growth of aquatic weeds
6. micro climatic changes
7. RIS causes earthquakes
8. breeding of disease vectors

Downstream problems

1. Water logging and salinity due to over irrigation
2. micro climatic changes
3. salt water intrusion at river mouth
4. loss of fertility due to sediment deposits
5. out break of vector born diseases.

WATER RESOURCES

Water is an indispensible resource. Around 97% of world surface is covered with water. Most of the animals and plants have 60-65% of water in their body.

Unique features of water

1. High specific heat
2. High latent heat of vapourisation
3. Good solvent for oxygen, nutrients and pollutants
4. Anomalous expansion on freezing
5. High surface tension

Global distribution of water is very much random depending on the geographical conditions. The availability of water decreases in the following order.

1. Tropical rain forest
2. Temperate regions
3. Deserts

Water is used for domestic, irrigation and also industrial purposes

Out of the total available water 75% is used for agriculture, 20% for industrial usage. In our country ~93% of water is used for agricultural purposes.

Ground water:

9.86% of fresh water is ground water and it is 35-50% greater than surface water.

Aquifer: The layer of soil which is permeable has the ability to store water is called an aquifer. It is generally made up of gravel, sand etc.

Unconfined aquifer: it is covered by permeable layer. The recharge of this layer is by rainfall or snowmelt.

Confined aquifer: sandwiched between impermeable layers. The recharge is through unconfined aquifer layers.

Over utilization of ground water:

Over utilization of water leads to rapid depletion of water resources, ground subsidence, lowering of water table and water logging.

Effects of over utilization of ground water:

Reasons: Economic development, rapid industrial growth and population explosion

The use of ground water and surface water rates which are higher than that of recharge ultimately leads to

- Water scarcity
- Water logging
- Salination
- alkalization

- water pollution or contamination

  - creates declining of water levels
  - crops failure and reduction in agricultural production
  - over pumping of ground water create drought, famine and food shortage
  - over pumping of ground water sea water intrusion in coastal aquifers
  - land subsidence may due to over pumping of ground water
    - river pollution due to industrial activities and dumping of waste into rivers, which in turn force to utilize the ground water, ultimately leads to over pumping

Clean water is universal right. It is the responsibility of everyone to ensure the purity of water. Water is a valuable commodity and it has to be conserved.

Surface water:

When evaporation and transpiration rates are lower than the rainfall, surface water body like lake, river, pond, streams etc. are formed.

Flood: over flow of water, whenever the water in flow is greater than the carrying capacity of the channels flood occurs.

Causes:

1. heavy rainfall, snow melt, sudden release of water from dams.
2. Prolonged down pour leading to overflowing of rivers and lakes
3. Reduction in carrying capacity due to obstructions or sediments etc.
4. Deforestation, overgrazing, mining increases water run off
5. Removal of dense forests from hilly regions

Effects:

1. Submerges the flooded area
2. Loss of soil fertility due to soil erosion
3. Extinction of civilization at costal area

Flood management:

1. Dams and reservoirs can be constructed
2. Embankments and proper channel management
3. Flood way should not be encroached
4. Forecasting or flood warning
5. Decrease of run off by infiltration through afforestation or rain water harvesting etc.

Drought :

Unpredictable delay in climatic condition occurring due to monsoon rain failure.

Types:

Meterological : in order of month or year, actual moisture supply at a given place consistently falls below critical level.

Hydrological: deficiency in surface and subsurface water supplies

Agricultural: inadequate soil moisture to meet the need of a particular crop at particular time or

susceptibility of crops during different stages in its development

Socioeconomic: reduction in the availability of food and social securing of people

Causes:

- Deforestation and lesser rainfalls coupled with cutting of trees for timber leads to desertifictation.
- Over drafting of ground water, subsidence of soil, drying of wetlands
- Pollution of soil with solid waste, industrial effluents etc makes land useless and dry
- Population explosion in man and livestock leads to enhanced requirement of timber, fuel wood, grazing
- Shifting cultivation

Effects:

- Increase of water in stream pond
- Ground water table get declined
- Loss of agricultural crops
- Loss of biodiversity
- Government spent a lot of money as drought relief f und

Control measures

- Rain water harvesting
- Watershed management
- Prevent deforestation
- Encourage afforestation

CONFLICTS OVER WATER

Due to increase in population and decrease in water resources conflicts over water starts Conflicts over the water around world was classified as

- Control of water resources
- Military food resources
- Political resources
- Terrorism
- Military targets
- Development disputes

Causes:

- Conflicts through use 1. Shipping traffic in international water .2 dam construction
- Construction of power stations on
- Conflicts through pollution-rhine river,Europe
- Distributional conflict-relative storage
- Euphrates, Nile, Ganges - plataneous in upper basin, reduced in lower basin due to extensive use.
- Anatolian dam project by turkey Farakka dam in India

  Distributional conflict: Absolute shortage. Colorada and Rio Grande, Jordan

Conflicts management:

- Enact laws to check practices to control water pollution
- Sharing river solved by interlinking river
- Power must be given to national water authority and river basin authority and river s-basin authority for equitable distribution of basin water-demand fo0r nationalization of water needs

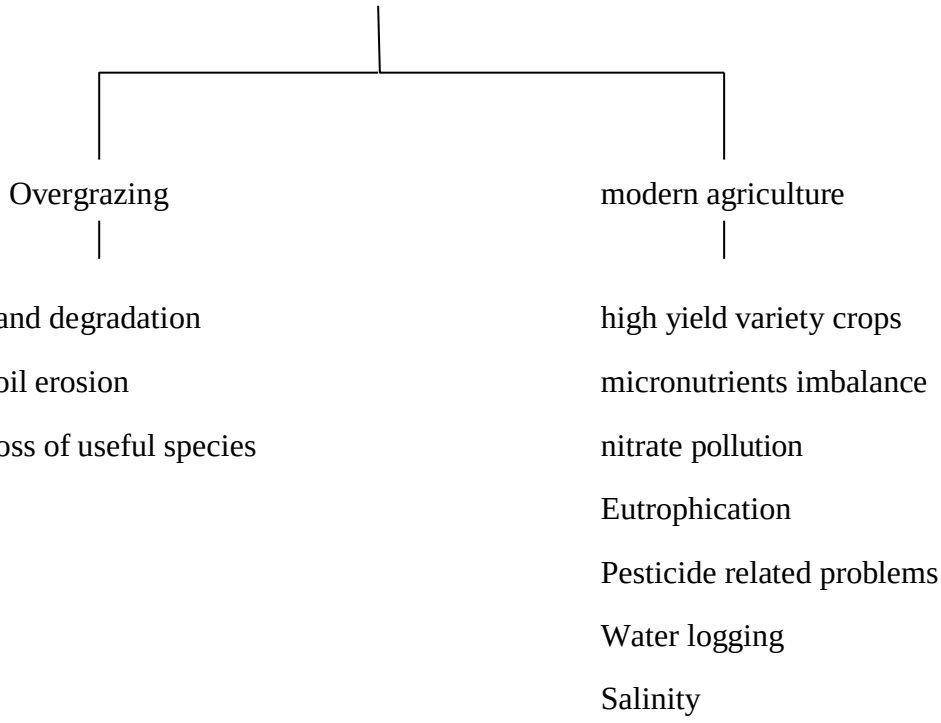
MINERAL RESOURCES

- ✓ Environmental impacts of over extraction of mineral resources:
  - Depending on the conditions of terrain and depth of ore deposits 2 types of mining operations are carried out. 1. open cast mining and 2. underground mining. In both types each steps in mining processing produce several environmental effects such as,
  - Deforestation takes place due to removal of vegetal covers.
  - Great volume of debris has been generated which disrupt the surface and ground water circulation. It also reduces the water carrying capacity of streams very close to mining area
  - The stacking of over burden and building of soil banks creates problems of landslides
  - Under ground fire in coalmines is a hazard that is difficult to control
  - Mining and ore processing normally causes air pollution and water pollution
  - The acid water generated in coalmines can pose a serious problem of water pollution, which adversely affects the flora and fauna.
  - Deeper excavation of ground causes lowering of water table, which leads to drying of wells or sea water intrusion
  - In stone quarries, blasting of rocks not only annoying the people nearby, but also cause hazard from fly rocks and dusts and damage to buildings due to vibrations

The disposal of waste material produced after concentrations of ore create increase concentration of heavy metals and toxic elements in the environment.

FOOD RESOURCES:

PROBLEMS FACED BY FOOD RESOURCES



WORLD FOOD PROBLEMS:

- Problems mainly under nutrition and malnutrition
- Natural calamities:-famine, drought, earthquake, flood, gale, storm
- Disease and medical facilities
- Pest damage:-insects, bacteria, viruses, parasites consume 60% of world‟s food production
- Hunger
- Population explosion in rural areas
- Environmental pollution
- Lack of water for irrigation
- Less rainfall due to deforestation
- Livestock overgrazing
- Overfishing

CHANGES CAUSED BY OVERGRAZING AND AGRICULTURE:

Overgrazing:

Process of eating away the vegetation along with its roots without giving a chance to regenerate

- Land degradation-leads to organically poor, dry, compacted soil cannot be used for further cultivation
- Soil erosion-cover of vegetation gets removed from soil
- Loss of useful species-good quality grasses and herbs with high nutritive value, when grazed lose even the root stocks which carry the reserve food for regeneration get destroyed which gives raise to secondary species like parthenium, Lantane, Xanthium etc
- To prevent –match the forage supplement to the herd‟s requirement.eg.Switch grass

Modern agriculture:

The practice through which specific plant species are cared and managed so as to obtain maximum yield of consumable parts of plants –agriculture

Makes use of hybrid seeds and selected and single crop variety, high tech equipment and lots of energy subsides in the form of fertilizers, pesticides and irrigation water e.g. green revolution

- Damage to soil
- Water contamination
- Water scarcity
- Global climate change
- Water logging-results when soil is over irrigated
- Soil salinity-increase plant productivity, interferes with water uptake by plants
- Fossil fuels and pesticides produce air pollution

Impacts related to high yielding varieties:

- Monoculture ie the same genotype is grown over vast areas. Disease spread easily

- Micronutrient imbalance e.g Zinc deficiency-affect soil productivity

- Nitrate pollution-nitrogenous fertilizers applied deep soil contaminates ground water. cause blue baby syndrome methaemoglobinemia- affects infants
- Eutrophication: Over nourishment of lakes due to agriculture field wash out-leads to algal bloom-dead organic matters increases due to decomposition-leads to oxygen demand

Problems associated with pesticide use:

- Evolution of genetic resistance
- Imbalance in ecosystem
- Creation of new pest
- Persistence, Bioaccumulation and Biomagnification
- Mobility through soil, water, air, washed away into rivers, streams, when it rains can harm fishes
- Creating super pest
- Death of non starget organisms
- Salinity
- Water logging

Water logging / salinisation:

Saturation of soil with irrigation water or excessive precipitation. So that water table rises close to surface.

Water logging results when soils are over irrigated without drainage. Occurs in clayey soil, soil root zone becomes saturated with so much water blocking oxygen supply for growth and soil becomes unsuitable. Carbondioxide and ethylene accumulate around roots and affects plants

ENERGY RESOURCES

Growing energy needs:

Population explosion, Luxurious life, Industries, Agriculture, mining, transportation, lighting, cooling, heating, building all need energy. Fossil fuels like coal, oil, natural gas produce 95% of energy

Sources of energy

Primary-

Renewable energy-resources which can be generated continuously in nature and are in exhaustible and can be used again endlessly.wood, Tidal, Solar, wind, hydropower, biomass, biofuel, geothermal, hydrogen

Non – renewable energy- Resources which have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted.coal, petroleum, natural gas

Secondary-petrol, electrical energy, coal burning

Energy renewable	Advantage	Disadvantage
	1. Wide availability 2. Low cost 3. Decentralized power production 4. Low pollution 5. Available for the future	1. Unreliable supply 2. Produced in small quantity 3. Difficult to store 4. Cost more
Energy non renewable	1. Available in high concentrated form 2. Easy to store 3. Reliable supply 4. Lower cost	1.highly pollution Available only in few places High running cost Limited supply and will one day get exhausted

Use of alternate energy sources:

Refers to energy sources which are not based on the burning of fossil fuels or the splitting of atoms.

Solar energy:

Total energy from sun per year-35,000 times the energy used by man

Used to run car, power plants and spaceships

Energy harvesting devises:

Solar heat collectors

Solar cells ,,

Solar cooker

Solar water heater

Solar furnace

Solar power plants

Wind energy:

Average wind velocity of earth -9 m/sec and power produced when a windmill is facing the wind od 10 miles/hr-50 watts.eg.largest wind farm-Kanyakumari in tamilnadu is generating 380 MW electricity

Hydro power:

- Comes from damming of rivers and utilization of high pressure, its kinetic energy is transformed into turbine blades and used to generate electricity
- Minimum water falls height-10 m
- Hydro power potential of India-$4x10^{11}$KW/Hr

Tidal Energy

Uses the natural motion of tides to fill reservoirs which are then slowly discharged through electricity producing turbines

Ocean thermal energy

Energy available due to the difference in water temperature. The surface of the tropical ocean and at deeper level is called OTE. A difference of 20^0c or more is required for operating OTE power plants.

Geothermal energy

Energy harassed from the hot rocks inside earth. eg. natural geysers in Manikaran,kully,sohana

Biomass energy

Organic matter produced by plants

Types:

1.Energy plantations:

Solar energy is trapped by green plants through photosynthesis and converted to biomass e.g Leucaema,Sugarcane, sweet sorghum, Sweetbeet aquatic weeds like hyacinth, Sea weeds,potato,cereal-energy plantations

Produce energy by burning directly or by getting converted into burnable gas or converted to fuels by fermentation.

Petro crops

Latex containing plants Euphorbias, oil palms rich in hydrocarbons and yield oil like substance under high temperature and pressure-refined to form gasoline

LAND RESOURCE

Land is critically important national resource which supports all living organisms including plants and animals. The soil profile of land determines its ability to serve socio-economic needs.

It has been estimated that more than 5000 million tonnees of top soil is eroded annually along with 5 million tones of nutrients. „About 1/3 of this is lost in sea while the rest in

reservoirs and rivers leading to flood.

About 38% of the area in India suffers from moderate to high degree of water based erosion. The per capita availability of land in the country has declined from 1.37 hectare in 1901 to 0.33 hectare in 2000. All these lands cannot be utilized for agricultural purpose. Some land would be required for other activities (to maintain urban area).

Effective steps have to be taken for preventing diversion of land suitable for sustainable farming to non-farm uses. Simultaneously, degraded lands and waste lands have to be improved by ecological restoration. The Department of Land Resources was setup in April 1999 by ministry of Rural Development to act as nodal agency for land resource management.

Land Degradation:

Land degradation is defined as the reduction in soil capacity to produce in terms of quality, quantity goods and services. The definition is also based on

1. sustainability or ability to produce continuously and indefinitely.
2. quality of land resource that makes it sustainable or resistant to degradation
3. carrying capacity or the number of people and animals the land can normally support without significant stress.

Landscapes generally undergo degradation but are usually compensated by nature‟s inherent recovering ability. Whenever degradation occur exceeding nature‟s restorative capacity, the result will be a disaster.

Man induced landslides:

The hill slopes are prone to land slides, landslips, rockslides etc. These hazardous features have reduced the overall progress of the region as they obstruct the roads, communication media and water flow. There are two types of slides

1. slides due to natural factors
2. slides induced by man and his activities

Some of the human activities that cause land sliding are

- massive deforestation
- erratic agricultural practices
- road building
- Unscientific quarrying etc.
- Engineering. Constructions

Soil erosion:

1. Terracing: Terracing reduces soil erosion on steep slopes by concerting the land into a series of broad, level terraces. This retains water for crops at each level and reduces soil erosion by water run off.
2. Contour Farming: This method is adopted for gently sloped land. This involves planting crops in rows across the contour of gently sloped land.

3. Alley Cropping or Agro forestry: In this method crops are planted together in strips or alleys between trees and shrubs that can provide fruits and fuel wood. The trees and shrubs provide shade which reduce water loss by evaporation and preserve soil moisture.

Wind Breaks or Shelter Belts: Wind breaks and shelter belts or trees are established to reduce wind erosion and also for retaining soil moisture.

ROLE OF INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES:

Natural resources-forest,water,soil,food,mineral and energy

Overuse of these resources cause problems

Conserve water:

- Don‟t keep water taps running
- Install water saving toilets
- Check forwater leaks
- Reuse soapy water
- Use drip and sprinkling irrigation
- Conserveenergy
- Turn off lights,fan when not in use
- Use solarcooker for cooking
- Try riding bicycle

Protect soil:

- Don‟t uproot plants
- Grow grass which binds soil andprevent erosion
- Make compost
- Use green manure
- Don‟t over irrigate
- Use mixed cropping

EQUITABLE USEOF RESOURCES FOR SUSTAINABLE IFE STYLE:

- Most developed countries like USA, Canada, Japan, Australia have 22% of natural resources, use 88%.73%of its energy and command 85%of its income
- Less developed countries has 78% of population, 12% Usage of natural resources, 27% of energy, 15% of income
- Gap arises due to increase in population distribution of resources and wealth
- Problem solved by equitable distribution of resources and wealth
- Global consensus has to be reached for more balanced distribution of basic resources like safe drinking water, food, fuel etc. So poor low developed countries able to sustain their life
- Two basic cause of unsustainability are over population in poor countries and over consumption of resources by rich countries generate wastes
- Rich countries lower down their consumption level
- Poor countries fulfilled by providing them resources

Review questions

1. What is artesian well?

A well or hole in aquifer flows freely at the surface

2. What is wetland?give examples and use

Wetlands are the natural water storage bodies on ground surface

Eg.Swamps, Meadows, Marshes

3. State the major process which have major environmental impact while processing of minerals.

Smelting,chemical extractions

4. What is salinization?

During over irrigation, all the water is not absorbed in the soil. such water evaporates leaving behind a thin crust of dissolved salts in the top soil.

5. Give two examples of primary and secondary sources of energy?

Primary source-fossil fuels, hydro energy

Secondary source-petrol, electrical energy

6. What is ocean thermal energy conversation?

In oceans, a thermal gradient (i.e., the temperature difference) of about 200C exists between surface water heated by sun and colder deep water. This difference can be harnessed to produce power. This concept is OTEC.

7. Give any four environmental benefits of dam

- Source of cleaner and safer power
- For irrigation of agricultural lands
- Helps in recharging of ground water
- Habitat for many fishes and wildlife

8. What are the sources of water

Ground water, surface water, sea water, rain water

9. What is sardar sarovar Narmada project?

It is a multipurpose project on river Narmada, bringing the benefits of irrigation, power and drinking water to Gujarat, Mathya Pradesh and Rajasthan.

10. What is integrated pest management?

The process of controlling crop pests using ecological system

UNIT 2 - ECOSYSTEMS

Ecosystem: An ecosystem is a group of biotic communities of species interacting with one another and with their non-living environment exchanging energy and matter.

Ecology: The study of animals and plants in their relation to each other and to their environment. Now ecology is often defined as “the study of ecosystems”.

Structural Aspects of Ecosystems

Two major components of ecosystem are

(i) Abiotic components

(ii) Biotic components

(i) Abiotic components

Main abiotic factors of the ecosystem are include

(1) Climatic factors: solar radiation, temperature, wind, water currents, rainfall.

(2) Physical factors: light, fire, pressure, geomagnetism,

(3) Chemical factors: acidity, salinity and the availability of inorganic nutrients needed by plants.

(ii) Biotic components

The plants, animals and microorganisms (all living things) present in an ecosystem form the biotic component.

These consists of three types (**a) producers, (b) consumers, and (c) decomposers or reducers**

(a) Producers

They are mainly the green plants, which can synthesize their food themselves by making use of CO_2 and water in the presence of sunlight by in presence of chlorophyll, through the process of photosynthesis. They are also known as **photo autotrophs** (auto=self; troph=food, photo=light).

Some microorganisms which can produce food to some extent through oxidation of certain chemicals in the absence of sunlight. They are known as **chemosynthetic organisms or chemo-autotrophs**.

(b) Consumers

Primary consumers or Herbivores: They feed directly on producers. e.g. rabbit, deer, sheep, insect

Secondary consumers or carnivores: They feed on herbivores they are called secondary consumers e.g. small fish, frog.

Tertiary consumers: They feed on secondary consumers e.g. big fish, snake.

Detritivores (Detritus feeders or Saprotrophs): They feed on the parts of dead organisms, wastes of living organisms. e.g. beetles, termites, ants, crabs etc

(c) Decomposers

They derive their nutrition by breaking down the complex organic molecules to simpler organic compounds and ultimately into inorganic nutrients. Eg: Various bacteria and fungi

FUNCTIONAL ATTRIBUTES OF ECOSYSTEMS

The major functional attributes of ecosystems are as follows:

(i) Food chain, food webs and trophic structure (Ecological pyramids)

(ii) Energy flow

(iii) Cycling of nutrients (Biogeochemical cycles)

(iv) Primary and Secondary production

(v) Ecosystem development and regulation

FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

FOOD CHAIN

The transfer of energy within the ecosystem (among various levels) by a sequence of eating and being eaten in an ecosystem is known as food chain.

Some common examples of simple food chains are:

(i) Grass → grasshopper → Frog → Snake → Hawk (Grassland ecosystem)

(ii) Phytoplanktons → Zoo plankton → small fish → Large fish (Marine ecosystem)

Some features of food chain:

(i) Involves nutritive interaction between the various biotic components of an ecosystem.

(ii) A food chain is always straight (unidirectional flow of energy).

(iii) Usually 80 to 90% of potential energy is lost as heat when energy is transferred from one level to another.

(iv) Shorter food chains provide greater available energy and vice – versa.

(v) Most food chains have no more than four or five links.

Significance of food chain:

(a) Understand the feeding relationships and interaction between organisms in any ecosystem.

b) Comprehend the energy flow mechanism and matter circulation in ecosystems.

c) Understand the movement of toxic substances and the problem of 'Biological magnification' in the ecosystem.

d) Analyse the link between biological diversity & stability of an ecosystem.

Types of food chain

I. Grazing food chain: It starts with green plants (primary producers) and ends in carnivores

Eg: Grass → Rabbit → Fox

II. Detritus food chain: It starts with dead organic matter which the detritivores and decomposers consume. Partially decomposed dead organic matter and even the decomposers are consumed by detritivores and their predators.

Eg: Leaf litter → algae → crabs → small carnivor ous fish → large carnivorous fish (Mangrove ecosystem)

Eg: Dead organic matter → fungi → bacteria (Forest ecosystem)

FOOD WEBS

A network of food chains which are interconnected is called food web.

FOOD CHAINS AND FOOD WEBS- A COMPARISON

	Food Chain		Food Web
1,	Simple structure	1.	Quite complex structure
2.	Unidirectional	2.	Multi directional
3.	No. Of organisms are less	3.	No of organisms are large.
4.	Food chain is a single strand of different levels of energy transfers	4.	Food web will show many food chains in a particular ecosystem (eg: forest)

ECOLOGICAL PYRAMIDS

Graphic representation of trophic structure and function of an ecosystem, starting with producers at the base and successive trophic levels forming the apex is knows as an **ecological pyramid**.

Ecological pyramids are of three general types as under:

(i) **Pyramid of numbers:** It shows the number of individual organisms at each level

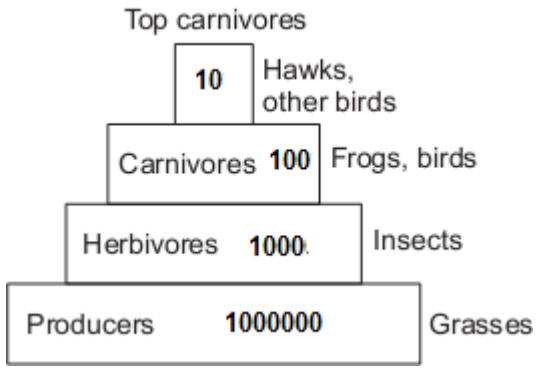
(ii) **Pyramid of energy:** It shows the rate of energy flow and/or productivity at successive trophic levels.

(iii) **Pyramid of biomass:** It shows the total biomass of each tropic level in the food chain.

(i) Pyramid of numbers

The pyramids of numbers show the relationship between producers, herbivores and carnivores at successive trophic levels in terms or their numbers.

(i) **Grass land:** In a grassland the producers, (mainly grasses) are always maximum in number. The number decreases towards apex, as number of every other level is less than number of grasses. The secondary consumers, snakes and lizards are less in number than the rabbits and mice. In the top (tertiary) consumers hawks or other birds, are least in number.



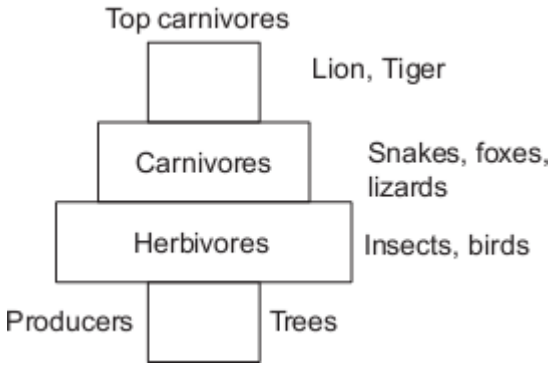
UPRIGHT

(ii) **Pond:** The producers, which are mainly the phyto-planktons as algae, bacteria etc. are maximum in number. The herbivores, which

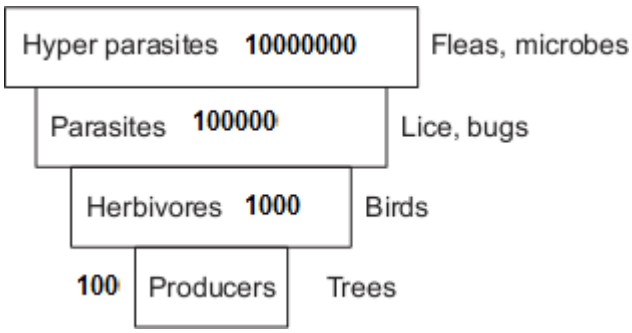
are smaller fishes are less in number than the producers. The secondary consumers (carnivores), such as small fish which eat up each other are less in number than the herbivores. Finally, the top (tertiary) consumers, the bigger fish are least in number

UPRIGHT (SIMILAR TO ABOVE)

(ii) **Forest:** Producers, are mainly large-sized trees which are less in number form the base of the pyramid. Herbivores, which are the fruit-eating birds, elephants, deer etc. are more in number than the producers. Thereafter there is a gradual decrease in the number of successive carnivores. **The pyramid is narrow on both sides and broader in the middle**



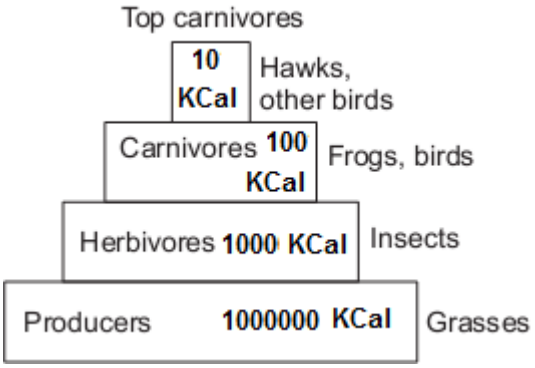
(iii) **Parasitic food chain:** Parasitic food chain shows an inverted pyramid of number. The producers are big trees. Fruit eating birds acting like herbivores which are larger in number. A much higher number of lice, bugs etc. grow as parasites on these birds while a still greater number of hyperparasites like bugs, fleas and microbes feed upon them, thus making an **inverted pyramid**



(ii) Pyramid of energy

The amount of energy present at each trophic level is considered for this type of pyramid. Pyramid of energy gives the best representation of the trophic relationships and it is always **upright**.

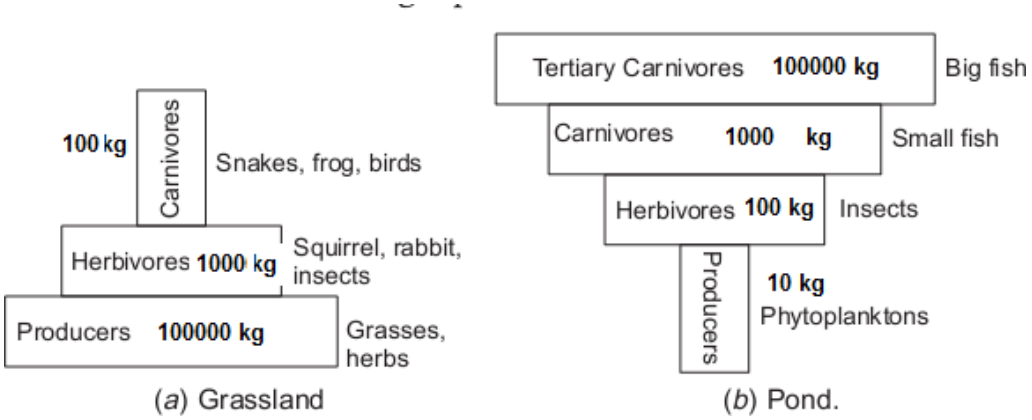
At every successive trophic level, there is a huge loss of energy (about 90%) in the form of heat, respiration etc. Thus, at each next higher level only 10% of the energy passes on. Hence, there is a sharp decline in energy level of each successive trophic level as we move from producers to top carnivores. Therefore, the pyramid of energy is always upright.



(iii) Pyramid of biomass

It is based upon the total biomass (dry matter) at each trophic level in a food chain. The pyramid of biomass can also be upright **or inverted**. Figure show

pyramids of biomass in a forest and an aquatic ecosystem. The pyramid of biomass in a forest is upright in contrast to its pyramid of numbers. This is because the producers (trees) accumulate a huge biomass while the consumers total biomass feeding on them declines at higher trophic levels, resulting in broad base and narrowing top.



ENERGY FLOW IN THE ECO SYSTEM

Flow of energy in an ecosystem takes place through the food chain and it is this energy flow which keeps the ecosystem going. The most important feature of this energy flow is that it is unidirectional or one-way flow.

Flow of energy follows the two laws of Thermodynamics.

Ist law of Thermod ynamics states that energy can neither be created nor be destroyed but it can be transformed from one form to another.

The solar energy captured by the green plants (producers) gets converted into biochemical energy of plants and later into that of consumers.

IInd law of Thermodynamics states that energy is lost when it is transferred from one level to another. As energy flows through the food chain, there occurs dissipation of energy at every trophic level. The loss of energy takes place through respiration, loss of energy in locomotion, running, hunting and other activities. At every level there is about 90% loss of energy and the

energy transferred from one trophic level to the other is only about 10%.(10% law).

Energy flow models: The flow of energy through various trophic levels in an ecosystem can be explained with the help of various energy flow models.

(a) Universal energy flow model: Energy flow through an ecosystem was explained by E.P. Odum as the universal energy flow model. As the flow of energy takes place, there is a gradual loss of energy at every level, thereby resulting in less energy available at next trophic level as indicated by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy is mainly the energy not utilized (NU). This is the energy lost in locomotion, excretion etc. or it is the energy lost in respiration (R) which is for maintenance. The rest of the energy is used for production (P).

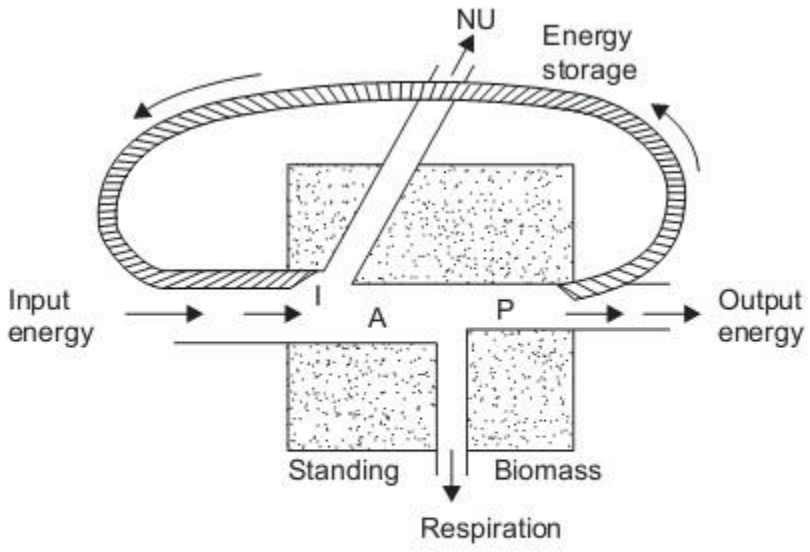


Fig. 3.8. Universal energy flow model applicable to all living components (I = Energy input; A : assimilated energy ; P = Production ; NU = Energy not used.

(b) Single channel energy flow model: The flow of energy takes place in a unidirectional manner through a single channel of green plants or producers to herbivores and carnivores. Figure depicts such a model and illustrated the

gradual decline in energy level due to loss of energy at each successive trophic level in a grazing food chain.

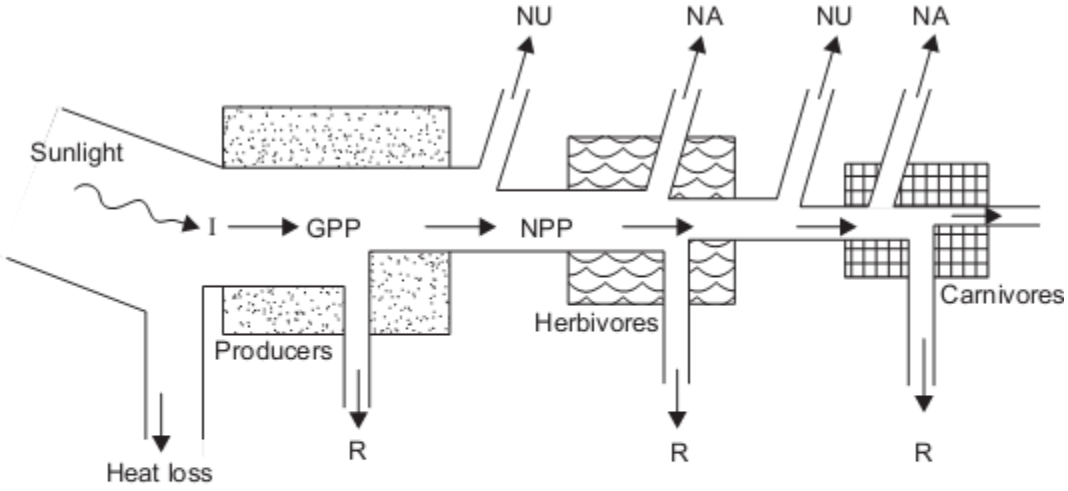


Fig. 3.9. One-way energy flow model showing unidirectional flow through primary producers, herbivores and carnivores. At each successive trophic level there is huge loss of energy (I = Solar energy input ; GPP = Gross primary production ; NPP = Net primary production ; NU = Energy not used ; NA = Energy not assimilated e.g. excretion ; R = Respiratory loss).

(c) Double channel or Y-shaped energy flow model: In nature, both grazing food chain and detritus food chain operate in the same ecosystem. However, in many cases it is the grazing food chain which predominates. In marine ecosystem where primary production in the open sea is limited and a major portion of it is eaten by herbivorous marine animals. Therefore, very little primary production is left to be passed on to the dead or detritus compartment.

On the other hand, in a forest ecosystem the huge quantity of biomass produced cannot be all consumed by herbivores. Rather, a large proportion of the live biomass enters into detritus (dead) compartment in the form of litter. Hence the detritus food chain is more important there. The two channel or Y-shaped model of energy flow shows the passage of energy through these two chains, which are separated in time and space.

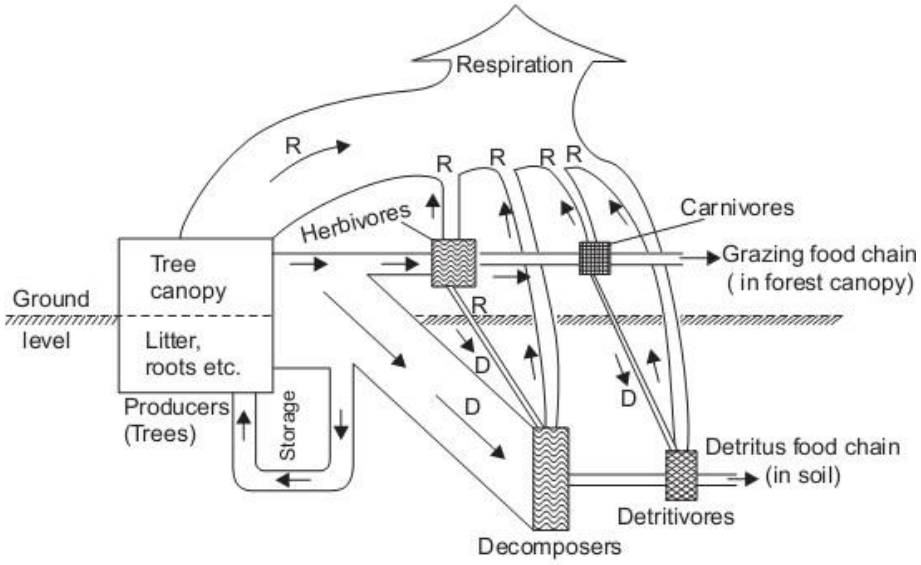


Fig. 3.10. Y-shaped or 2-channel energy flow model showing energy flow through the grazing food chain and the detritus food chain (R = Respiration, D = Detritus or dead matter).

NUTRIENT CYCLES (BIO GEOCHEMICAL CYCLES)

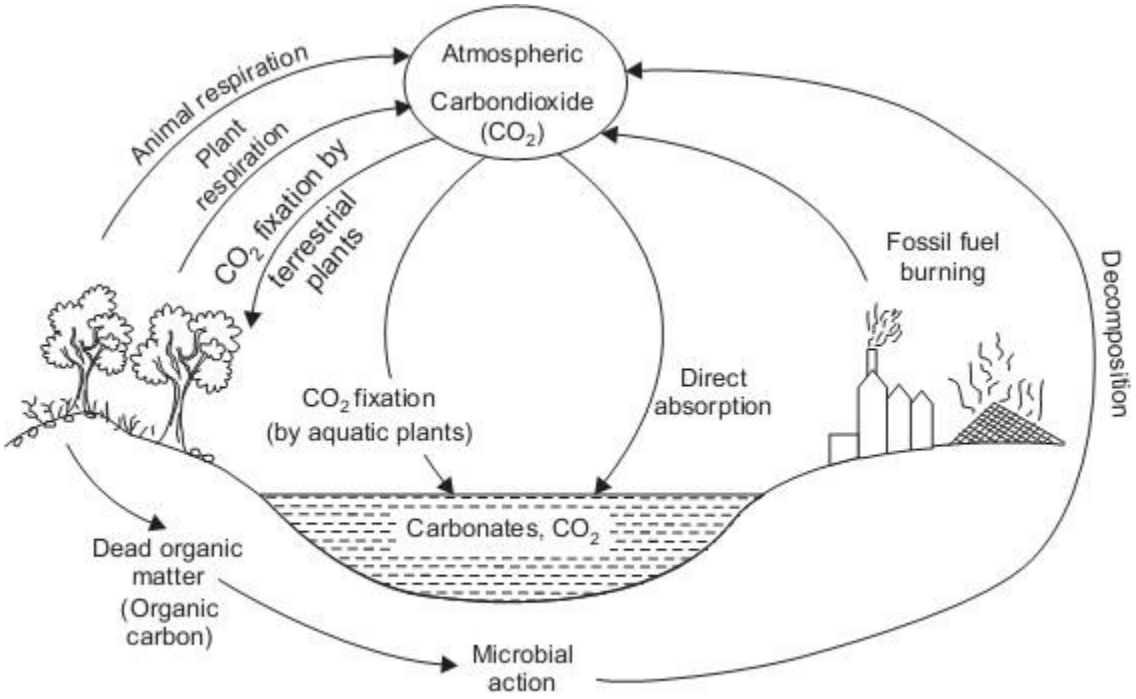
These are of two types

- Gaseous cycles like carbon (as carbon dioxide), oxygen, nitrogen, etc.
- Sedimentary cycles like sulphur, phosphorus, etc.

CARBON CYCLE

- **Carbon is removed from the atmosphere**: Green plants are constantly removing CO_2 from the atmosphere through the process of photosynthesis. Certain bacteria, also referred to as chemoautotrophs, use carbon dioxide to synthesize the organic compounds they need.
- **Entry of carbon from plants into the animal world**: The carbon present in the food (starch) made by green plants reaches animals through the food chain. Carnivorous animals receive this carbon when they eat other animals.

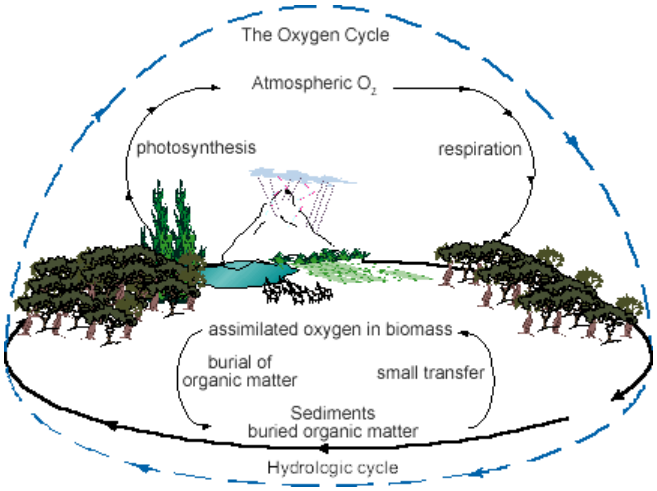
- **Entry of carbon from atmosphere into the water bodies**: CO_2 is continuously being dissolved in the seas and oceans through the process of diffusion. Once dissolved, this CO_2 may remain as it is in the marine waters or may get converted into carbonates (CO_3^{-2}) and bicarbonates (HCO_3^-). The CO_2 dissolved in water is used by marine plants for photosynthesis. The carbonates are converted into $CaCO_3$, by certain marine organisms. This is used by corals and oysters to make their shells. When these organisms die, their shells deposit on the sea floor and finally turn into sedimentary rocks.
- **Carbon moves from living things to the land**: As plants and animals die and get buried under the ground, after millions of years, they change into fossil fuels due to high pressure and other physical and chemical changes.
- **Carbon returns to the atmosphere**: CO_2 is regularly being returned to the atmosphere by the process of respiration in plants and animals. Burning of wood and fossil fuels in industries and automobiles also releases CO_2.



Carbon cycle.

OXYGEN CYCLE

Atmospheric oxygen is the major source of oxygen (21% of air). Oxygen is taken up by plants and animals from the air during respiration. The plants return oxygen to the atmosphere during photosynthesis. So equilibrium is maintained. Oxygen Cycle and Carbon Cycle are related.



NITROGEN CYCLE

Nitrogen is present in the atmosphere as N_2 in large amount (78%) and it is fixed either by the physical process of lightening or biologically by some bacteria and/or cyanobacteria (blue green algae). The nitrogen is taken up by plants and used in metabolism for biosynthesis of amino acids, proteins, vitamins etc. and passes through the food chain. After death of the plants and animals, the organic nitrogen in dead tissues is decomposed by several groups of ammonifying and nitrifying bacteria which convert them into ammonia, nitrites and nitrates, which are again used by plants. Some bacteria convert nitrates, into molecular nitrogen or N_2 which is released back into the atmosphere and the cycle goes on.

VARIOUS STEPS IN NITROGEN CYCLE

Atmospheric nitrogen fixation by lightning - The enormous energy of lightning breaks nitrogen molecules and enables their atoms to combine with oxygen in the air forming nitrogen oxides. These dissolve in rain, forming nitrates, that are carried to the earth.

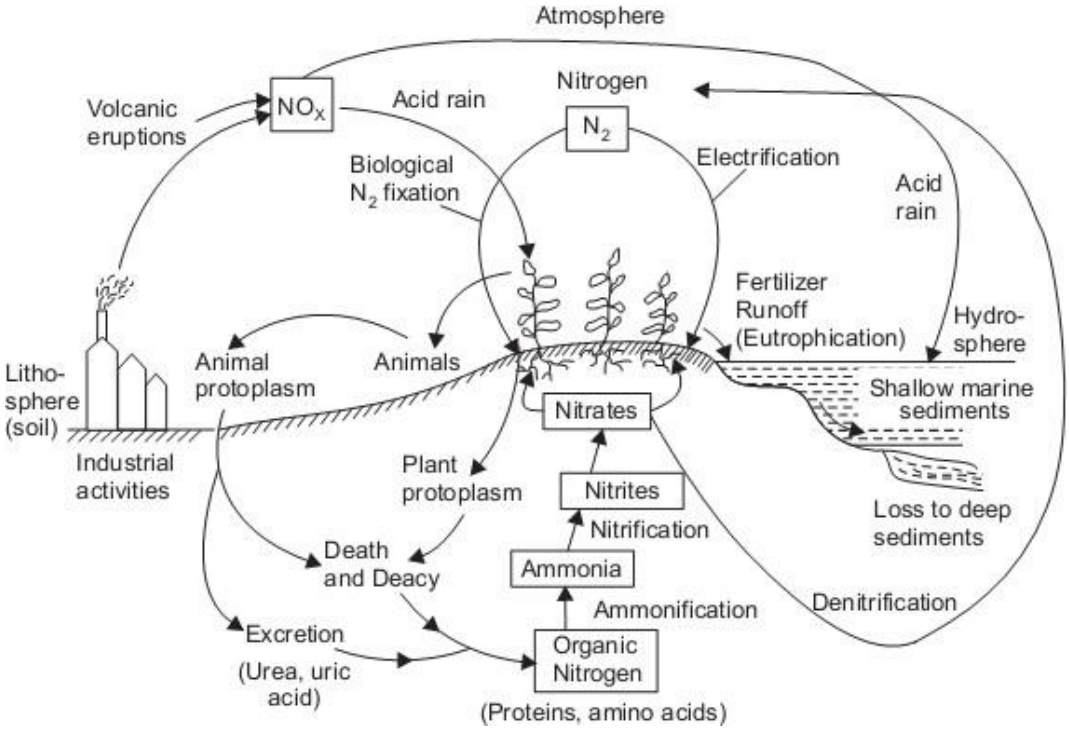
Biological nitrogen fixation by certain microbes — alone or in a symbiotic relationship with some plants and animals. eg: Rhizobium and Nitrogen-fixing c*yano bacteria*

Industrial Fixation: Use of nitrogen rich fertilizers

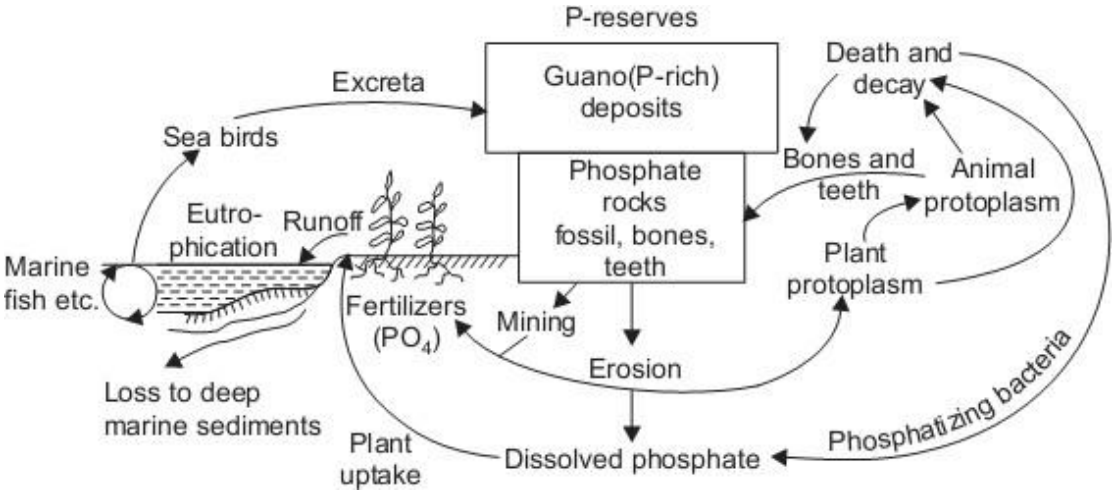
Ammonification: Bacteria, or fungi, convert the organic nitrogen (dead remains of organisms) into ammonium (NH_4^+) (Eg: Bacillus)

Nitrification: Biological oxidation of ammonia with oxygen into nitrite followed by the oxidation of these nitrites into nitrates (Eg: Nitrobactor)

Denitrification: Denitrification is the reduction of nitrates back into inert nitrogen gas (N_2) by bacteria, completing the nitrogen cycle. (Eg: Pseudomonas and clostridium).



PHOSPHORUS CYCLE



PHOSPHATE UTILIZATION

i) The reservoir of phosphorus lies in the rocks, fossils etc. Considerable amount of phosphorus from the soil rock is washed into the sea by rains and floods (an estimated amount of 2 million tonnes of phosphate rock is lost to sea) where sea weeds take up phosphorus and is then passed onto fishes and sea birds.

ii) Terrestrial plants absorb phosphorus as phosphate ions (orthophosphate ions) from the soil.

iii) Animals obtain phosphates by consuming plants as food (as organic phosphate through the food chain).

PHOSPHORUS PRODUCTION

1) Some amount of phosphorus is returned to earth in the form of birds excreta - Guano deposits (excreta of marine birds) and dead fish (around 60,000 tonnes which is less than 0.5% of phosphorus discharged from rivers).

2) Death and decay of organisms and decomposition of organic matter by microorganisms releases the phosphates into the soil, making them available to plants once again.

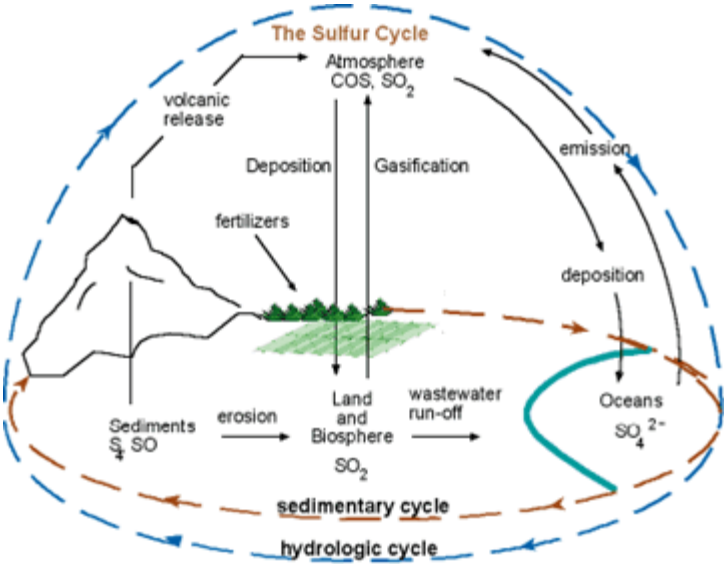
3) Zooplanktons excrete phosphorus into water (negligible amount)

Once phosphorus becomes a part of the soil water as phosphate or in dissolved state in any aquatic system, it re-enters the cycle through producers. Phosphorus incorporated in bones and teeth also remain outside the natural cycle for a long time as the bones and teeth are resistant to decay.

Therefore, phosphorus cycle is an imperfect cycle and shows one way flow which can be represented as:

Phosphate rocks → Land ecosystem → Oceans → Ocean sediment

SULPHUR CYCLE



Sulfur is one of the constituents of many proteins, vitamins and hormones. It recycles as in other biogeochemical cycles.
The essential steps of the **sulfur cycle** are:

- Mineralization of organic sulfur to the inorganic form, hydrogen sulfide: (H_2S).
- Oxidation of sulfide and elemental sulfur (S) and related compounds to sulfate (SO_4^{2-}).
- Reduction of sulfate to sulphide (S^{2-}).
- Microbial immobilization of the sulfur compounds and subsequent incorporation into the organic form of sulfur.

HUMAN IMPACT ON SULFUR CYCLE

Human impact on the sulfur cycle is primarily in the production of sulfur dioxide (SO_2) from industry (e.g. burning coal) and the internal combustion engine. Sulfur dioxide can precipitate onto surfaces where it can be oxidized to sulfate in the soil (it is also toxic to some plants), reduced to sulfide in the atmosphere, or oxidized to sulfate in the atmosphere as sulfuric acid, a principal component of acid rain.

ECOSYSTEM PRODUCTIVITY

PRIMARY PRODUCTION

Primary productivity of an ecosystem is defined as the rate at which radiant energy is converted into organic substances by photosyn-thesis or chemo-synthesis by the primary producers.

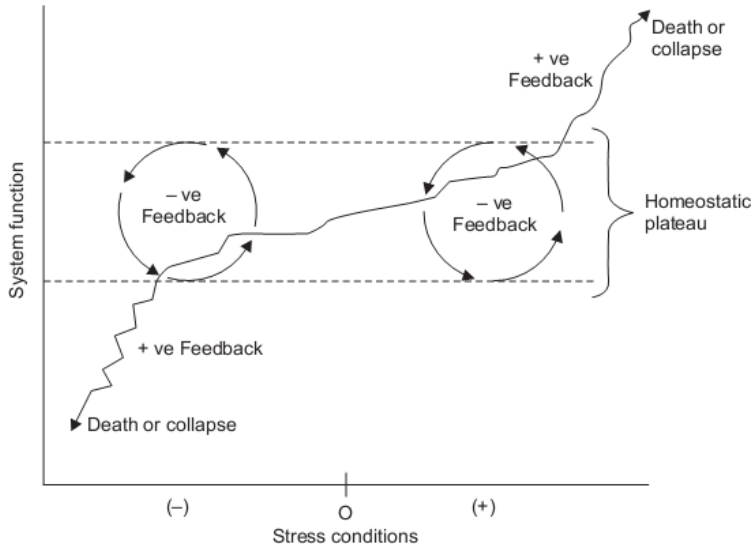
SECONDARY PRODUCTION

The energy stored at consumer level for use by the next trophic level is thus defined as secondary production.

ECOSYSTEM REGULATION

All ecosystems regulate themselves and maintain themselves under a set of environmental conditions. Any environmental stress tries to disturb the normal

ecosystem functions. However, the ecosystem, by itself, tries to resist the change and maintain itself in equilibrium with the environment due to a property known as **homeostasis. Homeostasis is the inherent property of all living systems to resist change.** However, the system can show this tolerance or resistance only within a maximum and a minimum range, which is its range of tolerance known as homeostatic plateau . Within this range, if any stress tries to cause a deviation, then the system has its own mechanisms to counteract these deviations which are known as negative feedback mechanisms. So, negative feedback mechanisms are deviation counteracting mechanisms which try to bring the system back to its ideal conditions. But, if the stress is too high and beyond the range of homeostatic plateau, then another type of mechanisms known as positive feedback mechanisms start operating. These are the deviation Accelerating mechanisms. So the positive feedback mechanisms add to the stress conditions and tend to take the system away from the optimal conditions.



Human beings should try to keep the ecosystems within the homeostatic plateau. They should not contribute to positive feedbacks otherwise the ecosystems will collapse.

ECOLOGICAL SUCCESSION

Ecological succession is defined as an orderly process of changes in the community structure and function with time mediated through modifications in the physical environment and ultimately culminating in a stabilized ecosystem known as climax.

The whole sequence of communities which are transitory are known as **Seral stages** or **seres** whereas the community establishing first of all in the area is called a **pioneer community**.

Process of Succession

The process of succession takes place in a systematic order of sequential steps as follows:

(i) **Nudation:** It is the development of a bare area without any life form. The bare area may be caused due to landslides, volcanic eruption etc. (topographic factor), or due to drought, glaciers, frost etc. (Climatic factor), or due to overgrazing, disease outbreak, agricultural/ industrial activities (biotic factors).

(ii) **Invasion:** It is the successful establishment of one or more species on a bare area through dispersal or migration, followed by **establishment**. Dispersal of the seeds, spores etc. is brought about by wind, water, insects or birds. Then the seeds germinate and grow on the land. As growth and reproduction start, these pioneer species increase in number and form groups or aggregations.

(iii) **Competition and co-action:** As the number of individuals grows there is competition, both inter-specific (between different species) and intra-specific (within the same species), for space, water and nutrition. They influence each other in a number of ways, known as **co-action**.

(iv) **Reaction:** The living organisms grow, use water and nutrients from the substratum, and in turn, they have a strong influence on the environment which is modified to a large extent and this is known as reaction. The modifications are very often such that they become unsuitable for the existing species and favour some new species, which replace them. Thus, reaction leads to several seral communities.

(v) **Stabilization:** The succession ultimately culminates in a more or less stable community called climax which is in equilibrium with the environment.

MAJOR ECOSYSTEM TYPES

FOREST ECOSYSTEM

Depending upon the prevailing climatic conditions forests can be of various types

a) Tropical Rain Forests: They are evergreen broadleaf forests found near the equator (tropics). They are characterized by high temperature, high humidity and high rainfall.

b) Tropical deciduous forests: They are found a little away from the equator and are characterized by a warm climate the year round. Different types of deciduous trees are found here, which lose their leaves during dry season.

c) Tropical scrub forests: They are found in areas where the dry season is even longer. Here there are small deciduous trees and shrubs.

d) Temperate rain forests: They are found in temperate areas with adequate rainfall. These are dominated by coniferous trees like pines, firs, redwoods etc.

e) Temperate deciduous forests: They are found in areas with moderate temperatures.

1. Abiotic Substances (Non-Living Components)

The Abiotic substances of forest eco system include basic inorganic and organic compounds of the environment or habitat of the organism.

(a) Inorganic Components: The inorganic components of an ecosystem are carbon dioxide, water, nitrogen, calcium, and phosphate. All of these are involved in matter cycles (biogeochemical cycles).

(b) Organic Components: The organic components of an ecosystem are proteins, carbohydrates; lipids and amino acids, all of these are synthesized by

the biota (flora and fauna) of an ecosystem and are reached to ecosystem as their wastes, dead remains, etc.

(c) The climate, temperature, light, soil etc., are other abiotic components of the eco-system.

2. Biotic Substances (Living Components)

PRODUCERS

These include green plants like herbs, shrubs and trees. These prepare food (starch) from water and CO_2 in presence of sunlight and chlorophyll. The nature of plants associated may vary according to the location.

Examples : Grass, trees etc.

CONSUMERS

A) Herbivores (plant eaters): They feed directly on producers and hence also known as primary consumers . e.g. rabbit, deer, squirrel, insects.

B) Carnivores (meat eaters): They feed on other herbivores. If they feed on herbivores they are known as **secondary consumers.** E.g. frog, fox. If they feed on other secondary consumers they are known as **tertiary consumers**. Eg: snake, lion, tiger.

DECOMPOSERS

They break down complex compounds of dead tissues of producers and consumers,absorb some of the decomposition products and release simple substances consumable by autotrophic organisms. Decomposers include earthworms, bacteria, fungi etc.

DESERT ECOSYSTEM

A *desert* biome is one that receives less than 25 cm of annual precipitation.

One third of the earth's surface (land) are covered by deserts

Desert are classified into two.

a) Hot and dry: Temperature exhibit daily extreme because the atmosphere contains little humidity to block the Sun's rays. (Sahara)

b) Cold: Cold deserts can be covered in snow or ice. (Antartica)

1. Abiotic Substances (Non-Living Components)

The Abiotic substances of desert eco system include basic inorganic and organic compounds of the environment or habitat of the organism.

(a) Inorganic Components: The inorganic components of an ecosystem are carbon dioxide, water, nitrogen, calcium, and phosphate.

(b) Organic Components: The organic components of an ecosystem are proteins, carbohydrates; lipids and amino acids. However, organic content is much lesser when compared to any other eco system.

(c) The climate, temperature, light, soil etc., are other abiotic components of the eco-system.

2. Biotic Substances (Living Components)

PRODUCERS

There are many kinds of plants in the desert. They are the date palms, cacti, thorn acacia, bushes, desert milkweed, desert willow, desert tobacco and many annuals. Xerophytic plants like cacti store water in stems and have extended root system.They prepare food (starch) from water and CO_2 in presence of sunlight and chlorophyll. Desert ecosystem has low productivity.

CONSUMERS

A) Herbivores (plant eaters): They feed directly on producers and hence also known as primary consumers. These are small mammals like kangaroo rat, ground squirrels, certain insects and Arabian camels.

B) Carnivores (meat eaters): They feed on other herbivores. If they feed on herbivores they are known as **secondary consumers.** These are lizards, snakes like rattle snake, some mammals like mongoose, tarantula and scorpions. Some animals eat both plants and animals. These are called omnivores. Some are called scavengers as they feed on dead animals.

DECOMPOSERS

They break down complex compounds of dead tissues of producers and consumers,absorb some of the decomposition products and release simple

substances consumable by autotrophic organisms. Decomposers include earthworms, bacteria, fungi etc.

A typical desert food chain:

Date palm (producer)→Kangaroo rats(herbivore)→Sandy cat (carnivore).

SIMILARLY YOU ARE SUPPOSED TO STUDY GRASSLAND, POND/LAKE, RIVER, EUSTRINE AND MARINE ECOSYSTEM BY YOURSELF

BIODIVERSITY

The variety and variability of life on earth is known as biodiversity.

Levels(Types) of biodiversity

Genetic diversity: Due to the diversity of genetic materials within species (**Example:** different breeds of dogs- pug, bull dog, Dalmatian, Alsatian etc. Tiger-

Royal Bengal tiger, Siberian tiger, White tiger. Elephant- Indian elephant and African elephant. Varities of orchids, rice, mangoes etc)

Species diversity: The variation among species in a community.

Example : Cat and tiger and very closely related by different species.

Community Diversity: Variation in the biological communities in an ecosystem. Different populations forms a community and diversity exists among various communities. **Example :** population of dogs and population of humans

Ecosystem diversity: Variation in the structure and functions of different ecosystems. **Example :** Forest ecosystem and pond ecosystem are quite diverse. Ecosystem diversity has 3 perspectives

Alpha Diversity: Within community diversity. Alpha diversity refers to the diversity of organisms sharing the same Community/Habitat.

Beta Diversity: Between community diversity. It refers to the diversity of organisms sharing two habitat.

Gamma Diversity : Diversity of the habitat over the total landscape or geographical area is called gamma diversity

Diversity at different levels of biological organization

1. Individual (species or organism) A species is a group of reproductively isolated organisms. It is the basic unit of taxonomic classification of organisms

2. Population: Population is a group of individuals of the same species occupying a distinct space at a certain time. It contains ***genetic variation*** within itself.

3. Community: A group of interacting organisms sharing a specific geographical area and it shows ***species diversity***.

4. Ecosystem: It refers to all the abiotic factors (physical and chemical constituents) and all the communities that established in a specific area. C***ommunity diversity*** exists at this level due to the presence of different communities in an ecosystem.

5. Biomes-Largest ecological unit present in different geographic area and named after the dominant vegetation. Variation in the structure and functions of different ecosystems creates ***ecosystem diversity***.

Terrestrial biodiversity of earth is described as biomes.

6. Biosphere: Biosphere is the sum of all the ecosystems established on Earth..

It is the whole portion of Earth colonized by living beings.

IMPORTANT SPECIES IN A COMMUNITY

Keystone Species- *Species or set of species whose impact on its community or ecosystem is much larger and more influential* and whose extinction would consequently lead to the extinction of other forms of life. Keystone species help to support the ecosystem (entire community of life) of which they are a part.

In the African savanna, the larger herbivores, especially the elephants, shape their environment. The elephants destroy trees, making room for the grass species. Without these animals, much of the savannah would turn into woodland. Thus elephant is a keystone species. Beaver, starfish are other examples.

Indicator Species: : Species that serve as early warning s of damage to a community or ecosystem. They quickly respond to environmental change and considered as **biological indicators** ex., Presence or absence of trout(a kind if fish) species in water indicates the quality of water

Native species: Species that normally seen in a particular ecosystem. Species which are native to particular area.

Exotic or alien Species: Species that migrate or accidentally introduced into an ecosystem by human beings.

THE VALUES (IMPORTANCE) OF BIODIVERSITY

Each organism has its own significance in an ecosystem and it is vital for healthy biosphere. Main uses of biodiversity are the following

1. Consumptive values

2. Productive values

3. Social values

4. Ethical values

5. Aesthetic values

6. Optional values

7. Ecosystem service values

8. Genetic value

1. CONSUMPTIVE VALUE

- These are direct use values
- For the essential needs, natural products can be harvested and directly consumed
- Natural products are gathered, harvested and hunted for food, medicine, clothing, sheltering and fuel
- **Examples: Food,*Penicillin from fungi, different medicinal plants*.**

2. PRODUCTIVE VALUES OR COMMERCIAL VALUE

- Commercially harvested for markets
- Forestry, fisheries and use of fossil fuels

Examples: Fuel, Fibers from silk worm, musk from musk deer

3. SOCIAL VALUES

Values associated with the social, religion, spiritual aspects of life

- **Holy plants – tulsi, lotus,vembu**
- **Holy animals – cow, snake, peacock**
- **Holy River -Ganga, Cauveri**

4. ETHICAL VALUES

- Biodiversity lies in the understanding that humanity is part of nature and one among the other species.
- A species may or may not be useful but its existence in nature gives pleasure.
- It is essential for conservation of biodiversity.

- **All life must be preserved-Live and let live**
- Ex. We don't drive anything direct from zebra or giraffe but we strongly feel that these species should exist in nature and we feel sorry when we know that dodo or dinosaur is no more on earth.
-

5. AESTHETIC VALUES

The beauty of the nature has aesthetic values

- Must be enjoyed and preserved for future generation
- Eco-tourism -willingness to pay concept is estimated to generate 10 billion dollars income/year
- Eco-tourism facilitating the enjoyment of nature, which may generate many forms of income and employment in the tourism sector.

6. OPTIONAL VALUES

- Potentials of biodiversity –presently unknown and need to be explored and useful in future
- The possibility of a natural resources having some medicinal value

It includes the values of option to visit areas where variety of flora and fauna or specifically some endemic, rare endangered species exist.

7. ECOSYSTEM SERVICE VALUE

- **Air Purification**: Trees play an important role in absorbing greenhouse gases. Through photosynthesis, trees absorb and store atmospheric carbon, helping to combat global warming and purifying the air we breathe.
- **Protection of water** : Vegetation regulates and stabilizes water runoff and increases water yield and quality: eg coastal wet lands & Mangroves
- **Soil formatting and protection**: Helps in the formation and maintenance of soil structure and quality, the retention of moisture and nutrient levels, and the prevention of erosion
- **Nutrient cycling:** Cycling of nutrients in the ecosystem

- **Food production:** Production of food for all life forms.
- **Climate control:** Forest plays an important role in checking global warming and hence regulating the climate

8. GENETIC VALUE

- Specific habitats are important for breeding and spawning.
- Some habitats are genetic reservoirs from which seed and other materials can be obtained.
- Biotechnological advances permit genetic engineering (i.e., the transfer of genes from one organism to another).

Classification of species

• **Extinct species**-A species is said to be extinct when it is not seen in the wild for 50 years at a stretch. Eg Dodo, passenger pigeon, dinosaur, mammoth, saber-toothed tiger.

• **Endangered species**-When the number has been reduced to a critical level or whose habitats have been drastically reduced and when not protected and conserved they are endangered species eg: Giant panda

Critically endangered species: species are facing extremely high risk of extinction in immediate future

• **Rare species**-Species which are not endangered at present, but are at risk are categorized as rare species

• **Endemic species**-Species which are restricted to a particular area is called as endemic species Eg: Nilgiri Tahr, Lion tailed macque.

Few endangered species of India

1) Reptiles: Green sea turtle, Tortoise, Python

2) Birds: Peacock, Great Indian Hornbill, Pelican, Siberian White Crane

3) Carnivorous mammals: Indian wolf, red fox, royal Bengal tiger, lion, red panda, leopard, striped hyena, desert cat

4) Primates: Capped monkey, golden monkey, nilgiri langur, hoolock gibbon

5) Plants: many species of orchids

Hot Spots of Biodiversity

Areas that is rich in endemic species and containing high diversity of species and under threat of human activity. Hot Spots are the richest and most threatened reservoirs of plant and animal life on earth.

Key criteria for determining Hot Spots are:

-Presence of large number of endemic species the region should contain 0.5% of plant endemic species

- degree of threat which is measured in terms of habitat loss(70% loss)

Endemic species of India

• India has two biodiversity hotspots and thus possesses a large number of endemic species

• **Endemic flora**- Sapria himalayana, Uvaria lurida, Nepenthes Khasiana, Pedicularis perroter etc

• **Endemic animals**- Lion-tailed monkey, Nilgiri leaf monkey, Brown palm civet, Nilgiri tahr

Red List of Threatened Species(Red data book)

IUCN: International Union for Conservation of Nature and Natural Resources publishes Red Data Book-list the threatened species of plants and animals.

The main objectives are

– Identification and documentation of endangered species

– Providing a global index of the decline of biodiversity

– Create awareness about the importance of threatened biodiversity

– Defining conservation priorities and guiding conservation action

India as a mega-diversity nation

India is one of the 12 mega diversity countries in the world.

It is estimated that India ranks 10th among the plant rich countries of the world, 11^{th} in terms of number of endemic species of higher vertebrates and 6^{th} among the centers of diversity and origin of agricultural crops.

India has 350 different mammals (rated eight highest in the world), 1,200 species of birds (eighth in the world), 453 species of reptiles (fifth in the world) and 45,000 plant species, of which most are angiosperms, (fifteenth in the world). These include especially high species diversity of ferns (1022 species) and orchids (1082 species). India has 50,000 known species of insects, including 13,000 butterflies and moths. It is estimated that the number of unknown species could be several times higher.

Out of a total of 25 biodiversity hot-spots in the world, India possesses two, one in the north-east region and one in the western ghats.

A large proportion of the India Biodiversity is still unexplored.

Reasons for India as a mega-diversity nation

1) Endemism

- Species which are restricted only to a particular area are known as endemic.
- India shows a good number of endemic species. About 62% amphibians and 50% lizards are endemic to India.
- Western ghats are the site of maximum endemism

2) Centre of origin

- A large number of species are known to have originated in India
- Nearly 500 species of flowering plants have their origin in India
- India has been the center of origin for 166 species of crop plants and 320 species of wild relatives of cultivated crops.

3) Marine diversity

- The coastline of our country exhibits a rich biodiversity
- Along 7500 km long coastline, in the mangroves, coral reefs back waters etc, different species are found.
- The marine diversity is rich in mollusks, crustaceans and several species of mangrove plants and sea grasses

4) Hot spots of biodiversity

Areas which exhibit high species richness as well as high species endemism are termed as hot spots of biodiversity. There are 25 such hot spots of biodiversity

on a global level out of which two are present in India, namely the **Eastern Hima-layas and Western Ghats**

The biogeographical classification of India

Biogeography: Study of distribution, evolution, dispersal and environmental relationship of plants and animals in time and space

– Biogeographic classification of India was done by Rodgers and Panwar (1988)-describing 10 biogeographic zones in India

– Each zone has its own characteristic climate, soil, topography and biodiversity.

1. **Trans – Himalayan region** - upper region 6% of country's land mass- pine, deodar, leopard, black necked crane.
2. **The Himalayan region**- north-west, east and central Himalayan-pine, cork tree, sikkim stag, musk deer,
3. **The Indian desert**- Gujarat desert, Himalayan cold desert, Thar, Ladakh-Acacia,date palm, camel, desert cat ,mice, fox
4. **The semi arid region** -between desert and deccan plateau-Aravalli hills-Date palm, Gir Lion, Ranthambore.
5. **The western ghats**- mountain range along the western coast of India-Gujarat to Kanyakumari-Tuna, Tortoise, Lizards
6. **The deccan peninsula** –south of narmata valley, satpura mountain covers the north side,western ghats west side, eastern ghats east side-Pine,Sloth bear, Cheetal
7. **The gangetic plain**-ganges river side, 600 mm average rain fall, Sunderban forests-Jamun, Rhinoceros, Alligator
8. **The coastal region**- East and western coastal area-Coconut, banana, turtle, aligator, dolphin
9. **The north – east region**- a wide biodiversity-Bamboo, Tuna Chestnut, elephant, Rhinoceros.
10. **The Indian island** -Andaman-Nicobar, 300 islands with high biodiversity-Coconut, Cashew nut, Dolphin, Alligator

Threats to biodiversity

Major threat to biodiversity is Extinction of species. Extinction or elimination of a species is a natural process of evolution. Extinction at 10000 species per year or 27 per day!

Factors leading to extinction of Species

1. Destruction of Habitats : Destruction and loss of natural habitat is the single largest cause of biodiversity loss. Due to deforestation animals are deprived of shelter and food.

2. Habitat Fragmentation : Sometimes the loss of habitat is in instalments so that the habitat is divided into small and scattered patches, a phenomenon known as habitat fragmentation. There are many wild life species such as bears and large cats that require large territories to subsist. They get badly threatened as they breed only in the interiors of the forests.

3.Disturbance and pollution : Man made activities such as air/water pollution, eutrophication etc afftects biodiversity adversely. For example, oil spillage can affect marine ecosystem adversely. Natural causes like forest fire and volcanic eruption can also affect biodiversity.

4.Introduction of exotic species: These are new species entering a geographical region. Exotic species alter the habitat and natives cannot survive. Exotic species may kill or eat native species to the point of extinction. Disease causing microorganism if introduced may cause epidemic and eliminate the native species completely. Eg: Introduction of Water hyacinth-free floating exotic water weeds clogs rivers and lakes and threatens the survival of many aquatic species in India.

5. Hunting and over exploitation: Man hunts wild animals for food, safety and pleasure which can result in extinction of species. ex., Disappearance of dodo. Over fishing is depleting the marine and fresh water living resources. Many species of fishes, sea rurtles, sea cows and whales are facing extinction.

6.Poaching: Killing of prohibited wild animals for illegal trading of wildlife products is called poaching. Despite international ban, products from endangered

species, smuggling of wildlife items like furs, horns, tusks and herbal products are still going on. Animal products of commercial Value- hide, ivory, horn, teeth and bone.

7.Man wildlife Conflicts: Conflicts between man and wild animals is called wildlife conflict.

Reasons for man-wild life conflict

Habitat loss-compels them to move out of forests

Human encroachment – Humans occupy animal habitat

Ill, weak and sick animals attack man

Females of many animals attack to secure their babies

During hot summer for water

Shortage of food: bamboo- -elephant

Farmers put electric wire – injured animals turns violent

Human Settlements area in the migratory routes

Conservation of Biodiversity

The enormous value of biodiversity due to their genetic, commercial, medical, esthetic importance emphasizes the need to conserve biodiversity.

There are two approaches of biodiversity conservation

–In situ conservation

–Ex situ conservation

Insitu Conservation

This refers to the conservation of species in their natural habitat in place where the species normally occurs (within their natural habitat).

Protected Areas

• Areas especially dedicated to the protection and maintenance of biological diversity and of natural resources

• Protected areas are managed through legal means

• Examples: **National Parks, Wildlife Sanctuaries and Biosphere reserves**

National Parks

• Areas strictly reserved for wildlife and activities such as cultivation, grazing, cutting etc are not allowed

Private ownership right and manipulation of habitat not allowed.

Each national park aims at conservation of some particular species along with others

Nearly 100 Parks in India: Jim Corbett National Park – first in India

Some Important National Parks in India

- Jim Corbett National Park, Nainital-Tigers
- Kaziranga National Park, Assam- One horned Rhino
- Gir National Park, Gujarat- Indian Lion
- Bandipur National Park, Mysore- Tiger
- Periyar, Kerala -elephant and tiger
- Mudumalai National park Tamilnadu- Elephant

Wild life Sanctuaries

Area reserved for conservation of animals only.

– Killing, hunting, shooting or capturing of wildlife is prohibited under the control of highest authority

– Private ownership rights **are allowed** provided they do not affect wildlife adversely

- About 500 wildlife sanctuaries in our country
- **Vedanthangal Bird Sanctuary, TamilNadu- Water birds**

BIOSPHERE RESERVES

A special category of protected areas where in people are an integrated part of the environment for long-term conservation. Area is much larger when compared to national park and wild life sanctuary.

– Protection is granted: Flora, fauna and to the human communities who inhabit these regions, and their ways of life.

Roles of biosphere reserves

1. Conservation
2. Development
3. Scientific research, monitoring and education

15 biosphere reserves in India

– Within biosphere we have one or more national parks

- **Nilgiri Biosphere Reserve**

Sacred forests and lakes

Special sites, areas or landscapes that have one or more attributes which distinguish them as somehow extraordinary, usually in a religious or spiritual sense, are called **sacred places**. (Eg: Lake Pushkar)

• In our country many plants/ trees and animals are sacred and worshiped by local peoples.

Ex situ conservation

• This type of conservation is mainly done for conservation of crop varieties, the wild relatives of crops and all the local varieties

• In this the conservation in captivity under human care

• Threatened animals and plants are taken out from their natural habitat and placed in a place where they can be protected and given special care

Examples

1. Germ plasm banks or Gene banks

2. Botanical Gardens
3. Zoos
4. Genetic resource centers.
5. Pollen grain, seed, seedling, tissue culture, DNA

Methods of Ex-Situ Conservation

• **Long Term Captive breeding**

Zoo's (800 in world) & botanical Gardens & Arboreta (A place where an extensive variety of woody plants (trees & shrubs) are cultivated for scientific, educational, and ornamental purposes.(1500 in world))

- Vital conservation action for all Critically Endangered species.

• **Short Term propagation & release**

-Endangered species bred in captivity & released in wild later

- Practiced when the population declines due temporary set back in living conditions

Cryo-preservation

Preservation of seeds, gametes and embryos of endangered species, pollen etc. using liquid N2 at temp as low as -196 c for several years without losing viability

Seed Bank and Gene banks

Seeds and genetic resources of different strains of commercially important plants can be stored for long periods in seed banks

Important Gene/Seed banks in India

National Bureau of Plant Genetic Resources (NBPGR), New Delhi: Agricultural and horticultural crops and their wild relatives are preserved by cryo-preservation

National Bureau of Animal Genetic Resources (NBAGR),Haryana Preserves the semen of domesticated bovine animals:

National Facility for Plant Tissue Culture Repository (NFPTCR), New Delhi: Conservation of varieties of crop/plants/trees by tissue.

Tissue culture

Eggs can be fertilized in vitro and plants can be propagated by tissue culture methods. If seed is not available, it is possible to produce a plant with this method. It can be used to produce many copies of the same plants then which may be used to produce plants with better flowers, odors, fruits or any other properties of the plants that are beneficial to the human beings.

By artificial insemination

Breeding of the captive species can be done by artifical insemination. In this method semen is injected to a female for breeding.

Cloning

Cloning can be used for breeding purpose. Cloning describes the processes used to create an exact genetic replica of another cell, tissue or organism. The copied material, which has the same genetic makeup as the original, is referred to as a clone. The most famous clone was a Scottish sheep named Dolly.

There are three different types of cloning:

- **Gene cloning**, which creates copies of genes or segments of DNA
- **Reproductive cloning**, which creates copies of whole animals
- **Therapeutic cloning**, which creates embryonic stem cells. Researchers hope to use these cells to grow healthy tissue to replace injured or diseased tissues in the human body.

Unit – III Biodiversity

BIODIVERSITY DEFINITION*:* Bio means „life" and diversity means „variety", hence Biodiversity refers to variety of life on the earth. Planet earth (biosphere) contains more than 20 million species of organisms. They differ widely from one another. Diversification in the species is influenced by various physical and climatic factors, resulting in the production of new sub-species. Biodiversity is defined as, "the variety and variability among all groups of living organisms and the ecosystem in which they occur".

LEVELS OF BIODIVERSITY:

A. GENETIC BIODIVERSITY

The genes found in organisms can form enormous number of combinations each of which gives rise to some variability. When the genes within the same species show different version due to new combinations, it is called genetic variability. For example rice belongs to the species Oryzasativa which has many varieties that differ in size, shape, aroma etc.

B. SPECIES BIODIVERSITY

This is the variability found within the population of a species or between different species of a community. It broadly represents the species richness and their abundance in a community. Shannon Wiener index and Simpson index are two popular indices of measuring species diversity.

C. ECOSYSTEM BIODIVERSITY

This is the diversity of ecological complexity showing variations in ecological niche, trophic structure, food webs, nutrient cycling etc. The ecosystem also shows variations with respect to physical parameters like moisture, temperature, altitude, precipitation etc.

BIOGEOGRAPHICAL CLASSIFICATION OF INDIA:

S. No.	Biogeographic zone	Biotic province	Important Flora & Fauna
1	Trans-Himalayan	Upper region	Pine,deodar- Wild sheep, yak, leopard, wolf
2	Himalayan	North west, west, central and East Himalayas	Pine, cork tree, sal, dhaak- Wild bear, sambar, leopard, Sikkim stag, musk deer
3	Desert	Kutch, Thar and Ladkh	Acacia, zizyphus, khejri, date palm- Camel, bastard, wild ass, desert cat, fox, rat
4	Semi-arid	Central India, Gujarat	Acacia, date palm, peepal -Gir lion, tiger, sariska and Ranthampore tiger
5	Western ghats	Malabar coast Western ghats mountain	Sheeshan, peepal, tuna, bahera- Tortoise, frog, lizards, snakes

Unit – III Biodiversity

6	**Deccan peninsula**	**Deccan plateau**	**Acacia, palaash, tuna, pine, castor- Sambar, sloth bear, tiger, cheetal, four horned stag, wild elephant, wild buffalo**
7	**Gangetic plain**	**Upper and lower Gangetic plain**	**Sal, acacia, jamun, mango, bael- black chinkara, stag, rhinoceros, gazzel, Aligator, turtle**
8	**North-east India**	**Brahmaputra valley**	**Bamboo, sal, jack fruit, tuna, Chestnut cator- Elephnat, Rhinocers, yak, deer, porcupine**
9	**Islands**	**Andaman islands, Nicobar islands & Lakshadeep islands**	**Bahera, Harar, jack fruit, cardamom, coconut, cloves- Dolphin, alligator, Molluscs**
10	**Coasts**	**West coast East coast**	**Coconut, Banana, cashew Nut – Dugong, Dolphin, Turtle, Alligator, Molluscs**

VALUE OF BIODIVERSITY: (Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values)

1. CONSUMPTIVE USE VALUE

- **Food:** A large number of wild plants are consumed by human beings as food. About 80,000 plants are from wild. About 90% of crops are domesticated from tropical forest.
- **Drugs and medicine**: About 75% of population depends upon plant or plant extracts for medicine. Penicillin antibiotic drug is derived from the fungus penicillium.
- **Fuel:** The fossil fuels coal, petroleum and natural gas are products of fossilized biodiversity.

2. PRODUCTIVE USE VALUE

These are the commercially usable values where the product is marketed and sold. It may include lumber or wild gene resources that can be traded for use by scientist for introducing desirable traits in the crops and domesticated animals. It includes animal products like tusk of elephants, musk deer, silk from silk worm, wool from sheep, fur of many animals etc. Many industries like paper and pulp. Silk, textile, ivory works industry depend on them.

3. SOCIAL VALUE

It is associated with social life, customs, and religion and psycho-spiritual aspects of the people. Many plants are considered holy and sacred in our country like tulsi, peepal, Mango, Lotus, Bael etc. many animals like cow, snake, peacock, bull, owl etc also have significant place in social importance. The tribal people are very closely linked with the wildlife in the forest.

4. ETHICAL VALUE

It is otherwise called existence value. It involves ethical issues like “all life must be preserved” and “live and let live” concept. For the survival of human race, all biodiversity has to be protected because biodiversity is valuable.

5. AESTHETIC VALUE

People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco –tourism. The willingness to pay concept annually generates 12 billion revenue.

6. OPTION VALUE

It is the value of knowing that there are biological resources existing on the biosphere that may one day prove to be an effective option for something important in the future it suggests that any species may prove to be miracle species someday.

BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVEL:

BIODIVERSITY AT GLOBAL LEVEL:

It is estimated that there are about 20 million species of plants and animals in earth of which only 1.6 million species have been formally identified with 34 hotspot regions at the global level. There are 12 megadiversity nations which are highly rich in biodiversity which includes India. Most of the world‟s biodiversity are near the equator especially tropical rain forests and coral reefs. South America also has unique species and biodiversity.

BIODIVERSITY AT NATIONAL LEVEL:

India is rich in biodiversity due to its varying climate and topographical features. It occupies only 2.5% of global land of which about 40% is under cultivation. There are 96 national parks, 572 wildlife sanctuaries 14 biosphere reserves and 2 hotspots with 46,000 plant species and 91,000 animal species, 50,000 varieties of rice, 1000 varities of mango, etc.,

1. India ranks 10^{th} among the plant rich countries of the world
2. 11^{th} in terms of Endemic species.
3. 6^{th} among origin of agricultural crops.
4. 12^{th} mega biodiversity country in the world.

BIODIVERSITY AT REGIONAL OR LOCAL LEVEL:

Tamilnadu is rich in biodiversity with natural habitat constituting 4% of country‟s total area which shares the Western Ghats with Kerala, Karnataka, Maharashtra, Goa and, Eastern Ghats with Andhra Pradesh and Odisha accounting for nearly about one third of the total flora of India.

1. **Point Richness**: Refers to number of species at a single point.
2. **Alpha Richness**: Refers to the number of species found in a small homogeneous area.
3. **Beta Richness**: Refers to rate of change in species composition across different habitats.
4. **Gamma Richness**: Refers to the rate of change across large landscape gradients.

INDIA AS A MEGA BIODIVERSITY NATION:

India is one of the 12 mega biodiversity countries in the world. The Ministry of environmental and forests, Government of India (2000) records 47,000 species of plants and 81,000 species of animals which is about 7% and 6.5% respectively of global flora and fauna.

1. **Endemism**: Species which are restricted to only to a particular area are known as endemic. India shows a good number of endemic species. About 62% of amphibians and 50% of lizards are endemic.

2. **Centre of origin**: A large number of species have known to originate in India. Nearly 5000 flowering species, 166 species of crop plants and 320 species of wild relatives of cultivated crops origin in India.

3. **Marine diversity**: Along 7500 km long coastline of our country in the mangroves, estuaries, coral reefs, back waters etc. there exist a rich biodiversity. More than 340 species of corals of the world are found here.

HOTSPOTS OF BIODIVERSITY

A **biodiversity hotspot** is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot- map, a region must meet two strict criteria:

1. It must contain at least 0.5% or 1,500 species of vascular plants as endemics.
2. It must have lost at least 70% of its primary vegetation.

Around the world, at least 25 areas qualify under this definition, with nine others possible candidates. These sites support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of endemic species.

The importance of biodiversity: Biodiversity is often used to draw attention to issues related to the environment. It can be closely related to:

- The health of ecosystems.

For example, the loss of just one species can have different effects ranging from the disappearance of the species to complete collapse of the ecosystem itself. This is due to every species having a certain role within an ecosystem and being interlinked with other species.

- The health of mankind.

Experiencing nature is of great importance to humans and teaches us different values. It is good to take a walk in the forest, to smell flowers and breathe fresh air. More specifically, natural food and medicine can be linked to biodiversity.

Hot spots of Biodiversity in India:

The hot spots of biodiversity are the geographic areas which possess the high endemic species. At the global level these are the areas of high conservation priority, if these species are lost they can never be replaced or regenerated.

Criteria for recognizing Hotspots: The richness of the endemic species is the primary criterion; they should have a significant percentage of specialized species; the site should be under threat and should contain important gene pools of plants of potential use.

Two hot spots in India are:

1. Eastern Himalayas (Indo-Burma region) and
2. Western Ghats (Srilanka region).

Eastern Himalayas: Comprises of Nepal, Bhutan and neighboring states of Northern India- 35,000 plant species are found here and 30 % are endemic – also rich in wild plants of economic value eg. Rice, banana, citrus, ginger, chilli, jute and sugarcane – Taxal yielding plant also scarcely distributed – 63% mammals are from this region- 60% of Indian Birds- huge wealth of fungi, insects, mammals and birds found in this region

Western Ghats: Comprises of parts of Maharashtra, Karnataka, Tamilnadu and Kerala – nearly 1500 endemic, dicotyledones 62% amphibians and 50% lizards are endemic here- Ternstroemia, Japonica, Rhododendron and Hypericum common plants- Blue Bird and Lizard hawk are common animals.

Biodiversity is the richness & varied species of different organisms contained in a particular ecosystem – Indian biodiversity is highly diverse and rich such that there are various hot spots. However there are numerous threats to our Biodiversity.

THREATS TO BIODIVERSITY :(Habitat loss, Poaching of wildlife & Man-wildlife conflicts)

In 2006 many species were formally classified as rare or endangered or threatened; moreover, scientists have estimated that millions more species are at risk which has not been formally recognized. About 40 percent of the 40,177 species assessed using the IUCN Red List criteria are now listed as threatened with extinction.

LOSS OF HABITAT:

***Habitat destruction*:**

Habitat destruction has played a key role in extinctions, especially related to tropical forest destruction. Factors contributing to habitat loss are: overpopulation, deforestation, pollution (air pollution, water pollution, soil contamination) and global warming or climate change. Habitat size and numbers of species are systematically related. Physically larger species and those living at lower latitudes or in forests or oceans are more sensitive to reduction in habitat area.

Climate change:

Global warming is also considered to be a major potential threat to global biodiversity in the future. Climate change has seen many claims about potential to affect biodiversity but evidence supporting the statement is tenuous. Increasing atmospheric carbon dioxide certainly affects plant morphology and is acidifying oceans, and temperature affects species ranges, phenology, and weather, but the major impacts that have been predicted are still just *potential* impacts. We have not documented major extinctions yet, even as climate change drastically alters the biology of many species.

POACHING: Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars per year continues. The developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth in wildlife.

Overexploitation:

Overexploitation occurs when a resource is consumed at an unsustainable rate. This occurs on land in the form of overhunting, excessive logging, poor soil conservation in agriculture and the illegal wildlife trade Joe Walston, director of the Wildlife Conservation Society's Asian programs, called the latter the "single largest threat" to biodiversity in Asia. The international trade of endangered species is second in size only to drug trafficking.

MAN-WILDLIFE CONFLICTS:

CAUSES OF MAN WILDLIFE CONFLICT:

1. Dwindling habitats of elephants, Tigers, rhinos and bears due to forest shrinkage compels them to move outside forest.
2. Usually ill, weak, and injured animals have a tendency to attack the humans.
3. Earlier Forest department used to cultivate paddy, sugarcane within the sanctuaries, due to lack of such practices the animals move out of forest food.
4. Villagers put Electric Wiring around their crop field which injures the elephants and turn them violent.
5. Wildlife corridors have been disrupted which makes the animals attack human beings during their migration.

REMEDIAL MEASURES TO CURB THE CONFLICT:

1. Tiger conservation Project (TCP) has made provisions for making available vehicles, tranquillizer guns, binoculars and radio sets etc., to tactfully deal with any imminent danger.
2. Adequate crop compensation and cattle compensation scheme must be started.
3. Solar powered fencing should be provided to prevent animals from straying into fields.
4. Cropping pattern should be changed near the border.
5. Wildlife corridors should be provided.

Introduced and invasive species:

Barriers such as large rivers, seas, oceans, mountains and deserts encourage diversity by enabling independent evolution on either side of the barrier, via the process of allopatric speciation. The term invasive species is applied to species that breach the natural barriers that would normally keep them constrained. Without barriers, such species occupy new territory, often supplanting native species by occupying their niches, or by using resources that would normally sustain native species.

Genetic pollution:

Endemic species can be threatened with extinction through the process of genetic pollution, i.e. uncontrolled hybridization, introgression and genetic swamping. Genetic pollution leads to homogenization or replacement of local genomes as a result of either a numerical and/or fitness advantage of an introduced species. Hybridization and introgression are side-effects of introduction and invasion.

Hybridization, genetic pollution/Erosion and food security

In agriculture and animal husbandry, the Green Revolution popularized the use of conventional hybridization to increase yield. Often hybridized breeds originated in developed countries and were further hybridized with local varieties in the developing world to create high yield strains resistant to local climate and diseases. Local governments and industry have been pushing hybridization. Formerly huge gene pools of various wild and indigenous breeds have collapsed causing widespread genetic erosion and genetic pollution. This has resulted in loss of genetic diversity and biodiversity as a whole.

UINT – IV POLLUTION

Environmental pollution can be defined as any undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil), which can cause harmful effects on various forms of life or property.

From an ecological perspective pollutants can be classified as follows:

Biodegradable or non-persistent pollutants: These can be rapidly broken down by natural processes. **Eg: domestic sewage, discarded vegetables, etc**

Non-degradable pollutants: These are the pollutants, which degrade at a very slow pace by the natural biological processes. **Eg: inorganic salts, metallic oxides, aluminium cans and DDT.**

On the basis of the form in which they persist after their release into the environment, pollutants can be categorized under two types:

(i) Primary pollutants: These include those substances, which are emitted directly from some identifiable sources. Examples are

(a) Sulphur compounds: SO_2, SO_3, H_2S produced by the oxidation of fuel.

(b) Carbon compounds: Oxides of carbon ($CO+CO_2$) and hydrocarbons.

(c) Nitrogen compounds*:* NO_2 and NH_3

(d) Halogen compounds: Hydrogen fluoride (HF) and hydrochloric acid (HCl).

(e) Particulate matter

(ii) Secondary pollutants: The secondary pollutants are produced by the combination of primary emitted pollutants. Eg: The fog deposited with smoke and chemical fumes forms a dark and thick covering, the smog.

AIR POLLUTION

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the environment.

Sources of air pollution

1. **Natural sources:** Forest fire and volcanic eruption can lead to air pollution. Hydrocarbons emitted by decomposition of organic matter can lead to air pollution. Pollen grains is also a pollutant.
2. **Anthropogenic sources (human activity):** Main reason for air pollution is human activities.
   a. **Burning of fossil fuels:** Burning of fossil fuels such as petrol, diesel, coal etc leads to serious air pollution.
   b. **Emissions from Automobiles:** Vehicles are mainly responsible for more than 80% of total air pollution. The major pollutants in CO, NO_x, SO_x etc.
   c. **Industrial emissions:** Factories,petroleum refineries, fertilizer plants, and steel industries, thermal power plants are the main sources of air pollution. They add various harmful gases like CO, SO_3, NO, Hydrocarbons etc., to the atmosphere.
   d. **Agricultural Activities:** Spraying of insecticides and pesticides also cause air pollution.

COMMON AIR POLLUTANTS

(i) **Carbon Dioxide:** CO_2 causes nausea and headache. It's increase in the air may cause green house effect which can melt the polar ice resulting in rise in level of oceans and flooding of coastal regions.

(ii) **Carbon Monoxide:** It is a very poisonous gas and is produced by incomplete combustion of fuel. If inhaled it combines with hemoglobin and reduces its oxygen-carrying capacity. This leads to dizziness, reduced vision and death.

(iii) **Oxides of Nitrogen:** These include NO and NO_2, which are released by automobiles and chemical industries as waste gases and also by burning of materials. These are harmful and lower the oxygen carrying capacity of blood.

(iv) **Oxides of Sulphur:** High concentration of SO_2 causes chlorosis (yellowing of leaves), plasmolysis, damage to mucous membrane and metabolic inhibition. SO_2 and SO_3 react with water to form Sulphuric and sulphurous acids resulting in acid rain.

(v) **Hydrocarbons:** These are unburnt discharges from incomplete combustion of fuel in automobiles.

(vi) **Particulate Matter:** Industries and automobiles release fine solid and liquid particles into the air. These are injurious to respiratory tract.

Effects of Air Pollution

Effect on Plants:

(i) SO_2 causes chlorosis and also results in the death of cells and tissues.

(ii) Fluorides and PAN damage leafy vegetables such as lettuce and spinach.

(iii) Oxides of nitrogen and fluorides reduce crop yield.

(iv) Smog bleaches and blaze foliage of important leafy plants.

(v) Hydrocarbons cause premature yellowing, fall of leave and flower buds, discoloration and curling of sepals and petals.

(vi) Smoke and dust cover the leaf surface and reduce photosynthetic capacity of plants.

(vii) Ozone damages cereals, fruits, and cotton crop.

Effect on Man:

The effect of pollutants on animals and man are as follows

(i) **Ozone:** Ozone causes dryness of mucous membranes, changes eye vision, causes headache and pulmonary congestion. Ozone has been reported to produce chromosomal defects.

(ii) **SO_2:** SO_2 causes drying of mouth, scratchy throat, smarting eyes and disorders of respiratory tract.

(iii) **NO_x :** Short or long term exposure to oxides of nitrogen can cause severe respiratory illness, aggravate asthma and cause lung malfunction.

(iv) **CO:** CO diffuses into blood stream and reduces oxygen transport. CO damages cardiovascular system.

(v) **Hydrocarbons**: Hydrocarbons can act as carcinogens and lead to different cancers.

(vi) **Suspended particles (Particulate matter):** These can aggravate bronchitis and asthma. Exposure to these particles over a long period of time damages lung tissue

Control of Air Pollution

Air pollution can be minimized by the following methods:

a) **Afforestation and controlling deforestation:** Trees should be planted on the roadside, riverbanks, parks and' open places as they can act as "pollution moderators".

b) **Law enforcement:** Pollution control laws should be enforced strictly. Constant monitoring of industrial/automobile exhaust must be carried out.

c) **Use of low sulfur coal:** Using low sulphur coal in industries or Removing sulphur from coal can considerably reduce air pollution.

d) **Using non-conventional sources of energy:** Use of eco-friendly energy sources like solar energy, wind energy can reduce air pollution.

e) **Increasing the height of chimneys:** The height of chimneys should .be increased to the highest possible level to reduce pollution at the ground level.

f) **Removal of particulate matter:** Particles larger than 50 mm are separated in gravity settling tanks. Using cyclone collectors or electrostatic precipitators separates fine particles.

g) **Checking vehicular pollution:** Vehicular pollution can be checked by regular tune-up of engines; replacement of more polluting old vehicles; installing catalytic converters.

SMOG

Smog is a form of air pollution in which smoke particles are mixed with fog.

Smog = Smoke + Fog

Types of Smog

i) **London smog:** This is mainly a product of burning large amounts of high sulfur coal. The main constituent of London-type smog is soot, fly ash, sulfur dioxide, sodium chloride and calcium sulfate particles. If concentrations are high enough, sulfur dioxide can react with atmospheric hydroxide to produce sulfuric acid. Due to the presence of reducing impurities it is known as reducing smog.

Health problems: SO_2 can severely affect respiratory system. Higher amounts of SO_2 can even lead to death. Great smog of London in 1952 caused death of more than 4000 people.

ii) **Los Angeles smog (Photochemical smog):** Commonly seen in the Los Angeles Basin, is mainly composed of ozone, volatile hydrocarbons (VOC), Peroxy acetyl nitrate (PAN), nitrogen dioxide etc. It usually happens in the noon, as the reactions forming smog are triggered by sunlight. Since it contains oxidizing impurities it is also known as oxidizing fog.

$$NO_2 + Sunlight \rightarrow NO + O.$$

$$O. + O_2 \rightarrow O_3$$

$$O_3 + NO \rightarrow O_2 + NO_2$$

Health problems: Ozone has the ability to oxidize and destroy lung tissue. Short term exposures to elevated levels of ozone (above 75 ppm) have been linked to a host of respiratory irritations including coughing, wheezing, difficulty in breathing etc.. Prolonged exposure to smog can cause a permanent reduction in lung function, elevate the risk of developing asthma.

A comparison of London smog and photochemical smog

	London smog	**Photochemical smog**
Name:	(New York smog, grey smog)	(L.A. smog, Denver smog, brown smog)
Weather:	It occurs early mornings.	It occurs during mid day (noon)
Content:	Particulates, Sulfur oxides	NO_x, ozone, PAN, hydrocarbons.
Sources:	Buring coal.	Gasoline, combustion. (primarily from automobile exhaust)
Nature	Reducing in nature	Oxidizing in nature

Particulate pollution

Particulate refers to small solid particles which remain in suspension in air. The smaller the particle size, the greater the total surface area per unit mass of particle, and so the higher the pollutant load that is likely to be carried.

Causes:

The main causes for particulate pollution are forest fires, volcanic eruptions, debris and fly ash formed by burning fuels, automobile exhaust etc.

Consequences:

Some of the consequences of particulate pollution are

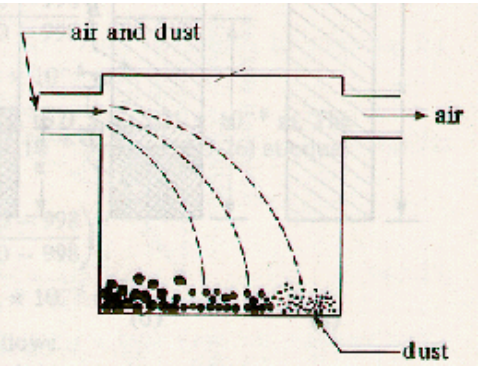
- Premature death in people with heart or lung disease,
- Nonfatal heart attacks,
- Irregular heartbeat,
- Aggravated asthma,
- Decreased lung function, and
- Increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

AIR POLLUTION CONTROL DEVICES

There are five main categories of particulate control devices which are widely used.

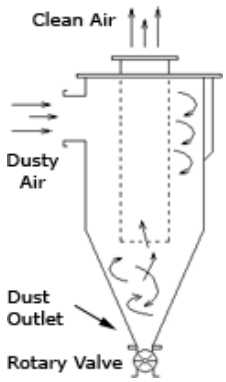
- **i) Gravity settling chamber**

  As the name implies, this depends upon gravity settling to remove particles from the gas stream. Gravity settling chambers are used only for very large particles in the upper end of the supercoarse size range (approximately 75 micrometers and larger). The very low terminal settling velocities of most particles encountered in the field of air pollution limits the usefulness of gravity settling chambers.



- **ii) Cyclone collector**

In a Cyclone, the particulate matter is removed by centrifugal and inertial forces. This is induced by forcing particulate containing gas to change direction. It is provided after the settling chamber to collect the smaller particulate matter that could not be collected in the settling chamber. There are two main types of mechanical collectors: (1) large-diameter cyclones, and (2) small-diameter multi-cyclones. Large-diameter cyclones are usually one to six feet in diameter; while small-diameter multi-cyclones usually have diameters between 3 and 12 inches.



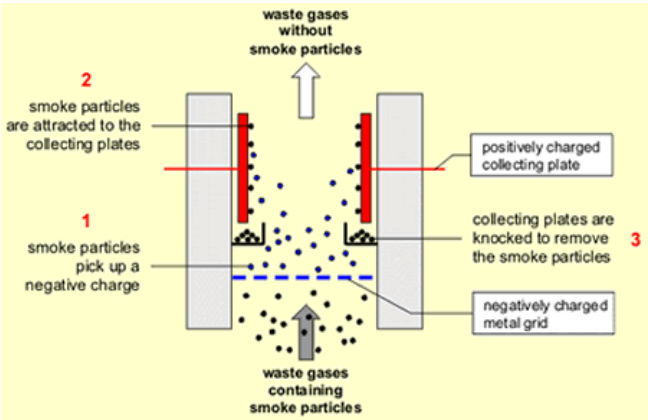
- **iii) Particulate wet scrubbers**

  In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid, by forcing it through a pool of liquid, or by some other contact method, so as to remove the pollutants. It is very useful in removing SO_2 and other small particulate matter.

  Advantages of wet scrubbers

- Wet scrubbers have the ability to handle high temperatures and moisture.
- Wet scrubbers can remove both gases and particulate matter.
- Wet scrubbers can neutralize corrosive gases.
- **iv) Electrostatic precipitators**

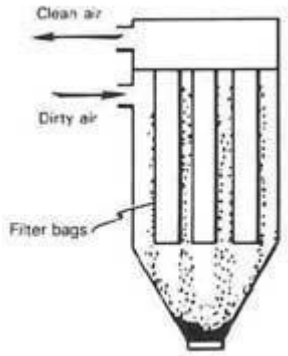
  An electrostatic precipitator (ESP) uses non-uniform, high-voltage fields to apply large electrical charges to particles moving through the field. The charged particles move toward an oppositely charged collection surface, where they accumulate.



- **v) Fabric filters**

Fabric filters collect particulate matter on the surfaces of filter bags. They are one of the most efficient and cost effective types of dust collectors available and can achieve a collection efficiency of more than 99% for very fine particulates.

Dust-laden gases enter the bag house and pass through fabric bags that act as filters. The bags can be of woven or felted cotton, synthetic, or glass-fiber material in either a tube or envelope shape.



Baghouse

Indoor Air Pollution

The most important indoor air pollutant is **radon gas**. Radon gas is responsible for a large number of lung cancer deaths each year. Radon can be emitted from building materials like bricks, concrete, tiles etc. which are derived from soil containing radium. Radon is also present in groundwater and natural gas and is emitted indoors while using them.

Many houses in the under-developed and developing countries including India use fuels like coal, dung-cakes, wood and kerosene in their kitchens. Incomplete combustion produces the toxic gas carbon monoxide. Coal contains varying amounts of sulphur which on burning produces sulphur dioxide

AIR POLLUTION- CASE STUDY

BHOPAL GAS TRAGEDY

Place: Bhopal, Madhya Pradesh.

Date: Night of 2nd and morning of 3rd December, 1984

Company: Union Carbide India Limited (UCIL)

Gas responsible: Methyl isocyanate (MIC). MIC was an intermediate used for the production of pesticide, Sevin.

Toxic effects of MIC: MIC is a volatile fluid with a boiling point of about 40˚C. MIC has an extremely irritating effect on mucous membrane. At higher concentrations, there are difficulties in breathing, with pressure over the chest and pain when inhaling. MIC also has an irritating effect on moist skin and may cause injury to the cornea of the eye.

Reason for the tragedy: The reason for the accident at Bhopal is assumed to have been that water entered the tank where about 40 ton MIC was stored. A combination of the human factor and an improper plant safety system also resulted in disaster.

Death: Four months after the tragedy, the Indian government reported to its parliament that 1,430 people had died. In 1991 the official Indian government panel charged with tabulating deaths and injuries updated the count to more than 3,800 dead and approximately 11,000 with disabilities. However it is unofficial death toll is expected to be much more.

Tragedy

During the night of 2–3 December 1984, water entered tank containing 40 tons of MIC. A runaway reaction started which was accelerated by contaminants, high temperatures and was catalyzed by iron (stainless steel pipelines).The resulting exothermic reaction increased the temperature inside the tank to over 200°C and raised the pressure forcing about 30 tons of MIC to escape. The gases were blown in southeastern direction over Bhopal. The huge cloud of deadly gas

quickly spread out from the factory and enveloped an area of over 20 square kilometers.

In the middle of the night, people living around the Union Carbide chemical factory in Bhopal woke up coughing, their eyes burning. Thousands died immediately. Panic broke out and the police instructed people to run away from the gas, but by doing so they inhaled even more gas. By morning streets of Bhopal was covered by corpses of humans and animals.

AFTER EFFECTS

UCC Chairman, CEO Warren Anderson was arrested and released on bail by the Madhya Pradesh Police in Bhopal on 7 December 1984. Legal battle is still going on between Union Carbide (now Dow Chemicals) and Indian authorities. Most of the victims and their families are yet to receive the compensation.

WATER POLLUTION

Water pollution is the any alteration in physical, chemical or biological characteristics of water making it unsuitable for domestic and industrial purposes often causing health hazard.

Sources of water pollution

i) **Point source:** It is single identifiable source of water pollution. Eg: Factory outlet, Power plant outlet.

ii) **Non point source:** It is difficult to trace the origin of these water pollutants. Eg: acid rain, percolation of fertilizer or pesticides into ground water.

Causes of water pollution

i) **Domestic sewage:** This includes household's wastes like food wastes, synthetic detergents used for washing clothes and cleaning bathrooms and latrines.

ii) **Industrial effluents:** Industrial wastes (Often untreated) are discharged into the nearby rivers and other water sources. Textiles,

sugar and fertilizers factories, oil refineries, drugs manufacture, rubber, and rayon fibers, the paper industries etc cause significant water pollution.

iii) **Agricultural sources:** Extensive use of fertilizers, pesticides, herbicides result in severe water pollution. From soil these reach water causing eutrophication, biomagnification etc.

iv) **Thermal pollution:** In power plants and nuclear power stations, water as coolant and becomes hot. The hot water on entering the main water body raises its temperature, which kills fishes and other aquatic life.

v) **Pathogenic organisms:** Sewage and domestic waste from houses introduces pathogenic organisms viz., protozoa, worms-eggs and bacteria into water. This contaminated water if consumed causes jaundice, typhoid, dysentery, cholera, etc

vi) **Waste heat:** Waste heat from industrial discharges increases the temperature of water bodies and affects distribution and survival of sensitive species.

Consequences of water pollution

Effects on ecosystem:

i) **Ecosystem destruction:** Different species living in water can get killed due to water pollution disrupting the entire ecosystem.

ii) **Eutrophication:** Excess of phosphates and nitrate may result in algal bloom called eutrophication. This may eventually lead to the death of the water body.

iii) **Loss of species:** Many organisms find hard to survive in polluted environment which may lead to migration or extinction of species. For eg: Acid rain severely affects mussels, oysters etc (shell made of $CaCO_3$)

iv) **Biomagnification:** Pesticide residues, heavy metals etc concentrate when passed through food chain or food web. While passing through the organisms, the concentration of pollutants gets increased, called biomagnification.

Effects on Human Health

i) **Heavy metals:** Compounds of mercury damages brain. Cadmium damages kidneys and liver. Lead compounds are known to affect the proper functioning of brain.

ii) **Water born diseases:** Water pollution makes water unfit for drinking purposes. Polluted water can cause certain waterborne diseases like diarrhea, typhoid, cholera, and jaundice.

iii) **Other complications/diseases:** Nitrate when present in excess in drinking water causes **blue baby syndrome.** Excess of fluoride in drinking water causes defects in teeth and bones called fluorosis. Nitrate in stomach partly gets changed into nitrites which can produce cancer-causing products in the stomach.

Effects on animal health

i) **Shortage of drinking water:** Water pollution may lead to severe scarcity in drinking water for animals. This may lead to large scale death of aquatic and terrestrial animals

ii) **Imbalance in the ecosystem:** Water pollution can lead to reduced reproduction rate, increased incidence of diseases, Imbalances created in secondary food chains.

CONTROL OF WATER POLLUTION

i) **Water treatment:** Domestic sewage and industrial wastes should be treated before discharging them into water bodies.

ii) **Minimal use of pesticides and fertilizers:** Use of pesticides, insecticides and fertilizers should be done judiciously. Rapid biodegradable substitutes for pesticides should be employed.

iii) **Afforestation and control of deforestation:** Planting trees would reduce pollution by sediments, silt and mud in the river banks.

iv) **Cooling towers/ponds:** These can be used to cool the hot water from industries before discharging into the rivers. This can control thermal pollution.

v) **Domestic methods:** Separate ponds and tanks to be used for cattle and animals. In towns where sewage facilities are not available, septic tanks should be made in the houses. Rivers and lakes should not be used for bathing or washing as it contaminates water.

SOME TERMINOLOGIES RELATED WITH WATER POLLUTION

Biochemical oxygen demand (BOD) is the oxygen demand using an oxygenated sample whereby the oxygen level is depleted by bacteria consuming the available organic material in the sample.

The result is that the oxygen content of the water will be decreased. Basically, the reaction for biochemical oxidation may be written as:

Oxidizable material + bacteria + nutrient + O_2 => CO_2 + H_2O + oxidized inorganics such as NO_3, SO_4^{2-}, etc.

Generally, it takes 5 days to perform the BOD test.

Chemical oxygen demand (COD) is typically determined by digesting the sample in a strong oxidizing agent under acidic conditions. This is a chemical method usually completed within few hours.

Waste Water Treatment

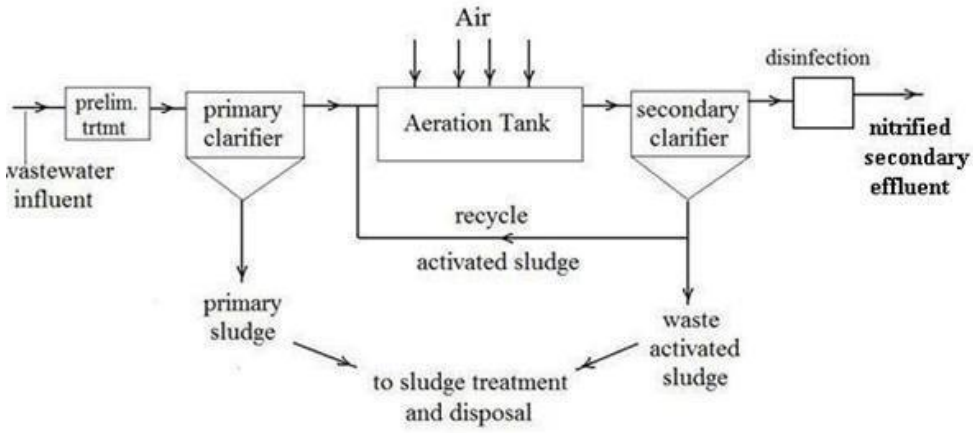
Domestic sewage and industrial wastes should be properly treated before these are drained in the mainstream water. The following are the various steps involved.

Primary treatment: It involves physical processing of sedimentation, flotation and filtration where sewage water is passed through screens to remove larger particles and then through grinding mechanism to reduce the larger particles to smaller size. The sewage is finally passed through settling tanks to remove suspended impurities.

Secondary treatment: Sewage obtained after primary treatment is sent to aeration tank where it is mixed with air and sludge laden with bacteria and algae. The algae provide oxygen to the bacteria and decompose organic matter into simple compounds (aerobic biological treatment processes). Most commonly employed method is **activated sludge process**.

Activated Sludge process

Primary effluent is mixed with return activated sludge to form mixed liquor. This is aerated for a specified length of time. During the aeration the activated sludge organisms use the available organic matter as food producing stable solids and more organisms. The suspended solids produced by the process and the additional organisms become part of the activated sludge. The solids are then separated from the wastewater in the settling tank. The solids are returned to the influent of the aeration tank (return activated sludge). Periodically the excess solids and organisms are removed from the system (waste activated sludge).



Activated Sludge Wastewater Treatment Flow Diagram

Tertiary treatment: Removal from wastewater of traces or organic chemicals and dissolved solids that remain after primary treatment and secondary treatment.

WATER POLLUTION –CASE STUDIES

MINIMATHA DIASTER

Minamata disease was discovered for the first time in the world at Minamata City, Japan, in 1956.

Place: Minamatha Bay, Japan

Date: In 1950's

Company: Chisso Corporation's chemical factory

Chemical responsible: Mercury compounds. Inorganic mercury salts used as catalyst for the preparation of acetaldehyde. These compounds were converted into highly toxic organic mercury species- methyl mercury, dimethyl mercury by microorganisms. This was consumed by weeds, small fishes and finally reached man. This was a classic example of biomagnification.

Health issues: Symptoms of Minamata disease include numbness in the limbs, difficulty in moving the hands and legs, a narrow vision, difficulty in hearing, hand and leg tremors, and movement disorders of the eyeballs, etc. In severe cases, people could become mad or unconscious, leading to death. Even in mild cases, symptoms such as headache, fatigue, and difficulty in tasting and smelling, etc. occur, bringing about obstacles in daily life. Animals were also severely affected. Cats became “mad” and “committed suicide”. Birds fell down from sky dead.

ITAI-ITAI DISEASE

Itai-itai disease (ouch-ouch sickness"), was a case of mass cadmium poisoning in Toyama Prefecture, Japan, starting around 1912. The cadmium poisoning caused softening of the bones and kidney failure. This disease made bone fragile and weak, when touched caused severe pain causing the victim to say “Ouch-Ouch” and hence the name. The disease is named for the severe pains caused in the joints and spine. The mining companies were successfully sued for the damage.

SOIL POLLUTION

Soil pollution is the presence of toxic chemicals (pollutants or contaminants) in soil in high enough concentrations to be of serious risk to health of living organisms or ecosystem.

Sources of Soil Pollution

The major sources of soil pollution are

i) **Industrial Wastes:** Many factories like sugar, cement, fertilizer, leather etc produces large amount of toxic solid wastes which causes severe soil pollution. Thermal power plants generate a large quantity of “Fly ash”. Industrial sludge may contain various salts, toxic substances, metals like mercury, lead, cadmium, arsenic etc.

i) **Urban Wastes:** Wastes likes plastics, glasses, garbage and rubbish materials, rubber etc from houses can pollute soil. Many of these are non-biodegradable and quite toxic.

ii) **Agricultural practices:** Fertilizers, Insecticides, fungicides, pesticides etc can accumulate in the soil. This can reduce the kill the useful microorganisms in the soil and finally enter the near by water bodies.

iv) **Radioactive pollutants:** Radioactive fallout from nuclear dust, laboratories may contain highly radioactive materials. Isotopes of radium, uranium, thorium, strontium, iodine, caesium etc reach the soil and persist there for a long time and keep on emitting radiations.

v) **Biological wastes:** Human and animal wastes (excreta) can contaminate soil. The sewage sludge contains many pathogenic organisms, bacteria, viruses and intestinal worms which cause soil pollution.

Effects of soil pollution

i) **Decrease in agricultural productivity:** Many waste materials like plastics, glass etc are non-biodegradable. Dumping them on land can change the pH of the soil, severely affect the fertility and hence productivity. Many of these substances are toxic for the useful micro organisms present in soil.

ii) **Ground water pollution:** Percolation of toxic wastes causes ground water pollution. Chemicals, pesticides, fertilizers from soil may percolate and contaminate ground-water resources.

iii) **Spread of diseases:** Pathogens present in the wastes and excreta contaminate the soil and vegetable crops causing diseases in man and domesticated animals.

iv) **Radiation sickness:** Radioactive fallout on vegetation is the source of radio-isotopes which enter the food chain in the grazing animals. Some of these radioisotopes replace essential elements in the body and cause abnormalities.e.g. strontium-90 instead of calcium gets deposited in the bones and tissues. The bones become brittle and prone to fracture.

v) **Salination of soil:** Increase in the concentration of soluble salts in soil is called salination. This adversely affects the quality and productivity of soil. Excessive irrigation led soil salinity, vegetation loss and turns into barren land

Control of soil pollution

i) **Recycling of soild wastes:** Materials like paper, glass and plastics can be recycled and reused. Metals should be recovered from scrap and disposed materials.

ii) **Use of eco-friendly agricultural methods:** Use of chemical fertilizers should be reduced by the use of bio fertilizers and manures. Use of pesticides can be reduced by adopting biological control of pests.

iii) **Proper disposal of solid wastes:** Solid wastes should be properly collected and disposed off by appropriate method.

iv) **Production of bio-manure/bio-gas from soild wastes:** Biodegradable organic waste should be used for generation of biogas. Cattle dung should be used for methane generation. Waste can be used for making compost manure.

NOISE POLLUTION

Noise pollution is excessive, displeasing human, animal, or machine-created environmental noise that disrupts the activity or balance of human or animal life.

Sound is measured in a unit called the **'Decibel'**. Ordinary conversation has a noise value of 60 decibels. If loudness exceeds 80 decibels, it can cause noise pollution. Noise becomes troublesome above 140 decibels.

Sources of Noise Pollution

i) **Transport/Traffic:** One of the main sources of noise are various modes of transportation (like air, road, rail-transportation). For example, noise caused by taking off and landing of airplanes exceed 110 db.

ii) **Industrial activity:** Use of sirens, heavy machines, engines, turbines, cutting, grinding etc causes significant noise pollution.

iii) **Domestic activity:** Use of grinders, food blenders, television, music system can produce unpleasant loud sound disturbing the neighborhood.

iv) **Celebrations:** People celebrate festivals by exploding crackers. There is a great concern over the noise levels generated during Diwali which involves extensive use of firecrackers.

Effects of Noise pollution

Noise pollution can cause the following effects.

i) **Hearing damage:** Noise can cause temporary or permanent hearing loss. It depends on intensity and duration of sound level. Auditory sensitivity is reduced with noise level of over 90 dB in the mid high frequency for more than a few minutes.

ii) **Physical and mental balance:** Constant noise affects a man physically and mentally. Physical effects include blood vessels to contract, skin to become pale, muscles to constrict and rise in blood pressure leading to tension, insomnia (sleeplessness) and nervousness. Lack of concentration anxiety, stress and mental fatigue are significant health effects of noise.

iii) **Interferes with man's communication:** In a noisy area communication is severely affected. This may increase the rate of accidents especially in industries.

iv) **Affects efficiency and productivity:** Noise pollution can also lead to lowered worker efficiency and productivity and higher accident rates on the job.

v) **Health effects:** Loud and sudden noise affects the brain. Intermittent noise leads higher incidence of psychiatric illness and also a danger to health of pregnant mothers and small infants.

Control of Noise Pollution

Following methods can control noise pollution:

i) **Reduction in sources of noise:** Sources of noise pollution like heavy vehicles and old vehicles may not be allowed to ply in the populated areas.

ii) **Proper maintenance:** Proper oiling will reduce the noise from the machinery and other moving parts.

iii) **Use of sound absorbing substances/silencers:** Use of substances that absorb sound or silencer in motor vehicles can reduce the intensity of noise pollution. Proper acoustics of buildings will reduce noise pollution.

iv) **Planting trees:** Plants and trees should be planted all around the hospitals, libraries and schools and colleges. These trees can absorb noise.

v) **Personal precaution:** Industrial workers should be provided with ear plugs or cotton plugs. Rooms in hospitals can be made sound proof. People should not cause nuisance to public by playing music, television very loud

vi) **Law enforcement:** Legislation can ensure that sound production is minimized at various festivals and social functions. Unnecessary horn blowing should be restricted especially in vehicle-congested areas. Fire crackers shall not be used at any time in silence zones, as defined by the Ministry of Environment and Forests.

THERMAL POLLUTION

Thermal pollution is a form of water pollution that refers to degradation of water quality by any process that changes ambient water temperature. It can be defined as presence of waste heat in the water which can cause undesirable changes in the natural environment.

Causes

i) **Industries:** Heat producing industries eg: thermal power plants, nuclear power plants, refineries, steel mills etc uses water for various purposes. Waste water, often above ambient temperature is discharged to nearby water body causing thermal pollution.

ii) **Nuclear power plants:** Nuclear power plants use water as coolant. After heat exchange water having higher temperature is discharged to water body.

iii) **Domestic homes:** Hot water discharged from homes (geyser) and kitchen can also cause thermal pollution.

Effects of Thermal pollution

i) **Reduction in amount of dissolved oxygen:** The dissolved oxygen content of water is decreased as the solubility of oxygen in water is decreased at high temperature. This can severely affect aquatic plants and animals as they depend of dissolved oxygen for photosynthesis.

ii) **Increased toxicity of chemicals at higher temperature:** Toxicity of pesticides, detergents and chemicals in the effluents increases with increase in temperature.

iii) **Migration of fishes:** Some of the less tolerant fishes migrate to cooler areas due to thermal pollution.

iv) **Change in the ecosystem:** The composition of flora and fauna of the ecosystem will change because the species sensitive to increased temperature due to thermal shock will be replaced by temperature tolerant species.

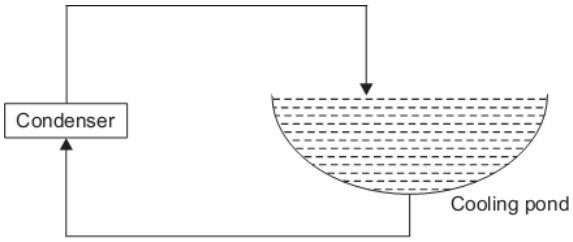
v) **Reduced fertility rate in fishes:** The eggs of fish may hatch early or fail to hatch at all causing decrease in population.

vi) **Change in metabolic activities:** Metabolic activities of aquatic organisms increase at high temperature and require more oxygen, whereas oxygen level falls under thermal pollution.

Control of Thermal pollution

The following methods can be employed for control of thermal pollution:
(i) Cooling ponds, (ii) Spray Ponds and (iii) Cooling towers.

(i) Cooling Ponds: The cooling pond receives thermal energy in the water from the thermal plant's condensers and water from condensers is stored in ponds. Energy is dissipated mainly through evaporation (natural evaporation cools the water). Once the water has cooled in the pond, it is reused by the plant or discharged in nearby water body. New water is added to the system to replace the water lost through evaporation.



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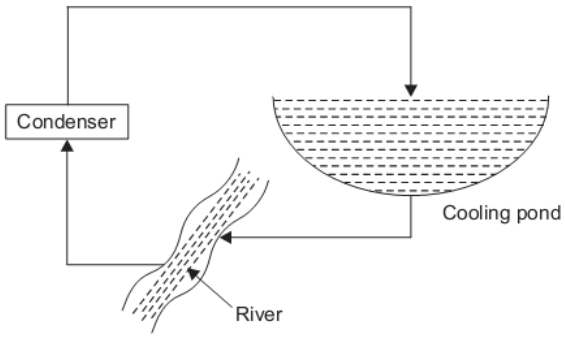
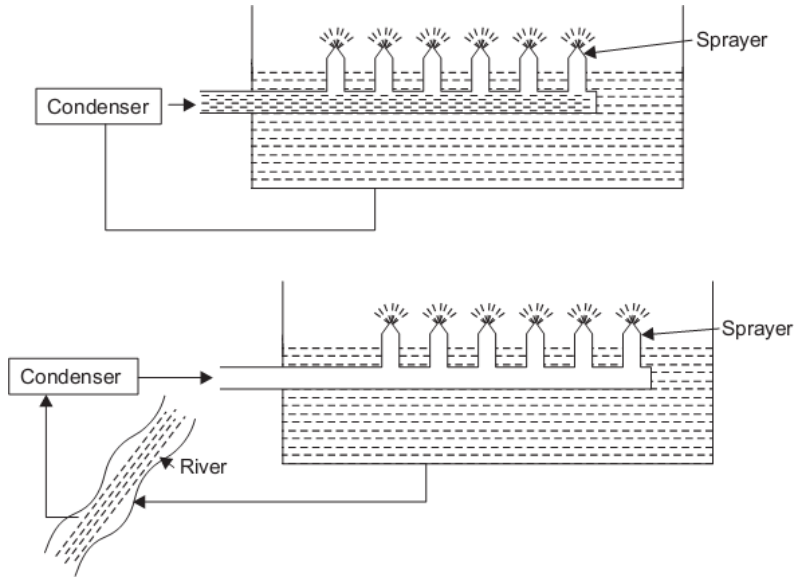
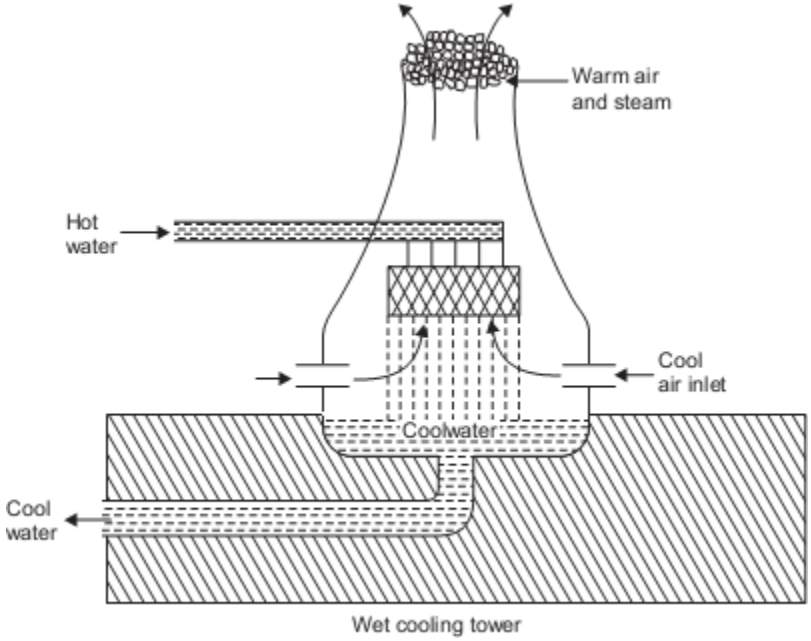


(ii) Spray Ponds: The water from condensers is received in spray ponds. Here the water is sprayed through nozzles where fine droplets are formed. Excess heat from these fine droplets is dissipated to the atmosphere.



(iii)Cooling Towers:

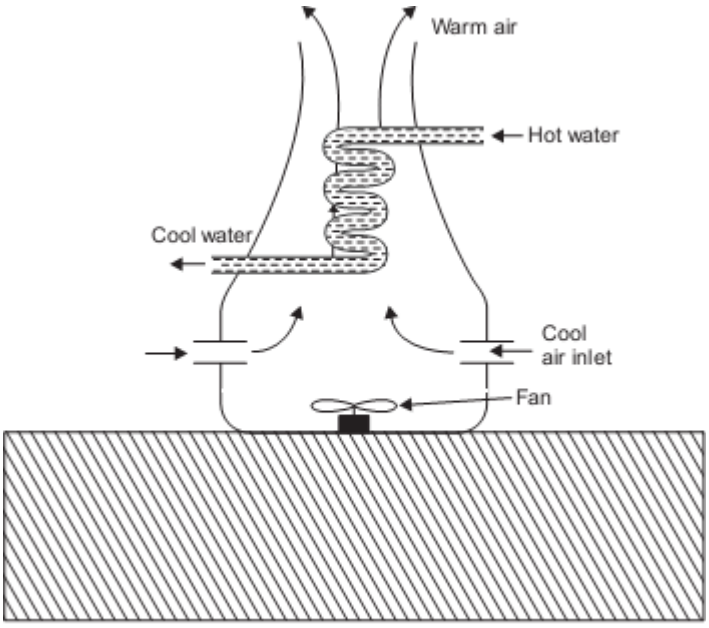
(a) Wet cooling tower: Hot water is sprayed over baffles. Cool air entering from sides takes away the heat and cools the water. This cool water can be recycled or discharged. Large amount of water is lost through evaporation.



Wet cooling tower

(b) Dry cooling tower: The heated water flows in a system of pipes. Air is passed over these hot pipes with fans. There is no

water loss in this method but installation and operation cost of dry cooling tower is many times higher than wet cooling tower.



Dry cooling tower

MARINE POLLUTION

Marine pollution: Discharge of waste substances into sea water resulting in harm to living resources, hazards to human health, hindrance to fishery and impairment of quality for use of sea water.

Causes of marine pollution

i) **Oil spillage:** Most important marine pollutant is oil. Tankers transporting oil contribute to oil pollution significantly. After delivering the oil through sea-route, earlier empty tankers used to be filled with water called ballast-water to maintain balance. The ballast-water containing residual oil from tankers was released into the sea on completion of return journey.

ii) **Heavy metals:** Heavy metals like lead, cadmium, mercury etc can reach sea through various rivers, sediments etc.

iii) Pesticides and Insecticides: Indiscriminate use of fertilizers and pesticides can lead to marine pollution. Finally these chemicals make their way into the ocean.

iv) Other man made pollutants: Plastics and other synthetic materials are light weight and non biodegradable. Hence cause a serious threat to marine life.

Effects of marine pollution

i) Oil: Oil in the sea water affects sensitive flora and fauna. Phytoplankton, zooplankton, algal species, various species of invertebrates, coral reefs, fish, birds and mammals are affected by oil pollution. Fishes show mortality (death) because the fish gills get laden with oil after the slimy mucus of gills is affected. Oil disrupts the insulating capacity of feathers. Death occurs due to loss of buoyancy and subsequent drowning of birds.

ii) Heavy metals: Heavy metals like mercury, cadmium, lead etc cause severe health hazards for aquatic flora and fauna.These metals can magnify over food chain (biomagnification)

iii) Pesticides and other chemicals: Many of the chemicals are non-bio degradable and stay in water for long time. Many pesticides like DDT can cause biomagnifications.

v) Plastics: Many animals like fishes, turtles consume plastic causing gastro-intestinal health problems.

Control measures of marine pollution

(i) Toxic pollutants from industries and sewage treatment plants should not be discharged in coastal waters.

(ii) Run off from non-point sources should be prevented to reach coastal areas.

(iii) Dumping of toxic, hazardous wastes and sewage sludge should be banned.

(iv) Developmental activities on coastal areas should be minimized.

(v) Oil and grease from service stations should be processed for reuse.

(vi) Oil ballast should not be dumped into sea.

(vii) Ecologically sensitive coastal areas should be protected by not allowing drilling.

NUCLEAR POLLUTION

Nuclear pollution is defined as the physical pollution of air, water or land by radioactive substances emitting harmful radiations which can cause health hazards to living beings.

Causes

i) **Natural causes:** Natural sources of radiation include cosmic rays coming from space. Radioactive Radon-222 present in rocks, Uranium, Thorium and other species present in rocks and minerals.

ii) **Anthropogenic causes:** These are some man made radiation sources.

a) Nuclear powerplants: Every nuclear power plant produces few kilogram highly radioactive wastes. Many of these wastes have long half life period and will continue to emit radiations for many years if not disposed properly.

b) Nuclear accidents: Accidents happening in a nuclear reactor may lead to the leakage of radioactive materials which can cause serious health concerns. Eg: Chernobyl reactor meltdown in 1986, Fukushima daiichi leakage in 2011.

c) Weapons of mass destruction: Many developed countries have the technology to prepare nuclear weapons. Use of these weapons can have pollute environment and can have devastating effects. Eg: Atomic Bomb dropped on Hiroshima and Nagasaki.

d) Laboratories: X-rays are widely used in hospitals. Radioactive materials are used in cancer therapy and treatment. These all can cause various problems.

Biological Effects of Radiations

i) **Death:** Very high radiation doses are found to be deleterious and may kill the organisms which are exposed within minutes.

ii) **Mutation:** Genetic damage is caused by radiations, which induce mutations in the DNA, thereby affecting genes and chromosomes. The damage is often seen in the off springs and may be transmitted upto several generations.

iii) **Cancer:** Radioactive iodine (I^{131}) accumulates in thyroid gland and causes thyroid cancer. Strontium-90 can replace calcium in the bones and causes leukemia or cancer of bone marrow. Ionizing radiations can also induce various types of cancer.

iv) **Somatic domages:** Somatic damage includes burns, miscarriages, eye cataract etc can happen if a person is exposed to radiation beyond permissible limit. Low level exposure can result in temporary decrease in Red blood cell count, Mild radiation sickness etc.

Control of Radiation pollution

i) **Nuclear powerplants:**

a) Location of nuclear power plants should be carefully done after studying long term and short term effects. It should be located in a place where density of population is very less.

b) Proper disposal of wastes, from both laboratories and nuclear power plants, should be done.

c) Better operator training and better instrumentation to avoid nuclear accidents.

d) Leakage of radioactive elements from nuclear reactors, laboratories, transport,careless handling and use of radioactive fuels should be checked.

e) Regular inspection of areas of nuclear activities for radiation level.

f) Workers in nuclear plants should be provided with nuclear gadgets and safety measures against accidents.

ii) **General awareness:** Public should be made aware about various hazards of nuclear radiation and should be educated about the precautionary measures to be taken, in case of a radioactive fall out.

Methods used for disposal of nuclear wastes

i) **Deep ocean disposal**: In this method, containers made of borosilicate glass are filled up with nuclear waste. This glass has the capacity to prevent any nuclear radiation from leaking out. The container is enclosed in yet another water-tight metal container and dumped into the ocean. Though these containers are said to be leak-proof, there is a possibility that a minor quantity of radiation can escape from these containers.

ii) **Deep geological burial:** The containers used in this method are similar to the ones used in the deep ocean disposal system. But in this case, the containers are buried deep underground, in less-populated areas. This method depends on the natural decaying ability of the radioactive material for its success. The materials are buried deep under the earth for thousands of years and allowed to settle into a safe level of radioactivity.

iii) **Nuclear waste recycling:** This is a new waste disposal method being looked into, in which the uranium, plutonium and other fission products are separated into different streams using chemical processes. The advantage of doing this is that these products can be re-used or disposed of more easily. However, the recycling process is not feasible at present because many countries do not have proper facilities to implement this method, and it is also a costly process.

CASE STUDIES

HIROSHIMA AND NAGASAKI INCIDENT

Place: Hiroshima and Nagasaki

Date: August 6,1945 at 8:15 a.m and August 9,1945 at 11:02 am

Name of the bomb: Little boy and Fat man. Little Boy was a relatively simple, uranium 235-based bomb, and was never tested before being exploded over Hiroshima. Fat Man, the Nagasaki bomb, was a more complex plutonium bomb.

Reason: Attack of Japan on Pearl harbour.

Hiroshima Bombing: This atomic bomb, the equivalent of 20,000 tons of TNT was dropped in the city. In minutes, half of the city vanished. According to U.S. estimates, 80,000 people were instantly vaporized. 140,000 were injured many more were made homeless as a result of the bomb. Deadly radiation reached over 100,000. In the blast, thousands died instantly. The city was unbelievably devastated. Of its 90,000 buildings, over 60,000 were demolished. About 30 minutes after the explosion, a heavy rain began falling in areas to the northwest of the city. This "black rain" was full of dirt, dust, soot and highly radioactive particles that were sucked up into the air at the time of the explosion and during the fire. It caused contamination even in areas that were remote from the explosion.

Nagasaki Bombing: At 11:02 a.m., the atomic bomb, "Fat Man," was dropped over Nagasaki. It was a plutonium based atomic bomb. Of the 286,000 people living in Nagasaki at the time of the blast, 74,000 people were killed and another 75,000 sustained severe injuries. More than forty percent of the city was destroyed. Major hospitals had been utterly flattened and care for the injured was impossible. Schools, churches, and homes had simply disappeared. Transportation was impossible.

Since radiations from nuclear elements remain active even after, the generations to follow up also suffered from various diseases. Even the

babies in the mother's womb were affected and a few perished. Blindness, deafness, skin diseases and cancers, distortion of bones and other parts became the fortune of human civilization. For decades abnormally high amounts of cancer, birth defects, and tumors haunted victims in both Hiroshima and Nagasaki.

CHERNOBYL DISASTER

Place: Chernobyl nuclear power plant, Ukraine

Date: 26 April, 1986

Reason: Faulty operations of shutting down the plant

Incident: On 26 April, 1986 the accident occurred at the reactor of the Chernobyl power plant designed to produce 1000 MW electrical energy. The reactor had been working continuously for 2 years. It was shut down on April 25, 1986 for intermediate repairs. Top executives were busy in the preparations for national holiday, The May Day. Due to faulty operations of shutting down the plant, an explosion occurred in the reactor at 01.23 hrs on April 26, 1986. Three seconds later another explosion occurred. The explosion was so severe that the 1000 tonne steel concrete lid of the reactor 4 blew off. Fire started at the reactor due to combustion of graphite rods. The reactor temperature soared to more than 2000°C. Fuel and radioactive debris spewed out in a volcanic cloud of molten mass of the core and gases. The debris and gases drifted over most of the northern hemisphere. Belarus, Poland, Denmark, Sweden and Norway were affected.

On first day of the accident 31 persons died and 239 people were hospitalized. Since the cloud was rich in Iodine-131, Cesium-134 and Cesium-137, it was feared that some of the 5,76,000 people exposed to the radiations would suffer from cancer specially thyroid cancer and leukaemia. Children were more susceptible as I-131 is ingested mainly through milk and milk products. Since children consume more milk and their thyroid glands are in the growing stage, an increase in thyroid cancer

in children from areas near Chernobyl was registered. People suffered from ulcerating skin, loss of hair, nausea and anemia. Agricultural produce was damaged for years. Intense radiations destroyed several fields, trees, shrubs, plants etc. Flora and fauna were destroyed. Blood abnormalities, hemorrhagic diseases, changes in lungs, eye diseases, cataract, and reproductive failure and cancer cases increased.

FUKUSHIMA DAIICHI NUCLEAR DISASTER

The **Fukushima Daiichi nuclear disaster** was a series of equipment failures, nuclear meltdowns, and releases of radioactive materials at the Fukushima I Nuclear Power Plant, following the Tōhoku earthquake and tsunami on 11 March 2011.It is the largest nuclear disaster since the Chernobyl disaster of 1986.

The plant comprises six separate boiling water reactors originally designed by General Electric (GE), and maintained by the Tokyo Electric Power Company (TEPCO). At the time of the quake, Reactor 4 had been de-fuelled while 5 and 6 were in cold shutdown for plant maintenance. The remaining reactors shut down automatically after the earthquake, and emergency generators came online to control electronics and coolant systems. The tsunami resulted in flooding of the rooms containing the emergency generators. Consequently those generators ceased working, causing eventual power loss to the pumps that circulate coolant water in the reactor. The pumps then stopped working, causing the reactors to overheat, even after a nuclear reactor shut down. The flooding and earthquake damage hindered external assistance.

In the hours and days that followed, Reactors 1, 2 and 3 experienced full meltdown. As workers struggled to cool and shut down the reactors, several chemical explosions occurred. As the water levels in the fuel rods

pools dropped, they began to overheat. Fears of radioactivity releases led to a 20 km (12 mi)-radius evacuation around the plant.

It was given maximum value of 7 in International Nuclear Event Scale (INES). The Japanese government estimates the total amount of radioactivity released into the atmosphere was approximately one-tenth as much as was released during the Chernobyl disaster. Significant amounts of radioactive material have also been released into ground and ocean waters. Measurements taken by the Japanese government 30–50 km from the plant showed caesium-137 levels high enough to cause concern, leading the government to ban the sale of food grown in the area. Tokyo officials temporarily recommended that tap water should not be used to prepare food for infants. A few of the plant's workers were severely injured or killed by the disaster conditions resulting from the earthquake. There were no immediate deaths due to direct radiation exposures, many workers received significant radiation doses. On 16 December 2011, Japanese authorities declared the plant to be stable, although it would take decades to decontaminate the surrounding areas and to decommission the plant altogether.

ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

The role of an individual in maintaining a pollution free, pure and congenial environment and in preserving its resources is actually the need of the hour. Every human being has the responsibility to protect the mother earth. A small effort made by each individual at his own place will have pronounced effect at the global level. It is aptly said, **“Think globally act locally”**.

Individuals can play an important role in abatement of air, water, soil or noise pollution. Some roles are given below.

Air pollution reduction

i) Maintenance of vehicles should remain proper as to avoid introduction of harmful gases and other pollutants in to the atmosphere.
ii) Cut down the use of chlorofluorocarbons (CFCs) as they destroy the ozone layer.
iii) Use CFC free refrigerators.
iv) Use of less polluting fuels like hydrogen, natural gas instead of coal, petrol etc. Reduce your dependency on fossil fuel especially coal or oil.
v) Use mass transport system. For short-visits use bicycle or go on foot. Decrease the use of automobiles.
vi) Plant more trees, as trees can absorb many toxic gases and can purify the air by releasing oxygen.
vii) Help more in pollution prevention than pollution control.

Water pollution reduction

i) Use pesticides only when absolutely necessary and that too in right amounts. Wherever possible integrated pest management, including alternate pest control methods (biological control), should be used.
ii) Use low phosphate, phosphate-free or biodegradable dish washing liquid, laundry detergent and shampoo. This will reduce eutrophication of water bodies.
iii) Use organic manure instead of commercial inorganic fertilizers.
iv) Do not put pesticides, paints, solvents, oils or other harmful chemicals into the drain or ground water.
v) Industrialists should check for proper disposal of treated water from factory units as to avoid thermal pollution of water bodies. They should also deploy a water treatment plant to prevent the flow of hazardous material.
vi) Don't wash laundry, vehicles or clean vessels in open water bodies.

Soil pollution reduction

i) Use rechargeable batteries. Rechargeable batteries will reduce metal pollution.
ii) The solid waste generated during one manufacturing process can be used as a raw material for some other processes.
iii) Promote reuse and recycling wherever possible and reduce the production of solid wastes.
iv) Biodegradable materials can be converted into compost or maure or for the production of bio-gas.
v) Timely disposal of waste to prevent decomposition of household refuge as to check foul odours and spread of disease by insects, flies and other pathogenic bacteria.

Noise pollution reduction

i) Music lovers should listen and operate their music systems at optimum levels as to avoid noise pollution.
ii) Minimize the use of loud speakers and other devices which produce noise.
iii) Proper maintenance of vehicles to prevent making loud noise.
iv) Planting trees can help in reduction of noise pollution.
v) Limit the use of crackers during festival season. See to it that crackers don't produce unbearable noise.
vi) The use of horn while driving should be minimized.

SOLID WASTE MANAGEMENT

Solid waste can be classified as municipal, industrial, agricultural, medical, mining waste and sewage sludge.

Sources of wastes:

Waste from homes (Domestic waste) - polyethylene bags, empty metal and aluminum cans, scrap metals, glass bottles, waste paper, diapers, cloth/rags, food waste etc.

Waste from shops - waste paper, packaging material, cans, bottles, plastic bags, peanut shells, eggshells, tea leaves etc.

Biomedical waste- anatomical wastes, pathological wastes, infectious wastes etc.

Construction/demolition waste- rubbles, wood, concrete etc.

Industrial waste- Factory rubbish, packaging material, organic wastes, acids, alkalis and metals, radioactive wastes, fly ash, scrap metal, rubber, plastic, paper, glass, wood, oils, paints, , tars, dyes, scrap leather, ceramics, abrasives, slag, heavy metals, asbestos, batteries etc.

Classification:

Biodegradable wastes: The solid waste materials that can be degraded by micro-organisms. Eg: vegetable wastes, stale food, tea leaves, egg shells, dry leaves etc.

Non-biodegradable wastes: Wastes that cannot be degraded by micro-organisms. Eg: polyethylene bags, scrap metal, glass bottles etc.

Different steps in solid waste management are

a) Collection b) Segregation c) Storage d)Transportation e) Processing f) Disposal

a) Collection: Waste from our homes is generally collected by our local authorities through regular waste collection, or by special collections for recycling.

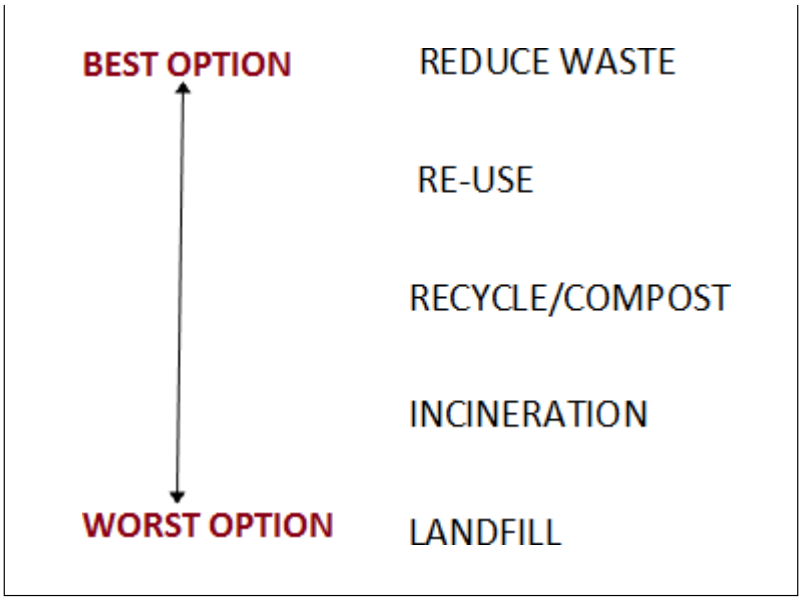
b) Segregation: This includes organizing awareness programmes for segregation of wastes and shall promote recycling or reuse of segregated materials. Recycling is the reprocessing of discarded materials into new useful products. Thus from this definition recycling occurs in three phases: first the waste is sorted and recyclables collected, the recyclables are used to create raw materials. These raw materials are then used in the production of new products. The process of reducing, reusing and recycling saves money, energy, raw materials, land space and also reduces pollution. Recycling of paper will reduce cutting of trees for

making fresh paper. Reuse of metals will reduce mining of ores, preventing pollution.

c) **Storage:** Collected waste materials are stored in such a manner as they do not create unhygienic and insanitary conditions around it. Wastes stored are not exposed to open atmosphere. Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black.

d) **Transportation:** Vehicles used for transportation of wastes shall be covered. Waste should not be visible to public, nor exposed to open environment preventing their scattering.

e) **Processing:** Treatment methods are selected based on the composition, quantity, and form of the waste material. Treatment and disposal options are chosen as a last resort to the previously mentioned management strategies reducing, reusing and recycling of waste**.**



Incineration: Incineration is the most common thermal treatment process. This is the combustion of waste in the presence of oxygen. After incineration, the wastes are converted to carbon dioxide, water vapour and ash. Incineration technologies have the advantage of reducing the

volume of the waste, rendering it harmless and reducing transportation costs. During incineration high levels of toxic dioxins, furans, lead and cadmium may be emitted with the fly ash of incinerator.

Pyrolysis and Gasification: Pyrolysis and gasification are similar processes which decompose organic waste by exposing it to high temperatures and low amounts of oxygen. Gasification uses a low oxygen environment while pyrolysis allows no oxygen. These techniques use heat and an oxygen starved environment to convert biomass into other forms.

Composting: Composting is the controlled aerobic decomposition of organic matter by the action of micro organisms and small invertebrates. The process is controlled by making the environmental conditions optimum for the waste decomposers to thrive. The rate of compost formation is controlled by the composition and constituents of the materials i.e. their Carbon/Nitrogen (C/N) ratio, temperature, moisture content and the amount of air. Correct C/N ratio, optimum temperature of 50-60 C, moderate moisture levels and sufficient oxygen or air is required for composting. Most widely used composting is vermicomposting-using earthworms.

Sanitary landfill: Sanitary Landfills are designed to greatly reduce or eliminate the risks that waste disposal may pose to the public health and environmental quality.In a sanitary landfill, garbage is spread out in thin layers, compacted and covered with clay or plastic foam.In the modern landfills the bottom is covered with an impermeable liner, usually several layers of clay, thick plastic and sand. The liner protects the ground water from being contaminated due to percolation of leachate. Leachate from bottom is pumped and sent for treatment. When landfill is full it is covered with clay, sand, gravel and top soil to prevent seepage of water. Several wells are drilled near the landfill site to monitor if any leakage is contaminating ground water. Methane produced by anaerobic decomposition is collected and burnt to produce electricity or heat.

DIASTER MANAGEMENT

Disaster: A sudden event, such as an accident or a natural catastrophe, that causes great damage or loss of life.

Disasters are mainly of two types,

1. **Natural disasters:** Example – earthquakes, floods, cyclones,landslides, etc.
2. **Manmade disasters:** Example – war, bomb blasts, chemical leaks, etc.

Diaster management: Disaster/emergency management involves preparing for a disaster before it happens, disaster response (e.g. emergency evacuation, quarantine, mass decontamination, etc.), as well as supporting, and rebuilding society after natural or human-made disasters have occurred. The main aim of disaster management is to reduce the impact of diaster though we cannot prevent the disaster itself.

The process of disaster management involves four phases: **mitigation, preparedness, response, and recovery.**

i) **Mitigation:** Mitigation efforts attempt to prevent hazards from developing into disasters or to reduce the effects of disasters when they occur. It focuses on long-term measures for reducing or eliminating risk. Mitigation involves Structural and Non-structural measures taken to limit the impact of disasters.

Structural Mitigation: This involves proper layout of building, particularly to make it resistant to disasters.

Non Structural Mitigation: This involves measures taken other than improving the structure of building. For example, earthquakes happen on daily basis in Japan. To reduce the impact of the earthquake, houses are made of wood rather than concrete.

ii) **Preparedness:** Plans or preparations made to save live or property, and help the response and rescue service operations. This phase covers implementation /operation,early warning systems and capacity building so the population will react appropriately when an early warning is issued.

iii) **Response:** This includes actions taken to save lives and prevent property damage, and to preserve the environment during emergencies or disasters. The response phase is the implementation of action plans like emergency evacuation, quarantine, mass decontamination, etc.

iv) **Recovery:** This includes actions that assist a community to return to a sense of normalcy after a disaster. Recovery efforts are primarily concerned with actions that involve rebuilding destroyed property, re-employment, and the repair of other essential infrastructure.

FLOODS

Floods are defined as a relatively high flow of water discharged from river and stream network, which sets the riverbank margins to overflow and lead to the inundation of low land areas surrounding the riverbed.

Floods arise from abnormally heavy rains, dam failures, snow melts, river blockages.

Types of Floods

Floods can be classified into three categories as under:

(i) River floods

Rivers carry water above its carrying capacity due to heavy rains or by melting of snow or sometimes both especially in the mountainous tracts.

(ii) Coastal floods

Coastal flooding is associated with tropical cyclones/ harsh winds arising at the ocean surface. Prolonged and indefinite rains in the rainy season marked from June-September results in extreme flood in coastal river basins.

(iii) Flash floods

These floods occur within six hours of the beginning of rainfall and are characterized with rising clouds, thunderstorms and tropical cyclones. These result from runoff from a torrential downpour, particularly if the catchments slope is unable to absorb and hold a significant part of water. Other causes of flash floods include dam failure, sudden break up of glaciers etc.

Effects of Floods

1. Rising water, erosion and the force damages the residential and commercial building. They are dangerous for villages lying in the coastal areas as it sweeps away everything, which comes into its path. In mountainous areas it is the chief cause of landslides.
2. Fisherman, local people, cattle, animals and vegetation suffer a great loss of life and property. Most of the deaths are reported to be from drowning.
3. Fresh water supplies by all sources are nearly destroyed and contaminated hence the areas falling under its impact bear a great risk of suffering from water borne diseases.
4. The destruction of food and fodder crops result in acute food shortage.
5. Floods also make soil infertile, as the topsoil is lost due to erosional activity.
6. Floods are also known to preserve, wetlands and recharge ground water.

Flood Control

1. Depth and width of the riverbed could be increased as its capacity to carry larger loads increases manifold and thus reduce the area of the flood plain.

2. A network of canals can be established from the river systems, which generally leads to floods. This would also benefit the agricultural economy/ section.
3. Reservoirs should be made for storing floodwater and releasing them at manageable rates. This would require careful engineering. Dams, and reservoirs would further lead to generation of resources.
4. Newly constructed residential as well commercial buildings should have foundations, which are strong enough to respond to flood conditions.
5. Rivers and streambeds should be stabilized with stone, masonry or vegetation at the banks. This should strictly be followed where rivers pass through cities, especially near bridges.

Post Disaster Requirements

Primary response: Search and Rescue operations, water provision, Medical assistance, Disaster epidemiological surveillance assessment, food and and temporary shelter.

Secondary response: Reconstruction of houses, equipment and tools, supply Creation of employment, of animals, and assist with assistance to farmers, recovery of small business, Distribution of farm and fisheries.

Two great river systems cause serious flood problems in India: **Brahmputra River and River Ganges.**

The main problem of flooding in the northeastern region arises from the Brahmaputra river and its tributaries. The river in monsoon season overflows its banks and causes a great damage to life and property both. Several times it has affected Kaziranga wildlife sanctuary where rhinoceros population died due to rising floods.

Northern tributaries of the Ganga, namely the Rapti, the Sharada,the Ghaghra and the Gandak cause extensive flooding along their banks. Damodar cause extensive flooding. In Delhi and Haryana it is the Yamuna, the biggest tributary of the Ganga, which causes a marginal amount of flooding.

FLOOD MITIGATION		
Before the Disaster	**During the Disaster**	**After the Disaster**
• Learn warning signs and community alert systems • Stockpile emergency building materials • Install check valves in sewer traps to prevent flood waters from backing up in sewer drains • Plan and practice an evacuation route • Have disaster supplies on hand • Develop an emergency communication plan in case of separation • Ask an out-of-state relative to serve as the "family contact" • Teach family members how and when to turn off the gas, electricity, and water and teach children how and when to call emergency numbers • Ask your insurance agent about flood insurance	During a flood watch: If indoors: • Turn on battery operated radio to get latest emergency information • Get pre-assembled emergency supplies • If told to leave, do so immediately. If outdoors: • Climb to high ground and stay there • Avoid walking through any floodwaters. • If in a car, turn around and go another way; if your car stalls, abandon it immediately and climb to higher ground. During an evacuation: • If advised to evacuate, do so immediately to avoid flooded roads, being sure to follow recommended evacuation routes and listen to radio for evacuation instructions	• Don't return home until authorities express it is safe to do so • Help neighbors whom may need assistance • Use extreme caution when entering buildings • Inspect foundations for cracks or other damage and examine walls, floors, doors, and windows to make sure that the building is not in danger of collapsing • Watch out for animals, especially poisonous snakes, that may have come into your home with flood waters • Watch for loose plaster and ceilings that could fall • Take pictures of damage for insurance claims • Look for fire hazards • Throw away all food came in contact with flood waters • Pump out flooded basements gradually to avoid structural damage • Service damaged septic tanks and leaching systems ASAP - damaged sewage systems are health hazards.

EARTH QUAKE

An earthquake is a motion of the ground surface, ranging from a faint tremor to a wild motion capable of shaking buildings apart and causing gaping fissures to open in the ground.

The point on a fault at which the first movement occurs during an earthquake is called the **epicenter**. The **Richter scale** devised by Charles Richter in 1935 measures the magnitude or intensity of energy released by an earthquake. The severity of an earthquake is generally measured by its magnitude on Richter Scale, as shown below

Richter Scale	*Severity of earthquake*
Less than 4	Insignificant
4 - 4.9	Minor
5 - 5.9	Damaging
6 - 6.9	Destructive
7 - 7.9	Major
More than 8	Great

The science that studies the behavior and patterns of seismic waves is called **seismology**.

Causes of Earthquakes

Earthquakes are caused mainly due to disequilibria in any part of the crust of the earth. Some reasons are

(1) Volcanic activity

Volcanic activity is considered to be one of the major causes of earthquakes. Volcanic activity and seismic events are so intimately related to each other that they become cause and effect for each other. Earthquakes follow each volcanic eruption and many of the severe earthquakes cause volcanic eruptions. Violent gases during the process of volcanic eruption to escape upward and hence they push the crystal surface from below with great force and thus cause severe earth tremors of high magnitude. **Eg:** The famous eruption of Cracatoa on August 26, 1883 sent up a plume of ash and debris 26 kilometers high and 6,000 kilometers

wide, and the explosion could be heard from Myanmar to Australia. The huge tidal waves created by the explosion destroyed 165 villages in Sumatra and Java, killing more than 36,000 people.

(2) Hydrostatic Pressure and Anthropogenic Causes

Certain human activities such as pumping of ground water and oil, deep underground mining, blasting of rocks by dynamites for constructional purposes, nuclear explosion, storage of huge volume of water in big reservoirs etc. also cause earth tremors. Construction of large dams and enormous volume of water in big reservoirs behind the dams cause disequilibria of adjusted rocks below the reservoirs.

(3) Plate Tectonic Theory

The earth is composed of solid and moving plates having either continental crust or oceanic crust or even both continental oceanic crusts. The earth's crust consists of 6 major plates (Eurasian plate, American plate, African plate, Indian plate, Pacific plate and Antarctic plate) and 20 minor plates. These plates are constantly moving in relation to each other. Collision of plates can cause earthquakes.

Effects of Earthquake

(i) Landslides

Weaker landmasses and tectonically sensitive land margins cause landslides and debris falls, which damage settlements and transport systems on the lower slope segments.

(ii) Damage to Life and property

Structures such as buildings, roads, rails, factories, dams, bridges suffer a huge damage thus causing a heavy loss of human life and property both.

(iii) Damages to Government Infrastructure

Cities and towns are worst affected due to large concentration of human population, commercial complexes and residential areas. Due to collapse of large buildings there is greater loss of life and property. Due to collapse of buildings ground water pipes are bent and damaged thus water supply is disrupted,

electric and telephone poles are uprooted and there is total disruption of power and communication. Other side effects are collapsed sewage system causing epidemics, roadblocks etc.

(iv) Fire Hazard

Earthquakes strongly shake the buildings and thus strong oscillations cause severe fires in houses, mines and factories because of overturning of cooking gas cylinders, contact of live electric wires, churning of blast furnaces, displacement of other electric and fire-related appliances.

(v) Landmass Deformation

Severe earth tremors and resultant, vibrations caused by severe earthquakes result in the deformation of ground surface because of crusts and troughs in the ground surface and faulting activity.

(vi) Flash Floods

Strong seismic events result in the damages of dams and cause severe flash floods. Severe floods are also caused because of blocking of water flow of rivers due to rock blocks and debris produced by severe tremors on the hill slopes facing the river valleys.

(vii) Tsunamis

The seismic waves, caused by the earthquakes traveling through seawater, generate high sea waves and cause great loss of life and property. Since the Pacific Ocean is girdled by the earthquakes and volcanoes, tsunamis are more common in the pacific with a minimum frequency of 2 tsunamis per year.

EARTHQUAKE MITIGATION		
Before the Disaster	**During the Disaster**	**After the Disaster**
• Check for hazards in the home • Identify safe places in each room • Locate safe places outdoors • Ensure all family members know how to respond after an earthquake • Teach children when and how to call emergency numbers • Have disaster supplies on • Develop an emergency communications plan in case of separation during the earthquake • Ask an out-of-state relative or friend to serve as the family contact	• If indoors: Take cover under a piece of heavy furniture or against an inside wall and stay inside • If outdoors: Move into the open, away from buildings, street lights, and utility wires and remain there until shaking stops • If in a moving vehicle: Stop quickly, stay in vehicle, move to a clear area away from buildings, trees, overpasses, or utility wires	• Be prepared for after shocks • Help injured or trapped persons and give first aid where appropriate • Listen to a battery operated radio for emergency information • Stay out of damaged buildings and return home only when authorities say it is safe

CYCLONES

Cyclones are the centers of low pressure characterized by inward spiraling winds that rotate counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere of the Earth. They range in shape from circular, elliptical to V shape. From locational viewpoint cyclones are classified into two principal types e.g. i) temperate cyclones ii) tropical cyclones.

Temperate cyclones are those which occur in mid latitudes i.e. 40^0 to 60^0 N & S. These are formed due to convergence of the warm (tropical) and Cold (Polar) air masses.

Tropical cyclones are those which occur in lower latitudes, normally 10^0 to 30^0 N & S latitudes and are caused due to the convergence of warm dry and warm moist air masses.

One of the requirements for formation of tropical cyclones is that the sea surface temperature (SST) should be above 26°C. Tropical cyclones move like a spinning top at the speed of 10-30 Km per hour. They can last for a week or so and have a diameter varying between 100 to 1500 Km.

Tropical cyclones are called **hurricanes** in the Atlantic, Caribbean and north eastern Pacific, **typhoons** in the western Pacific and '**cyclones** in the Indian Ocean and **willy willies** in the sea around Australia.

Environmental Impact of Cyclones

The destruction from a tropical cyclone depends mainly on its intensity, its size, and its location.

i) **Change in weather:** The main effects of tropical cyclones include heavy rain, strong wind, large storm surges at landfall, and tornadoes.

ii) **Destruction to life and property:** Cyclones can inflict heavy loss to human lives and property in terms of destruction of buildings, transport systems, water and power supply systems, disruption of communication system, destruction of standing agricultural crops, domestic and wild animals, natural vegetation, private and public institutions etc. Nearly two million people have died globally due to tropical cyclones.

iii) **Change in landscape:** Tropical cyclones act to remove forest canopy as well as change the landscape near coastal areas, by moving and reshaping sand dunes and causing extensive erosion along the coast.

iv) **Spread of diseases:** Standing water can cause the spread of disease, and transportation or communications infrastructure may have been destroyed, hampering clean-up and rescue efforts.

HURRICANE MITIGATION

Before the Disaster	During the Disaster	After the Disaster
• Plan an evacuation route and learn safe routes inland • Have disaster supplies on hand • Develop an emergency communication plan in case of separation • Ask an out-of-state relative to serve as the "family contact" • Teach family members when and how to turn off gas and electricity • Trim back dead or weak branches from trees • Check into flood insurance • Teach children when and how to call emergency numbers • Make arrangements for family pets because some emergency shelters may not allow pets	Hurricane Watch (conditions within 24-36 hours): • Listen to battery-operated radio for progress reports; check emergency supplies • Fuel car • Bring in outdoor objects • Secure buildings by closing and boarding up windows • Remove outside antennas • Turn refrigerator and freezer to coldest settings • Store drinking water in clean bathtubs, jugs, and bottles • Review evacuation plan Hurricane Warning: • Listen to radio for instructions • Tie down mobile home and evacuate immediately • Store valuables in waterproof container • Avoid elevators. If at home: • Stay inside, away from anything glass • Keep a supply of batteries and flashlights • Avoid open flames as a source of light • If power is lost, turn off major appliances to reduce power "surge." • If evacuation is necessary: leave ASAP, avoiding flooded roads and washed-out bridges • Secure home by unplugging appliances and turning off electricity and the main water valve • Take blankets and sleeping bags to a shelter and leave immediately	• Stay tuned to radio for information, returning home only when authorities advise it is safe to do so • Help injured or trapped persons and give first aid where appropriate • Avoid loose or dangling power lines and report them to the power company or fire department • Beware of snakes, insects, and animals driven to higher ground by flood water • Open windows and doors to ventilate and dry your home • Check refrigerated foods for spoilage • Take pictures of the damage for insurance claims • Drive only if necessary and avoid flooded roads and washed-out bridges • Use telephones only for emergency calls.

TSUNAMI

A tsunami is a giant wave (or series of waves) created by an undersea earthquake, volcanic eruption or landslide. “Tsunami” in Japanese means “harbor wave”. Tsunamis are not “tidal waves”

Causes of Tsunami

i) **Earthquakes:** These are the most destructive and common tsunamis. When a earthquake is massive, at least 7.5 in magnitude, it displaces enough water to case a huge wave.

ii) **Volcanic eruption:** A massive volcanic eruption can disturb the ocean floor which can lead to the formation of tsunami. The explosive eruption of Krakatau in 1883 created a tsunami that claimed more than 36,000 lives.

iii) **Landslides:** Enormous submarine landslides can occur on the flanks of ocean islands which can lead to tsunami. Landslides can be triggered by earthquake or volcanic activity.

iv) **Meterorites:** Asteriods falling into the ocean can lead to tsunami.

Theory of tsunami propagation

Tsunamis can be generated when the sea floor suddenly displaces the overlying water vertically. A tsunami moves at a speed related to the water depth, therefore the tsunami slows as the water depth decreases. The tsunami's energy flux, being dependent on both its wave speed and wave height, remains nearly constant. As a result, the tsunami's speed decreases as it travels into shallower water and its height increases. It travels as fast as 200 m/s (440 mi/hr) in open ocean As a tsunami reaches the shore, it begins to lose energy. It slows down and height increases when approaching shallow coast Tsunamis reach the coast with tremendous amounts of energy.

Effects of Tsunami

a) Large scale destruction to life and property.

b) Tsunami cause fire, disrupt communication and transportation

TSUNAMI MITIGATION		
Before the Disaster	**During the Disaster**	**After the Disaster**
• Find out if your house is in danger and know the height of your street above sea level • Be familiar with warning signs (earthquakes, ground rumbling, or rapid rise and fall of coastal waters) • Ensure all family members know how to respond • Make evacuation plans with more than one route and pick an elevated inland location • Teach children how and when to call emergency numbers. • Have disaster supplies on hand (flashlight, extra batteries, portable battery-operated radio, first aid kit, emergency food and water, nonelectric can opener, cash and credit cards, and sturdy shoes) • Develop an emergency communications plan in case of separation during the earthquake Ask an out-of-state relative or friend to serve as the family contact.	• Listen to radio for emergency and evacuation information • Climb to higher ground as soon as warning of a tsunami is released • Stay away from the beach - if you can see the wave, you are too close to escape it • Do not assume that one wave means the danger is over - the next wave may be larger than the first • Stay out of the area and do not return until authorities say it is safe to do so	• Stay tuned to radio for emergency information • Help injured or trapped persons and give first aid where appropriate • Do not move seriously injured persons unless they are in immediate danger of further injury • Stay out of damaged buildings • Enter home with caution, checking for electrical shorts and live wires • Do not use appliances or lights until properly checked by an electrician • Open windows and doors to help dry the building • Shovel mud while it is still moist to give walls and floors an opportunity to dry • Check food supplies, throwing out all fresh food that may be contaminated and have tap water tested by local health department.

LANDSLIDES

The sliding down of a mass of earth or rock from a mountain or cliff is called landslide.

Causes of landslides

Geological causes	Morphological causes	Physical causes	Human causes
Weathered materials	Slope angle	Intense rainfall	Excavation
Sheared materials	Uplift	Rapid snow melt	Loading
Jointed or fissured materials	Rebound	Prolonged precipitation	Drawdown
Adversely orientated discontinuities	Fluvial erosion	Rapid drawdown	Land use change
Permeability contrasts	Wave erosion	Earthquake	Water management
Material contrasts	Glacial erosion	Volcanic eruption	Mining
Rainfall and snow fall	Erosion of lateral margins	Thawing	Quarrying
Earthquakes	Subterranean erosion	Freeze-thaw	Vibration
Working of machinery	Slope loading	Ground water changes	Water leakage
	Vegetation change	Soil pore water pressure	Deforestation
	Erosion	Surface runoff	land use pattern
		Seismic activity	pollution
		Soil erosion	

LANDSLIDES MITIGATION		
Before the Disaster	During the Disaster	After the Disaster
• Get a ground assessment of your property • Minimize home hazards (plant ground cover on slopes, build retaining walls, and in mudflow areas, build channels or deflection walls to direct flow around buildings) Recognize landslide warning signs: • Doors/windows stick or jam for the first time, new cracks appear in plaster or foundations, outside walks, walls, or stairs pull away from buildings, underground utility lines break, bulging ground appears at base of a slope, ground slopes downward in one direction and may begin shifting in that direction under your feet; faint rumbling sound that increases in volume as landslide nears • Make evacuation plans, planning at least two routes allowing for blocked and closed roads • Develop an emergency communication plan and ask an out-of-state relative or friend to serve as the family contact • Purchase flood insurance.	If indoors: • Stay inside and get cover under a sturdy piece of furniture. If outdoors: • Try to get out of path of mudflow • Run to nearest high ground in a direction away from path • If rocks and other debris are approaching, run for nearest shelter such as a group of trees or a building • If escape is not possible, curl into a tight ball and protect your head. Be cautious of sinkholes: • Sinkholes occur when groundwater dissolves a vulnerable land surface such as limestone, causing the land surface to collapse from lack of support.	• Stay away from slide area • Check for injured and trapped persons and give first aid where needed • Listen to battery-operated radios for emergency information • Remember flooding may occur after a mudflow or landslide • Check for damaged utility lines and report damage to the utility company • Check the building foundation, chimney, and surrounding land for damage • Replant damaged ground as soon as possible since erosion caused by loss of ground cover can lead to flash flooding.

SOCIAL ISSUES AND THE ENVIRONMENT

SUSTAINABLE DEVELOPMENT

Sustainable development: Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Achieving sustainable growth and development

i) **Using appropriate technology:** Using appropriate technology is one which is locally adaptable, environment and eco-friendly, pollution free can help in making the development sustainable.

ii) **Refuse, Reduce, Reuse, and Recycle approach:** The 4-R approach advocating refusal of non-renewable resource unless it is absolutely essential, minimization of resource use, using them again and again instead of passing it on to the waste stream and recycling the materials can help in achieving the goals of sustainability. It reduces pressure on our resources as well as reduces waste generation and pollution.

iii) **Prompting environmental education and awareness:** Making environmental education the centre of all learning process will greatly help in changing the thinking and attitude of people towards our earth and the environment. Introducing the subject right from the school stage will inculcate a feeling of belongingness to earth in the small children and will help in transforming our life styles to sustainable ones.

iv) **Consumption of renewable resources:** It is very important to consume the natural resources in such a way that the consumption should not exceed regeneration capacity(over exploitation should be avoided)

v) **Conservation of non renewable resources:** Non renewable resources should be conserved by recycling and reusing.

vi) **Population control:** Population explosion is the root cause of most of the environmental problems. By controlling or slowing down population growth sustainability can be achieved.

vii) **Government Policies:** Better protection of natural assets will require coordinated efforts across all sections of governments, businesses, and international institutions.

URBAN PROBLEMS RELATED TO ENERGY

Cities are the main centers of economic growth, trade, education, innovations and employment. In developing countries too urban growth is very fast and in most of the cases it is uncontrollable and unplanned growth. The energy requirements of urban population are much higher than that of rural ones. This is because urban people have a higher standard of life and their life style demands more energy inputs in every sphere of life.

Some of the major urban problems related to energy are as under:

a) Electricity

Electricity from various sources is a major requirement of expanding cities, towns and villages. Housing gadgets like T.V., computer, music systems, geysers,fans, lights, A.C.s, microwave, water lifting pump, warm blowers, coolers, etc. form the essential components of a house. It is well known that major part of electricity is lost in transmission and some part is stolen. The remainder is simply not enough to support the majority of people in the city and that's why the problem of electricity in cities is on the rise. Buildings are constructed at a great rate but we don't construct dams, supplying electrical units, increasing in number at the same pace. Therefore, what majority of the cities face today is a usual cut of electricity for a minimum of 6-8 hrs. This makes today's urban life handicapped. Rich enjoy the resource benefit from the rising generator and inverter culture but majority of the population don't.

b) Fossil fuels (petroleum, natural gas and coal)

Fossil fuels have always been under a great threat from times immemorial. With rise in technology man started generating power from nuclear sources, hydroelectric power, wind power etc. But still these contribute a little. We still depend on thermal power (fuelled by coal) a lot.

i) Petrol and Diesel: Transport and communication has brought the petroleum reserves of the world under a great threat. The rise in number of vehicle per year is immense. Every day thousands of new vehicles hit the road which causes demand for fuel and make lead to price hike.

ii) Natural Gas: The common usage of natural gas is in the form of Liquid Petroleum Gas (LPG). There is a great rise in the usage of LPG driven

household commodities with the expanding population. Earlier the LPG usage was only limited to kitchen for cooking. Now many vechicles are powered by LPG. The advent of technology introduced a numerous household items making its use like gas geysers, gas heaters, gas fans, gas lanterns etc. In a way it is serving as a substitute of electricity, which is other reason for increasing pressure on oil wells/reserves.

iii) **Coal:** The world population has extracted and used coal reserves thinking as if it is a never-ending commodity/resource. Later, its usage in the railways became the chief cause of its rapid exhaustion. Coal reserves may be over in another 150 years. It should be used judiciously and economically.

c) **Fuel wood:** Fuel wood being used for the ignition of fire is chiefly responsible for the deforestation. Most of the rural people still depend on firewood as their primary fuel.

RAINWATER HARVESTING

Rainwater harvesting is a technique of increasing the recharge of ground water by capturing and storing rainwater. This is done by constructing special water-harvesting structures like dug wells, percolation pits, lagoons, check dams etc. Rainwater, wherever it falls, is captured and pollution of this water is prevented. Rainwater harvesting is not only proving useful for poor and scanty rainfall regions but also for the rich ones.

OBJECTIVES:

Rainwater harvesting has the following objectives:

(i) to reduce run off loss
(ii) to avoid flooding of roads
(iii) to meet the increasing demands of water
(iv) to raise the water table by recharging ground water
(v) to reduce groundwater contamination
(vi) to supplement groundwater supplies during lean season

TRADITIONAL RAIN WATER HARVESTING

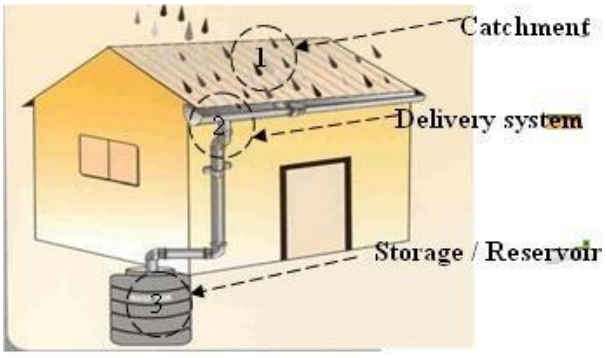
In India, it is an old practice in high rainfall areas to collect rainwater from roof-tops into storage tanks. In foot hills, water flowing from springs are collected by embankment type water storage. In Himalayan foot-hills people use the hollow bamboos as pipelines to transport the water of natural springs. Rajasthan is known for its 'tankas' (under-ground tanks) and khadins (embankments) for harvesting rainwater. In our ancient times we had adequate Talaabs, Baawaris, Johars, Hauz etc. in every city and villages to collect rain-water.

RAIN WATER HARVESTING TECHNIQUES

There are two main techniques of rain water harvestings a) Storage of rainwater on surface for future use b)Recharge to ground water.

a) Storage of rainwater on surface for future use

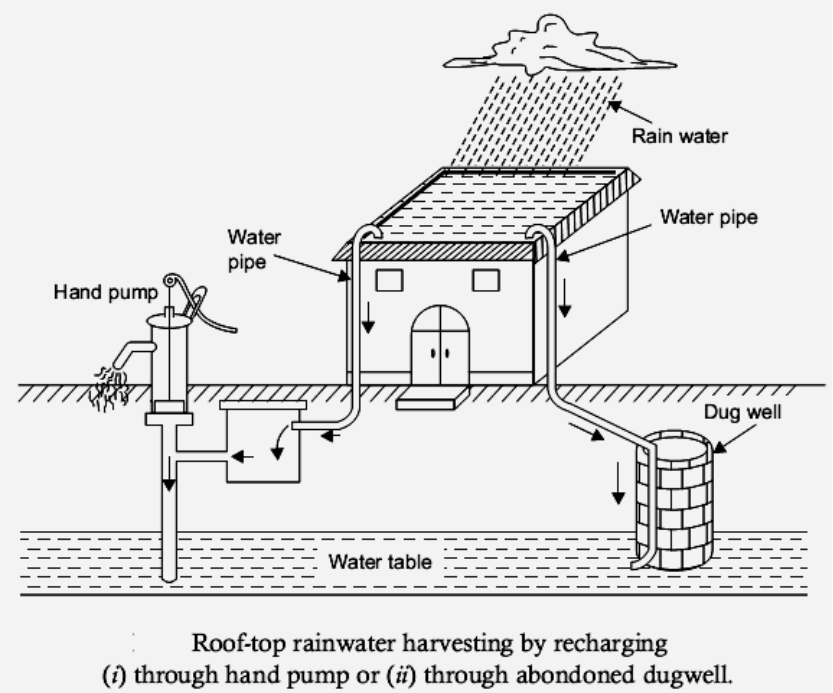
In this method rain water collected from the roof of the building is diverted to a storage tank. The storage tank has to be designed according to the water requirements, rainfall and catchment availability. Each drainpipe should have mesh filter at mouth and first flush device followed by filtration system before connecting to the storage tank. Water from storage tank can be used for secondary purposes such as washing and gardening etc. This is the most cost effective way of rainwater harvesting. The main advantage of collecting and using the rainwater during rainy season is not only to save water from conventional sources, but also to save energy incurred on transportation and distribution of water at the doorstep.



b) Recharge to ground water

Ground water aquifers can be recharged by various kinds of structures to ensure percolation of rainwater in the ground instead of draining away from the surface. Commonly used recharging methods are include Recharging of bore wells, dug wells, recharge pits, trenches etc.

In roof top rainwater harvesting, which is a low cost and effective technique for urban houses and buildings, the rain-water from the top of the roofs is can be used to recharge underground aquifers by diverting the stored water to some abandoned dug-well or by using a hand pump.



Roof-top rainwater harvesting by recharging
(*i*) through hand pump or (*ii*) through abondoned dugwell.

Advantages of Rainwater harvesting

Rainwater harvesting helps in

a) recharging the aquifers
b) improving groundwater quality
c) improving soil moisture content
d) reducing soil erosion by minimizing run-off water.

WATERSHED MANAGEMENT

Watershed is defined as the land area from which water drains under gravity to a common drainage channel. Watershed can range from a few square kilometres to few thousand square kilometers in size.

Importance of watershed

The watershed comprises complex interactions of soil, landform, vegetation, land use activities and water. People and animals are an integral part of a watershed having mutual impacts on each other. A watershed affects us as it is directly involved in sustained food production, water supply for irrigation, power generation, transportation as well as for influencing sedimentation and erosion, vegetation growth, floods and droughts.

Objectives of watershed management

(i) To rehabilitate the watershed through proper land use adopting conservation strategies for minimizing soil erosion and moisture retention so as to ensure good productivity of the land for the farmers.

(ii) To manage the watershed for beneficial developmental activities like domestic water supply, irrigation, hydropower generation etc.

(iii) To minimize the risks of floods, droughts and landslides.

(iv) To develop rural areas in the region with clear plans for improving the economy of the region.

Various measures taken up for management include the following:

(i) **Water harvesting:** Proper storage of water is done with provision for use in dry seasons in low rainfall areas. It also helps in moderation of floods.

(ii) **Afforestation and Agroforestry:** In watershed development, afforestation and crop plantation play a very important role. They help to prevent soil erosion and retention of moisture. In high rainfall areas woody trees are grown in between crops to substantially reduce the runoff and loss of fertile soil. Trees like Eucalyptus and varities of grasses are grown along with maize or wheat to achieve the above objectives. Woody trees like teak are grown successfully in such agroforestry programmes in watershed areas of river Yamuna.

(iii) **Mechanical measures for reducing soil erosion and runoff losses:** Several mechanical measures like terracing, bunding, bench terracing, no-

till farming, contour cropping, strip cropping etc. are used to minimize runoff and soil erosion particularly on the slopes of watersheds.

(iv) **Scientific mining and quarrying:** Due to improper mining, the hills lose stability and get disturbed resulting in landslides, rapid erosion etc. Scientific mining and quarrying practises must be adopted to minimize the destructive effects of mining in watershed areas.

(v) **Public participation:** People's involvement including the farmers and tribals is the key to the success of any watershed management programme, particularly the soil and water conservation. People's cooperation as well as participation has to be ensured. Government and NGO have a big role to play. Properly educating the people about the campaign and its benefits or sometimes paying certain incentives to them can help in effective public participation.

RESETTLEMENT AND REHABILITATION ISSUES

Developmental projects are planned to bring benefits to the society. However, in the process of development, very often there is over-exploitation of natural resources and degradation of the environment. Very often, the native people of the project site are directly affected. These native people are generally the poorest of the poor, underpriviledged tribal people and they have to undergo tremendous economic and psychological distress.

(a) **Displacement problems due to dams:** The big river valley projects have one of the most serious socio-economic impacts due to large scale displacement of tribal people from their ancestral home and loss of their traditional profession or occupation. In India, in the past 50 years more than 20 million people are estimated to have been directly or indirectly affected by these dams. The Hirakud Dam has displaced more than 20,000 people re-siding in about 250 villages.

(b) **Displacement due to Mining:** Mining is another developmental activity, which causes displacement of the native people. Several thousands of hectares of land area is covered in mining operation and the native people are displaced.

(c) **Displacement due to Creation of National Parks:** When some forest area is covered under a National Park, it is a welcome step for conservation of the natural resources. However, it also has a social aspect associated with it which is often neglected. A major portion of the forest is declared as core-area, where the entry of local dwellers or tribals is prohibited. When these villagers are deprived of their ancestral right or access to the forests, they usually retaliate by starting destructive activities. Providing these people alternate means of livelihood is a necessity.

REHABILITATION PROBLEM

Some problems associated with rehabilitation are

i) **Poverty:** Tribals are usually the most affected amongst the displaced who are already poor. Displacement further increases their poverty due to loss of land, home, jobs, food insecurity, loss of access to common property assets, increased morbidity and mortality and social isolation.

ii) **Loss of cultural values:** Most of the cultural activities are very closely associated to their habitat. Marriages, social and cultural functions, their folk-songs, dances and activities vanish with their displacement. Even when they are resettled, it is individual-based resettlement, which totally ignores communal settlement.

iii) **Loss of heritage:** The age-long indigenous knowledge, which has been inherited and experienced by them about the flora, fauna, their uses etc. gets lost.

iv) **Ignorant of market trends:** The tribals are not familiar with the market policies and trends. Even if they get cash compensation, they get alienated in the modern economic set-up.

ROLE OF NGO'S

NGO's are nongovernmental organizations. These voluntary organizations can help by advising the government about some local environmental issues and at the same time interacting at the grass-root levels. They can act as an effective and viable link between the two. They can act both as an 'action group' or a 'pressure group'. They

can be very effective in organizing public movements for the protection of environment through creation of awareness.

Objectives of NGO's

i) To describe and discuss the common characteristics of health system functioning in the given socio - economic, socio- cultural, political and ecological settings.

ii) The fundamental objective is to act as a catalyst in bringing about local initiative and community participation in overall improvement in quality of life.

Some of the activities taken up by NGO's include – solid waste management, zero waste management, afforestation, vegetable roof gardening, rainwater harvesting, AIDS awareness, pollution control etc.

Greenpeace is a non-governmental environmental organization with offices in over forty countries and with an international coordinating body in Amsterdam, the Netherlands. Activities of Greenpeace have made huge impacts all over the globe. The "Chipko Movement" for conservation of trees by **Dasholi Gram Swarajya Mandal** or the "Narmada Bachao Andolan" organized by **Kalpavriksh**, are some of the instances where NGO's have played a landmark role in the society for conservation of environment. The Bombay Natural History Society (BNHS), the World Wide Fund for Nature - India (WWF, India) Kerala Sastra Sahitya Parishad, Centre for Science and Environment (CSE) and many others are playing a significant role in creating environmental awareness.

The total number of NGOs in our country is about 70,000. They have a great role in creating environmental awareness, disseminating information and promoting sustainable growth and development.

ENVIRONMENTAL ETHICS—ISSUES AND POSSIBLE SOLUTIONS

Environmental ethics: A search for moral values and ethical principle in human relations with the natural world.

If we think "Man is all powerful and the supreme creature on this earth and man is the master of nature and can harness it at his will", it reflects our **human-centric** thinking.

If we think “Nature has provided us with all the resources for leading a beautiful life and she nourishes us like a mother, we should respect her and nurture her”, this is an **earth-centric** thinking.

These two world-views are discussed here in relation to environ-mental protection:

(a) Anthropocentric Worldview: This view is guiding most industrial societies. It puts human beings in the center giving them the highest status. Man is considered to be most capable for managing the planet earth. The guiding principles of this view are:

(i) Man is the planet’s most important species and is the in-charge of the rest of nature.

(ii) Earth has an unlimited supply of resources and it all belongs to us.

(iii) Economic growth is very good and more the growth, the better it is, because it raises our quality of life and the potential for economic growth is unlimited.

(iv) A healthy environment depends upon a healthy economy.

(v) The success of mankind depends upon how good managers we are for deriving benefits for us from nature.

(b) Eco-centric Worldview: This is based on earth-wisdom. The basic beliefs are as follows:

(i) Nature exists not for human beings alone, but for all the species.

(ii) The earth resources are limited and they do not belong only to human beings.

(iii)Economic growth is good till it encourages earth-sustaining development and discourages earth-degrading development.

(iv) A healthy economy depends upon a healthy environment.

(v) The success of mankind depends upon how best we can cooperate with the rest of the nature while trying to use the resources of nature for our benefit.

Some important ethical guidelines known as Earth ethics or Environmental Ethics are as follows:

- You should love and honour the earth since it has blessed you with life and governs your survival.
- You should keep each day sacred to earth and celebrate the turning of its seasons.

- You should not hold yourself above other living things and have no right to drive them to extinction.
- You should be grateful to the plants and animals which nourish you by giving you food.
- You should limit your offsprings because too many people will overburden the earth.
- You should not waste your resources on destructive weapons.
- You should not run after gains at the cost of nature, rather should strive to restore its damaged majesty.
- You should not conceal from others the effects you have caused by your actions on earth.
- You should not steal from future generations their right to live in a clean and safe planet by impoverishing or polluting it.
- You should consume the material goods in moderate amounts so that all may share the earth's precious treasure of resources.

CLIMATE CHANGE

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period- at least 30 years is called climate.

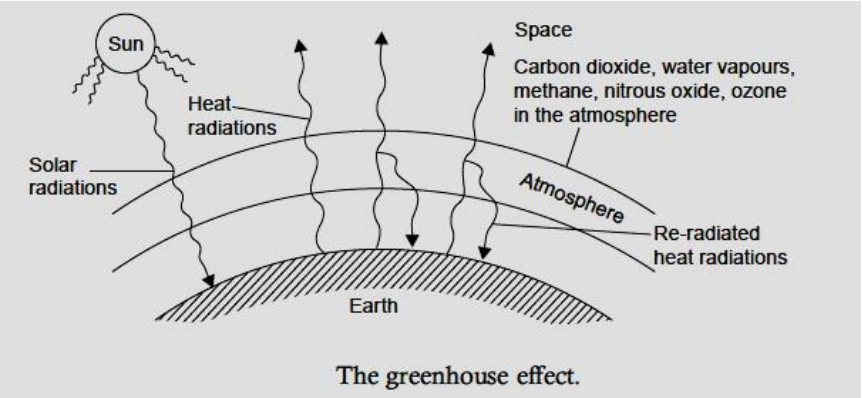
It is observed that earth's temperature has changed considerably during the geological times. The surface of the Earth has warmed, on average, 0.3 to 0.6 °C since the late 19^{th} century. In addition, most of the ill effects of climate change are linked to extreme weather events, such as hot or cold spells of temperature, or wet or dry spells of rainfall, or cyclones and floods.

GREEN HOUSE EFFECT AND GLOBAL WARMING

Sun is the primary source of energy for earth. Nearly 30% of the solar radiation falling on earth's surface is reflected back to the space. The rest of the radiation is trapped by earth's atmosphere. The amount of heat trapped in the atmosphere

depends mostly on the concentrations of heat trapping or green house gases and the length of time they stay in the atmosphere. The major green house gases are **carbon dioxide, ozone, methane, nitrous oxide, chlorofluorocarbons (CFCs) and water vapour.** As the effect is similar in nature to what happens in a botanical greenhouse (the glass panes allows the light energy to enter inside but diminishes the loss of heat), these gases are called greenhouse gases and the resultant warming from their increase is called the **greenhouse effect.**

The average global temperature is 15°C. In the absence of green house gases this temperature would have been -18°C. Therefore, Green House Effect contributes a temperature rise to the tune of 33°C. Heat trapped by green house gases in the atmosphere keeps the planet warm enough to allow us and other species to exist.



The greenhouse effect.

The concentration of CO_2 in the Earth's atmosphere was about 280 parts per million by volume (ppmv) in 1750, before the Industrial Revolution began. By 1994 it was 358 ppmv and rising by about 1.5 ppmv per year. If emissions continue at current rate, the concentration will be around 500 ppmv, nearly double the pre-industrial level, by the end of the 21st century.

Global warming

Due to manmade activities the concentration of green house gases are increasing at a fast rate. This causes the earth's surface temperature to rise slowly. Deforestation, use of fossil fuels, use of CFC's are responsible for such a situation. In the past few decades, earth's temperature has increased by 2-3 degrees. This effect is known as **global warming. Greenhouse effect leads to global warming.**

Causes of green house effect

i) **Deforestation:** Due to deforestation, photosynthesis takes place to limited extend, which increases CO_2 content in the atmosphere leading to global warming.

ii) **Burning of fossil fuels:** Large amount of greenhouse gases (CO_2, NO_x, SO_x etc) are released into the atmosphere due to the burning of fossil fuels, oil, coal and gas.

iii) **Electrical Appliances:** Chlorofluorocarbons (CFCs) are widely used in refrigerators as coolants, aerosol cans, foaming agents, fire extinguisher chemicals, and cleaners used in the electronic industry. These gases slowly make way into earth's atmosphere resulting in global warming.

iv) **Population explosion:** Population growth increases CO_2 level (by respiration). With the increase in population, the needs and wants of people increase leading to urbanization and industrialization resulting in higher green house emission.

Consequences of Greenhouse Effect

i) **Global temperature increase:** It is estimated that the earth's mean temperature will rise between 1.5 to 5.5°C by 2050 if input of greenhouse gases continues to rise at the present rate.

ii) **Rise in Sea Level:** With the increase in global temperature there will be rise in sea water levels mainly due to melting of polar ice caps and glaciers. An increase in the average atmospheric temperature of 3°C would raise the average global sea level by 0.2-1.5 meters. One meter rise in sea level will submerge low lying areas of cities like Shanghai, Cairo, Bangkok, Sydney, Hamburg and Venice. Agricultural lowlands and deltas in Egypt, Bangladesh, India, China and will be submerged in water. This will also damage to lagoons, estuaries and coral reefs.

iii) **Effects on Human Health:** Global warming will lead to changes in the rainfall pattern in many areas, thereby affecting the distribution of vector-borne diseases like malaria, filariasis etc. Warmer temperature and more water stagnation would favour the breeding of mosquitoes, snails and some insects, which are the vectors of diseases like malaria, filariasis.

iv) **Effects on Agriculture:** Global warming can lead to water scarcity and may result in drought. Soil moisture will decrease and evapo-transpiration will increase, which may drastically affect wheat and maize production in tropical and subtropical regions. Increase in temperature and humidity will increase pest growth like the growth of vectors for various diseases. Pests will adapt to such changes better than the crops.

v) **Natural disasters:** The source of origin for many Indian rivers like Brahmaputra, Ganges, Indus are The Himalayas. Melting of ice can lead to frequent flooding. As the temperature of oceans rise, so will the probability of more frequent and stronger hurricanes.

vi) **Economic effects:** Extreme weather might reduce global gross domestic product by up to one percent, and that in a worst-case scenario global per capita consumption could fall 20 percent.

vii) **Ocean Acidification:** Increased atmospheric CO_2 increases the amount of CO_2 dissolved in the oceans. CO_2 dissolved in the ocean reacts with water to form carbonic acid, resulting in acidification

Control of Global Warming

To slow down global warming the following steps will be important:

(i) Cut down the current rate of use of CFCs and fossil fuels.
(ii) Use energy more efficiently.
(iii) Shift to renewable energy resources.
(iv) Increase Nuclear Power Plants for electricity production.
(v) Shift from coal to natural gas.
(vi) Trap and use methane as a fuel.
(vii) Adopt sustainable agriculture.
(viii) Stabilize population growth.
(ix) Control deforestation and plant more trees.

OZONE LAYER DEPLETION

Ozone layer is a layer in earth's atmosphere containing relatively high concentrations of ozone (O_3). It is mainly found in the lower portion of the stratosphere from approximately 20 to 30 kilometres above earth. The ozone layer is

often referred to as the **"umbrella of life"** because it protects life on Earth from harmful UV rays.

The **Dobson Unit** is the most common unit for measuring ozone concentration. One Dobson Unit is the number of molecules of ozone that would be required to create a layer of pure ozone 0.01 mm thick at a temperature of 0 C and a pressure of 1 atmosphere. Over the Earth's surface, the ozone layer's average thickness is about 300 Dobson Units or a layer that is 3 millimeters thick.

Formation and Function of ozone layer

Ultraviolet radiations less than 242 nm decompose molecular oxygen into atomic oxygen (O) by photolytic decomposition.

$$O_2 + hv \rightarrow O + O$$

The atomic oxygen rapidly reacts with molecular oxygen to form ozone.

$$O + O_2 + M \rightarrow O_3 + M$$

(M is a third body necessary to carry away the energy released in the reaction).

Ozone thus formed distributes itself in the stratosphere and absorbs harmful ultraviolet radiations (200 to 320 nm) and is continuously being converted back to molecular oxygen.

$$O_3 + hv \rightarrow O_2 + O$$

Absorption of UV radiations results in heating of the stratosphere. Thus there is equilibrium between the formation and destruction of ozone. This equilibrium is disturbed by reactive atoms of chlorine, bromine etc. which destroy ozone molecules and result is thinning of ozone layer generally called **ozone hole**.

Causes for ozone hole formation

Choloroflurocarbons: Major reason for the depletion of ozone layer is halogen atoms (F, Cl, Br) which are formed by the photochemical decomposition of CFC's. **CFC** is an organic compound that contains only carbon, chlorine, hydrogen and fluorine. CFC's are widely used as coolants in refrigeration systems and air conditioners, propellants for aerosols due to low boiling point. These slowly rise up and reach stratosphere and cause depletion of ozone. The chemical reaction can be represented as

$$CF_2Cl_2 + hv \rightarrow CF_2Cl + Cl$$

$$Cl + O_3 \rightarrow ClO + O_2$$

$$ClO + O \rightarrow Cl + O_2$$

In the second step, Cl is generated again which can cause the reaction to continue like a chain reaction. One chlorine atom can thereby destroy thousands of ozone molecules. Similarly other atoms present in CFC like Fluorine and Bromine can also cause similar effect.

Effects of Ozone Depletion

Ozone depletion in the stratosphere will result in more UV radiation reaching the earth especially UV-B (290-320 nm).

In humans

i) The UV-B radiations affect DNA. Any change in DNA can result in mutation and cancer.

ii) Cases of skin cancer (basal and squamous cell carcinoma) which donot cause death but cause disfigurement will increase.

iii) Easy absorption of UV rays by the lens and cornea of eye will result in increase in incidents of cataract.

iv) Melanin producing cells of the epidermis (important for human immune system) will be destroyed by UV-rays resulting in immuno-suppression. Fair people (can't produce enough melanin) will be at a greater risk of UV exposure.

In plants and animals

i) Phytoplanktons are sensitive to UV exposure. Ozone depletion will result in decrease in their population thereby affecting the population of zooplankton, fish, marine animals, infact the whole aquatic food chain.

ii) Yield of vital crops like corn, rice, soybean, cotton, bean, pea and wheat will decrease.

iii) The UV radiation enhances the rate of evaporation through stomata and decreases the moisture content of the soil. This condition adversely affects the growth and development of crop plants and reduces the crop yield.

Other implications

i) Degradation of paints, plastics and other polymer material will result in economic loss due to effects of UV radiation resulting from ozone depletion.

ii) It contributes in the Global Warming. If ozone depletion continues, the temperature around the world may rise even up to 5 degrees.

Control of ozone layer depletion

i) **Reduce/replace the usage of CFC's:** One molecule of CFC destroys more than few thousands of ozone molecules via chain reaction. So usage of CFC's has to be discouraged and kept minimum. Use of other alternative coolants which are less damaging has to be promoted.

ii) **Reduce the use of methyl bromide:** Methyl bromide is an insecticide used for fumigation of soils structures and storage. It is a source for bromine atoms which can destroy ozone. Its use of has to be controlled.

iii) **Control of deforestation:** Check in deforestation will ensure slightly higher percentage of oxygen in the atmosphere.

iv) **Proper maintenance:** Air conditioning and refrigerating units should regularly be checked for leaks and corrected if any.

ACID RAIN

Acid rain is a rain or any other form of precipitation that is unusually acidic (pH below 5.6). Natural rain water has a pH of 5.6 at 20°C because of formation of carbonic acid due to dissolution of CO_2 in water. Acid precipitation is a mixture of strong mineral acids sulphuric acid (H_2SO_4), nitric acid (HNO_3) and in some locations, hydrochloric acid (HCl).

Acid rain literally means 'the presence of excessive acids in rain waters'. Acid rain can be wet or dry.

Causes:

i) **Oxides of Nitrogen:** Oxides of nitrogen, represented by NO_x is mainly responsible for acid rain. Automobile exhaust, factory emission contains large amounts of NO_2. It is also emitted by natural processes like lightning, volcanic eruptions, forest fires, and action of bacteria in the soil.

Nitrogen dioxide (NO_2) reacts with water to form nitrous acid (HNO_2) and nitric acid (HNO_3)

$$2NO_2 + H_2O \text{ -----> } HNO_2(aq) + HNO_3(aq)$$

ii) **Oxides of sulphur:** Oxides of Sulphur (SO_2 and SO_3 represented as SOx) are produced when fossil fuels containing sulphur are burnt. Small

amounts are found in automobile exhaust. Large amounts of these gases are while processing of crude oil, in utility factories, and iron and steel factories. SO_2 is also produced naturally by volcanic activity.

Sulfur dioxide reacts with water to form sulfurous acid (H_2SO_3)

$$SO_2 + H_2O \rightleftharpoons H_2SO_3(aq)$$

Sulfur dioxide (SO_2) can be oxidised gradually to sulfur trioxide (SO_3)

$$2SO_2 + O_2 \text{----- } > 2SO_3$$

Sulfur trioxide (SO_3) reacts with water to form sulfuric acid (H_2SO_4):

$$SO_3 + H_2O \text{-----} > H_2SO_4(aq)$$

Effects of acid rain

On plant life:

i) **Loss of waxy coating on leaves:** Frequent acid rain dissolves the waxy protective coating of the leaves. This makes the plant susceptible to disease. When the leaves are damaged, the plant loses its ability to produce sufficient amounts of nutrition for it to stay healthy.

ii) **Root damage:** Roots of plants are damaged by acid rain, causing the growth of the plant to be stunted, or even in its death.

iii) **Death of micro organisms:** Useful micro organisms which release nutrients from decaying organic matter, into the soil are killed off, resulting in less nutrients being available for the plants.

iv) **Loss of beneficial nutrients from the soil**: Acid rain washes away the beneficial minerals and nutrients in soil before the plants have a chance of using them for their growth.

On animal life:

i) **Heavy metal leaching:** Acid rain causes harmful elements like mercury and aluminium to be leached from the soil and rocks and it is then carried into the lakes where aquatic life may be affected.

ii) **Death of aquatic organisms:** As the pH reaches 5.5, plankton, certain insects and crustaceans begin to die. At a pH of around 5.0, the fish population begin to die. Below pH 5.0, entire fish population may die.

iii) **Loss of fertility:** It results in the fish's ability to maintain their calcium levels. This impairs reproduction the ability of the fish, because the eggs become too weak or brittle. This can result in killing of fish.

In humans

i) **Respiratory problems:** Acid rain can cause nose and eye irritation, headache, asthma and dry coughs. Acid rain can aggravate asthma.

Buildings and monuments

i) **Deterioration of buildings:** It causes deterioration of buildings especially made of marble e.g. monuments like Taj Mahal. It caused the tarnishing of Taj Mahal (Dry acid deposition containing SO_2 primarily from the exhaust of Mathura refineries. Oil refineries in Mathura emit nearly 25 tonnes of SO_2 per day despite using low sulphur content coal).

ii) **Deterioration of objects:** Acid rain corrodes ceramic, textiles, paints, and metals. Rubber and leather deteriorate if exposed to acid rain. It damages metals and car finishes.

Control of acid rain

i) **Use of low sulphur content coal:** Coal with lower sulphur content is desirable to use in thermal plants.

ii) **Replacement of coal by natural gas:** Replacement of coal by natural gas would also reduce the problem substantially.

iii) **Reduction of NOx and SOx emission:** Emission of SO_2 and NO_2 from industries and power plants should be reduced by using pollution control equipments.

iv) **Strict law enforcement:** Strict laws must be brought for air pollution reduction (especially CO_2, NO_2 and SO_2). Heavy fine must be imposed if accepted emission levels are crossed.

v) **Use of renewable sources of energy:** Use of alternate eco friendly sources of energy can minimize pollutants and hence acid rain.

vi) **Use of eco-friendly vehicles:** Pollutants can be minimized by using pollution control devices like catalytic converters in vehicles. Another method is the usage of natural gas as fuel in automobiles.

WASTE LAND RECLAMATION

Economically unproductive lands suffering from environmental deterioration are known as **wastelands.** The wastelands include salt-affected lands, sandy areas, gullied areas, snow covered areas, glacial areas, barren hill-ridge etc.

Characteristics features of wasteland can be summarized as under:

- The land becomes ecologically unstable and unproductive.
- Land that has nearly or completely lost its topsoil.
- Land that has developed toxicity in the zone of roots for the growth of most plants.

National Wasteland Development Board (NWDB) aims at the reclamation and use of waste lands.

Methods For Reclaiming Land

i) **Land development and leaching:** For reclamation of the salt affected soil, it is necessary to remove the salts from the root-zone which is usually achieved by leaching i.e. by applying excess amount of water to push down the salts. Land after leveling and ploughing, the field is bunded in small plots and leaching is done. Continuous leaching for few hours can remove 90% of soluble salts.

ii) **Reclamation of waterlogged land:** Drainage is required for water-logged land.

(a) **Surface drainage:** This is used in areas where water stands on the fields after heavy rains by providing ditches to runoff the excess water.

(b)Sub-surface drainage: Horizontal sub-surface drainage is provided in the form of perforated corrugated PVC pipes with an envelope of gravel 2-3 m below the land surface. Chances of evaporation of water leading to accumulation of salts almost become nil in this method.

iii) **Irrigation Practices:** Scientific irrigation practices can help in waste land recovery. Over-irrigation may lead to water-logging while under-irrigation may lead to desertification.

iv) **Selection of tolerant crops and crop rotations:** Tolerance of crops to salts is found to range from sensitive, semi-tolerant, tolerant to highly tolerant. Barley, sugar beet and date-palm are highly tolerant crops which do not suffer from any reduction in crop yield even at a high salinity.

Wheat, pearl millet, soyabean, mustard and coconut are salt-tolerant crops. Rice, millets, maize, pulses, sunflower, sugarcane and many vegetables like bottle gourd, brinjal etc. are semi-tolerant. These different crop combinations can be grown on saline soils.

v) **Gypsum amendment:** Amendment of high sodium soils with gypsum is recommended for reducing soil sodicity as calcium of gypsum replaces sodium from the exchangeable sites.

vi) **Green-manures, fertilizers and biofertilizers:** Application of farm yard manure or nitrogen fertilizers have been found to improve saline soils. Blue green algae have been found to be quite promising as biofertilizers for improving salt-affected soils.

vii) **Afforestation Programmes**: The National Commission on Agriculture (NCA) launched several afforestation schemes to prevent the problem of spreading wasteland. The National Wasteland Development Board, in the Ministry of Environment and Forests has set a target of bringing 5 million ha of wasteland annually under firewood and fodder plantation.

viii) **Social Forestry Programmes:** These programmes mostly involve strip plantation on road, rail and canal-sides, rehabilitation of degraded forest lands, farm-forestry, waste-land forest development etc.

CONSUMERISM AND WASTE PRODUCTS

Consumerism refers to the consumption of resources by the people. Two types of conditions of population and consumerism exist.

(i) **People over-population:** It occurs when there are more people than available supplies of food, water and other important resources in the area. Excessive population pressure causes degradation of the limited resources, and there is absolute poverty, under-nourishment and premature deaths.This occurs in less developed countries (LDCs). Here due to large number of people, adequate resources are not available for all. So there is less per capita consumption although overall consumption is high.

(ii) **Consumption over-population:** This occurs in the more developed countries (MDCs). Here population size is smaller while resources are in

abundance and due to luxurious life-style per capita consumption of resources is very high. More the consumption of resources more is the waste generation and greater is the degradation of the environment.

In LDC's - No. of people is very high, but per capita use of resources and waste generated are less.

In MDC's - No. of people is low, but per capita use of resources and wastes generated are very high.

On an average, a U.S. citizen consumes 50 times as much as anIndian.

The Environment Protection Act, 1986

The main aim of the act is to provide for the protection and improvement of environment and for matters connected therewith. The Act clearly states and explain each and every term very precisely like environment, environmental pollutants, environmental pollution, handling, hazardous substance, prescribed.

General Powers of the Central Government

1. Subject to the provisions of this Act, the Central Government shall have the power to take all measures, as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment.
2. Planning and execution of a nationwide program for the prevention, control and abatement of environmental pollution;
3. Laying down standards for the quality of environment in its various aspects;
4. Laying down standards for emission or discharge of environmental pollutants from various sources.
5. Restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards;
6. Laying down procedures and safeguards for the handling of hazardous substances;
7. Examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution;
8. Carrying out and sponsoring investigations and research relating to problems of environmental pollution;

9. Inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and giving, by order, of such directions touch authorities, officers or persons as if may consider necessary to take steps for the prevention, control and abatement of environmental pollution;
10. Preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution.

THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

It provides for maintaining and restoring the wholesomeness of water by preventing and controlling its pollution. **Pollution** is defined as such contamination of water, or such alteration of the physical, chemical or biological properties of water, or such discharge as is likely to cause a nuisance or render the water harmful or injurious to public health and safety or harmful for any other use or to aquatic plants and other organisms or animal life.

The salient features and provisions of the Act are the following:

(i) It provides for maintenance and restoration of quality of all types of surface and ground water.
(ii) It provides for the establishment of Central and State Boards for pollution control.
(iii) It confers them with powers and functions to control pollution. The Central and State Pollution Control Boards are widely represented and are given comprehensive powers to advise, coordinate and provide technical assistance for prevention and control of pollution of water.
(iv) The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards.
(v) The Act makes provisions for various penalties for the defaulters and procedure for the same.

The main regulatory bodies are the Pollution Control Boards, which have been, conferred the following duties and powers:

Central Pollution Control Board (CPCB):

i) It advises the central government in matters related to prevention and control of water pollution.

ii) Coordinates the activities of State Pollution Control Boards and provides them technical assistance and guidance.

iii) Organizes training programs for prevention and control of pollution.

iv) Organizes comprehensive programs on pollution related issues through mass media.

v) Collects, compiles and publishes technical and statistical data related to pollution.

vi) Prepares manuals for treatment and disposal of sewage and trade effluents.

vii) Lays down standards for water quality parameters.

viii) Plans nation-wide programs for prevention, control or abatement of pollution.

ix) Establishes and recognizes laboratories for analysis of water, sewage or trade effluent sample.

State Pollution Control Board:

i) The Board advises the state government with respect to the location of any industry that might pollute a stream or a well.

ii) It lays down standards for effluents and is empowered to take samples from any stream, well or trade effluent or sewage passing through an industry.

iii) The State Board is empowered to take legal samples of trade effluent in accordance with the procedure laid down in the Act. The sample taken in he presence of the occupier or his agent is divided into two parts, sealed, signed by both parties and sent for analysis to some recognized lab. If the samples do not conform to the prescribed water quality standards (crossing maximum permissible limits), then consent is refused to the unit.

iv) The Board suggests efficient methods for utilization, treatment and disposal of trade effluents.

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

According to this act, **air pollution** has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such

concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.

The main objectives of the Act are as follows:

(a) To provide for the Prevention, Control and abatement of air pollution.

(b) To provide for the establishment of Central and State Boards with a view to implement the Act.

(c) To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution.

The main regulatory bodies are the Pollution Control Boards, which have been, conferred the following duties and powers:

Central Pollution Control Board (CPCB):

a) It advises the central govt. in matters related to prevention and control of air pollution.

b) Coordinates the activities of State Pollution Control Boards and provides them technical assistance and guidance.

c) Organizes training programs for prevention and control of air pollution.

d) Organizes comprehensive programs on pollution related issues through mass media.

e) Collects, compiles and publishes technical and statistical data related to pollution.

f) Plans nation-wide programs for prevention, control or abatement of pollution.

State Pollution Control Boards (SPCB)

i) State govt. is empowered to issue instructions to the authority in charge of registration of motor vehicles (under Motor Vehicles Act, 1939) that is bound to comply with ensuring emission standards from automobiles.

ii) In consultation with the State Pollution Control Board, the state government may declare an area within the state as "**air pollution control area"** and can prohibit the use of any fuel other than approved fuel in the area causing air pollution. No person shall, without prior consent of State Board operate or establish any industrial unit in the air pollution control area.

THE WILDLIFE PROTECTION ACT, 1972

This Act passed in 1972, clearly states and explains each and every term very precisely like animal, habitat, hunting, license, national park, sanctuary, wild animal, wild life etc.

(i) It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.

(iii) Under the Act, comprehensive listing of endangered wild life species was done for the first time and prohibition of hunting of the endangered species was mentioned.

(iii) The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.

(iv) The Act provides for the constitution of Central Zoo Authority.

(v) There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.

(vi) The Act imposes a ban on the trade or commerce in scheduled animals.

(vii) It provides for legal powers to officers and punishment to offenders.

(viii) It provides for captive breeding program for endangered species.

Penalties

A person who breaks any of the conditions of any license or permit granted under this Act shall be treated guilty. The offence is punishable with imprisonment for a term which may extend to three years or with a fine of Rs 25,000 or with both. An offence committed in relation to any animal specified in Schedule I, or Part II of Schedule II, like the use of meat of any such animal, or animal articles like a trophy, shall be punishable with imprisonment for a term not less than one year and may extend to six years and a fine of Rs 25,000.

FOREST (CONSERVATION) ACT, 1980

The salient features of the Act are as follows:

(i) The State Government has been empowered under this Act to use the forests only for forestry purposes. If at all it wants to use it in any other way,it has to take prior approval of central Government, after which it can pass orders for declaring some part of reserve forest for non-forest purposes (e.g mining) or

for clearing naturally growing trees and replacing them by economically important trees (reforestation).

(ii) It makes provision for conservation of all types of forests and for this purpose there is an Advisory committee which recommends funding for it to the Central Government.

(iii) Any illegal non-forest activity within a forest area can be immediately stopped under this Act. Non-forest activities include clearing of forest land for cultivation of any type of plants/crops or any other purpose (except re-afforestation). However, some construction work in the forest for wildlife or forest management is exempted from non-forest activity (e.g. fencing, making water-holes, trench, pipelines, check posts, wireless communication etc.)

Penalties for offences in Reserved Forests: No person is allowed to make clearings or set fire to a Reserved Forest. Cattle are not permitted to trespass into the Reserved Forest. Felling, collecting of timber, bark or leaves, quarries or collecting any forest product is punishable with imprisonment for a term of six months, or with a fine which may extend to Rs.500, or both.

Penalties for offences in Protected Forests: A person who commits any of the following offences like felling of trees, or strips off the bark or leaves from any tree or sets fire to such forests, or kindles a fire without taking precautions to prevent its spreading to any tree mentioned in the Act, whether standing or felled, or fells any tree, drags timber, or permits cattle to damage any tree, shall be punishable with imprisonment for a term which may extend to six month or with a fine which may extend to Rs.500, or both.

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POPULATION

Population: Number of organisms of same species in a given area at a given time.

Population dynamics: Change of population with time.

Demography: A social science which entails the statistical study of human populations. It deals with (i) Changes in population size (growth or decline) (ii) Composition of the population (age groups, sex ratio) (iii) Distribution of population

SOME STATISTICS TO REMEMBER

Current World population **:** 7.18 billion (September 2013)

Exceeded 7 billion in March 2012

World population was around 1 billion in 1810. It became 7 times in past 200 years.

DEMOGRAPHICS OF INDIA

Current Indian population **:** 1.21 billion (2011 census)

Indian population growth rate **:** 1.41% (ranked 102nd in the world in 2010. Decreased significantly in the past few decades)

Birth rate:	22.22 births/1,000 population
Death rate:	6.4 deaths/1,000 population
Life expectancy:	69.89 years
–male:	67.46 years
–female:	72.61 years
Fertility rate:	2.5 children born/woman
Infant mortality rate:	30.15 deaths/1,000 live births

Most populated city – Mumbai (12.5 million)

Chennai- 4.6 million (2011 census)

POPULATION CHARACTERISTICS

i) Nature of Population growth

Refers to how the number of individuals in a population increases (or decreases) with time.

Exponential growth- 'J' shaped curve for less developed countries(LDC)

If a population has a constant birth rate through time and is never limited by food or disease the birth rate alone controls the population. Eg: growth in bacteria, some insects etc. (not for human population)

$P = P_0 e^{rt}$

where P: Future population after t years P_o: Present population

r: annual growth rate

t: Number of years

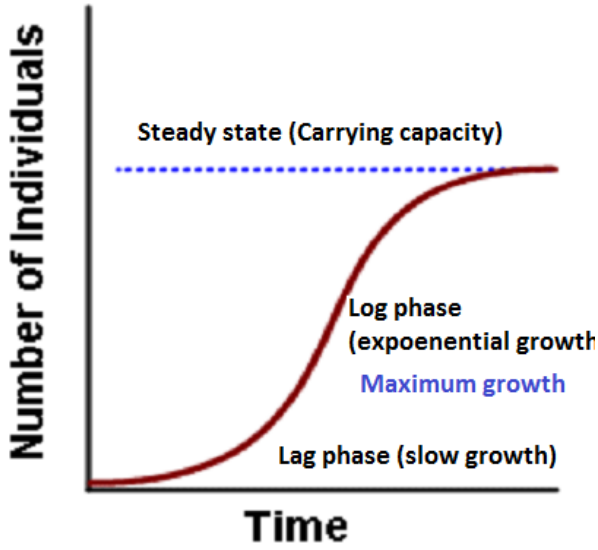
$r = P_2 - P_1 / P_1 X\ t$

P_2: Present Polpulation, P_1: population before t years

Logistic Growth: The **curve is 'S' Shaped** form showing the initial slow growth, followed by steep growth and finally standardized with less growth.

• In most real populations both food and disease become important factors to decide population as conditions become crowded.

• There is an upper limit to the number of individuals the environment can support ie it is determined by the "carrying capacity" of the environment.



The logistic curve shows three phases

- **Lag phase:** little growth
- **Exponential phase:** rapid growth
- **Stationary phase:** stable growth

Zero (population) growth –More developed countries (MDC)

- A condition in which the birth plus immigration equals death plus emigration and population remains constant.
- More developed countries (MDC) show zero population growth.

ii) Population Dispersion

It describes how individuals disperse themselves in their habitats. Three types of dispersion

Uniform Dispersion: Species is evenly distributed about their habitat

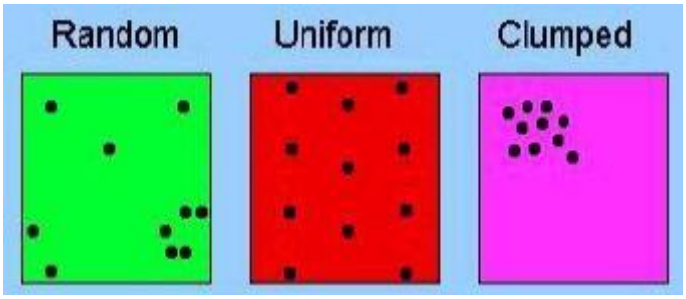
- Caused by a species ability to survive anywhere in the habitat
- They use the resources found immediately around them and spread out to use all of the available resources
- Ex. Arrangement of shrubs in deserts

Random Distribution: Population found randomly about their habitat

- Individual have been distributed by chance
- Ex: Free floating marine larvae

Clumped Dispersion: Population found in tight clusters, dispersed across a large landscape

- Caused by a no of factors such as species are together for protection, are grouped around natural resources necessary to their survival
- Ex. Clusters and clones of plants.



iii) Population Doubling Time

Time needed for a population to double its size at a constant annual growth rate

T_d = 70/r, where T_d-doubling time in years (r- annual growth rate) .

For example if a country has annual growth rate of 2%, its population doubling time will be 70/2= 35 years.

iv) Total Fertility rate

Average number of children that would be born to a woman in her lifetime.

TFR----1.9 in most developed nations (MDC)

4.7 in developing nations or less developed nation (LDC)

In our country TFR is 6.1 in 1950 currently 2.6 (2011)

Crude birth rate: Number of live births occurring during the year, per 1,000 population estimated at midyear.

$$\text{Crude birth rate} = \frac{\text{Number of births}}{\text{Estimated midyear population of that year}} \times 1000$$

v) Mortality

Number of deaths per thousand of individuals in a year.

Decrease in mortality rate will increase population. Due to technological advancements, better medical facilities and better literacy rate, the mortality rate has gone down in India.

Infant mortality rate: It is the number of infants dying before reaching one year of age, per 1,000 live births. The rate has been declined in the last 50 years in our country.

Crude death rate: It is the number of deaths in a particular year per thousand people in a particular region.

$$\text{Crude death rate} = \frac{\text{Number of deaths}}{\text{Estimated midyear population of that year}} \times 1000$$

vi) Replacement level

Number of offspring replacing two parents

For a developing nation this is always greater than 2, while for a developed country it is mostly under 2.

vii) Migration

The movement of individuals into (immigration) or out of place (emigration) a place or country.

People migrate from one place to another for better economic and social life.

viii) Female –Male Ratio

Sex-ratio is the number of females per thousand males of population.

Due to female infanticide and gender-based abortions, ratio has been upset in many countries including India (933: 1000).

ix) Life expectancy

Average age that a newborn infant is expected to attain in a given country.

x) Demographic transition

It is the correlation between population growth and industrialization.

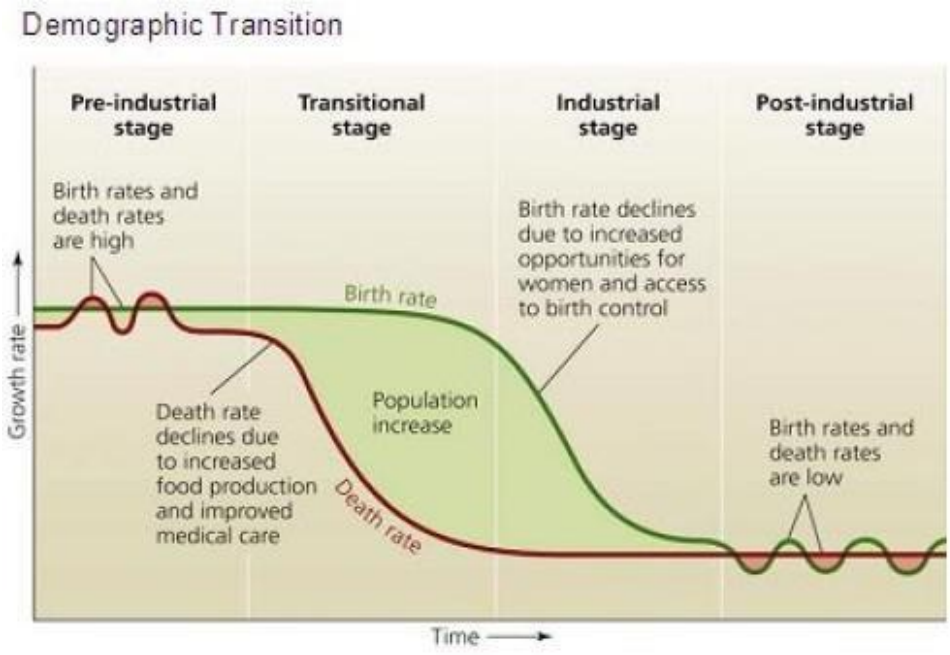
Demographic transition occurs in four phases:

(a) Pre industrial phase: Characterized by high growth and death rates and net population growth is low.

(b) Transitional phase: Industrialization begins. Better hygiene, medical facility and food. Death rate decreases. Birth rate remains high. Most of the developing countries are currently in this phase.

(c) Industrial phase: Birth rate drops. Many developed countries are currently in this stage. A few developing countries have entered this phase.

(d) Post industrial phase: Birth rate drops further and zero population growth is achieved. Many European countries are in this stage now.



POPULATION PYRAMIDS

A population pyramid represents the age and sex structure of a population. The shape of the pyramid reflects the characteristics of a population.

- Graphs are on their sides with the axis in the middle. Population plotted on the X-axis and age on the Y-axis. The number of males is shown on the left, females on the right in five-year age groups.
- Different age classes are pre-productive (0-14 yrs) reproductive (15-44yrs) and post-productive (45yr and above)

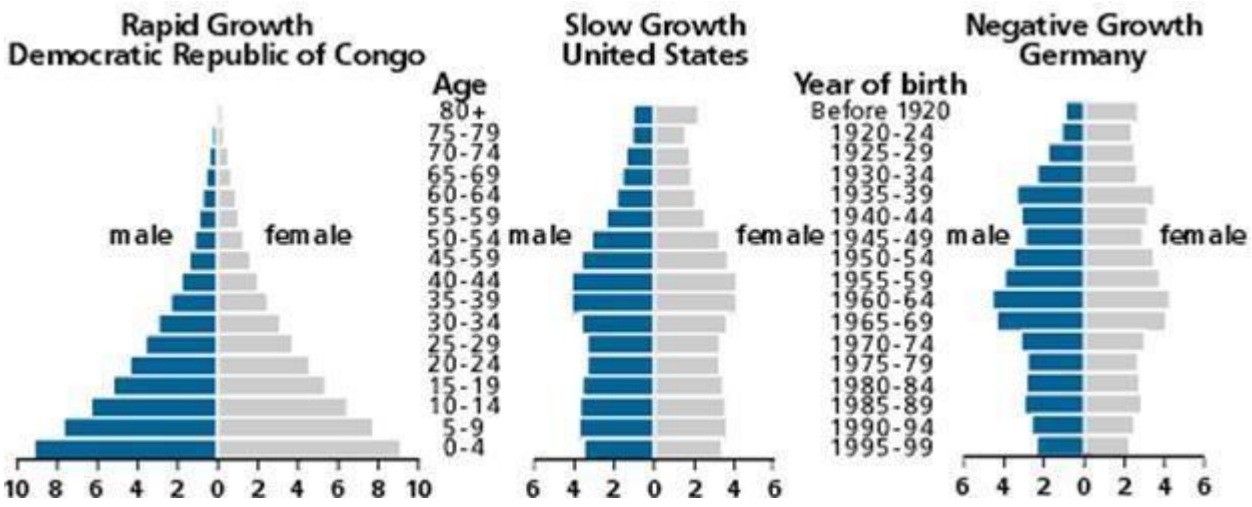
Information derived from Population Pyramids

The following information can be obtained from population pyramids

- Birth and death Rate
- Life expectancy
- Sex ratio
- Fertility Rate
- Infant Mortality Rate
- Can relate to social & economic problems of the nation.

- **There are three Types of population pyramids**

1. Pyramid Shaped **2. Bell shaped** **3. Urn shaped**



a) Pyramid Shaped: (*Growing population*)-Least Developing Countries

Characteristics

- Very young population is more, making a broad base and old people are less.
- Large no of individuals in very young age will soon enter into reproductive age and population will increase.
- Less no of people in old age indicates less loss of population due to death
- This is characteristic of traditional poor countries indicated by:-
    i. High Fertility

ii. High Morality

iii. High proportion of children (young age)

iv. Moderate Growth Rate.

- Developing countries like India, Philippines, Ethiopia, Nigeria etc

b) Bell Shaped *(Stable or zero population growth):*

Characteristics

- It is bell shaped pyramid which tapers towards the top.
- It shows that the birth and death rates are almost equal.
- Birth rate has declined, resulting in people of almost equal no of age group 0-35yrs.
- In the next 30 yrs, the people entering into reproductive age group is not going to change much and such age pyramids indicate stable population results in zero population growth.
- This includes contemporary developed countries characterised by:-

  i. Declining Fertility

  ii. Declining Mortality

  iii. Moderate Growth Rate

  iv. Aging population

- Countries like Finland, France have this kind of population growth.

c) Urn Shaped (*Negative growth):*

Characteristics

- This pyramid has a narrow base and narrow top.
- It shows that the birth and death rates are declining.
- The number of young class is smaller than the productive middle age class.
- In the next 10 yrs, the no. of population in reproductive age class will thus become less than before and hence decline in the population growth.
- These are future developed countries characterised by:-

  i. Low fertility

ii. Low Mortality

iii. Ceasing Growth Rate

iv. Very old Population

- Germany, Italy, Hungary, Sweden, Japan have this type of population pyramid.

Population Explosion

Population explosion: A rapid and significant increase in the size of a population caused by such factors as a sudden decline in infant mortality, death rate or an increase in life expectancy.

REASONS

i) **Better health care facilities:** In the past few decades there has been a remarkable improvement in the health facilities which resulted in the decrease of mortality rates.

ii) **Increased food productivity and distribution:** Green revolution, use of scientific methods in agriculture resulted in increased food production which could feed millions. In other words, famine and drought incidents reduced considerably.

iii) **Illiteracy and lack of awareness about family planning concepts:** Though there has been an increase in literacy rate among the people, many in the under-developed countries still remain ignorant of many family planning techniques.

iv) **Believes and cultural reasons:** In many Middle East countries, polygamy is common. Number of male children is of family prestige and pride. So parents prefer to have as many off springs (preferably male) as possible. Many parents believe that more children are needed (help) to take care of them at their old age.

v) **Eradication/control of diseases:** Many diseases like small pox have been eradicated completely. Other diseases like plague, polio, malaria is

under check in many countries. Earlier, these diseases used to wipe out entire city.

vi) **Government and other agencies funding:** Many agencies like WHO, World bank, UNO and other agencies monitor the progress of many under developed countries by releasing funds for improved health facility, better living conditions. Many schools in india have adopted free mid day meal program which reduce poverty and starvation.

CONSEQUENCES

i) **Inadequate fresh water:** Population explosion can lead to severe shortage of drinking water, especially in semi-dry or dry areas.

ii) **Depletion of natural resources:** It can lead to over exploitation of many natural resources (water, forest, mineral, food, energy, soil etc).

iii) **Pollution:** More number of people will result in severe environmental pollution (air, water, soil, marine, noise etc).

iv) **Deforestation:** Forest will be cleared for human settlement, agriculture etc. Deforestation cause extinction of rare and endangered species.

v) **Poverty, malnutrition and starvation:** Shortage of food and drinking water among people can result in poverty and malnutrition.

vi) **Emergence of new epidemics and diseases:** Malnutrition along with unhygienic living conditions and lack of good healthcare facility can result in the emergence of epidemics

vii) **Unemployment issues, Lower wages:** Population explosion can result in serious unemployment issues as the number of people having minimum education will be more. Severe competition may result in the underpayment.

viii) **Climate change:** Growing population can result in the increase of greenhouse gases which can result in global warming.

viii) **Other social issues:** Population explosion can result in inflation, increased crime rate, high child mortality rates etc.

Remedies to population explosion

- Emigration to other countries in search of better opportunities.
- Educating the youth about the problems associated with population explosion.
- Adoption of any family planning methods
- Late marriage reduce the fertility rate
- Health and sanitation
- Recreation facilities
- Changes in social outlook
- High standard of living
- Changes in religious outlook
- Respectful position for women
- Creating awareness
- Easy accessibility to control methods

Carrying capacity: Number of individuals of a species that can be indefinitely sustained in a given area without harming the habitat. It depends and varies with the habitat.

If growth exceeds carrying capacity, environmental resistance lower population size and population enter the death phase. Species will become threatened, endangered or extinct.

Environmental Resistance: Any factor in the environment limiting carrying capacity.

Four main factors:

- Raw Material Availability
- Energy Availability
- Waste Accumulation and Disposal
- Organism Interactions

THEORIES OF POPULATION

Malthusian (Thomas Malthus) Theory

Malthus, in his “essay, “The Principles of Population”, hypothesised that there is relationship between economic development and population growth. He claimed that population was increasing faster than food production, and he feared eventual global starvation.

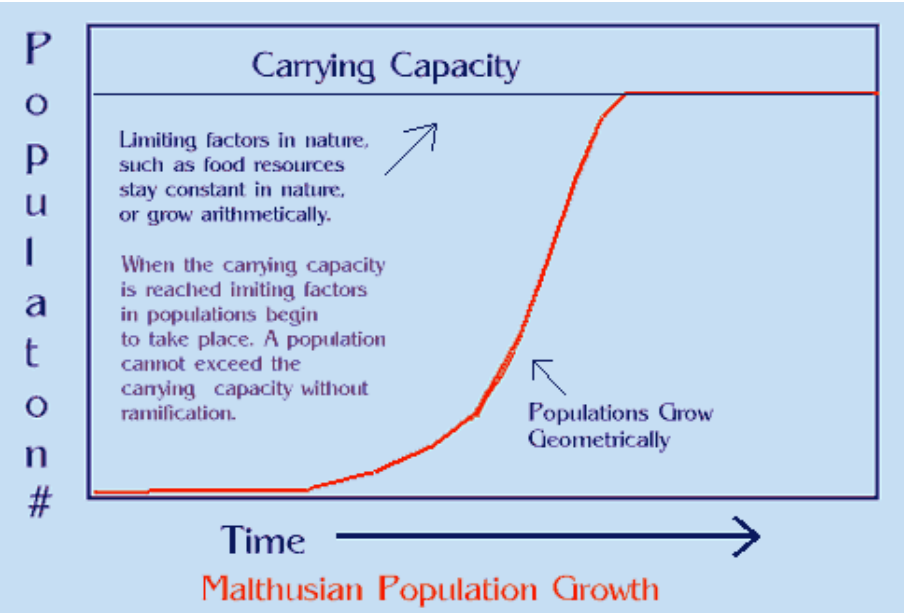
He suggested that populations tend to grow in geometric progression (Exponential), doubling in size every 'n' years depending on the population growth rate; while food supplies can at best grow in arithmetic progression.

Population: 1, 2, 4, 8, 16, 32……..

Food: 1, 2, 3, 4, 5…….

Consequences:

- Population growth will be limited by food availability
- Result in Starvation, poverty, disease, crime, misery and reduction in population growth.
- **Positives and preventive checks:** If population exceeds agricultural production, some positive checks like famines, diseases outbreak and violence as well as preventive checks like birth control are needed to stabilize the population growth.



Marxian (Karl Marx) Theory of population

- Karl Marx contradicted Malthus's view. Marx's view on population is that there is no problem such as overpopulation.
- Social exploitation and oppression of the less privileged people leads to poverty, overcrowding, unemployment, environmental degradation that in turn causes over population.
- His view was that the problem was caused due to capitalism, in that, capitalists facilitate the unequal distribution of food and resources. This is so because the capitalist possess the concentration of the economy's wealth whilst the working class lives in poverty.
- Population growth is symptom rather than a root cause of poverty, resource depletion, pollution and other social evils.

Remedial measures

- Equity and social justice to all
- Allowing everyone to enjoy a good standard of living is the need that can help in achieving stabilised global population

HUMAN RIGHTS

Human Rights and the salient features of the Universal Declaration of Human Rights adopted by UN on December 10th 1948

Human rights are the rights a person has, because he or she is a human being. Human rights are held by all persons equally, universally, and forever.

Human rights are inalienable and thus cannot be taken away from a person under any circumstances. You cannot lose these rights any more than you can cease being a human being.

Human rights are considered as the basic standards without which people cannot live in dignity. To violate someone's human rights is to treat that person as though he or she was not a human being. To advocate human rights is to demand that the human dignity of all people be respected.

Thus Human rights are universal legal guarantees protecting individuals and Groups against actions which interfere with fundamental freedoms and human dignity.

Some of the most important characteristics of human rights are the following:

- Human Rights are guaranteed by international standards and legally protected.
- Human Rights focus on the dignity of the human beings.
- Human Rights are indivisible and hence one cannot be denied, waived or taken away.
- Human Rights are interdependent; all human rights are part of a complementary framework. For example, our ability to participate in our government is directly affected by our right to express our self, to get an education, and even to obtain the necessities of life.
- Human rights are interrelated and universal.

Human Rights in India

Our Constitution guarantees every citizen of India six fundamental rights. They are

- Right to Equality
- Right to freedom of Speech and Activity
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies.

VALUE EDUCATION

Education is one of the most important tools in bringing about socio economic and cultural progress of a country. Education does not simply means acquiring knowledge and information but also its right use within the framework of spectrum of ethical values

'Values' – Ones own principles and standards from enables one to judge between the right and wrong behavior / actions / practices.

Value-based Education

Value based education provides proper direction to youth and inculcate positive attitude in them and teach them the distinction between right and wrong.
It teaches humans to be compassionate, helpful, peace loving, generous and tolerant so that they can create more harmonious, peaceful, enjoyable and sustainable future.

Need for value based Environmental education

The environment belongs to each one of us and our actions affect environment. When environment gets degraded, it affects our health, well being and our future. Value education in relation to environment provides an understanding and appreciation of nature and the importance of its conservation. It helps to create a sense of earth citizenship and sense of duty to care for the earth and its resources and to manage them in a sustainable way.

Following attitudes and behavior to be incorporated through this education

1) Human values

To develop positive attitudes towards environment and to recognize that 'man in nature' rather than 'nature for man'.

2) Social Values

To develop values such love, compassion, tolerance and justice towards nature so that all forms of life (biodiversity) can be protected.

3) Cultural and Religious Values

To nurture, respect and protect every aspect of nature by considering them sacred (plants, rivers, mountains etc are sacred)

4) Ethical values

To promote earth – citizenship thinking rather than human centric thoughts/ views

5) Global Values

To recognize that nature and all the natural phenomenon occurring in the earth are interconnected and exist in harmony. Disturbing the harmony will lead to ecological collapse.

6) Spiritual values

To develop principles of self restraint, contentment, reduction of desires and freedom from greed and severity in attitude. These values will help to attain sustainable development and environmental conservation

Women And Child Welfare

Women and child development is of great importance in the socio-economic growth of any country because of following reasons.

i) They form high priority group as they form 70% of population in developing countries (65% in India)

ii) They constitute vulnerable or special risk as soft, weak, prone to diseases easily and most of them are economically depended on their spouse or parents.

In recent years, the **empowerment of women** has been recognized as the central issue in determining the status of women. The **National Commission for Women** was set up by an Act of Parliament in 1990 to safeguard the rights and legal entitlements of women. The 73rd and 74th Amendments (1993) to the Constitution of India have provided for **reservation of seats in the local bodies of Panchayats and Municipalities for women, laying a strong foundation for their participation in decision making at the local levels.**

Rights and Privileges of women

- Men and women equal rights and opportunities in the political, economic and social spheres.
- Equal protection of law,

- Prohibit discrimination against any citizen on grounds of religion, race, caste, sex or place of birth,
- Positive discriminations in favor of women
- Securing all citizens, men and women, equally, the right to means of livelihood
- Equal pay for equal work
- Humane conditions of work and maternity relief.

Important Social Legislation relating to Women

- The Child Marriage Restraint (Amendment) Act, 1976
- The Equal Remuneration Act, 1976
- The Medical Termination of Pregnancy Act, 1971
- The Dowry Prohibition Act, 1961
- Family Courts

Policies Concerning Women's development

- The **National Plan of Action for Women (NPA)** adopted in 1976 became a guiding document for the development of women till 1988
- The **National Perspective Plan for Women (NPP)** -holistic approach for the development of women.
- **National Policy for the Empowerment of Women (2001)**

National Policy for the Empowerment of Women (2001)

The policy aims at:

- The advancement, development and empowerment of women in all spheres of life.
- Ensuring women's equality in power sharing and active participation in decision-making.
- Mainstreaming a gender perspective in the development process.
- Comprehensive economic and social empowerment of women.
- Partnership with community-based organisations.
- Implementation of international obligations / commitments and cooperation at the international, regional and sub-regional levels.

Various other schemes for women welfare

- **Balika samridhi yojana (1997)** – to encourage enrolment & retention of girl child in schools by providing free education for girl child along with a financial grant to the family below poverty line

Child welfare in India

The development of children is the first priority on the country's development agenda, not because they are the most vulnerable, but because they are our supreme assets and also the future human resources of the country

Legislative measures and policies

- **Child Labour (Prohibition & Regulation Act) (1986)-**An Act to prohibit the engagement of children in certain employments and to regulate the conditions of work of children in certain other employments.
- **The Child Marriage Restrain Act, 1929** -to abolish and eliminate child marriage.
- **The Juvenile Justice (Care and Protection of Children) Act, 2000.**
- **The Commissions for Protection of Child Rights Act, 2005**
- **The National Policy for Children (1974)**

  This Policy aims at
- Providing adequate services towards children, both before and after birth and during the growing stages for their full physical, mental and social development.

Constitutional Provisions for children

- Free and compulsory education to all children of the age of six to fourteen years
- Prohibits trafficking of human beings and forced labour.
- Prohibits employment of children below the age of fourteen years in factories, mines or any other hazardous occupation

Other Schemes for Children welfare

- Schemes/Projects Programmes being implemented by the **Ministry of Women and Child Development** are as under:
- **Integrated Child Development Services (ICDS) Scheme**
- **Rajiv Gandhi National Creche Scheme for the children of working mothers**
- ***Gramodya Yojana*** and ***Nutrition Programme for Adolescent Girls***
- **Integrated Programme for Juvenile Justice**
- **Balwadi Nutrition programmaes** (1970 -71)-to provide nutrition, informal schooling for providing early education to children of 3-5yrs
- **Child labour eradication scheme(1984)** -to shift child labour from hazardous jobs into schools
- **Mid day Meal scheme for school children(1995)-**To provide free mid day meal to primary school children in the country

Integrated Child Development Scheme (ICDS) -Launched in ***1975***

Objectives of ICDS:

- Lay the foundation for proper psychological development of the child
- Improve nutritional & health status of children 0-6 years
- Reduce incidence of mortality, morbidity, malnutrition and school drop-outs
- Enhance the capability of the mother and family to look after the health, nutritional and development needs of the child
- Achieve effective coordination of policy and implementation among various departments to promote child development

HIV/AIDS

HIV: HIV (Human Immunodeficiency Virus) is a virus that causes AIDS (Acquired Immunodeficiency Syndrome), a health condition in which a person is affected by a series of diseases because of poor immunity.

- HIV by itself is not an illness and does not instantly lead to AIDS.

AIDS: Acquired Immunodeficiency Syndrome is a health condition that results from the deficiency in the body's immunity following HIV infection.

- Break down the body's immune system leaving the patient to a number of life threatening infections

Transmission of HIV

- **Contaminated Fluids**: Contamination of blood stream with HIV infected body fluids, particularly blood, semen, breast milk and vaginal fluid
- **Sharing of needles:** Sharing of HIV contaminated needles in blood transfusion
- **Unprotected sex:** By sexual contact with affected person
- **Maternal-fetal transmission** -Infected mother give birth to infected baby. Breast milk can also act as a transmission-medium.
- **Improperly sterilized hospital tools:** If surgical devices like syringes and scalpels, or even certain instruments, used on an infected person, are used on another person without proper sterilization Contaminated needles or syringes used drugs

HIV is not spread by

- Physical touch of infected persons
- Air borne- by means of sneezing or coughing
- Water borne -by means of saliva, tears etc

Mechanism of HIV infection

- HIV is a retro virus which damages immune system by destroying lymphocytes (white blood cell), helper T cell Development of HIV:
- Incubation period is longer- an average of eight years
- During the "asymptomatic" or incubation period, the virus will be actively multiplying, infecting, and killing cells of the immune system

Four Stages of infection

- ***Initial Infection-destruction of helper T cells*** or lympocytes
- ***Asympotic or incubation period***

- ***AIDS related complex (ARC)***
- ***Final stage- Fully infected AIDS patients*** receiving different kinds of infection

What are the early and later symptoms of HIV/AIDS?

- Many people do not develop any symptoms when they first become infected with HIV.
- ***More persistent or severe symptoms may not surface for several years, even a decade or more,***

Symptoms at later stage

- Lack of energy
- Weight loss -Rapid loss of more than 10 pounds of weight that is not due to increased physical exercise or dieting
- Frequent fevers and sweats
- Periods of extreme and unexplained fatigue that may be combined with headaches, lightheadedness, and/or dizziness
- Long-lasting bouts of diarrhoea
- Swelling or hardening of glands located in the throat, armpit, or groin
- Increasing shortness of breath

How is HIV diagnosed?

- **Two types of tests are available to diagnose HIV infection**

1. **Study the presence of antibodies produced by body in response to HIV**

- ELISA (Enzyme Linked Immuno sorbent Assay),
- Western Blot (WB)
- Immunoflouroscent Assay (IFA).
- Saliva and Urine test

2. Study the presence of virus itself.

Polymerase Chain Reaction (**PCR)-** looks for HIV itself in the blood. This test, which recognizes the presence of the virus' genetic material in the blood, can detect the virus within a few days of infection.

Treatment against HIV and AIDS

HAART (Highly Active Antiretroviral Therapy)

- The commonly available treatment for AIDS is the treatment against opportunistic infections.

Prevention

- Global education about disease
- Use of screened blood samples, disposable infections.
- Protected Sex (use of condoms)
- Monogamy or abstinence from sex
- The risk of HIV transmission from a pregnant woman to her baby is significantly reduced if she takes treatment during pregnancy
- It is necessary to treat STD as soon as you suspect infection
- The **National AIDS Research Institute (NARI)** was established in 1992 with the mission to provide leadership in biomedical research on HIV/AIDS in India with an aim to compliment and strengthen the National AIDS Control Programmes.

ENVIRONMENT AND HUMAN HEALTH

Health: According to world health organisation (WHO) health is a state of complete physical, mental and social well-being and not merely the absence of diseases or infirmity.

Environment and public health issues are

i) Infectious Diseases
ii) Disposal of Chemicals
iii) Pesticide and heavy metal contamination
iv) Occupational hazards
v) Noise

vi) Radiation

vii) Food

viii) Settlement

i) Infectious diseases

Unhygienic conditions of environment forms the breeding grounds for various deadly diseases causing organism like virus, bacteria, vectors etc.

They pose greater threats to health, more severely in the developing countries.

Infectious organism cause food poisoning, respiratory diseases and gastrointestinal diseases.

- **Water-borne(Polluted water):** Cholera, Dysentery, Amoebiosis, Hepatitis
- **Air-borne(Polluted air):** Asthma, Bronchitis, Pneumonia, Tuberculosis
- **Food-borne(Food-poisoning):** Cholera, Dysentery
- **Vector-borne:** Malaria, Typhoid, Filaria
- **Animal-borne:** Plague

ii) Disposed Chemicals

A large number of chemicals are introduced in the environment by anthropogenic activities

Chemical can be divided into two categories

Hazardous: Any substance or preparation which by its physico-chemical properties or handling is liable to cause harm to human beings, other living organisms, property or environment. **Eg: explosives and inflammable chemicals**

Toxic Chemicals(Toxins): Poisonous chemicals which kill cells and can serious health concerns including death. These substances can have pronounced impact on physic-chemical activities if it is present beyond threshold/permissible limit.

Carcinogenic: Cause cancer **Eg: aromatic hydrocarbons like benzene, various amines etc**

Mutagenic: affect genetic material (DNA) in cells **Eg: Polycyclic aromatic hydrocarbon, benzene, sodium azide.**

Teratogenic/Embryotoxins: Cause abnormalities during embryonic growth and development. **Eg: various pesticides, heavy metals etc**

Neurotoxins: Affect nervous system **Eg: Lead**

iii) Pesticide and heavy metal contamination:

Some of the pesticides and other pollutants may act as inhibit hormones in humans and other species and affect reproduction, development and various ailments including tumors.

Many chemical like DDT and other chlorinated pesticides accumulate in food chain and show deleterious effect at the top of the food chain. Heavy metals, arsenic, chromium, lead, mercury affect human health.

iv) Occupational Hazards

Workers in various factories, mines, construction of dams, buildings, commercial forms, forestry and agriculture are exposed to risks, especially health hazards

Dust: Lung diseases

Silicosis: Dust contaminating free silica or silicon dioxide-reduces life expectancy.

Asbestosis: Finest fibres of asbestos find access to respiratory tract leading to respiratory problems

v) Noise

Sound levels beyond the permissible level of human ear may damage ears.

Elevated workplace or other noise can cause hearing impairment, hypertension, heart diseases etc. It can affect pregnant mothers and their foetus.

vi) Radiation

Cosmic and ultraviolet rays cause harmful effects on human health which may include cancer.

vii) Diet

Contamination of food can cause indigestion, food poisoning and other various ill effects. Undernutrition or malnutrition makes humans prone to other diseases.

viii) Settlement

Improper settlement and poor physical environment may cause various psychological problems which affect various vital physiological processes in the body.

FAMILY PLANNING

Family planning is the planning of when to have children, how many children to have and the use of birth control and other techniques to implement such plans.Family planning allows couples to decide their family size and also the time spacing of their offspring.

Family planning means a deliberate effort and the adoption of suitable methods, to restrict the growth of family. That is to say family planning involves a deliberate limitation on the size of family.

Following are some of the important family planning measures:

- **Use of contraceptives (Mechanical, Chemical methods):**

Contraception means the prevention of conception. There are many contraceptive techniques available for use.

Mechanical method

- **Condom (For male's use):** The condom is a sheath of rubber, which fits over the erect penis. It is placed on the penis of male before it is introduced into the vagina for copulation.
- **Diaphragm (For female's use):** The diaphragm is a rubber cup stretched over collapsible metal spring coil. It is designed to fit over the cervix (the mouth of uterus).
- **Intrauterine Contraceptive Device (IUD):** It is a small metal or plastic device, which is designed to fit inside the uterus mouth. A doctor must fit and remove IUD. Eg: Copper T
- **Norplant:** A new implant has been cleared by Health Ministry of India. The implant placed below the skin, ensures the contraceptive power up to

5 years. It is new contraceptive to India and there is some resistance to woman's body. Initially it will be used in urban areas.

Chemical Method

- **Jellies, creams and foam:** A number of different spermicidal jellies, creams, and foams are available for use of contraceptive agents. These jellies, creams or foams are inserted into vagina five to fifteen minutes before copulation to take place.
- **Oral contraceptive:** These are popularly known as pill are combinations of synthetic sex. Hormones (estrogens and progesterone) e.g. mala D. They suppress the production of ovum by hormones and alter the adulatory cycle.
- **Sterilization:** It is surgical technique by which the passage of sperms or ovum is disconnected. Both men and women can be sterilized without loosing their ability to function sexually.
- **Vasectomy:** In man the sterilization procedure is called a vasectomy. In this procedure the vasa deferentia, the tubes that lead from the testes to the ejaculatory ducts, are cut so that the sperm produced in the testis cannot reach the ejaculatory ducts to enter the ejaculate.
- **Tubectomy:** In females tubectomy is done. In this procedure, the fallopian tubes, which transport the egg from the ovaries to the uterus are cut and tied off.

ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH

Information Technology (IT) is defined as the collection, processing, storage and dissemination of information.

Development of internet facilities, Geographical information system, Remote sensing technologies etc generates up-to-date information on various aspects of Environment and health.

Database is the collection of inter-related data on various subjects.It is in computerized form and can be retrieved whenever required.

ROLE OF IT IN ENVIRONMENT

i) ENVIS – Environmental Information System

- Realising the importance of collecting, handling and storing Environmental Information, the Government of India established Environmental Information System (ENVIS) , in 1982.
- ENVIS is a decentralized system with a network of Centres ensuring environmental information collection, storage, retrieval and dissemination to all concerned.
- Collects information from 25 centers all over the country.
- Generates network of database on areas like pollution control, clean technologies, remote sensing, coastal ecology, biodiversity, Western Ghats, Environmental Management, renewable energy, Desertification, Mangroves, Wildlife, Mining etc.

FEW OBJECTIVES OF ENVIS

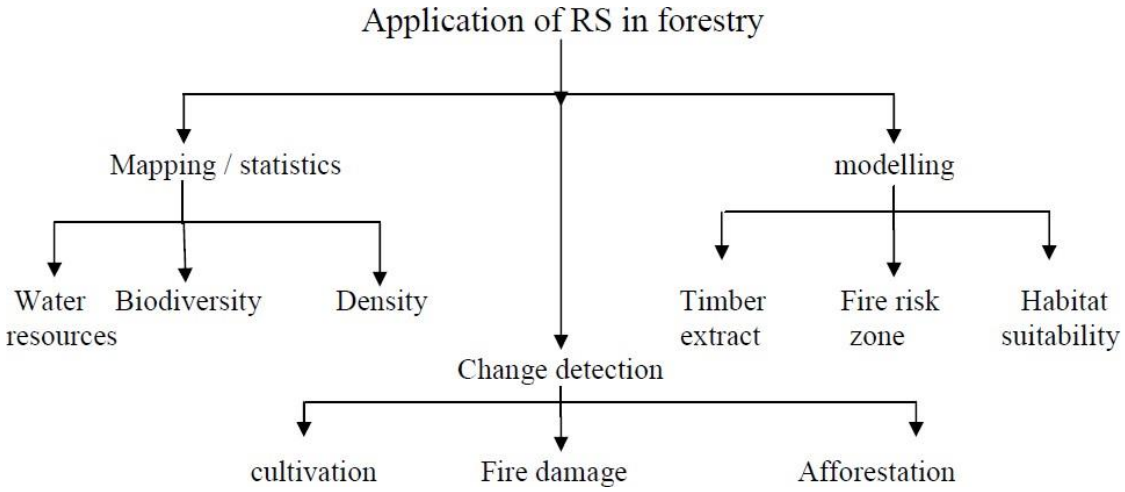
a) To build up a repository and dissemination centre in Environmental Science and Engineering
b) To support and promote research, development and innovation in environmental information technology.
c) To promote exchange of information amongst developing countries.

ii) NIMS – National Management Information System

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.

iii) RIS – Remote Sensing Information System

- Remote Sensing is the collection of data by sensors not in direct contact with the phenomena of interest.
- A typical RIS system has four elements: a source, the sensor, interactions with the atmosphere, and interactions with the earth's surface.
- Satellite imageries provide the actual information about various physical and biological resources and their degradation in a digital form through remote sensing.
- Satellite data also helps in providing correct, reliable and verifiable information about forest cover, conservation efforts etc.
- Provides information of ozone layer depletion, smog, approach of monsoon etc.
- To discover many new reserves of oil, minerals etc.
- To find out land cover, forest cover, bio diversity etc. by mapping
- Plays a key role in Environmental Management, Environmental Impact Assessment etc.



iv) GIS – Geographical Information System

- GIS is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
- Different thematic maps containing digital information on a number of aspects like water resources, industrial growth, road network, soil type,

forest land, grass land etc. are superimposed in a layered form in computer using software.

- For interpretation of polluted zones, degraded lands, emission sources etc.
- Zoning Atlas is prepared by GIS to locate suitable areas for industrial growth
- GIS plays a key role in resource mapping, environmental conservation, management, planning, Coral reef mapping etc.
- Helps in disaster Management and relief operations

v) WWW– World Wide Web

- Internet and web resource materials, On line learning centre, provides the most current and relevant information on environmental applications, problems & solutions etc.
- **Student and teacher friendly features:** To get detailed information, case studies, current articles, career information, encyclopedia (Wikipedia), videos (youtube) etc.

vi) Computer based instruments for environment studies

Environmental monitoring, data collection and analyses involve the extensive use of computers. Many techniques involve automated sampling and analysis. Almost all analytical techniques involved like Atomic absorption spectrometry, flame photometry etc are attached to computer where data can easily read, analysed, compared and stored.

ROLE OF IT IN HUMAN HEALTH

Information technology (IT) has the potential to improve the quality, safety, and efficiency of health care. Combination of IT and health is **bioinformatics.** Some applications of computer based technology in the field of health are listed below.

i) Electronic health record (EHR)

- EHR is a systematic collection of electronic health information about individual patients or populations.

- It is a record in digital format that is theoretically capable of being shared across different health care settings.
- EHRs may include a range of data, including medical history, medication and allergies, immunization status, laboratory test results, radiology images, vital signs, personal stats like age and weight, and billing information.
- EHR saves considerable amount of time for doctors, as it contains entire medical history of the patient.
- It also helps in easy access and sharing of information.

ii) Automated dispensing machines (ADMs)

- This is an advanced technology distributes required medication doses to the prescribed patients on time.

iii) Picture archiving and communications system (PACS)

- This technology captures and integrates diagnostic and radiological images from various devices (e.g., x-ray, MRI, computed tomography scan), stores them, and disseminates them to a medical record, a clinical data repository, or other points of care.

iv) Medical Transcription

- Medical transcription is the transcribing (typing) of doctor's reports from dictated audio files. These files are used for diagnosis, information sharing and health care delivery.

v) Teleconferencing

- Using latest computer aided technology, it is possible for a physician to have a teleconference with other medical experts in the middle of surgery.

vi) Endoscopy and Laproscopy

- An *endoscopy* involves examining the inside of a person's body using an *endoscope*. An *endoscope* is a medical device consisting of a long tube with light or cameras attached that is used to look inside a body

cavity or organ. The image of the organ can be seen on computer monitor and can be studied for the growth of tumor, cancer etc.

- Lapscropic (key hole) surgery uses computer based applications.

vii) Instruments in health care

- Magnetic resonance imaging unit (MRI scan), Computed Axial Tomography (CT scan), Intensive Care units (ICU) etc widely use computers for functioning.

viii) Mobile blood banks

- Mobile blood banks have data of different blood groups and those who are in need of blood to meet critical medical situations can get it from these banks. Software application helps people to find a nearest donor from his/her own locality. Information on all listed blood donors with the requested blood group and their phone numbers will be available through the application.

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