Semester – II

19AEC101 **ENVIRONMENTAL STUDIES** **3H – 3C**

Instruction Hours / week:L: 3 T: 0 P: 0 **Marks:**Internal:**40** External:**60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To create the awareness about environmental problems among people.
- To develop an attitude of concern for the environment.
- To motivate public to participate in environment protection and improvement.

Course Outcomes (COs)

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
7. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

Unit I – INTRODUCTION - ENVIRONMENTAL STUDIES & ECOSYSTEMS

Environment Definition, Scope and importance; Ecosystem, Structure and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession. Classification of ecosystem. Forest ecosystem, GrasslandEcosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Unit II - NATURAL RESOURCES - RENEWABLE AND NON-RENEWABLE RESOURCES

Natural resources - Renewable and Non – Renewable resources. Land resources and land use change, Land degradation, soil erosion and desertification. Forest resources -Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water resources- Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water.Use of alternate energy sources, growing energy needs, case studies.Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit III - BIODIVERSITY AND ITS CONSERVATION

Levels of biological diversity - genetic, species and ecosystem diversity.Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Bio-geographical classification of India. Biodiversity patterns (global, National and local levels). Hot-spots of biodiversity. India as a mega-diversity nation. Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Unit IV - ENVIRONMENTAL POLLUTION

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution.Nuclear hazards and human health risks. Solid waste management and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Case studies.

Unit V - SOCIAL ISSUES AND THE ENVIRONMENT

Concept of sustainability and sustainable development. Water conservation -Rain water harvesting, watershed management.Climate change, global warming, ozone layer depletion,acid rain andits impacts on human communities and agriculture. Environment Laws (Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act). International agreements (Montreal and Kyoto protocols).Resettlement and rehabilitation of projectaffected persons.Disaster management (floods, earthquake, cyclones and landslides).EnvironmentalMovements (Chipko, Silent valley, Bishnois of Rajasthan). Environmental ethics: Roleof Indianand other religions and cultures in environmental conservation. Environmental communication and public awareness,case studies (e.g., CNG vehicles in Delhi).Human population growth: Impacts on environment, human health and welfare.

Suggested Readings

1. Anonymous. 2004. A text book for Environmental Studies, University Grants Commission and Bharat Vidypeeth Institute of Environmental Education Research, New Delhi.
2. Anubha Kaushik., and Kaushik, C.P. 2004. Perspectives in Environmental Studies. New Age International Pvt. Ltd. Publications, New Delhi.
3. Arvind Kumar. 2004. A Textbook of Environmental Science. APH Publishing Corporation, New Delhi.
4. Daniel, B. Botkin., and Edward, A. Keller. 1995. Environmental Science John Wiley and Sons, Inc., New York.
5. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S.Chand & CompanyPvt. Ltd., New Delhi.
6. Odum,E.P., Odum, H.T. and Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.
7. Rajagopalan, R. 2016.Environmental Studies: From Crisis to Cure, Oxford University Press**.**
8. Sing, J.S., Sing. S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Publishing Company, New Delhi.
9. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources.Daya Publishing House, New Delhi.
10. Tripathy. S.N., and Sunakar Panda. (2004). Fundamentals of Environmental Studies (2nd ed.). Vrianda Publications Private Ltd, New Delhi.
11. Verma, P.S., and Agarwal V.K. 2001. Environmental Biology (Principles of Ecology).S.Chand and Company Ltd, New Delhi.
12. Uberoi, N.K. 2005. Environmental Studies. Excel Books Publications, New Delhi.

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Coimbatore – 641 021.

LECTURE PLAN
DEPARTMENT OF BIOTECHNOLOGY

STAFF NAME: Dr. A. A. ARUNKUMAR
SUBJECT NAME: ENVIRONMENTAL STUDIES SUB.CODE:19AEC201
SEMESTER: II CLASS: I B.Sc. (BT)

S. No	Lecture Duration Period	Topics to be Covered	Support Material/Page Nos
		UNIT-I	
1	1	Environment Definition, Scope and importance	T1: 70 – 71
2	1	Components of Environment	T1: 71
3	1	Ecosystems Definition, concept	T1: 71
4	1	Ecosystem scope and importance	T1: 71
5	1	Structure and functions of ecosystems	T1: 72
6	1	Energy flow	T1: 73
7	1	Ecological Succession	T1: 74
8	1	Food chain and Food webs	T1: 75
9	1	Classification of Ecosystems	T1: 76
10	1	Revision	
11	1	Possible Questions discussions	
	Total No of Hours Planned For Unit 1=11		
		UNIT-II	
1	1	Natural resources	R1: 61 - 75
2	1	Types of Natural resources and uses	R1: 75 - 80
3	1	Over – Utilization, Exploitation	R1: 90 - 95
4	1	Role of an Individual in conservation of natural resources	R1: 165 - 168
5	1	Equitable use of resources for sustainable lifestyles	R1: 165 - 175
6	1	Ill effects of fireworks	W1
7	1	Revision	
8	1	Possible Questions discussions	
	Total No of Hours Planned For Unit II = 8		
		UNIT-III	
1	1	Biodiversity types	T2: 90
2	1	Bio-geographical classification of India	T2: 96 – 101
3	1	Value of Biodiversity	T2: 61 – 75
4	1	Biodiversity at global, national and local levels	T2: 78 – 80

5	1	India as a mega – diversity nation	T2: 96 – 102
6	1	Hotspots of Biodiversity	W1
7	1	Threats to biodiversity – poaching of wildlife, Man animal conflict	T2: 42 – 43
8	1	Endangered and Endemic species of India	T2: 106 – 108
9	1	Conservation of biodiversity	T2: 306 -309
10	1	In-situ and Ex-situ conservation of biodiversity	T2: 306 -309
11	1	Revision	
12	1	Possible Questions discussions	
	Total No of Hours Planned For Unit III=12		
		UNIT-IV	
1	1	Air pollution, Water pollution	W1, T1: 121 –
2	1	Soil, Marine and Noise pollution	W1, T1: 135 –
3	1	Thermal Pollution	W1, T1: 165
4	1	Nuclear Hazards	W1, T1: 167
5	1	Solid Waste Management	W1, T1: 204 –
6	1	Role of individual in Prevention of Pollutants	W1, T1: 193
7	1	Pollution case study	W1, T1: 157 –
8	1	Disaster Management – Floods, Landslides, Earthquake, Cyclones	W1, T1: 201 -
9	1	Revision	
10	1	Possible Questions discussions	
	Total No of Hours Planned For Unit IV=10		
		UNIT-V	
1	1	Urban problems related to energy	T1 – 220 -223
2	1	Water conservation and management	T1 – 224, 228
3	1	Rain water harvesting	T1 – 224, 228
4	1	Watershed management	T1 – 224, 228
5	1	Resettlement and Rehabilitation	T1 – 165 – 168
6	1	Environmental Ethics	T1 – 165 – 175
7	1	Climate change – Global warming	T1 – 240 – 247
8	1	EPA, Value Education, Human rights, All Acts	T1 – 240 – 247
9	1	Significance of Environmental Education	T1 – 228 - 230
10	1	Ozone Depletion, Nuclear accidents and Holocaust	T1 – 228 - 247
11	1	Case Studies	W1
12	1	Wasteland Reclamation, Consumerism and waste products, Public awareness, Population, Explosion, family welfare.	W1
13	1	Human rights, Value Education, HIV / AIDS, Women and Children welfare, Role of IT in Environment and Human health	W1
14	1	Revision	W1
15	1	Discussion of Previous ESE Question Papers.	W1
	Total No of Hours Planned for unit V=15		
Total No of Hours Planned = 56			

REFERENCES

Singh, M.P., Singh, B.S., and Dey, S.S., (2004). Conservation of Biodiversity and Natural Resources. Daya Publishing House, Delhi.

Botkin, D.B., and Keller, E.A., (1995). Environmental Science, John Wiley and Sons, Inc., New York.

Uberoi, N.K., (2005). Environmental Studies, Excel Books Publications, New Delhi, India.

TEXT BOOKS

Tripathy, S.N., and Panda, S., (2004). Fundamentals of Environmental Studies; 2nd Edition, Vrianda Publications Private Ltd., New Delhi.

Kumar, A., (2004). A Textbook of Environmental Science; APH Publishing Corporation, New Delhi.

Verma, P.S., Agarwal, V.K., (2001). Environmental Biology (Principles of Ecology); S.Chand and Company Ltd., New Delhi.

Kaushik, A., Kaushik, C.P., (2004). Perspectives in Environmental Studies, New Age International Pvt. Ltd. Publications, New Delhi.

WEBSITES

www.wikipedia.org, http://en.wikipedia.org/wiki/Human–wildlife_conflict,
http://en.wikipedia.org/wiki/Environmental_education
http://www.gdrc.org/uem/disasters/1-dm_cycle.html
http://restoreyoureconomy.org/disaster-overview/phases-of-disaster/
http://en.wikipedia.org/wiki/Disaster
http://training.fema.gov/EMIWeb/EMICourses/E464CM/02%20Unit%202.pdf

CLASS: I BSc BT **COURSE NAME: ENVIRONEMTNAL STUDIES**

COURSE CODE: 19AEC201 **UNIT – I**

Environment Definition, scope and importance, components, Ecosystem Definition, Concept, Scope, importance, Structure and functions of ecosystem. Energy flow, Ecological succession Food chains and food webs. Classification of ecosystem.

ENVIRONMENT

DEFINITION

- Environment is derived from the French word Environner which means to encircle or surround.
- All the biological and non-biological things surrounding an organism are thus included in environment.
- Thus environment is sum total of water, air and land, inter-relationships among themselves and also with the human beings, other living organisms and property.
- The above definition given on Environment (Protection) Act, 1986 clearly indicates that environment includes all the physical and biological surroundings and their interactions.

COMPONENTS

- The natural environment of a living organism can be divided into three components.
    - Biotic components
    - Abiotic components
    - Energy components

Biotic Components

- It consists of all the living organisms present within the environment.

Abiotic components

- All other substances except living organisms are known as abiotic components.
- The abiotic components broadly consist of atmosphere (air), Hydrosphere (water) and Lithosphere (soil).

Energy components

- The energy component may be solar energy, geo-chemical energy, thermo-electrical energy, hydro-electrical energy, atomic energy and energy due to radiation.

ECOSYSTEM

Definition

- Tansley (1935) – self-regulating group of biotic communities of species interacting with one another and with their non-living environment exchanging energy and matter

CONCEPT OF ECOSYSTEM

- Living organisms cannot be isolated from their non-living environment because the later provides materials and energy for the survival of the farmer.
- An ecosystem is therefore defined as a natural functional ecological unit comprising of living organisms and their non-living environment that interact to form a stable self supporting system.

  Eg. Pond, lake, desert, grassland, forest, etc.

Ecosystem characteristics

- Structural features - composition and organization of biological communities and abiotic components constitute- structure of Ecosystem.
- Biotic structure – Plants, animals, microorganisms – form biotic components – nutritional behavior and status in the ecosystem – producers or consumers – how do they get their food.

SCOPE OF ECOSYSTEM

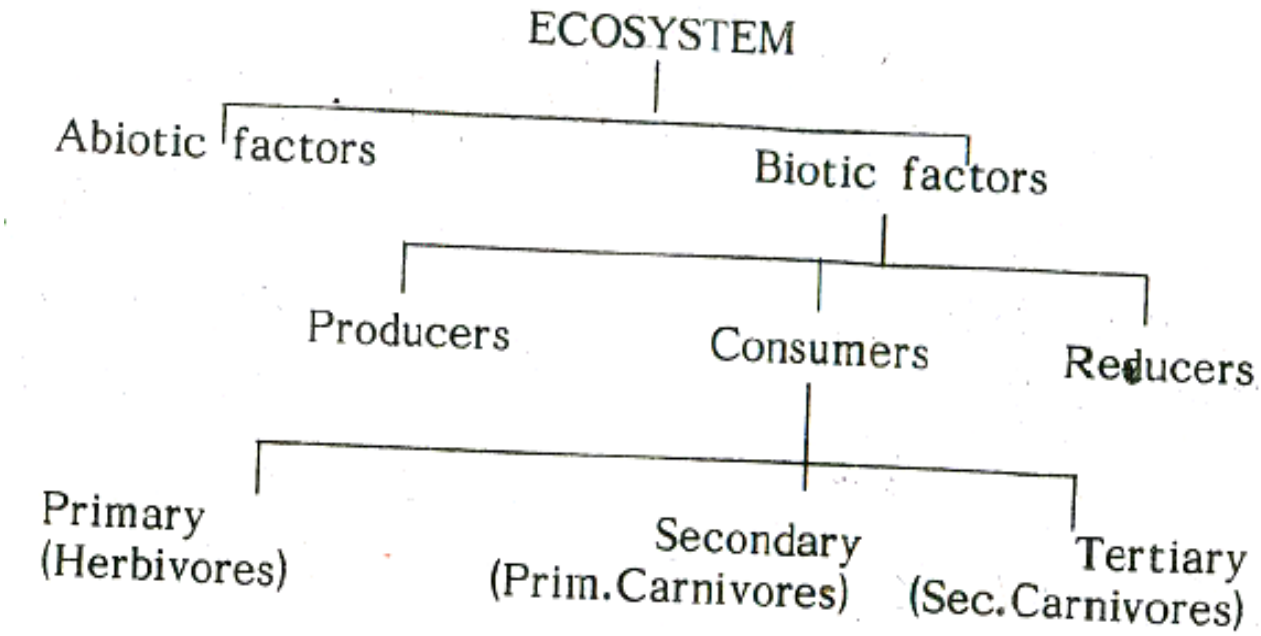
- Modern ecology focuses on the basic functional ecological unit the ecosystem.
- An ecosystem is any spatial or organizational unit which includes a community of living organisms and non-living substances of environment interacting to produce an exchange of materials between the living and non-living parts.
- It may be as small as a puddle or as large as the entire earth (biosphere or ecosphere).
- Further, an ecosystem may be natural as a pond, a lake, a river, an estuary, an ocean, a forest, etc., or it may be man-made or artificial like an aquarium, a dam, a cropland, a garden, an orchard, a city and so on.
- The term ecosystem was coined by A.G. Tansely (1935) – its ‘eco’ part means environment and the ‘system’ part implies, a complex of coordinated units.

IMPORTANCE OF ECOSYSTEM

- Ecosystem study indicates the available solar energy and the efficiency of an ecosystem to trap the same.
- It gives information about the available essential minerals and their recycling periods.
- Gross and net productivity of an ecosystem are known.
- It provides knowledge about the web of interactions and interrelations amongst the various populations as well as between populations and the abiotic environment.
- It helps human beings to know about conservation of resources, protection from pollution and inputs required for maximizing productivity.

STRUCTURE OF ECOSYSTEM

- The structure of any ecosystem is formed of two components, namely
    - Abiotic factors
    - Biotic factors.



Structure of an ecosystem.

Abiotic Factors

- The abiotic factors of an ecosystem include the non-living substances of the environment.

Example

- Water, soil, air, light, temperature, minerals, climate, pressure etc.
- The biotic factors of the ecosystem depend on the abiotic factors for their survival.

Biotic Factors

- The biotic factors include the living organisms of the environment.

Example

- Plants, animals, bacteria, viruses etc.
- The biotic factors of an ecosystem are classified into three main groups
    - Producers
    - Consumers
    - Reducers or decomposers.

Producers

- The organisms which carryout photosynthesis constitutes the producers of an ecosystem.
    - **Eg.** Plants algae and bacteria.
- The producers depend on the abiotic factors of the ecosystem for producing energy.
- They are provided with chlorophyll.
- Chlorophyll is used in the synthesis of energy rich compounds with the utilization of abiotic factors like light, CO_2, water and minerals
- A portion of the energy synthesized, is used by the producers for their growth and survival and the remaining energy is stored for future use.

Consumers

- Consumers are organisms which eat or devour other organisms.
- The consumers are further divided into three or more types.
- They are primary consumers, secondary consumers and tertiary consumers.

(i) Primary Consumers

- They eat the producers like plants, algae and bacteria.
- The primary consumers are also called herbivores.
- Elton referred the herbivores as key industry animals.
- Rabbit, deer, etc., are primary consumers in a terrestrial ecosystem.

(ii) Secondary Consumers

- They kill and eat the-herbivores.
- They are also called carnivores.
- As these carnivores directly depend on herbivores, they are specifically called primary carnivores.
- Fox, wolf, etc. are the secondary consumers in a terrestrial ecosystem.

(iii) Tertiary Consumers

- They kill and eat the secondary consumers.
- They are also called secondary carnivores.
    - **Eg**. Lion, tiger, etc.

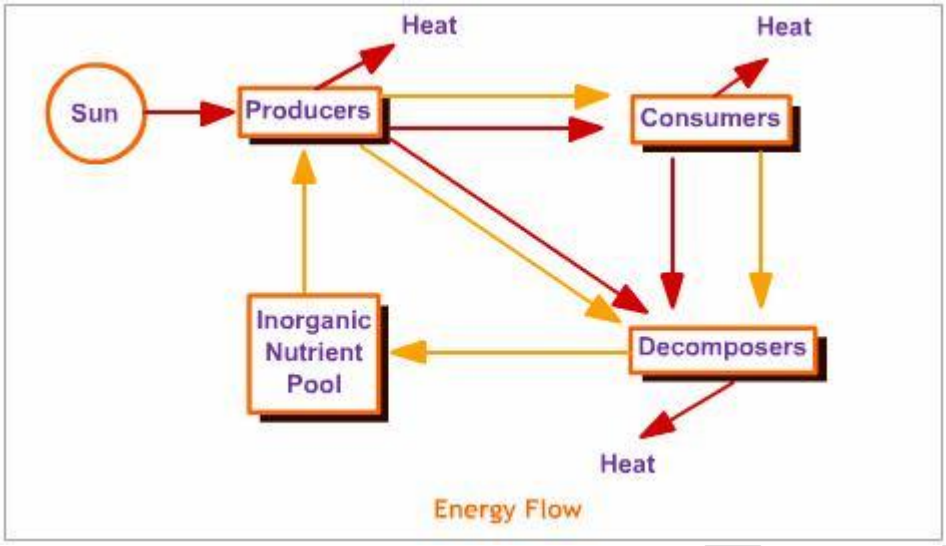
Reducers or Decomposers

- The decomposers are organisms that break up the dead bodies of plants and their waste products.
- They include fungi and certain bacteria.
- They secrete enzymes.
- The enzymes digest the dead organisms and the debris into smaller bits or molecules.
- These molecules are absorbed by the reducers.
- After taking energy, the reducers release molecules to the environment as chemicals to be used again by the producers.

FUNCTIONS OF ECOSYSTEMS

- Ecosystems have some functional attributes which keep the component parts running together.
- For example – green leaves prepare food and roots absorb nutrients from the soil.
- Herbivores feed on part of the plant production, and in turn serve as food for carnivores.
- Decomposers carry out the function of breaking down complex organic materials into simple inorganic product which can be used by the producers.
- All these functions in an ecosystem occur through delicately balanced and controlled processes.
- Thus, this cycle goes on and on, leading to efficient continuous functioning of the ecosystem.
- Food chain, food web and trophic structure.
- Energy flow
- Cycling of nutrients (biogeochemical cycles)
- Primary and secondary production
- Ecosystem development and regulation.

ENERGY FLOW IN ECOSYSTEM



- The diagram above shows how both energy and inorganic nutrients flow through the ecosystem.
- We need to define some terminology first.
- Energy "flows" through the ecosystem in the form of carbon-carbon bonds.
- When respiration occurs, the carbon-carbon bonds are broken and the carbon is combined with oxygen to form carbon dioxide.
- This process releases the energy, which is either used by the organism (to move its muscles, digest food, excrete wastes, think, etc.) or the energy may be lost as heat.
- The dark arrows represent the movement of this energy.
- Note that all energy comes from the sun, and that the ultimate fate of all energy in ecosystems is to be lost as heat. Energy does not recycle!!
- The other component shown in the diagram is the inorganic nutrients.
- They are inorganic because they do not contain carbon-carbon bonds.
- These inorganic nutrients include the phosphorous in your teeth, bones, and cellular membranes; the nitrogen in your amino acids (the building blocks of protein); and the iron in your blood (to name just a few of the inorganic nutrients).
- The movement of the inorganic nutrients is represented by the open arrows.
- Note that the autotrophs obtain these inorganic nutrients from the inorganic nutrient pool, which is usually the soil or water surrounding the plants or algae.
- These inorganic nutrients are passed from organism to organism as one organism is consumed by another.

- Ultimately, all organisms die and become detritus, food for the decomposers.
- At this stage, the last of the energy is extracted (and lost as heat) and the inorganic nutrients are returned to the soil or water to be taken up again.
- The inorganic nutrients are recycled, the energy is not.
- Many of us, when we hear the word "nutrient" immediately think of calories and the carbon-carbon bonds that hold the caloric energy.
- IT IS VERY IMPORTANT that you be careful in your use of the word nutrient in this sense.
- When writing about energy flow and inorganic nutrient flow in an ecosystem, you must be clear as to what you are referring.
- Unmodified by "inorganic" or "organic", the word "nutrient" can leave your reader unsure of what you mean.
- This is one case in which the scientific meaning of a word is very dependent on its context. Another example would be the word "respiration", which to the layperson usually refers to "breathing", but which means "the extraction of energy from carbon-carbon bonds at the cellular level" to most scientists (except those scientists studying breathing, who use respiration in the lay sense).

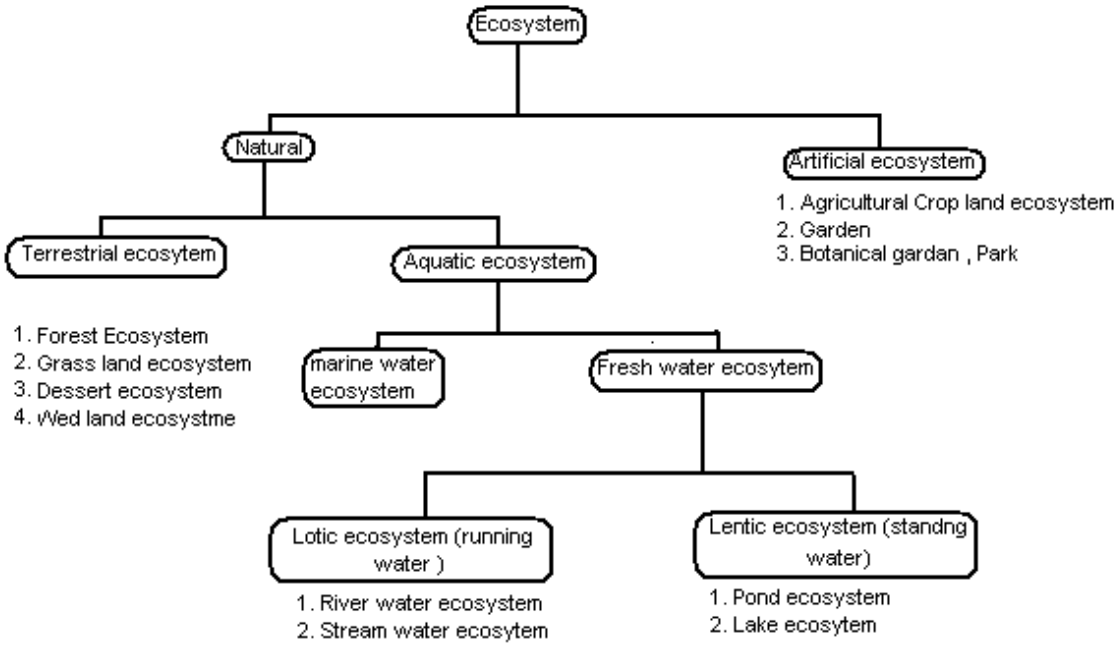
To summarize: In the flow of energy and inorganic nutrients through the ecosystem, a few generalizations can be made:

1. The ultimate source of energy (for most ecosystems) is the sun
2. The ultimate fate of energy in ecosystems is for it to be lost as heat.
3. Energy and nutrients are passed from organism to organism through the food chain as one organism eats another.
4. Decomposers remove the last energy from the remains of organisms.
5. Inorganic nutrients are cycled, energy is not.

ECOLOGICAL SUCCESSION

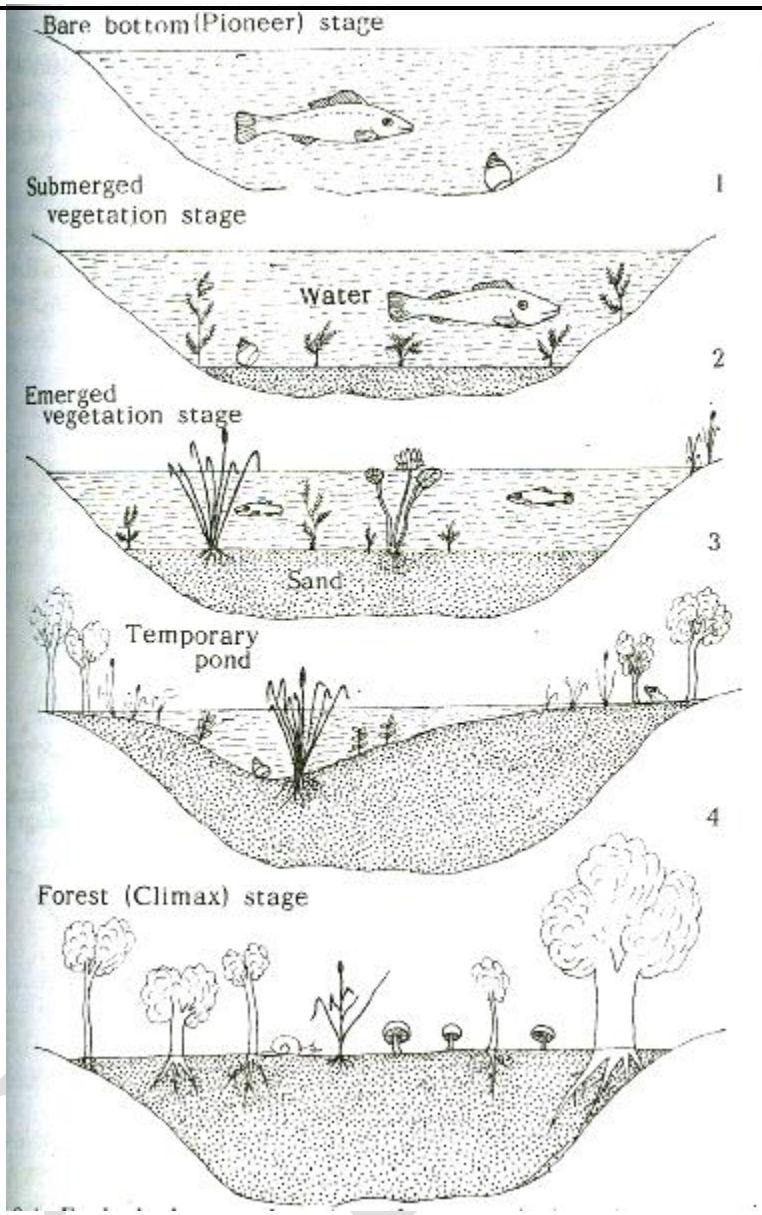
- The communities in any area are not stable.
- They are changing into other forms of communities from time to time.
- Thus in a particular area one community may be replaced by another community or by a series of communities.

Types of ecosystem



For example

- A pond community can be transformed into a marshy land community, if he pond is gradually filled with sand and mud.
- The marshy land in the course of time may give rise to a grassland community or a forest community according to the environmental factors prevailing there.
- This process of development of new communities is called ecological succession.
- It can be defined as an orderly and progressive replacement of one community by another till the development of a stable community in that area (Smith, 1965).



Ecological succession. A pond community is replaced by a forest community through ecological succession

Significance of Succession

- Ecological succession creates a stable community in the fluctuating physical environment. The stable or climax community has the ability to buffer and control the physical forces like water, temperature etc.
- It plays an important role in the slow dispersal of animals.

FOOD CHAINS

- The biotic factors of the ecosystem are linked together by food.

For example

- The producers form the food for the herbivores.

- The herbivores the food for the carnivores.
- The sequence of the eaters being eaten is called food chain.

  Producers ----------> Herbivores ----------> Carnivores
- The various steps in a food chain are called trophic levels.
- Owing to repeated eating being eaten the energy is transferred from to another trophic level.
- This transfer of energy from one trophic level to another is called energy flow.
- A typical food chain can be seen in a pond ecosystem.
- The algae and phytoplankton are eaten by the zooplankton.
- The zooplankton is eaten by fishes which are eaten by snakes.

Pond Ecosystem

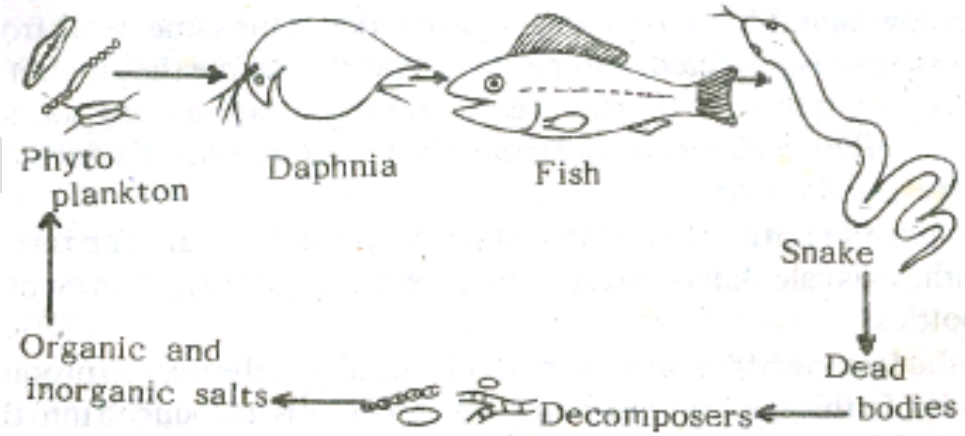
Phytoplankton ----------> Zooplankton ----------> Fishes ---------> Snakes

Grassland Ecosystem

Plants ----------> Mouse ----------> Snake ----------> Hawk

Forest Ecosystems

Plants ----------> Goat ----------> Man ----------> Lion



Food chain in a pond.

Types of food chains

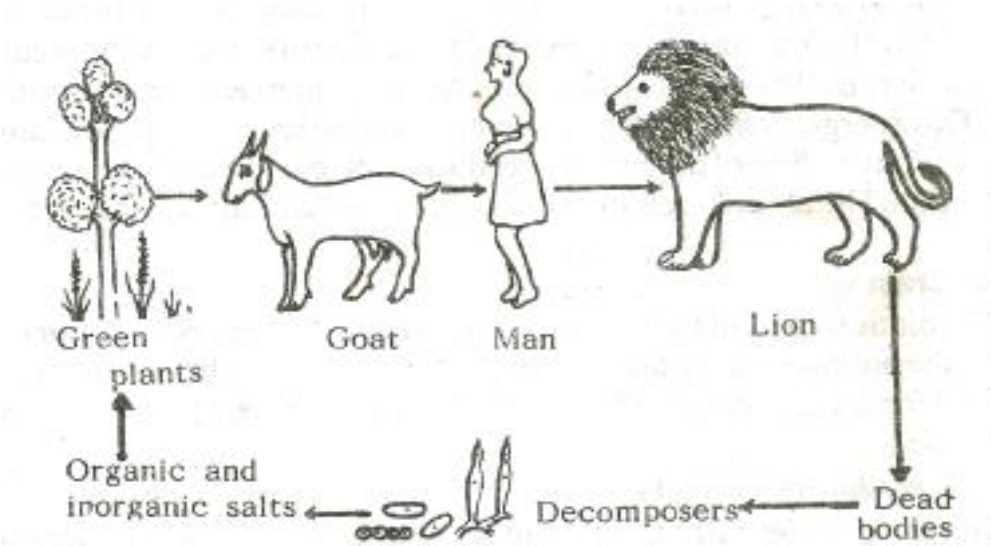
- The food chains are of two types, namely
  - Grazing food chain
  - Detritus food chain

Grazing food chain

- This food chain starts from plants, goes through herbivores and ends in carnivores.

  Plants-----> Herbivores ------> Primary carnivores-----> secondary carnivores

- This type of food chain depends on the autotrophs which capture the energy from solar radiation.



Food chain in a forest.

A few chains are given below

Grass --------> Grasshopper --------> Lizard --------> Hawk

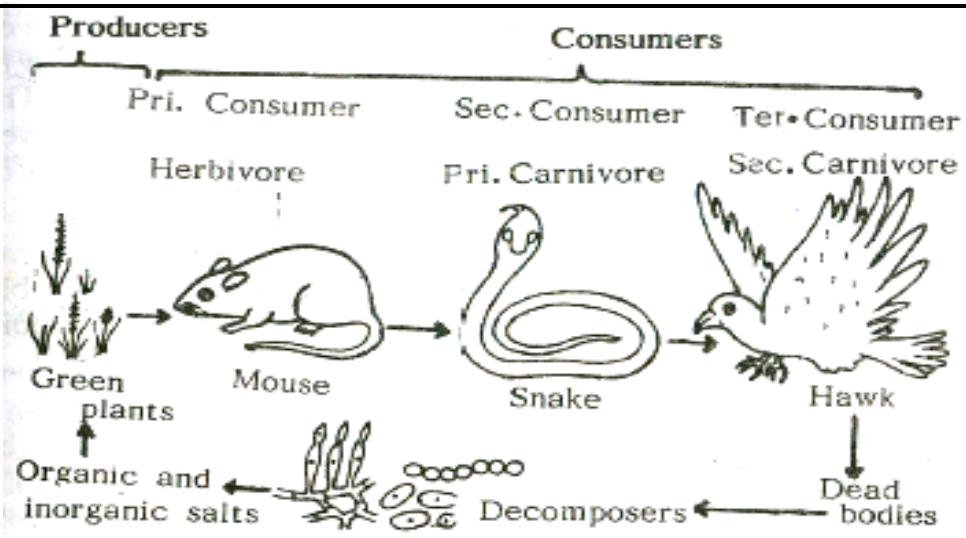
Grass --------> Mouse ----------> Snake ---------> Hawk

Phytoplankton ----------> Zooplankton ----------> Fishes ---------> Snakes

- The grazing food chain is further divided into two types, namely
  - Predator chains
  - Parasitic chains

Predator chains

- In predator food chains one animal capture and devours another animal.
- The animal which is called prey and the animal which eats other animals is called predator.
- The predator food chain is formed of plants, herbivores, primary carnivores, secondary carnivores and so on.



Food chain in a grassland.

Parasitic chain

- The plants and animals of the grazing food chain are infected by parasites.
- The parasitic chain within the grazing food chain is formed.

Detritus food chain

- It starts with dead organic matter and ends in inorganic compounds.
- There are certain groups of organisms which feed exclusively on the dead bodies of animals and plants.
- These organisms are called Detritivores.
- The Detritivores include algae, bacteria, fungi, protozoans, insects, millipeds, centripeds, crustaceans, mussels, clams, annelid worms, nematodes, ducks, etc.
- These organisms ingest and digest the dead organic materials.
- Some amount of energy is trapped and the remainder is excreted in the form of simple organic compounds.
- These are again used by another set of Detritivores until the organic compounds are converted into CO2 and water.

Dead organic materials ----------> Detritivores ----------> CO2 + H2O

Linking of Grazing and Detritus Food Chains

- The two main food chains cannot operate independently.
- They are interconnected at various levels.

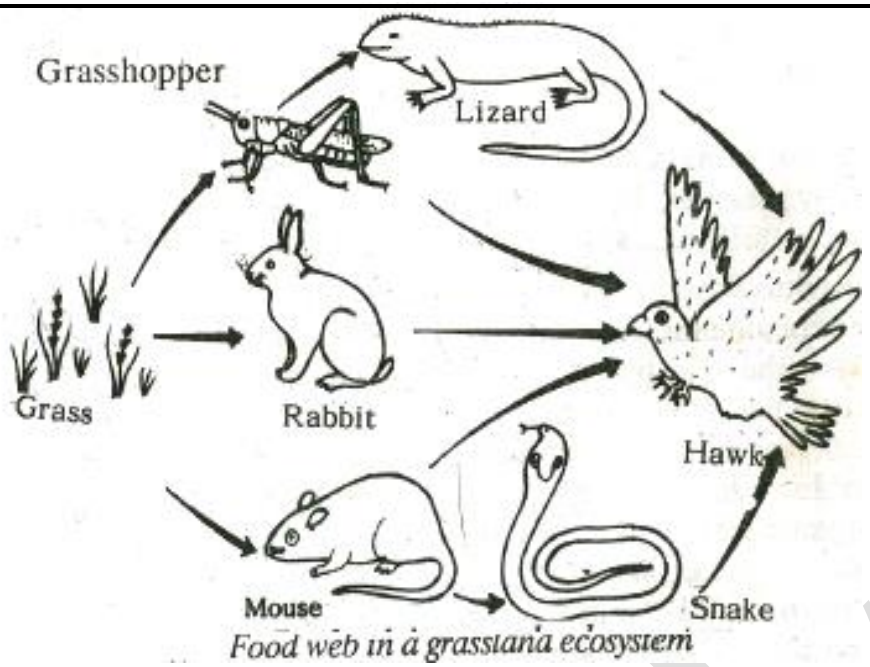
- According to Wilson and Bossert (1971) the stability of the ecosystem directly proportional to the number of such links.
- The detritus feeders obtain energy form the dead bodies of animals and plants which are components of the grazing food chain.
- Again some of the detritus feeders are eaten by the consumers of the grazing food chain.
- For example, in a pond ecosystem earthworms belonging to the detritus food chain are eaten by fishes belonging to the grazing food chain.

FOOD WEB

- In an ecosystem the various food chains are interconnected with each other to form a net work called food web.
- The interlocking of many food chains is called food web.
- Simple food chains are very rare in nature.
- This is because each other organisms may obtain food from more than one trophic level.
- In other words, one organism forms food for more than one organisms of the higher trophic level.

Examples

- In a grassland ecosystem, grass is eaten by grasshopper, rabbit and mouse.
- Grasshopper is eaten by lizard which is eaten by hawk.
- Rabbit is eaten by hawk.
- Mouse is eaten by snake which is eaten by hawk.
- In addition hawk also directly eats grasshopper and mouse.
- Thus there are five linear food chains which are inter interconnected to form a food web.
- This is a very simple food web.
- But in any ecosystem the food web is more complex.
- For example, in the grassland itself, in addition to hawk, there are many other carnivores such as vulture, crow, wolf, fox, man, etc.



Food web in a grassland ecosystem

Significance of Food Web

- Food webs are very important in maintaining the stability of an ecosystem.
- For example, the deleterious growth of grasses is controlled by the herbivores.
- When one type of herbivores becomes extinct, the other types of herbivores increase in number and control the vegetation.
- Similarly, when one type of herbivores animal becomes extinct, the carnivores predating on this type may eat another type of herbivore.

CLASSIFICATION OF ECOSYSTEMS

- The ecosystem may be large, as large as the world or small, as small as a cow dung ecosystem.
- The biosphere (the total life content of the world) is the major ecosystem.
- It comprises all other ecosystems.

Mega Ecosystem

- The biosphere is formed of four mega ecosystems.

(i) Marine Ecosystem

- It includes saline-water ecosystems like oceans, seas, estuaries, brackish waters, etc.

(ii) Limnic Ecosystem

- It includes all fresh water ecosystems like pond, pools, lakes, rivers, streams, etc.

(iii) Terrestrial Ecosystems

- It includes the ecosystems of air, forests, grasslands, deserts, etc.

(iv) Industrial Ecosystems

- These are man-made ecosystems. Eg. Cropland, city town, etc.

Macro Ecosystems

- The mega ecosystem is further divided into sub units called macro ecosystems.

Examples

- Forests.
- The terrestrial macro ecosystem is formed of many forest ecosystem.

Meso Ecosystems

- The macro ecosystem is further divided into meso ecosystems.

Examples

- The forest ecosystem is formed of many meso ecosystems like deciduous forest, coniferous forest, etc.

Micro Ecosystems

- The meso ecosystem is further divided into micro ecosystems.

Examples

- A low land in a forest, a mountain in a forest, etc.
- All ecosystems in the world are further divided into natural and artificial ecosystems.

Natural Ecosystems

- These are self-regulating systems without much direct human interference and manipulations.

Examples

- Ponds, lakes, rivers, seas, oceans, grasslands, deserts, etc.

Artificial Ecosystems

- These are man-made ecosystems.

Examples

- Crop lands, cities, towns, villages, etc.

ENVIRONMENTAL POLLUTION

Definition

- Pollution may be defined as an undesirable change in the physical, chemical or biological characteristics of our air, water and land that may or will harmfully affect human life, the lives of the desirable species, our industrial processes, living conditions and cultured assets, or that may or will waste or deteriorate our raw material resources.

Types of environmental pollution

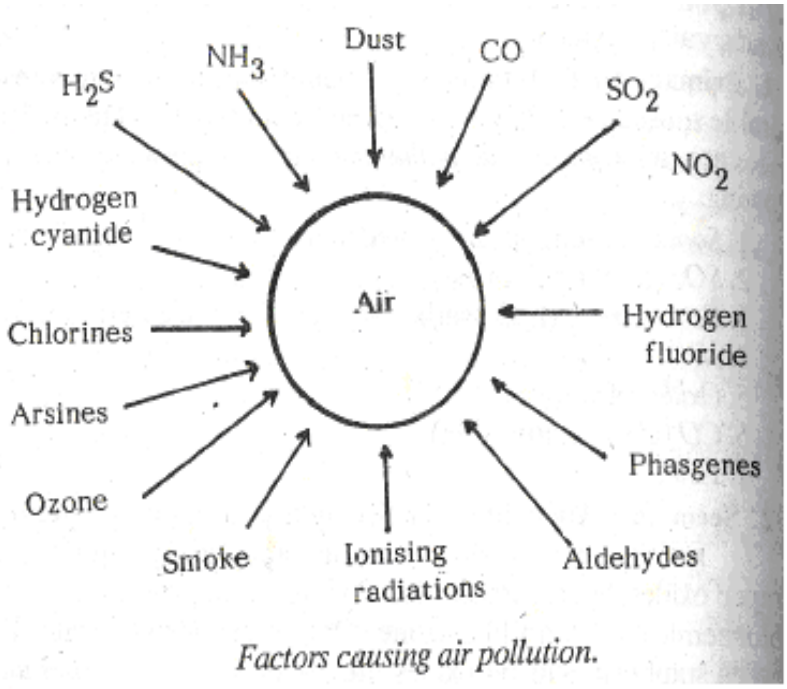
- Air pollution
- Water pollution
- Soil pollution
- Marine pollution
- Noise pollution
- Thermal pollution
- Nuclear hazards

AIR POLLUTION

- Air pollution refers to the undesirable change occurring in air causing harmful effects on man and domesticated species.

Air pollutants

- Dust
- Smoke
- Sulphur oxides (CO)
- Nitrogen oxides (SO_2)
- Ammonia (NH_3)
- Nitrogen dioxide(NO_2)
- Hydrogen cyanide
- Hydrogen fluorides
- Hydrogen sulphide (H_2S)
- Chlorines
- Phosgenes
- Arsines
- Aldehydes
- Ozone
- Ionizing radiations
- CO_2



Factors causing air pollution.

Air pollutants are two types

- Primary air pollutants
- Secondary air pollutants

Primary Air Pollutants

- Air is polluted by poisonous gases and undesirable substances.
- They are released by burning fossil fuels.
- These substances are called primary air pollutants.

The primary pollutants are following

- Soot released from unburned fuel
- SO_2
- Benzopyrene (hydrocarbon) released from cigarette smoke.
- NH_3
- Oxides of nitrogen
- CO (carbon monoxide)
- Lead

Secondary Air Pollutants

- Secondary air pollutants are poisonous nitrogen oxides, hydrocarbons and O_2 interact to produce more powerful photochemical oxidants like ozone (O_3), peroxyacetyl nitrate (PAN), Aldehydes, sulphuric acid, peroxides, etc.
- All these constitute photochemical smog.

CAUSES OF AIR POLLUTION

Agriculture

- Hydrocarbons released by plants, pollen grains, insecticides etc. cause air pollution.

Dust

- Dust in the air is increased by dust storms, wind, volcanoes, automobiles, etc.

Industries

- The Combustion of fossil fuels like coal, petroleum, etc. in industries is the main source of pollution.

Automobiles

- The combustion of petrol and diesel in automobiles releases harmful gases into the air.
- They also produce dust.

Ionising Radiations

- Ionizing radiations include alpha particle, beta particles and gamma rays.
- They are released into the air from testing atomic weapons and atomic explosions.

Freons

- Use of freons and other chlorine-flourine-carbons as refrigerants, coolants and as filling agents in aerosol pachages cause pollution.

Aerosols

- Aerosols are small particles of all sorts of solid or liquid substances suspended in the air.
- They block the stomata of plants and prevent he gaseous exchanges between plants and atmosphere.
- They may also change the climate of an area.

Biological indicators

- Some plants are sensitive to certain air pollutants.
- These plants are used to indicate the presence of these substances.

- These plants are called biological indicators

Example

- The tissues present in the tip of dusheri mango turns black when they are exposed to sulphur dioxide (SO_2) fumes.
- Pinto beans and petunias are used to indicate the presence of peroxy acetyl nitrate (PAN).
- Tobacco and annual blue-grass plants are used to show the presence of ozone (O_3).

ECOLOGICAL EFFECTS OF AIR POLLUTION

Death

- When air is polluted with poisonous gases, death comes as a result immediately. Bhopal episode is a good example.

Bhopal episode

- On 2nd December 1984about 3000 human beings died about 5000 paralysed and thousands of cattle, bird, dogs and cats died in one night at Bhopal.
- This mass death is due to the leakage of methyl isocyanate (toxic gas) into the air from art insecticide plant managed by Union Carbide.

Chlorosis

- The disappearance of chlorophyll is called Chlorosis.
- It is caused by SO_2 and fluorides present in the air.

Necrosis

- The breakdown of cells is called necrosis.
- It is caused by SO_2, nitrogen dioxide, ozone and fluorides.

Green house effect

- CO_2 is released into the air by the combustion of fuels.
- It is estimated that CO_2 content of the is increasing at the rated 0.4% per annum.
- This will result in an appreciable warming up of the ear.
- This is called green house effect.
- It is very likely that this will cause the melting of polar ice caps resulting in a rise of nearly 60 feet on the sea level.
- Coastal regions and low lying areas allover the world will be go under water.

Crop losses

- Heavy loss of crop plants is caused by smog.
- Smog denotes a combination of smoke and fog.
- The important components of s ozone and PAN (Peroxyacetyl nitrate).
- They damage leafy vegetables, cereals, textile crops, ornamental plants, fruits and forest trees.

Respiratory disorders

- Excessive ethylene accelerates respiration causing premature senescence (old age) and abscission (accumulation of yellow fluid (pus) in the body).
- Aldehydes irritate nasal and respiratory tracts.
- Chlorine and phosgene's (carbonyl chloride) cause pulmonary edema.

Nausea

- H_2S smells like rotten eggs and nausea.

Vomiting

- SO_2 causes vomiting.

Jaundice

- Arsines induce RBC breakdown and jaundice.

Oxygen carrying capacity

- CO reduces O_2 carrying capacity of RBC by its permanent combination with haemoglobin.

Coughing

- Coughing is induced by phosgenes (carbonyl chloride).

Headache

- SO_2 causes headache.

Cancer

- Cancer is caused by air pollutants like ash, soot, smoke. chromium, nickel and radioactive elements.

Mutation

- Radioactive elements produce mutation.
- Ozone produces chromosomal aberrations.

Cardiac diseases

- Cadmium causes high blood pressure and heart diseases.

Pneumonia

- Pneumonia is caused by breathing in too much of manganese particles.

Depletion of Ozone Umbrella

- Intheatmosphere, about 30km above the surface of the earth, the ozone molecules (O_3) form an umbrella.
- It prevents the penetration of harmful ultra violet radiation from the sun and thus protects the life of the earth.
- It is now feared that there is danger of appearing holes on the ozone umbrella.
- This is caused by the use of freons and other chlorine-fluorine-carbons as refrigerents, coolants in domestic refrigerators and otter cold storage facilities, and as filling agents in foam plastics and in aerosol packages.
- Reaching ozone umbrella, they destroy ozone molecules as a result of photochemical reactions.
- Over the past 16 years, the density of the ozone layer has been diminishing at an average rate of 3%.
- It is calculated that the depletion of ozone layer by I% results in an increase in the incidence of skin cancer by 5% to 7%.

Acid Rains

- One of the major environmental issues facing human society at the National and International level is the problem of acid.
- The rainwater is always slightly acidic as CO_2 in the atmosphere gets dissolved in it.
- However during recent years, it has been noted a further lowering of pH of rainwater often as 2.4.
- This lowering of pH is due to the dissolution of acids in the rain water.
- Precipitation of oxides of sulphur and nitrogen with rain is termed acid rain.
- Acid rain is caused by air pollution.
- When atmospheric air contains sulphur dioxide (SO_2) and oxides of nitrogen such as nitrous oxide (N_2O) and nitric oxide (NO), they dissolve in rainwater forming sulphuric acid and nitric acid.

- The rain water falls as acid rain.
- The main source of oxides of sulphur and nitrogen is the burning of fossil fuels in power plants based on coal and oil contribute more than 60% of all sulphur oxides and 25 to 20% of nitrogen oxides in the atmosphere.
- Automobiles make a sustainable contribution in large cities.
- Ozone is now recognized as a major factor in the formation of acid rain.
- Acid rain affects both materials and organisms.
- It attacks building materials principally sandstone, limestone, marble, steel and nickel.
- In plants, it leads to Chlorosis (gradual yellowing in which the chlorophyll making mechanism is impeded) or depigmentation of leaves.
- Acid rain increases the acidity of lakes and rivers.
- Vast tracts of forests and lakes in Europe and North America have been destroyed by acid.
- Acidity kills fish, bacteria and algae and the aquatic ecosystem collapses into sterility leaving a crystal clear but ultimately a dead lake.

CONTROL OF AIR POLLUTION

- The emission of exhaust from automobiles can be reduced by devices, such as positive crankcase ventilation valve and catalytic converter.
- Electrostatic precipitators can reduce smoke and dust from industries.
- Gaseous pollutants arising from industries can be removed by differential solubility of gases in water.
- A finepray of water in the device called scrubber can separate many gases like NH_3, SO_2, etc. from the emitted exhaust.
- Certain gases can be removed by filtration or absorption through activated carbon.
- Certain gases can be made chemically inert by chemical conversion.
- At the Government level pollution can be controlled by framing legislations.

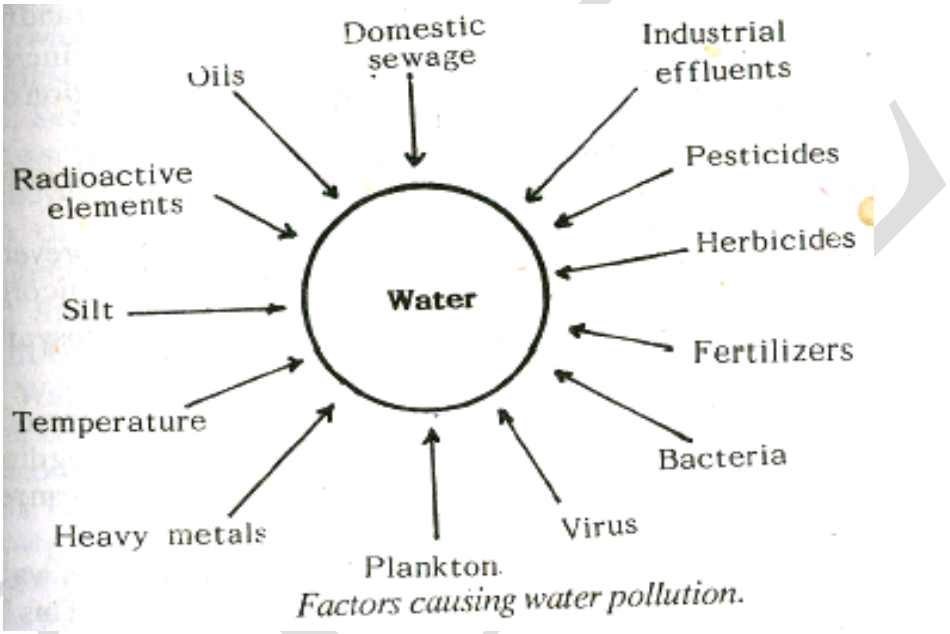
WATER POLLUTION

- Water is the soul of nature; its pollution will perish the world.
- Water pollution refers to the undesirable change occurring in water which may harmfully affect the life activities of man and domesticated species.

Water pollutants

The common water pollutants are as follows

- Domestic sewage
- Industrial effluents
- Pesticides
- Herbicides
- Fertilizers
- Bacteria and viruses
- Plankton blooms
- Heavy metals like mercury
- Temperature
- Silt
- Radioactivity
- Oils, etc.



Factors causing water pollution.

CAUSES OF WATER POLLUTION

Domestic sewage

- Domestic sewage consists of human faeces, urine, and the dirty used-up water in houses.
- It contains a large number of pathogenic bacteria and virus.
- The sewage is released into the rivers on the banks of which most of the cities are situated.

Industrial effluents

- All industrial plants produce some organic and inorganic chemical wastes.
- Those nonusable chemicals are dumped in water as a means of getting rid of them.
- The industrial wastes include heavy metals (Hg, Cu, lead zinc etc), detergents, petroleum, acids, alkalies, phenols, carbonate, alcohol cyanides, arsenic, chlorine, etc.

Thermal Pollution

- Many industries use water for cooling.

- The resultant warm water is discharged into rivers.
- This brings about thermal pollution.

Agricultural pollution

- The fertilizers used for crops are washed into ponds and rivers.

Pesticides

- Pesticides are used to control pests in fields and houses.
- They include DDT, BHC, endrin etc.

Radioactive wastes

- Liquid radioactive wastes are released into the sea around nuclear installations.
- The oceanic currents carry the radio active contaminants every where.
- Oil pollution
- Oil is a source of pollution in sea-water.
- Oil pollution is due to ship accidents, loading and discharging of oil at the harbour, oil refineries and off-shore oil production.

Retting

- The process of decaying coconut husk to get fibre for making coir is called retting.
- Retting releases H_2S.
- It makes water polluted.

ECOLOGICAL EFFECTS OF WATER POLLUTION

Minamata disease

- This disease is caused by mercury poisoning.
- It is characterized by crippling and death.
- This disease appeared in a coastal town, Minamata, in Japan.
- The primary cause for this disease was a p industry which was started on the san coast of Japan in 1905.
- From this factory a by-product called mercury was disposed into the sea.
- This mercury cumulated in marine animals.
- Later birds, cats and dogs which me the marine animals died.
- Finally many men who ate fish, crabs and shell fish died.
- Their initial symptoms of Minamata disease include the numbness of limbs, lips and tongue, impairment of motor control, deafness and blurring of vision.

- Finally it affects and destroys the brain.
- As a result of the attack of Minamata disease about 17 persons died and 23 became permanently disabled in the year 1953, in Japan.

Diarrhoea

- It is caused by mercury, cadmium and cobalt.

Mortality of Plankton and Fish

- Chlorine which is added to water control the growth of algae and bacteria in the cooling system of power stations may persist in streams to cause the mortality of plankton and fish.

Reduction in Productivity

- Intensive agriculture increases the amount of silt in lakes and rivers.
- Silt prevents the penetration of light to depths and thus reduces primary production.

Siltation

- Siltation is a phenomenon by which the gills of fish deposited with silt.
- This causes heavy mortality among fishes.

Poor Oxygenation

- Oil present on the surface of water prevents water oxygenation.
- This reduces respiration and metabolism in aquatic organisms.

Poor Photosynthesis

- Oil-pollution prevents photosynthesis in phytoplankton.

Red Tide

- When coastal waters are enriched with nutrients of sewage dinoflagellates multiply rapidly and form bloom.
- This blooming lat. liberate into the water toxic metabolic by-products which can result in a large scale death of marine fishes.
- This is called red tide.

Biochemical Oxygen Demand

- Sewage enriches the water with nutrients.
- This causes rapid growth of plankton and algae.
- This leads to oxygen depletion in water.
- The oxygen depletion causes the death of algae.
- They decay and decomposition of algae consumes more oxygen from water.

- Biochemical Oxygen Demand or biological oxygen demand (BOD) is the amount of oxygen required by the microorganisms in water.
- BOD is higher in polluted water (sewage) and lesser in drinking water.
- Increased BOD lowers the contents of dissolved O_2 in water causing the suffocation and death of aquatic flora and fauna.

Water-borne diseases

- Disease like jaundice, cholera, typhoid, diarrhoea, etc. are transmitted through water contaminated with sewage.

Methaemoglobinema

- The nitrate used in fertilizers enters the intestine of man through drinking water.
- In the intestine it is converted into nitrite.
- Nitrite is absorbed into the blood where it combines with haemoglobin to form methaemoglobin: Methaemoglobin cannot transport oxygen.
- This leads to suffocation and breathing troubles, especially in infants.
- This disease is called methaemoglobinema.

Eutrophication

- Domestic sewage and fertilizers add large quantities of nutrients such as nitrates and phosphates to the fresh water ecosystems.
- The rich supply of these nutrients makes blue green algae, green algae and other phytoplankton to grow abundantly.
- This increased productivity of lakes and ponds brought about by nutrient enrichment is known as eutrophication.
- As the algae use O_2 of the water for respiration, the O_2 is depleted from the water.
- The rapid growth also consumes all the nutrients of the water.
- The depletion of O_2 and nutrients lead to the death of algae and other phytoplankton.
- As other organisms, such as zooplankton and fishes of the water, depend on the blue green algae and phytoplankton for their food, they also die.
- This eutrophication leads to the complete depletion of the fauna from the ecosystem.

CONTROL OF WATER POLLUTION

Sewage Treatment

Pollution control by sewage treatment includes the following steps

- Sedimentation
- Dilution
- Storage

(i) Sedimentation

- When sewage is allowed to stand, the suspended particles settle to the bottom.
- So by sedimentation the suspended particles are removed from sewage.

(ii) Dilution

- The sewage can be diluted with water.
- This increases the O_2 contents and reduces BOD and CO_2.

(iii) Storage

- The diluted sewage is stored in a pond.
- This facilities the growth of microorganisms.
- This renders further oxidation of sewage.

Waste stabilization pond or oxidation pond

- The national Environmental Engineering Research Institute (NEERI) at Nagpur has devised a very economical method for the treatment of industrial and domestic effluents.
- Domestic and industrial wastes are stored in a dilute condition in shallow ponds called oxidation or stabilization ponds.
- After a few days micro-organisms and algae flourish.
- The micro-organisms decompose the organic wastes by oxidation, and the water is purified.
- This water is rich in nitrogen, phosphorus, potassium and other nutrients.
- This water can be used for fish agriculture etc.

Recycling

- Pollution can be prevented to a certain extent by reutilizing the wastes.
- This is called recycling.

Example

- The dung of cows and buffaloes can be used for the production of gobargas.
- Sewage can be used for irrigation fish culture after treatment in oxidation pond.
- Certain pollutants from industrial effluents can be removed by filtration and selective absorption.

- Excessive use of pesticides and herbicides should be avoided.
- At the Government level, legislations should be framed to control water pollution.

SOIL POLLUTION

- The contamination of soil by human and natural activities which may cause harmful effects on living beings.

Causes

- Industrial waste
- Urban waste
- Agricultural practices
- Radioactive pollutants
- Biological agent

Effects

- Affect human health
- Affect soil fertility
- Reduce soil productivity
- Cause abnormalities

Control measures

- Properly collect solid waste
- Microbial degradation
- Recovery of products from waste
- For methane generation, use cattle dung
- For biogas generation, use biodegradable organic waste

NOISE POLLUTION

- The word noise has a Latin origin nausea meaning a feeling of sickness at the stomach with an urge to vomit.
- Noise is defined as unwanted sound or sound without value.
- Noise pollution is the unwanted sound dumped into the environment.
- Noise is measured by the unit decibel (dB).
- One decibel is equal to the faintest sound that can be heard by the human ears.
- Some people feel discomfort with the sound of 85dB.

- But more people do not feel discomfort with the sound of 115 dB.
- Pain is usually felt at 145dB.

Causes of Noise Pollution

- Scooters
- Motor bikes
- Cars
- Tempos
- Vans
- Buses
- Trucks
- Tractors
- Aircrafts
- Supersonic aircrafts
- Motor boats
- Ships
- Loud speakers
- Loud pop-music
- Social gatherings
- Machines of factories
- Mills
- Industries
- Kitchen appliances
- Fire crackers and generators are some of the chief sources of pollutions.

ECOLOGICAL EFFECTS OF NOISE POLLUTION

- Noise diminishes the power of hearing.
- It gives pain to the ear.
- It interferes with communication-systems.
- It causes stress.
- It causes fright.
- It increases the rate of heart beat.
- It causes the constriction of blood vessels.
- It increases blood pressure.
- It causes head-ache.
- It causes the dilation of pupil of the eye.
- It causes emotional upsets and
- It causes deafness.
- Noise causes physical or mental fatigue and lack of concentration.
- In industrial situations this effect results in lowered efficiency, reduced work rate and higher chances for accident.

- Noise disturbs sleep.
- High frequency or ultrasonic sound can affect the semicircular canals of the internal ear and cause nausea and dizziness.

CONTROL OF NOISE POLLUTION

Noise pollution can be controlled in the following ways

- Legislations should be framed.
- The sources that generate unwanted sound should be reduced.
- Noisy automobiles should be condemned.
- Wheels of automobiles should be oiled properly.
- Industrialists must take up necessary steps to control noise.
- Loudspeakers should be set at a low sound.
- Trees absorb noise and thus reduce noise pollution. So thick vegetation must be grown around industries, cities and on the sides of roads.
- Noise-producing machines should be placed in closed rooms.
- Residential houses should be constructed far away from in factories and airports.

THERMAL POLLUTION

- Increase or decrease in the temperature of water, air and land by human activity is called thermal pollution.

Sources of thermal pollution

CO_2

- CO_2 is produced during the combustion of fuel in houses, factories, power stations, etc.
- It is also released by plants and animals in the process of respiration.
- The CO_2 contents of the atmosphere has gone up by 15% in the past 100 years.
- It is estimated that by the year 2000 AD the increase in the CO_2 contents of the air will be nearly 25%.
- This will result in an appreciable warming up of the earth.
- This is called green house effect.
- It is very likely that this will cause the melting of polar ice caps.

- This will result in an ice caps will lead to rise of nearly 60 feet in sea level.
- As a result coastal areas and low-lying areas all over the world will be flooded and will go under water.

Hot water

- Power stations, industries and nuclear reactors use large quantities of water for cooling purposes.
- The resulting hot waters are released into the rivers.

ECOLOGICAL EFFECTS OF THERMAL POLLUTION

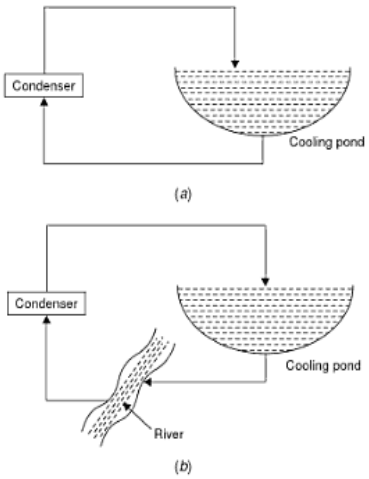
- When the temperature of the earth increases, ice caps melt. This will flood the coastal and low lying areas of land.
- A rise of 10°C in temperature increases the rate of exchange of salts between the organisms and the environment. This will accelerate the entry of toxins into the body from the external medium.

CONTROL OF THERMAL POLLUTION

- Cooling ponds
- Spray Ponds
- Cooling towers

Cooling Ponds

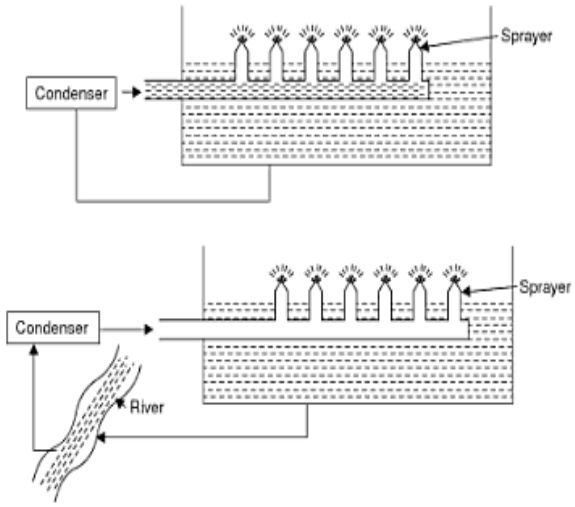
- Water from condensers is stored in ponds where natural evaporation cools the water which can then be recirculated or discharged in nearby water body.



Dissipation of heat by cooling ponds

Spray Ponds

- The water from condensers is received in spray ponds.
- Here the water is sprayed through nozzles where fine droplets are formed.
- Heat from these fine droplets is dissipated to the atmosphere.

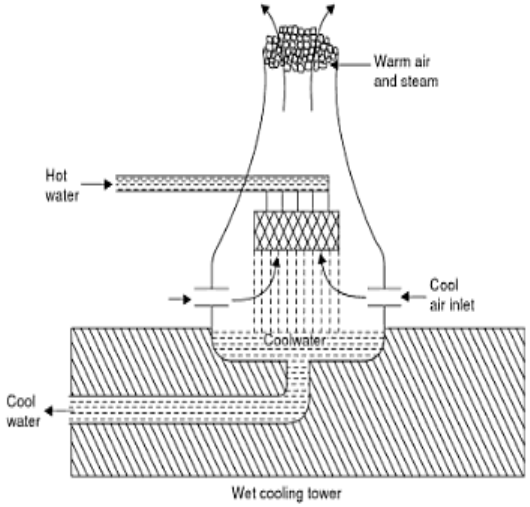


Dissipation of heat by spray ponds.

Cooling Towers

(i) Wet cooling tower

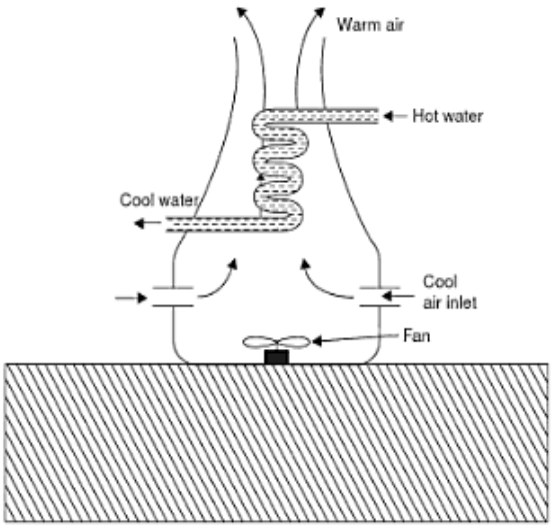
- Hot water is sprayed over baffles.
- Cool air entering from sides takes away the heat and cools the water.
- This cool water can be recycled or discharged.
- Large amount of water is lost through evaporation and in the vicinity of wet cooling tower extensive fog is formed which is not good for environment and causes damage to vegetation.



Wet cooling tower

(ii) 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

CLASS: I BSc BT **COURSE NAME: ENVIRONEMTNAL STUDIES**

COURSE CODE: 19AEC201 **UNIT – II**

Natural Resources - Renewable and Non-renewable Resources: Natural resources and associated problems. Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources: Use and over-utilization, exploitation. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ill-effects of fireworks.

Natural Resources:

A resource is anything needed by an organism or group of organisms. The sum of all physical, chemical, biological and social factors, which compose the surroundings of man, is referred as environment and each element of these surroundings constitutes a resource on which man draws in order to develop a better life. Resources which are not reproducible and are obtained from the finite non-living reserves are called non-renewable resources (eg.) Coal and metals.

Any material which can be transformed in a way that it becomes more valuable and useful can be termed as a resource. Thus, only part of our natural environment, such as land, water, air, minerals, forest, rangeland, wildlife, fish or even human population that man can utilize to promote his welfare may be regarded as a natural resource. In the case of humans, a resource is any form of energy of matter essential for the fulfillment of physiological, socio-economic and cultural needs, both at the individual level and that of the community.

The five basic ecological variables - energy, matter, space, time and diversity are sometimes combinedly called natural resources.

Classification of natural resources:

Based on quantity, mutability and reusability schematic representation of classification of natural resources:

Inexhaustible

- Unlimited or unending
- Both qualitative, and quantitative degradation

Exhaustible

- Limited.
- Quality may be degraded, not quantity

Renewable

- Perpetual harvest
- Ex. Human power, fertility of soil

Non-renewable

- No-replacement
- Ex. Species of wild

Based on Continual Utility

- Renewable
- Non renewable
- Cyclic resource

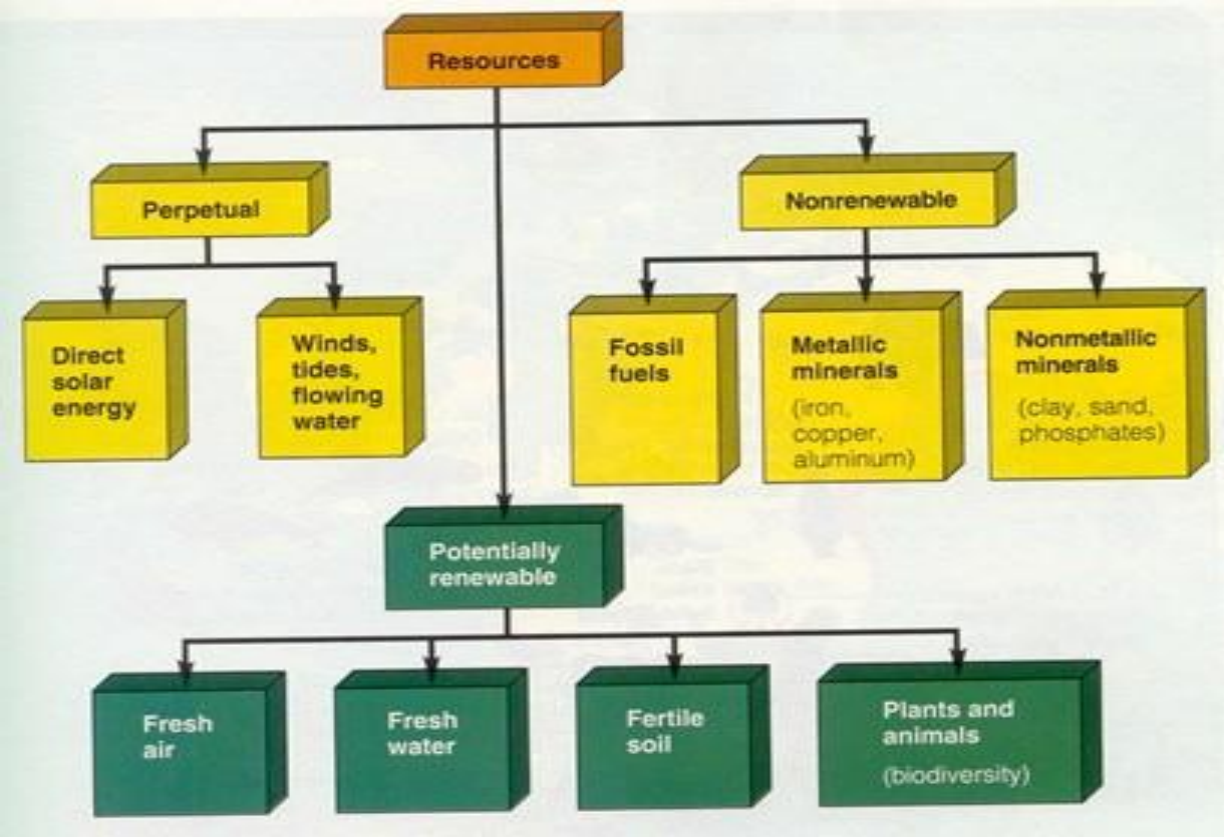
Based on origin

- Biotic and
- Abiotic

Based on Utility

- some as raw materials
- some as energy resources

Renewable resources are those which are reproducible and are obtained from the biomass of living organisms. (Eg.) Forests. Potentially renewable can become nonrenewable resources, if used for a prolonged time at a faster rate than it is renewed by natural processes.



Land

The land although appears to be available unlimited but, infact, its judicious use would limit the availability of this indispensable life support system. In rural land use planning, concentration is chiefly devoted to creating and developing more farmland by removing forests and natural grasslands, channeling streams for irrigation and so on. Unfortunately, no effort is made to save existing prime farmland from degradation by ill planned development.

A nation's well-being is inextricably linked with the fertility and abundance of soil resources. Productive land is since the source of human sustenance and security everywhere at all times, this resource because of mounting demands of swelling population and long mismanagement would put in jeopardy the very survival of man.

Deteriorating quality of urban and sub urban environment is to a great extent the result of injudicious land use and is a threat to the whole socio economic system. Major problems emerging out of abuse of land in cities include unsafe and unhygienic dwellings and those in rural areas are of erosion of soil and loss of fertility. While urban problems can be prevented and cured by proper town planning and municipal facilities, the problem relating to rural areas need long-term soil conservation programme.

Soil consists of mineral and organic matter, air and water. The proportions vary, but the major components remain the same. Minerals make up 50 per cent of an ideal soil while air and water make up 25 per cent each. Every soil occupies space. Soil extends down into the planet as well as over its surface. Soil has length, breadth, and depth. The concept that a soil occupies a segment of the earth is called the "soil body". a single soil in a soil body is referred to as a "pedon". The soil body is composed of many pedons and thus called a "polypedon".

Every soil has a profile or a succession of layers (horizons) in a vertical section down into the non-soil zone referred to as the parent material. Parent materials can be soft rock, glacial drift, wind blown sediments, or alluvial materials. The nature of the soil profile is important for determining a soil's potential for root growth, storage of water, and supply of plant nutrients.

Soil texture

Relative amounts of the different sizes and types of mineral particles

Soil porosity

A measure of the volume of pores or spaces per volume of soil and the average distances between these pores

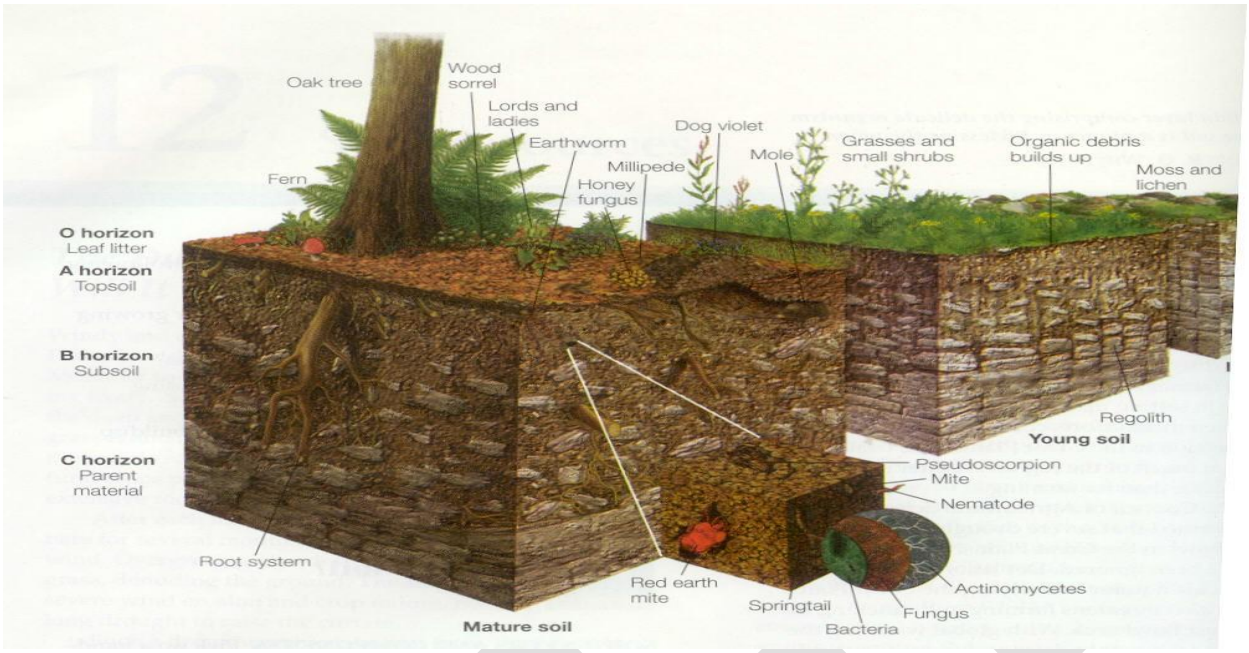
Soil permeability

Rate at which water and air move from upper to lower soil layers

Processes of soil formation – 2 stages

1) Weathering
2) Soil development or pedogenesis

- Weathering
    - Physical – Wetting- drying, Heating – cooling, Freezing, Glaciations, solution, sand blast
    - Chemical - Hydration, Hydrolysis, O/R, Carbonation, Chelation



Soil development

- Pedogenesis – lichens, bacteria, fungi, algae, microarthropods, mollusc – secretion of Organic acids, enzymes, CO_2, addition of Organic Matter – leads to soil formation – soil Profile
- Factors affecting soil formation
    - Passive Factors – Parent material, topography, time
    - Active Factors – Rainfall, Temp, humidity, Wind,
    - Biosphere effect (Phytosphere, Zoosphere, MO)

Throughout history, the progress of civilizations has been marked by a trail of wind-blown or water-washed soils that resulted in barren lands. Continuing to use the soil without appropriate soil conservation management is very destructive to the environment. Protecting the quality of our nation's topsoil is largely within human control. To many soil scientists, saving our soil is much more important than saving oil, coal, or natural gas resources.

Water Resources

Water is a vitally important substance in all parts of the environment. Water resources occupy a unique place among other natural sources. It is the most abundant and most widely distributed element in the world. It occupies about three fourths (70%) of the earth's surface. It occurs in all spheres of the

environment – in the oceans as a vast reservoir of saltwater, on land as surface water in lakes and rivers, underground as groundwater in the atmosphere as water vapor, and in the polar icecaps as solid ice. This amounts to a staggering 1400 million cubic kilometer, which is enough to cover the earth with a layer 3000 meters deep. This apparent abundance is, however, misleading and hides an ironical fact which is not always fully appreciated, a mammoth 97.5% of the amount, contained in the world's oceans and seas, being saline, is unfit for human consumption. We, like many creatures, require fresh water to survive, and that constitute a miserly 2.5 % of the total amount. Of this, about 68.9% lies inaccessible in ice fields and glaciers and another 29.9% is present as groundwater. In effect, only one – hundredth of three per cent (0.03%) of the world's total supply amounting to some 14 billion cubic meters is considered easily available for human use on a regular basis. This water is found in decreasing order of abundance in saline and freshwater lakes and reservoirs; as soil moisture; as water held in living organisms, as vapor, droplets, and miniscule ice crystals in the atmosphere; in swamps and marshes; and in rivers and streams. The problem would not have been so acute had freshwater been evenly distributed around the globe, throughout the seasons or from year to year. It is not so. Two thirds of the world's population i.e around 4 billion people lives in areas receiving only one quarter of the world's annual rainfall.

Freshwater distribution

About three-quarters of annual rainfall come down in areas containing less than one-third of the world's population. As water –short societies have done for centuries, many countries attempt to move water from where it occurs on nature to where the people want it, and also to store water for future use. Worldwide, there are 40,000 dams higher than 15 mts, most of them built in the last 50 years. Although dams help ensure a steady water supply, they often endanger aquatic systems by blocking river channels, altering water flows of rivers, food plains, deltas, and other natural wetlands, as well as imperiling plant and animal life.

How water is used?

The amount of water that people in a country actually use depends not only on minimum needs and how much water is available for use but also on the level of economic development and the extent of urbanization. Globally, of the three categories of freshwater use- for agriculture, industry and domestic, agriculture dominates. On a worldwide basis, agriculture accounts for about 69% of the annual water withdrawals; industry, about 23% and domestic use, about 8%.

India's Water Resources Potential

India receives an annual precipitation of about 4000 cu.km. About 1869 cu.km occurs as natural run off in rivers. India has 12 major rivers with a total catchments area of 252.8 million hectare. Of these, the Ganga-Brahmaputra-Meghana system is the biggest with a catchment area of about 110 m.ha. It also provides about 60% of the total amount of freshwater amongst other rivers. Others with catchment areas of more than 10 m.ha are Indus (32.1 m.ha), Godavari (31.3 m.ha.), Krishna (25.9 m.ha.) and Mahanadi (14.2 m.ha.) The national annual per capita availability of water in the country is about 2208 cu.m.

Groundwater

In India groundwater has been used for irrigation and domestic water supply since time immemorial. At present, more than 70% of the population uses groundwater for its domestic needs and more than half of the irrigation is provided from this source. The total replenishable ground water in India is estimated to be about 43.18850 million hectare meter per year. About 7.1 m ha m/yr is used for domestic and industrial use. It is estimated that about 32.47264 m ha m/yr is available for irrigation. About 32% of available groundwater resources have so far been used. There is increasing extraction of groundwater to meet the demands of the agriculture, especially for the cultivation of water intensive crops, like sugarcane. Some 90% of the groundwater extracted is used for irrigation. Today, more than million electric and diesel pumps are used to withdraw groundwater leading to falling water tables in most states.

Water scarcity

Years of rapid population growth and increasing water consumption have strained the world's freshwater resources. In some areas the demand for water already exceeds nature's supply, and a growing number of countries are expected to face water shortages in the near future.The world's population, at 6.1 billion is growing by about 80 million people each year. This number implies an increased demand for freshwater of about 64 billion cubic meters a year. A country is said to experience water stress when annual water supplies drop below 1,700 cubic meters per person. Below 1,000 cubic meters per person, the country faces water scarcity. Once a country experiences water scarcity, it can expect chronic shortages of freshwater that threaten food production, hinder economic growth and development, and damage eco system.

In 1995, 31 countries containing 458 million people faced either water stress or scarcity. By 2025, according to projections made by Population Action International, more than 2.8 billion people in

48 countries will be facing water stress or scarcity. By 2050, the number of water short countries soars to 54, affecting 4 billion people, or 40% of the projected global population. The worst hit areas are in the Middle East, North Africa and Sub-Saharan Africa. Over 200 million Sub Saharan Africans already live in water short countries. This figure balloons to 700 million by 2025, of whom over half will live in countries facing severe shortages for most of the year.

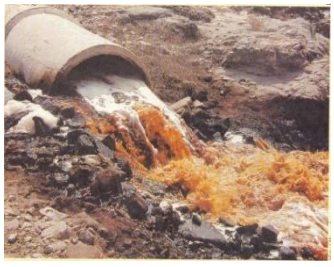
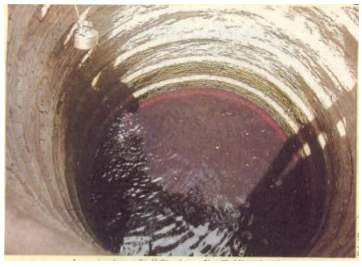
World Water Demand/Year

1940	1000 km^3
1990	4130 km^3
2000	5000 km^3
2002	6650 km^3

Water scarcity is now the single biggest threat to food production, as falling groundwater levels and shrinking rivers make less water available for agriculture. According to UNEP, India will be water – stressed before 2025-with average annual water availability limited to between 1000 cubic meters to 1700 cu. m per person.

Depletion of water resources

- Shrinking of rivers, lakes & ponds
- Water pollution – 70% of surface water polluted
- Ground water depletion - >10 cm/yr & pollution- NO_3
- Increase of sewage & industrial effluents
- India will be water stressed by 2025 (UNEP)
- Per capita water has decreased from 2208 to 1700cu.m in a decade


Water Pollution

The Indian homes produce about 75 % of the wastewater, and sewage treatment facilities are inadequate in most cities and almost absent in rural India. According to the Central Pollution Control Board, of the 8,432 large and medium industries in the country, only 4,989 had installed appropriate measures to treat wastewater before discharge. Of the over two million small scale industrial units, a number of which like tanneries are extremely polluting, very few have any treatment facilities whatsoever and their untreated wastes invariably find their way into country's water systems.

Management of water implies making the best use available water resources for human benefit while not only preventing and controlling its depletion and degradation but also developing it in view of the present and future needs. Floods, droughts, improper use, pollution, disease transmission are the important problems related to water. Pollution of a body of water is detrimental not only to the human society but also to regional ecology and the ecology of very aquatic system. It is therefore, essential that the water should not be treated as a simple repository of waste disposal, and if inevitable, the water only after proper treatment should be released in it under strict ecological considerations.

Drought

Drought may be caused due to variability of rainfall, delay in onset or early withdrawal of monsoon, duration of break in the monsoon, area differences in persistence of monsoon and human activities. Based on the physical characteristics, drought may be of meteorological drought, hydrological drought, soil-moisture drought, agricultural drought, socio-economic drought, famine and ecological drought.

Combating drought

Planning for drought includes;

- Scientific use of rainfall, surface and underground water.
- Introduction of proper cropping pattern.
- Development of irrigation facilities.
- Development of existing irrigation potential.
- Lining of canals and distributaries to minimize water losses.
- Drip irrigation/Trickle irrigation mainly in saline areas.
- Expeditious completion of continuing projects should be given priority in planning.
- Construction of new irrigation projects.
- Desilting of irrigation tanks.
- Technology of dry farming.

Dams: Today there are more than 45,000 large dams around the world, which play an important role in communities that harness these water resources for their economic development. Current estimates suggest that about 30-40 % of the irrigated land worldwide relies on dams. The world's two most populous countries China and India – have built around 57% of the world's large dams. In India, of the 16-18 million people displaced by dams, 40-50% wee tribal people, who account only for 8% of our nations one billion people.

Problems caused by Dams:

- Fragmentation and physical transformation caused by dams
- Serious impact on riverine ecosystems
- Social consequences of large dams due to the displacement of people
- Dislodging animal populations, damaging their habitat and cutting off their migratory routes
- Disruption of fishing and waterway traffic
- The emission of greenhouse gases from reservoirs due to rotting vegetation and carbon inflows from the catchment

Harmful Effects of Crackers & Fireworks

i) The SPM (suspended particulate matter) levels rise to a large extent during Diwali.

It can cause throat, nose & eye related problems which can later develop into adverse health hazards.

It can lead to headaches & reduced mental acuity when it reaches the level of 100 ppm.
It has much more severe effects in people with heart, respiratory or nervous system disorders.
It can aggravate problem for people suffering from cold, allergies or coughs and can also cause congestion of throat & chest.

ii) Increase amount of noise has harmful effects on animals as well as humans.
Standard decibel level for humans is 60 dB.
Increase in the decibel level can lead to:

Restlessness
Temporary or Permanent Hearing Loss
Fidgetiness
High Blood Pressure
Anger
Heart Attack
Sleep Disturbance
Impulsiveness
Can lead to withdrawal behaviour or hyperactivity in pregnant women, children & those suffering from respiratory problems.

iii) Fireworks can also cause health problems like:

Chronic bronchitis
Common Cold
Allergic Bronchitis
Bronchial Asthma
Sinusitis
Chronic Obstructive Pulmonary Diseases (COPD)
Ephysema
Rhinitis
Pneumonia
Laryngitis

iv) It results in smog which can reduce visibility thereby leading to accidents as well as is toxic if inhaled.
- It is said that one big firecracker like "1000 walas" and "hydrogen bombs" can produce up to 250 cc of smoke.

- It can also cause water contamination and acid rains.
- It results in air pollution that creates carcinogenic sulphur compounds and airborne arsenic effect.

v) Use of "rockets" near houses gives rise to many injuries each year. There is no law pertaining to the same.

vi) Harmful effects of fireworks displays:
- Green light produced in fireworks displays comes from Barium that is radioactive and poisonous.
- Blue colour produced from copper compounds comes from dioxins linked to cancer.
- Different effects are produced by using different chemicals that are linked to a host of health and respiratory problems.

CLASS: I BSc BT **COURSE NAME: ENVIRONEMTNAL STUDIES**

COURSE CODE: 19AEC201 **UNIT – III**

Biodiversity and Its Conservation: Introduction, definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Biodiversity and its conservation

- If we divide the whole earth's mass into 10 billion parts, it is only in one part where life exists and the astounding variety of living organ-isms numbering somewhere around 50 million species are all restricted to just about a kilometer- thick layer of soil, water and air. Isn't it wonderful to see that so much diversity has been created by nature on this earth from so little physical matter!
- Biodiversity refers to the variety and variability among all groups of living organisms and the ecosystem complexes in which they occur.
- From the driest deserts to the dense tropical rainforests and from the high snow-clad mountain peaks to the deepest of ocean trenches, life occurs in a marvellous spectrum of forms, size, colour and shape, each with unique ecological inter-relationships.
- Just imagine how monotonous and dull the world would have been had there been only a few species of living organisms that could be counted on fingertips!
- In the Convention of Biological diversity (1992) biodiversity y has been defined as the variability among living organisms from all sources including *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they arc a part.

Biodiversity

- Biodiversity is the abbreviated word for "biological diversity" (bio-life or living organisms, diversity-variety).
- Thus biodiversity is the total variety of life on our planet, the total number of races, varieties and species.
- The sum of total of various types of microbes, plants and animals (producers, consumers and decomposers) in a system.

Levels of Biodiversity

- Units of biodiversity may range from the genetic level within a species to the biota in a specific region and may extend up to the great diversity found in different biomes.

GENETIC DIVERSITY

- It is the basic source of biodiversity.
- The genes found in organisms can form enormous number of combinations each of which gives rise to some variability.
- Genes are the basic units of hereditary information transmitted from one generation to other.
- When the genes within the same species show different versions due to new combinations, it is called genetic variability.
- For example, all varieties belong to the species *Oryza*, but there are thousands of wild and cultivated varieties of rice which show variations at the genetic level and differ in their color, size, shape, aroma and nutrient content of the grain.
- This is the genetic diversity of rice.

SPECIES DIVERSITY

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

What is the number of species on this biosphere?

- The estimates of actual number vary widely due to incomplete and indirect data.
- The current estimates given by Wilson in 1992 put the total number of living species in a range of 10 million to 50 million.
- Till now only about 1.5 million living and 300.000 fossil species have been actually described and given scientific names.
- It is quite likely that a large fraction of these species may become extinct even before they are discovered and en-listed.

ECOSYSTEM DIVERSITY

- This is the diversity of ecological complexity showing variations in ecological niches, strophic structure, food-webs, nutrient cycling etc.

- The ecosystems also show variations with respect to physical parameters like moisture, temperature, altitude, precipitation etc.
- Thus, there occurs tremendous diversity within the ecosystems, along these gradients.
- We may consider diversity in forest ecosystem, which is supposed to have mainly a dominance of trees.
- But, while considering a tropical rainforest, a tropical deciduous forest, a temperate deciduous forest and a boreal forest, the variations observed are just too many and they are mainly due to variations in the above mentioned physical factors.
- The ecosystem diversity is of great value that must be kept intact.
- This diversity has developed over millions of years of evolution.
- If we destroy this diversity, it would disrupt the ecological balance.
- We cannot even replace the diversity of one ecosystem by that of another.
- Coniferous trees of boreal forests cannot take up the function of the trees of tropical deciduous forest lands and vice versa, because ecosystem diversity has evolved with respect to the prevailing environmental conditions with well regulated ecological balance.

BIOGEOGRAPGHICAL CLASSIFICATION OF INDIA

- India has different types of climate and topography in different parts of the country and these variations have induced enormous variability in flora and fauna.
- India as a rich heritage of biological diversity and occupies the tenth position among the plant rich nations of the world.
- It is very important to study the distribution, evolution, dispersal and environmental relationship of plants and animals in time and space.
- Biogeography comprising of Phytogeography and zoogeography deals with these aspects of plants and animals.
- In order to gain insight about the distribution and environmental interactions of flora and fauna of our country, it has been classified into ten biogeographic zones.
- Each of these zones has its own characteristic climate, soil, topography and biodiversity.

India's major biogeographic habitats

Sl. No	Biogeographic Zone	Biotic Province	Total area (Sq.Km.)
1	Trans-Himalayan	Upper Regions	186200
2	Himalayan	North-West Himalayas	6900
		West-Himalayas	720000
		Central Himalayas	123000
		East Himalayas	83000
3	Desert	Kutch	45000
		Thar	180000
		Ladakh	NA
4	Semi-Arid	Central India	107600
		Gujarat-Rajwara	400400
5	Western Ghats	Malabar Coast	59700
		Western Ghat Mountains	99300
6	Deccan Peninsula	Deccan Plateau South	378000
		Central Plateau	341000
		Eastern Plateau	198000
		Chhota Nagpur	217000
		Central Highlands	287000
7	Gangetic Plain	Upper Gangetic Plain	206400
		Lower Gangetic Plain	153000
8	North-East India	Brahmaputra Valley	65200
		North-Eastern Hills	106200
9	Islands	Andaman Islands	6397
		Nicobar Islands	1930
		Lakshadweep Islands	180
10	Coasts	West Coast	6500
		East Coast	6500

Value of Biodiversity

- The value of biodiversity in terms of its commercial utility, ecological services, social and aesthetic value is enormous.
- We get benefits from other organisms in innumerable ways.
- Sometimes we realize and appreciate the value of the organism only after it is lost from his earth.
- Very small, insignificant, useless looking organisms may play a crucial role in the ecological balance of the ecosystem or may be a potential source of some invaluable drug for dreaded diseases like cancer or AIDS.
- The multiple uses of biodiversity or biodiversity value has been classified by McNeely *et al* in 1990.

i) Consumptive use value

- These are direct use values where the biodiversity product can be harvested and consumed directly.
    - E.g. fuel, food, drugs, fibre, etc.

Food

- A large number of wild plants are consumed by human beings as food.
- About 80,000 edible plant species have been reported from wild.
- About 90% of present day food crops have been domesticated from wild tropical plants.
- Even now our agricultural scientists make use of the existing wild species of plants that are closely related to our crop plants for developing new hardy strains.
- Wild relatives usually possess better tolerance and hardiness.
- A large number of wild animals are also our sources of food.

Drugs and medicines

- About 75% of the world's population depends upon plants or plant extracts for medicines.
- The wonder drug *Penicillin* used as an antibiotic is derived from a fungus called *penicillium.*
- Likewise, we get *Tetracyclin* from a bacterium.
- Quinine, the cure for malaria is obtained from the bark of Cinchona tree, while *Digitalin* is obtained from foxglove (Digitalis) which is an effective cure for heart aliments.
- Recently *vinblastin* and *vincristine*, two anticancer drugs, have been obtained from Periwinkle (*Catharanthus*) plant, which possesses anticancer alkaloids.
- A large number of marine animals are supposed to possess anti-cancer properties which are yet to be explored systematically.

Fuel

- Our forests have been used since ages for fuel wood.

- The fossil fuels coal, petroleum and natural gas arc also products of fossilized biodiversity.
- Firewood collected by individuals are not normally marketed, but are directly consumed by tribals and local villagers, hence falls under consumptive value.

ii) Productive use values

- 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 scientists for introducing desirable traits in the crops and domesticated animals.
- These may include the animal products like tusks of elephants, musk from musk deer, silk from silk-worm, wool from sheep, fir of many animals, lac from lac insects etc, all of which are traded in the market.
- Many industries are dependent upon the productive use values of biodiversity.
    - **E.g.** the paper and pulp industry, Plywood industry, Railway sleeper industry, Silk industry, textile industry, ivory-works, leather industry, pearl industry etc.
- Despite international ban on trade in products from endangered species, smuggling of fur, hide, horns, tusks, live specimen etc. worth millions of dollars are being sold every year.
- Developing countries in Asia, Africa and Latin America are the richest biodiversity centers and wild life products are smuggled and marketed in large quantities to some rich western countries and also to China and Hong Kong where export of cat skins and snake skins fetches a booming business.

iii) Social Value

- These are the values associated with the social life, customs, religion and psycho-spiritual aspects of the people.
- Many of the plants are considered holy and sacred in our country like Tulsi (holy basil), Peepal, Mango, Lotus, Bael etc.
- The leaves, fruits of flowers of these plants are used in worship or the plant itself is worshipped.
- The tribal people are very closely linked with the wild life in the forests.
- Their social life, songs, dances and customs are closely woven around the wildlife.
- Many animals like Cow, Snake, Bull, Peacock, Owl etc. also have significant place in our psycho-spiritual arena and thus hold special social importance.
- Thus biodiversity has distinct social value, attached with different societies.

iv) Ethical value

- It is also sometimes known as existence value.
- It involves ethical issues like "all life must be preserved".
- It is based on the concept of "Live and Let Live".
- If we want our human race to survive, then we must protect all biodiversity, because biodiversity is valuable.
- The ethical value means that we may or may not use a species, but knowing the very fact that this species exists in nature gives us pleasure.
- We all feel sorry when we learn that "passenger pegion" or "dodo" is no more on this earth.
- We are not deriving anything direct from Kangaroo, Zebra or Giraffe, but we all strongly that these species should exist in nature.
- This means, there is an ethical value or existence value attached to each species.

v) Aesthetic value

- Great aesthetic value is attached to biodiversity.
- No one of us would like to visit vast stretches of barren lands with no signs of visible life.
- 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 now known as eco-tourism.
- The "Willingness to pay" concept on such eco-tourism gives us even a monetary estimate for aesthetic value of biodiversity.
- Ecotourism is estimated to generate about 12 billion dollars of revenue annually that roughly gives the aesthetic value of biodiversity.

vi) Option values

- These values include the potentials of biodiversity that are presently unknown and need to be explored.
- There is a possibility that we may have some potential cure for AIDS or cancer existing within the depths of a marine ecosystem, or a tropical rain-forest.
- Thus option value is the value of knowing that there are biological resources existing on this biosphere that may one day prove to be an effective option for something important in the future.
- Thus, the option value of biodiversity suggests that any species may prove to be a miracle species someday.
- The biodiversity is like precious gills of nature presented to us.

- We should not commit the folly of losing these gills even before unwrapping them.
- The option value also includes the values, in terms of the option to visit areas where a variety of flora and fauna, or specifically some endemic, rare or endangered species exist.

vii) Ecosystem service value

- Recently, a non-consumptive use value related to self maintenance of the ecosystem and various important ecosystem services has been recognized.
- It refers to the services provided by ecosystems like prevention of soil erosion, prevention of floods, maintenance of soil fertility, cycling of nutrients, fixation of nitrogen, cycling of water, their role as carbon sinks, pollutant absorption and reduction of the threat of global warming etc.
- Different categories of biodiversity value clearly indicate that ecosystem, species and genetic diversity all have enormous potential and a decline in biodiversity will lead to huge economic, ecological and socio-cultural loss.

THREATS TO BIODIVERSITY

- Extinction or elimination of a species is a natural process of evolution.
- In the geologic period the earth has experienced mass extinctions.
- During evolution, species have died out and have been replaced by others.
- However, the rate of loss of species in geological past has been a slow process, keeping in view the vast span of time going back to 444 million years.
- The process of extinction has become particularly fast in the recent years of human civilization.
- In this century, the human impact has been so serve that thousands of species and varieties are becoming extinct annually.
- One of the estimates by the noted ecologist, E.O. Wilson puts the figure of extinction at 10, 000 species per year or 27 per day.
- This startling figure raises an alarm regarding the serious threat to biodiversity.
- Over the last 150 years the rate of extinction has escalated more dramatically.
- If the present trend continues we would lose $1/3^{rd}$ to $2/3^{rd}$ of our current biodiversity by the middle of twenty first century.
- Let us consider some of the major causes and issues related to threats to biodiversity.

LOSS OF HABITAT

- Destruction and loss of natural habitat is the single largest cause of biodiversity loss.

- Billions of hectares of forests and grasslands have been cleared over the past 10,000 years for conversion into agricultural lands, pastures, settlement areas or development projects.
- These natural forests and grasslands were the natural homes of thousands of species which perished due to loss of their natural habitat.
- Severe damage has been caused to wetlands thinking them to be useless ecosystems.
- The unique rich biodiversity of the wetlands, estuaries and mangroves are under the most serious threat today.
- The wetlands are destroyed due to draining, filling and pollution thereby causing huge biodiversity loss.
- Sometimes the loss of habitat is in installments 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.
- Due to habitat fragmentation many song birds are vanishing.
- There has been a rapid disappearance of tropical forests in our country also, at a rate of about 0.6% per year.
- With the current rate of loss of forest habitat, it is estimated that 20-25% of the global flora would be lost within a few years.
- Marine biodiversity is also under serious threat due to large scale destruction of the fragile breeding and feeding grounds of our oceanic fish and other species, as a result of human intervention.

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 continuous.
- The developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth of wildlife.
- The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hong Kong are the major importers of the wild life products or wild life itself.
- The trading of such wild life products is highly profit making for the products who just hunt these prohibited wild life and smuggle it to other countries mediated through a mafia.

- The cost of elephant tusks can go upto $100 per kg; the leopard fur coat is sold at $100,000 in Japan while bird catchers can fetch upto $10,000 for a rare hyacinth macaw, a beautiful coloured bird, from Brazil.
- The worse part of the story is that for every live animal that actually gets into the market, about 50 additional animals are caught and killed.
- If you are fond of rare plants, fish or birds, please make sure that you are not going for the endangered species or the wild-caught species.
- Doing so will help in checking further decline of these species.
- Also do not purchase furcoat, purse or bag, or items made of crocodile skin or python skin.
- You will certainly help in preserving biodiversity by doing so.

MAN-WILDLIFE CONFLICTS

- We have discussed about the need to preserve and protect our wildlife.
- However, sometimes we come across conflicting situations when wildlife starts causing immense damage and danger to man and under such conditions it becomes very difficult for the forest department to pacify the affected villagers and gain local support for wild-life conservation.
- Instances of man animal conflicts keep on coming to lime light from several states in our country.
- In Sambalpur, Orissa 195 humans were killed in the last 5 years by elephants.
- In retaliation the villagers killed 98 elephants and badly injured 30 elephants.
- Several instances of killing of elephants in the border regions of Kote-Chamarajanagar belt in Mysore have been reported recently.
- The man-elephant conflict in this region has arisen because of the massive damage done by the elephants to the farmer's cotton and sugarcane crops.
- The agonized villagers electrocute the elephants and sometimes hide explosives in the sugarcane fields, which explode as the elephants intrude into their fields.
- In fact, more killings are done by locals than by poachers.
- Recently, in early 2004, a man-eating tiger was reported to kill 16 Nepalese people and one 4-year old child inside the Royal Chitwan National Park, 240Km South west of Kathmandu.
- The Park renowned for its wildlife conservation effort has become a zone of terror for the locals.
- At times, such conflicting situations have been reported from the border regions of Corbett, Dudhwa, Palamau and Ranthambore National Parks in our country as well.
- Very recently in June, 2004 two men were killed by leopards in Powai, Mumbai.

- A total of 14 persons were killed during 19 attacks since January by the leopards from the Sanjay Gandhi National Park, Mumbai which has created a panic among the local residents.

Causes of Man-animal conflicts

- Dwindling habitats of tigers, elephants, rhinos and bears due to shrinking forest cover comples them to move outside the forest and attack the field or sometimes even humans.
- Human encroachment into the forest areas raises a conflict between man and the wildlife, perhaps because it is an issue of survival of both.
- Usually the ill, weak and injured animals have a tendency to attack man.
- Also, the female tigress attacks the human if she feels that her newborn cubs are in danger.
- But the biggest problem is that if human-flesh is tasted once then the tiger does not eat any other animal.
- At the same time, it is very difficult to trace and cull the man-eating tiger and in the process many innocent tigers are also killed.
- Earlier, forest departments used to cultivate paddy, sugarcane etc. within the sanctuaries when the favorite staple food of elephants i.e. bamboo leaves were not available.
- Now due to lack of such practices the animals move out of the forest in search of food.
- It may be noted that, one adult elephant needs 2 quintals of green fodder and 150 kg of clean water daily and if it is not available, the animal strays out.
- Very often the villagers put electric wiring around their ripe crop fields.
- The elephants get injured, suffer in pain and turn violent.
- Earlier there used to be wild-life corridors through which the wild animals used to migrate seasonally in groups to other areas.
- Due to development of human settlements in these corridors, the path of wildlife has been disrupted and the animals attack the settlements.
- The cash compensation paid by the government in lieu of the damage caused to the farmers crop is not enough.
- In Mysore, a farmer gets a compensation of Rs. 400//- per quintal of expected yield while the market price is Rs. 2400/- per quintal.
- The agonized farmer therefore gets revengeful and kills the wild animals.

Remedial Measures to Curb the Conflict

- 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.
- Adequate crop compensation and cattle compensation scheme must be started, along with substantial cash compensation for loss of human life.
- Solar powered fencing should be provided along with electric current proof trenches to prevent the animals from straying into fields.
- Cropping pattern should be changed near the forest borders and adequate fodder, fruit and water should be made available for the elephants within forest zones.
- Wild life corridors should be provided for mass migration of big animals during unfavorable periods.
- About 300 km^2 area is required for elephant corridors for their seasonal migration.
- In similipal Sanctuary, Orissa there is a ritual of wild animal hunting during the months of April-May for which forest is burnt to flush out the animals. Due to massive hunting by people, there is a decline in prey of tigers and they start coming out of the forest in search of prey.
- Now there is WWF-TCP initiative to curb this ritual of "Akhand Shikar" in Orissa.

Conservations of Biodiversity: In-Situ Conservation and Ex-Situ Conservation!

Conservation is the protection, preservation, management, or restoration of wildlife and natural resources such as forests and water. Through the conservation of biodiversity and the survival of many species and habitats which are threatened due to human activities can be ensured. There is an urgent need, not only to manage and conserve the biotic wealth, but also restore the degraded ecosystems.

Humans have been directly or indirectly dependent on biodiversity for sustenance to a considerable extent. However, increasing population pressure and developmental activities have led to large scale depletion of the natural resources.

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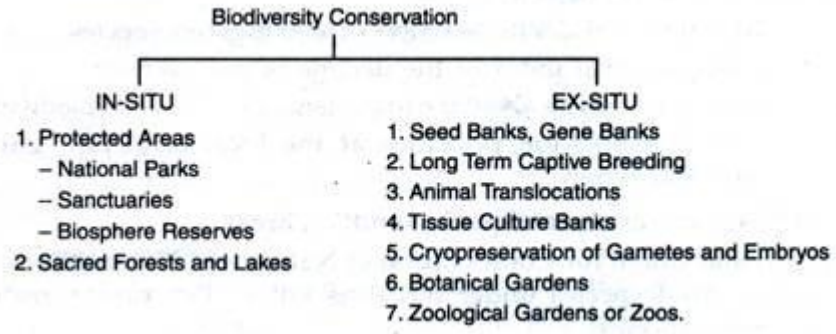
Types of Conservation:

Conservation can broadly be divided into two types:

1. In-situ conservation

2. Ex-situ conservation



In-situ Conservation:

In-situ conservation is on site conservation or the conservation of genetic resources in natural populations of plant or animal species, such as forest genetic resources in natural populations of tree species.

It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or cleaning up the habitat itself, or by defending the species from predators.

It is applied to conservation of agricultural biodiversity in agro forestry by farmers, especially those using unconventional farming practices. In-situ conservation is being done by declaring area as protected area.

In India following types of natural habitats are being maintained:

1. National parks

2. Wildlife sanctuaries

3. Biosphere reserves

INDIA has over 600 protected areas, which includes over 90 national parks, over 500 animal sanctuaries and 15 biosphere reserves.

1. National Parks:

A national park is an area which is strictly reserved for the betterment of the wildlife and where activities like forestry, grazing on cultivation are not permitted. In these parks, even private ownership rights are not allowed.

Their boundaries are well marked and circumscribed. They are usually small reserves spreading in an area of 100 Sq. km. to 500 sq. km. In national parks, the emphasis is on the preservation of a single plant or animal species.

Table. List of some major National Parks of India:

S.No.	Name	State	Established	Area (in km^2)
1.	Corbett National Park	Uttarakhand	1921	1318.5
2.	Dudhwa National Park	Uttar Pradesh	1977	490.29
3.	Gir National Park	Gujarat	1965	258.71
4.	Kanha National Park	Madhya Pradesh	1955	940
5.	Kanger Ghati National Park (Kanger Valley)	Chhattisgarh	1982	200
6.	Kaziranga National Park	Assam	1974	471.71
7.	Nanda Devi National Park	Uttarakhand	1982	630.33

8.	Sariska National Park	Rajasthan	1955	866
9.	Silent Valley National Park	Kerala	1980	237
10.	Sundarbans National Park	West Bengal	1984	1330.12

2. Wildlife Sanctuaries:

A sanctuary is a protected area which is reserved for the conservation of only animals and human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not interfere with well-being of animals. Boundaries of sanctuaries are not well defined and controlled biotic interference is permitted, e.g., tourist activity.

Table. List of some major Wildlife Sanctuaries of India:

S.No.	Name	State	Established	Area (in km^2)
1.	Ghana Bird Sanctuary	Rajasthan	1982	28.73
2.	Hazaribag Wildlife Sanctuary	Jharkhand	1954	183.89
3.	Mudumalai Wildlife Sanctuary	Tamil Nadu	1940	321.55
4.	Jaldapara Wildlife Sanctuary	West Bengal	2012	216
5.	Mount Abu Wildlife Sanctuary	Rajasthan	1960	288.84

6.	Anamalai Wildlife Sanctuary (Indira Gandhi Wildlife Sanctuary and National Park)	Tamil Nadu	1989	117.10

3. Biosphere Reserves:

It is a special category of protected areas where human population also forms a part of the system. They are large protected area of usually more than 5000 sq.km. A biosphere reserves has 3 parts- core, buffer and transition zone.

1. Core zone is the inner zone; this is undisturbed and legally protected area.

2. Buffer zone lies between the core and transition zone. Some research and educational activities are permitted here.

3. Transition zone is the outermost part of biosphere reserves. Here cropping, forestry, recreation, fishery and other activities are allowed.

The main functions of biodiversity reserves are:

1. Conservation:

To ensure the conservation of ecosystem, species and genetic resources.

2. Development:

To promote economic development, while maintaining cultural, social and ecological identity.

3. Scientific Research:

To provide support for research related to monitoring and education, local, national and global issues.

Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity.

Table. List of some major Biosphere Reserves of India:

S.No.	Name	State	Established	Area (in km^2)
1.	Nanda Devi	Uttarakhand	1982	5,860.69
2.	Manas	Assam	1990	2837
3.	Gulf of Mannar	Tamil Nadu	1980	10,500
4.	Great Nicobar	Andaman and Nicobar Islands	1989	885
5.	Panchmarhi	Madhya Pradesh	1999	4,926.28

Advantages of in-situ conservation:

1. The flora and fauna live in natural habitats without human interference.
2. The life cycles of the organisms and their evolution progresses in a natural way.
3. In-situ conservation provides the required green cover and its associated benefits to our environment.
4. It is less expensive and easy to manage.
5. The interests of the indigenous people are also protected.

Ex-Situ Conservation:

Ex-situ conservation is the preservation of components of biological diversity outside their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated or species, and draws on a diverse body of techniques and facilities. Such strategies include establishment of botanical gardens, zoos, conservation strands and gene, pollen seed, seedling, tissue culture and DNA banks.

i. Seed gene bank:

These are cold storages where seeds are kept under controlled temperature and humidity for storage and this is easiest way to store the germ plasma of plants at low temperature. Seeds preserved under controlled conditions (minus temperature) remain viable for long durations of time.

ii. Gene bank:

Genetic variability also is preserved by gene bank under normal growing conditions. These are cold storages where germ plam are kept under controlled temperature and humidity for storage; this is an important way of preserving the genetic resources.

iii. Cryopreservation:

This is the newest application of technology for preservation of biotic parts. This type of conservation is done at very low temperature (196°C) in liquid nitrogen. The metabolic activities of the organisms are suspended under low temperature, which are later used for research purposes.

iv. Tissue culture bank:

Cryopreservation of disease free meristems is very helpful. Long term culture of excised roots and shoots are maintained. Meristem culture is very popular in plant propagation as it's a virus and disease free method of multiplication.

v. Long term captive breeding:

The method involves capture, maintenance and captive breeding on long term basis of individuals of the endangered species which have lost their habitat permanently or certain highly unfavorable conditions are present in their habitat.

vi. Botanical gardens:

A botanical garden is a place where flowers, fruits and vegetables are grown. The botanical gardens provide beauty and calm environment. Most of them have started keeping exotic plants for educational and research purposes.

vii. Animal Translocation:

Release of animals in a new locality which come from anywhere else.

Translocation is carried in following cases:

1. When a species on which an animal is dependent becomes rare.

2. When a species is endemic or restricted to a particular area.

3. Due to habit destruction and unfavorable environment conditions.

4. Increase in population in an area.

viii. Zoological Gardens:

In zoos wild animals are maintained in captivity and conservation of wild animals (rare, endangered species). The oldest zoo, the Schonbrumm zoo which exists today also, was established in VIENNA in 1759.

In India, the 1st zoo came into existence at BARRACKPORE in 1800. In world there are about 800 zoos. Such zoos have about 3000 species of vertebrates. Some zoos have undertaken captive breeding programmes.

Advantages of ex-situ preservation:

1. It is useful for declining population of species.

2. Endangered animals on the verge of extinction are successfully breeded.

3. Threatened species are breeded in captivity and then released in the natural habitats.

4. Ex-situ centres offer the possibilities of observing wild animals, which is otherwise not possible.

5. It is extremely useful for conducting research and scientific work on different species.

CLASS: I BSc BT **COURSE NAME: ENVIRONEMTNAL STUDIES**

COURSE CODE: 19AEC201 **UNIT – IV**

Environmental Pollution - Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: Foods, earthquake, cyclone and landslides.

Environmental pollution: Causes, effects and control of air

India today is one of the first ten industrialized countries of the world. Today we have a good industrial infrastructure in core industries like metals, chemicals, fertilizers, petroleum, food etc. what has come out of these? Pesticides, detergents, plastics, solvents, fuels, paints, dyes, food additives etc. are some examples. Due to progress in atomic energy, there has also been an increase in radioactivity in the biosphere. Besides these, there are a number of industrial effluents and emissions particularly poisonous gases in the atmosphere. Mining activities also added to this problem particularly as solid waste.

Thus, pollution is a necessary evil of all development. Due to lack of development of a culture of pollution control, there had resulted a heavy backlog of gaseous, liquid and solid pollution in our country. It is to be cleaned. Thus pollution control in our country is a recent environmental concern.

What is pollution? Pollution is an undesirable change in the physical, chemical or biological characteristics of air, water and soil that may harmfully affect the life or create a potential health hazard of any living organism. Pollution is thus direct or indirect changes in any component of the biosphere that is harmful to the living component(s), and in particular undesirable for man, affecting adversely the industrial progress, cultural and natural assets or general environment.

What are pollutants? Any substance which causes pollution is called a pollutant. A pollutant may thus include any chemical or geochemical (dust, sediment, grit etc.) substance, biotic component or its product, or physical factor (heat) that is released intentionally by man into the environment in such a concentration that may have adverse harmful or unpleasant effects.

Environmental Pollutants

The various principal pollutants which pollute our air, water, land are as follows :

(1) Deposited matter – soot, smoke, tar, dust, grit etc.
(2) Gases – Oxides of nitrogen (NO, NO_2), sulphur (SO_2), carbon monoxide, halogens, (chlorine, bromine, iodine),
(3) Acids droplets – sulphruric, acid nitric acid etc.
(4) Fluorides
(5) Metals – Mercury, lead, iron, zinc, nickel, tin, cadmium, chromium etc.
(6) Agrochemicals – Biocides (pesticides, herbicides, fungicides, nematicides, bactericides, weedicides etc), and fertilizers.
(7) Complex organic substances – Benzene, ether, acetic acid, benzopyrenes etc.
(8) Photochemical oxidants – Photochemical smog, ozone, peroxyacetyl nitrate (PAN), peroxybenzoil nitrate (PBzN), nitrogen oxides, aldehydes, ethylene etc.
(9) Solid wastes
(10) Radioactive waste
(11) Noise

Kinds of Pollution

Various types of pollutions are classified in different ways. On the basis of the type of environment being polluted, we may recognize air pollution, water pollution, land soil pollution, marine pollution etc. on the basis of the kind of pollutant involved, we may have sulphur dioxide pollution, fluoride pollution, carbon monoxide pollution, smoke pollution, lead pollution, mercury pollution, solid waste pollution, radioactive pollution, noise pollution etc. Of the variety of pollutants, we recognize the following two basic types of pollutants: non degradable and biodegradable.

(1) Nondegradable pollutants

These are the materials and poisonous substances like aluminium cans, mercuric salts, long- chain phenolics, DDT etc. that either do not degrade or degrade only very slowly in nature. They are not cycled in ecosystem naturally but by subsequent movement in food chains and biogeochemical cycles.

(2) Biodegradable pollutants

They are the domestic wastes that can be rapidly decomposed under natural condition. They may create problems when they accumulate (i.e. their input into the environment exceeds their decomposition).

Atmosphere

The earth's vertically extended atmosphere, an envelope of gases is divided into the following layers : (i) troposphere (up to 5 km) – the lowest atmosphere in which temperature decreases with height bounded by land or sea surface below and by tropopause above, (ii) stratosphere (5 to 45 km) - the region above the troposphere, in which temperature increases up to 90^0C with height. This is limited by stratopause, (iii) mesosphere (45 to 80 km) – the part between stratosphere and thermosphere (ionosphere). Temperature again decreases up to – 80^0C. (iv) thermosphere (ionosphere) – above 80 km, the upper part in which temperature increases with height. There is no boundary between the atmosphere and void of outer space. About 75% of the earth's atmosphere lies within 16 km. of the surface and 99% of the atmosphere lies below an altitude of 30 km.

The atmosphere is an insulating blanket around the earth. It is source of essential gases, maintains a narrow difference of day and night temperatures and provides a medium for long-distance radio communication. It also acts as shield around the earth against lethal UV radiations and meteors. Without atmosphere, there will be no lightening, no wind, no clouds, no rains, no snow and no fire.

Normal composition of clean air at or near sea (1990) is as follows:

Gases	**Percent (by Volume)**
Nitrogen	78.084
Oxygen	20.9476
Argon	0.934
Carbon dioxide	0.0314
Methane	0.0002
Hydrogen	0.00005
Other gases	minute

Air is necessary for the survival of all higher forms of life on Earth. On an average, a person needs at least 30 lb of air every day to live, but only about 3 lb of water and 1.5 lb of food. A person can live about 5 weeks without food and about 5 days without water, but only 5 minutes without air. Naturally, every one likes to breathe fresh, clean air. But the atmosphere, that invisible yet essential Ocean of different gases called air, is as susceptible to pollution from human activities as are water and land environments.

Air Pollution

It is defined as the excessive concentration of foreign material in the atmosphere , which affects the health of individuals and also causes damage to the property.

Air pollution episodes

- ***London smog*** : SO_2 H_2SO_3 vapours in the atmosphere. When automobile exhausts are trapped by this smog and exposed to sunlight, it produces photochemical smog.
- ***Bhopal gas tragedy* :** The poisonous gas, methyl isocyanate (MTC) leakage in the pesticide manufacturing plant of Union Carbide of India Ltd., (UCIL), Bhopal, Madhya Pradesh on December 3, 1984. 46 tons of MIC was released spreading to 40 km. *Effects* : About 65,000 people suffered from various disorders in eyes, lungs, stomach, heart, etc. The immediate symptom is bronchospasm which causes coughing, chest pain and abdominal pain. Nearly 3000 people died within a short span of time, 1600 domestic animals died and crop yields were reduced .
- ***Darkening effect of Taj Mahal***

  Taj Mahal is a white marble stone mausoleum. Recently it was observed that the walls of Taj Mahal has become darkened and disfigured due to air pollution from nearby Mathura Oil refinery.

  $H_2O + SO_2$ H_2SO_3, $SO_2 + O_2$ SO_3; $SO_3 + H_2O$ H_2SO_4.

  The acid rain reacts with marble stone ($CaCO_3$) to produce calcium sulphate, causing darkening and disfigurement.

Types, sources and effects of air pollution

Air pollution may be simply defined as the presence of certain substances in the air in high enough concentrations and for long enough duration to cause undesirable effects. “Certain substances” may be any gas, liquid or solid, although certain specific substances are considered significant pollutants because of very large emission rates are harmful and unwanted effects. “Long enough durations” can be anywhere from a few hours to several days or weeks; on a global scale, durations of months and years are of concern.

Sources

Air pollution results from gaseous emission from mainly industry, thermal power stations, automobiles, domestic combustion etc.

1. **Industrial chimney wastes**: There are a number of industries which are source of air pollution. Petroleum refineries are the major source of gaseous pollutants. The chief gases are SO_2 and NO_X. Cement factories emit plenty of dust, which is potential health hazard. Stone crushers and hot mix plants also create a menace. Food and fertilizers industries which emit gaseous pollutants. Chemical manufacturing industries which emit acid vapours in air.
2. **Thermal power stations:** There are a number of thermal power stations and super thermal power stations in the country. The National thermal power corporation (NTPC) is setting up four mammoth coal-powered power stations to augment the energy generation. These are at Singrauli in U.P., Korba in M.P., Ramagundam in Andhra Pradesh and Farakka in W. Bengal. The coal consumption of thermal plants is several million tones. The chief pollutants are fly ash, SO_2 and other gases and hydrocarbons.
3. **Automobiles**: The toxic vehicular exhausts are a source of considerable air pollution, next only to thermal power plants. The ever increasing vehicular traffic density posed continued threat to the ambient air quality. Chief sources of emission in automobiles are (i) exhaust system, (ii) fuel tank and carburettor and (iii) crankcase. The exhaust produces many air pollutants including unburnt hydrocarbons, CO, NO_X and lead oxides. There are also traces of aldehydes, esters, ethers, peroxides and ketones which are chemically active and combine to form smog in presence of light. Evaporation from fuel tank goes on constantly due to volatile nature of petrol, causing emission of hydrocarbons. The evaporation through carburettor occurs when engine is stopped and heat builds up, and as much as 12 to 40 ml of fuel is lost during each long stop causing emission of hydrocarbons.

Criteria Air Pollutants

The five primary criteria pollutants include the gases- Carbon Monoxide (CO), nitrogen oxides (NO_X) , sulfur dioxide (SO_2), and solid or liquid particulates (smaller than 10 μm), and particulate lead.

a) Carbon Monoxide

- CO is a colourless, odourless and tasteless gas.
- It is produced when carbonaceous fuels are burned under less than ideal conditions.

- Incomplete combustion, yielding CO instead of CO_2, results when any of the following variables are not kept sufficiently high:

i. Oxygen supply
ii. flame temperature
iii. gas residence time at high temperature and
iv. combustion chamber turbulence.

- Most of the CO emissions are from the transportation sector. Hourly atmospheric concentrations of CO often reflect city driving patterns. Peaks occur on week days during the morning and late afternoon rush hours.
- The CO, at levels that occur in urban air has no detrimental effect on materials or plants; but adversely affects human health.
- CO interferes with the blood's ability to carry oxygen to the cells of the body. When inhaled, it readily binds to hemoglobin in the blood stream to form carboxyhemoglobin (COHb).
- Even small amounts of CO can seriously reduce the amount of oxygen conveyed throughout the body □ brain function is affected and heart rate increased in an attempt to offset the oxygen deficit.

b). Oxides Of Nitrogen

- oxides of nitrogen are known to occur – NO, NO_2, NO_3, N_2O, N_2O_3, N_2O_4 and N_2O_5.
- Nitric oxide (NO) and Nitrogen dioxide (NO_2) are important in air pollution study.
- There are two sources of nitrogen oxides (or NO_X):

i. *Thermal NO_X* are created when nitrogen and oxygen in the combustion air are heated to a high enough temperature (> 1000 K) to oxidise nitrogen.
ii. *Fuel NO_X* result from the oxidation of nitrogen compounds that are chemically bound in the fuel molecules themselves. Natural gas almost has no nitrogen in them and some coal can have 3% N by weight. Fuel NO_X is often the dominant source of NO_X.

- Almost all NO_X emissions are in the form of NO, which has no adverse health effects.
- However, NO can oxidise to NO_2, which in turn may react with hydrocarbons in the presence of sunlight to form photochemical smog, which is injurious.
- NO_2 also reacts with hydroxyl radical (HO) in the atmosphere to form nitric acid (HNO_3) and results in acid rain.
- NO_2 is an acute irritant at higher concentrations. Prolonged exposure to relatively low concentrations is linked to increased bronchitis in children. It can also damage plants. When converted to nitric acid it causes corrosion of metal surfaces.
- NO is a colourless gas, but NO_2 gives smog its reddish brown colour.
- Reductions in NO_X emissions have been harder to achieve.

- When mobile source controls are introduced, modifications to the combustion process that improve emissions of CO tend to make the NO_X problem worse and vice-versa. To control CO, it helps to increase the combustion air supply and to raise the temperature. To control NO_X, the opposite is true.

The NO-NO_2–O_3 photochemical reaction sequence

- NO is formed during combustion

$N_2 + O_2 \rightarrow NO$

The nitric oxide thus emitted, can oxidise to NO_2.

$2\,NO + O_2 \rightarrow NO_2.$

- If sunlight is available, NO_2 can photolyse, and the freed atomic oxygen can then help to form ozone:

$NO_2 + hv \rightarrow O + O$

$O + O_2 + M \rightarrow O_3 + M$

where hv represents a photon (□□ < 0.38 μm) and M represents a molecule (usually O_2 or N_2) whose presence is necessary to absorb excess energy from the reaction.

- Ozone can then convert NO back to NO_2 :

$O_3 + NO \rightarrow NO_2 + O_2$

- Thus, NO concentrations rise as early morning traffic emits its load of NO. Then as morning progresses, there is a drop in NO and a rise in NO_2 as NO gets converted to NO_2. As the sun's intensity increases toward noon, the rate of photolysis of NO_2 increases; thus NO_2 begins to drop while O_3 rises. Ozone is so effective in its reaction with NO that as long as O_3 is present, NO concentrations do not rise through the rest of the afternoon, even though there may be new emissions.

If only NO_2 photolytic cycle is involved, O_3 cannot accumulate in sufficient quantity in photochemical smog to account for the actual measured data. The introduction of hydrocarbons upsets the balance in production and destruction of ozone, thus allowing more O_3 to accumulate.

Photochemical smog and ozone

- When oxides of nitrogen, various hydrocarbons and sunlight come together, they initiate a complex set of reactions that produce a number of secondary pollutants known as photochemical oxidants.

- Ozone (O_3) is the most abundant photochemical oxidant responsible for chest constriction and irritation of the mucous membrane in people, cracking of rubber products and damage to vegetation.
- Other components of the photochemical smog viz., formaldehyde, peroxy benzoyl nitrate (PBzN), peroxy acetyl nitrate (PAN) and acrolein cause eye irritation.
- The formation of photochemical smog can be expressed in the simples terms as : Hydrocarbons + NO_X + sunlight □ photochemical smog.

C). Oxides of sulfur

- Over 80% of anthropogenic sulfur oxide emissions are the result of fossil fuel combustion in stationary sources. Of that, almost 85% is released from electric utility power plants. Only about 2% comes from highway vehicles.
- The only significant non combustion sources of Sulfur emissions are associated with petroleum refining, copper smelting and cement manufacture.
- Oil and coal generally contain appreciable quantities of sulfur (0.5-6%), either in the form of inorganic sulfides or as organic sulfur. When these fuels are burned, the sulfur is released mostly as sulfur dioxide (SO_2), but also with small amounts of sulfur trioxides (SO_3).
- SO_2, once released, can convert to SO_3 in a series of reactions which, once again, involve a free radical such as OH**.**

$$SO_2 + OH. \longrightarrow HO\,SO_2.$$

$$HO\,SO_2. + O_2 \longrightarrow SO_3 + HO_2.$$

- The HO_2 radical can then react with NO to return the initial OH. ($HO_2. + NO \rightarrow NO_2 + OH.$).

- Sulfur trioxide reacts very quickly with H_2O to form sulfuric acid, which is the principal cause of acid rain.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

- Sulfuric acid molecules rapidly become particles by either condensing on existing particles in the air or by merging with water vapour to from $H_2O - H_2SO_4$ droplets.
- Often a significant fraction of particulate matter in the atmosphere consists of such sulfate (SO_4^{2-}) aerosols.

- The transformation from SO_2 gas to sulfate particles is gradual, taking a matter of days. In either form, sulfur can be deposited during precipitation (wet deposition) or by slow continuous removal processes that occur without precipitation (dry deposition).
- Most sulfate particles in urban air have en effective size of less than 2 μm, with most of them being in the range of 0.2 μm. Their size allows deep penetration into the respiratory system.
- SO_2 is highly water soluble (much more than any of the other criteria pollutants). As a result, when it is inhaled it is most likely to be absorbed in the most passages of the upper respiratory tract, the nose and upper air ways.
- However, when sulfur is entrained in an aerosol, the aerodynamic properties of the particles themselves affect the area of deposition and it is possible for sulfur oxides to reach far deeper into the lungs.
- The combination of particulate matter and sulfur oxides can than act synergistically, with the effects of both together being much more detrimental than either of them separately.
- Sulfur oxides can damage vegetation. Sulfur pollutants can discolour paint, corrode metals and cause organic fibres to weaken. Airborne sulfates significantly reduce visibility and discolour the atmosphere.
- Prolonged exposure to sulfates causes serious damage to building marble, lime stone ($CaCO_3$) and mortar, as the carbonates in these materials are replaced by sulfates.

  $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$

  The calcium sulfate (gypsum) produced by this reaction is water soluble and easily washes away, leaving a pitted, eroded surface.

d).Lead

- Most lead emissions in the past have been from motor vehicles burning gasoline containing the antiknock additive, tetraethyl lead, $(C_2H_5)_4Pb$.
- Lead is emitted to the atmosphere primarily in the form of inorganic particulates.
- Much of this is removed from the atmosphere by settling in the immediate vicinity of the source.
- Air borne lead may affect human populations by direct inhalation, in which case people living nearest to highways are at greatest risk, or it can be ingested after the lead is deposited onto food stuffs.
- Most of human exposure to airborne lead is the result of inhalation. It has been estimated that about one third of the lead particles inhaled are deposited in the respiratory system and that about half of those are absorbed by the blood stream.

- The NAAQS standard for lead – 1.5 µg/m^3.
- Lead poisoning can cause aggressive, hostile and destructive behavioral changes as well as learning disabilities, seizures, severe and permanent brain damage and even death. Children and pregnant women are at greatest risk.
- Blood lead levels associated with neurobehavioral changes in children appear to begin at 50-60 µg per decilitre (µg/dL). Encephalopathy, with possible brain damage or death occurs at levels some what 80 µg / dL.
- Sources of lead exposure □□ air emissions, drinking water (lead can be leached out of lead solder used in copper piping systems), ingestion of lead in food and leaded paint.

e).Particulate Matter

Atmospheric *particulate matter* is defined to be any dispersed matter, solid or liquid, in which the individual aggregates are larger than single small molecules (about 0.0002□m in diameter), but smaller than 500□m.

- Particulate matter is diverse and complex.
- The ability of the human respiratory system to defend itself against particulate matter is, to a large extent, determined by the size of the particles.

Particles larger than 10□m

- Large particles that enter respiratory system can be trapped by the hairs and lining of the nose. Once captured, they can be driven out by a cough or sneeze.

- Smaller particles that make it into the tracheobronchial system can be captured by mucus, worked back to the throat by tiny hair like cilia, and removed by swallowing or spitting.

Particles smaller than 10□m

- These particles may make it into the lungs, but depending on their size, they may or may not he deposited there.
- Some particles are so small that they tend to follow the air stream into the lungs and then right back out again.
- Particles roughly between 0.5 and 10□m may be large enough to be deposited in the lungs by sedimentation. Sedimentation is most effective for particles between 2 and 4□m.
- Particulates <10□m are most important from view of adverse health effects on humans.
- High particulate concentration in the atmosphere, especially in conjunction with oxides of sulfur□ respiratory infection, cardiac disorders, bronchitis, asthma, pneumonia …
- Some particles are toxic. Many carbonaceous particles, especially those containing polycyclic aromatic hydrocarbons (PAHs) are suspected carcinogens.

- Particulate emissions have decreased substantially in the past few decades, due to tremendous reductions in combustion emissions (especially by electric utilities).

Indoor Air Quality

- People tend to spend more time indoors than out, and in many circumstances, the air we breathe indoors is even more polluted than outdoor air.

Sources of indoor air pollution

- Combustion (to heat water, cook and space heating) can produce elevated levels of CO and NO_X.
- Certain photocopying machines emit ozone.
- Formaldehyde emissions from particle board, plywood, urea – formaldehyde foam insulation.
- Asbestos used for fireproofing and insulation.
- Various volatile organics emitted from household cleaning products.
- Many pollutants, such as cigarette smoke and radon when emitted indoors can be concentrated, leading to harmful exposure levels.
- Tobacco smoke contains numerous known or suspected carcinogens, including benzene, hydrazine, benzo - □-pyrene (BaP) and Nickel.
- Smoke particles are small, averaging about 0.2 μm, so they are easily carried into the deepest regions of the lungs.
- A single cigarette smoke gives off on the order of 1012 smoke particles, most of which are released while the cigarette is simply smoldering in the air (*sidestream smoke*) rather than when a smoker takes a puff (*mainstream smoke*).
- Hence non smokers are also exposed to significant amount of smoke particles.
- Other indoor air pollutants arising from tobacco smoke include carbon monoxide, nicotine, nitrosamines, acrolein and other aldehydes.
- Another potentially important source of indoor air pollution is caused by wood-burning stoves and fireplaces.
- Wood combustion produces CO, NO_X, hydrocarbons and respirable particles and some emissions that are suspected carcinogens like benzo - □-pyrene.

Effects of air pollution

Air pollution is known to have many adverse effects, including those on human health, building facades and other exposed materials, vegetation, agricultural crops, animals, aquatic and terrestrial ecosystems, and the climate of earth as a whole.

a) Health effects

Perhaps the most important effect of air pollution is the harm it causes to human health. Generally, air pollution is most harmful to the very old and the very young. Many elderly people may already suffer from some form of heart or lung disease, and their weakened condition can make them very susceptible to additional harm from air pollution. The sensitive lungs of new born infants are also susceptible to harm from dirty air. But it is not just the elderly or the very young who suffer; healthy people of all ages can be adversely affected by high levels of air pollutants. Major health effects are categorized as being acute, chronic, or temporary.

There is much evidence linking lung cancer to air pollution, although the actual cause-and – effect relationship is still unknown. Typical effects of sulfur dioxide, oxides of nitrogen, and ozone include eye and throat irritation, coughing and chest pain. Nitrogen dioxide is known to cause pulmonary edema, an accumulation of excessive fluids in the lungs. Ozone, a highly irritating gas, produces pulmonary congestion; symptoms of ozone exposure may include dry throat, headache, disorientation, and altered breathing patterns.

b)Effect on Materials

Every year , air pollutants cause damage worth billions of rupees. Air pollutants breakdown the exterior paint in cars and houses. Air pollutants have discolored irreplaceable monuments, historic buildings, marble statues and other heritage and natural beauty sites.

c)Effect on plants.

Some gaseous pollutants enter leaf pores and damage the crop plants. Chronic exposure of leaves to air pollutants damages waxy coating, leads to damage from diseases, pests, drought and frost. Such exposure interferes with photosysthesis and plant growth, reduces nutrient uptake and causes leaves to turn yellow, brown or drop off. At higher concentrations of SO_2 most of the flower buds become stiff and hard and fall off. Prolonged exposure to higher levels of air pollutants from Iron smelters, coal burning power plants and industries, vehicles can damage trees and plants.

d)on Stratosphere

Ozone is continuously being created in the stratosphere by the absorption of short-wavelength UV radiation, while at the same time it is continuously being removed by various chemical reactions that convert it back to molecular oxygen. The rates of creation and removal at

any given time and location dictate the concentration of ozone present. The balance between creation and removal is being affected by increasing stratospheric concentrations of chlorine, nitrogen and bromine, which acts as catalysts, speeding up the removal process. CFCs are predominant.

Management of Air Pollution

For ages man has been dumping wastes into the atmosphere, and these pollutants have disappeared with the wind. We have seen that the main sources of air pollution are (i) motor vehicles,

(ii) industries-particularly their chimney wastes, (iii) fossil-fuel (coal) based plants, as thermal power plants. Steps are to be taken to control pollution at source (prevention) as well as after the release so pollutants in the atmosphere. There is an urgent need to prevent the emissions from the above said major sources of air pollution. The control of emissions can be realized in number of ways

1. **Source Correction**: There are several approaches or strategies for air pollution control. The most effective control would be to prevent the pollution from occurring in the first place. Complete source shutdown would accomplish this, but shutdown is only practical under emergency conditions, and even then it causes economic loss. Nevertheless, state public health officials can force industries to stop operations and can curtain highway traffic if an air pollution episode is imminent or occurring.

An important approach for air pollution control is to encourage industries to make fuel substitutions or process changes. For example, making more use of solar, hydroelectric, and geothermal energy would eliminate much of the pollution caused by fossil fuel combustion at power generating plants. Nuclear power would do the same, but other problems related to high level radioactive waste disposal and safety remain to be solved. Fuel substitutions are also effective in reducing pollution from mobile sources. For example, the use of reformulated gasoline or alternative fuels such as liquefied petroleum gas, compressed natural gas, or methanol for highway vehicles would help to clear the air. The use of correct operation and maintenance practices is important for minimizing air pollution and should not be overlooked as an effective control strategy.

2. ***Collection of pollutants:***

Often the most serious problem in air pollution control is the collection of the pollutants so as to provide treatment. Automobiles are most dangerous, but only because the emissions can not

be readily collected. If we could channel the exhausts from automobiles to some central facilities, their treatment would be much more reasonable than controlling each individual car. One success in collecting pollutants has been the recycling of blowby gases in the internal combustion engine. By reigniting these gases and emitting them through the car's exhaust system, the need of installing a separate treatment device for the car can be eliminated.

3. **Cooling:** The exhaust gases to be treated are sometimes too hot for the control equipment and the gases must first be cooled. This can be done in three general ways: dilution, quenching, or heat exchange coils. Dilution is acceptable only if the total amount of hot exhaust is small. Quenching has the additional advantage of scrubbing out some of these gases and particulates. The cooling coils are perhaps the most widely used, and are especially appropriate when heat can be conserved.

4. Treatment

The selection of the correct treatment device requires the matching of the characteristics of pollutant and features of the control device. It is important to realize that the sizes of air pollutants range many orders of magnitude, and it is therefore not reasonable to expect one device to be effective for all pollutants. Although, any new devices may appear any day in the market, the following are the most widely used:

(a) **Setting chambers** are nothing more than large places in the flues, similar to settling tanks in water treatment. These chambers remove only the large particulates.

(b) **Cyclones** are widely used for removing large particulars. The dirty air is blasted into a conical cylinder, but off the centerline. This creates violent swirl within the cone, and the heavy solids migrate to the wall of the cylinder where they slow down due to friction and exit at the bottom of the cone. The clean air is in the middle of the cylinder and exits out the top. Cyclones are widely used as pre-cleaners to remove the heavy material before further treatment.

(c) **Bag filters** operate like the common vacuum cleaner. Fabric bags are used to collect the dust which must be periodically shaken out of the bags. The fabric removes nearly all particulates. Bag filters are widely used in many industries, but are sensitive to high temperature and humidity.

(d) **Wet collectors** come in many shapes and styles. The simple spray tower is an effective method for removing large particulates. More efficient scrubbers promote the contact between air and water by violent action in a narrow throat section into which the water is introduced.

(e) **Electrostatic precipitators** are widely used in power plants. The particulate matter is removed by first being charged by electrons jumping from one high voltage electrode to the other, and then migrating to the positively charged electrode. The particulates will collect on the pipe and must be removed by banging the pipes with hammers. Electrostatic precipitators have no moving parts, require electricity, and are extremely effective in removing submicron particulates. They are expensive.

(f) **Gas scrubbers** are simply wet collectors as described above but are used for dissolving the gases.

(g) **Absorption** is the use of the material such as activated carbon to capture pollutants. Such adsorbers may be expensive to regenerate. Most of these work well for organics and have limited use for inorganic pollutants.

(h) **Incineration** is a method for removing gaseous pollutants by burning them to CO_2, H_2O and inerts. This works only for combustible vapours.

(i) **Catalytic combustion** involves the use of a catalyst to adsorb or chemically change the pollutants.

5. Dispersion

The concentration of the pollutants at the recipient is affected by atmospheric dispersion, or how the pollutant is diluted with clean air. This dispersion takes place horizontally as well as vertically. Earth rotation presents new areas for the sun to shine upon and to warm air. Accordingly a pattern of winds is set up around the world, some seasonal (e.g. hurricanes) and some permanent.

Diffusion is the process of spreading out the emission over a large area and thus reducing the concentration of the specific pollutants. The plume spread or dispersion as told above is horizontal as well as vertical. We assume that the maximum concentration of pollutants is in the plume centerline, i.e. in the direction of the prevailing wind. As we move further from the centerline, the concentration becomes lower. If we assume that the spread of a plume in both directions is approximated by a Gaussian probability curve, we can calculate the concentration of a pollutant at any distance X downwind from the source.

Ambient Air quality Standards

Area	**SPM (□g /m^3)**	**SO_2(□g /m^3)**	**CO(□g /m^3)**	**NO_x(□g /m^3)**

Industrial and Mixed use	500	120	5000	120
Residential and Rural	200	80	2000	80
Sensitive	100	3	1000	30

Integrated approach for air pollution Control

- Putting greater emphasis on pollution prevention rather than Control
- Reducing the use of Fossil fuels
- Improving quality of vehicular fuel
- Increasing the use of renewable energy

Causes, effects and control of water and marine pollution.

Water is one of the most important commodities which Man has exploited than any other resource for sustenance of his life. Most of the water in this planet is stored in oceans and ice caps which is difficult to be recovered for our diverse needs. It can be said that no water is pure or clean owing to the presence of some quantities of gases, minerals and life. Pure water is considered to be that which has low dissolved and suspended solids and obnoxious gases as well as low biological life. Water can be regarded polluted when it changes its quality or composition either naturally or as a result of human activities, thus becoming less suitable for drinking, domestic, agricultural, industrial, recreational, wildlife and other uses.

Some pollutants can be formed by way of concentrations and transformations of naturally occurring compounds during their domestic, agricultural or industrial use. The generation of sewage and the waste waters containing agrochemicals, certain pesticides and surfactants, petrochemicals, hydrocarbons, heavy metals and radionuclides are some important examples of pollutants originated in this way.

Sources of Water Pollutants

To understand the effects of water pollution and the technology applied in its control, it is useful to classify pollutants into various groups or categories. Water pollutant can be classified according to the nature of its origin as either a **point source** or a **dispersed source pollutant**.

A **point source** pollutant is one that reaches the water from a pipe, channel or any other confined and localized source. The most common example of a point source of pollutants is a pipe that discharges sewage into a stream or river. Most of these discharges are treatment plant effluents.

A **dispersed or non point source** is a broad, unconfined area from which pollutants enter a body of water. Surface runoff from agricultural areas carries silt, fertilizers, pesticides, and animal wastes into streams, but not at only one particular point. These materials can enter the water all along a stream as it flows through the area. Acidic runoff from mining areas is a dispersed pollutant. Storm water drainage systems in towns and cities are also considered to be dispersed sources of many pollutants, because, even though the pollutants are often conveyed into streams or lakes in drainage pipes or storm sewers, there are usually many of these discharges scattered over a large area.

Point source pollutants are easier to deal with, while pollutants from dispersed sources are much more difficult to control. Many people think that sewage is the primary culprit in water pollution problems, but dispersed sources cause a significant fraction of the water pollution. The most effective way to control the dispersed sources is to set appropriate restrictions on land use.

Oxygen – Demanding Wastes

One of the most important water quality parameters is the dissolved oxygen (DO) present. Oxygen – demanding wastes are substances that oxidize in the receiving body of water, reducing the amount of DO available. As DO drops, fish and other aquatic life are threatened and, in the

extreme case, killed. In addition, as dissolved oxygen levels fall, undesirable odors, tastes, and colors reduce the acceptability of the water as a domestic supply and reduce its attractiveness for recreational uses. Oxygen-demanding wastes are usually biodegradable organic substances contained in municipal wastewaters or in effluents from certain industries, such as food processing and paper production. In addition, the oxidation of certain inorganic compounds may also contribute to the oxygen demand. Even naturally occurring organic matter, such as leaves and animal droppings, that find their way into surface water add to the DO depletion. Minimum amounts required for a healthy fish population may be as high as 5-8 mg/L for active species, such as trout, or as low as 3 mg/L for less desirable species, such as carp.

There are several measures of oxygen demand commonly used. The chemical oxygen demand, or COD, is the amount of oxygen needed to chemically oxidize the wastes, while the biochemical oxygen demand, or BOD, is the amount of oxygen required by microorganisms to biologically degrade the wastes. BOD has traditionally been the most important measure of the strength of organic pollution, and the amount of BOD reduction in a wastewater treatment plant is a key indicator of process performance.

Pathogens

It has long been known that contaminated water is responsible for the spread of many contagious diseases. Pathogens are disease-producing organisms that grow and multiply within the host. Examples of pathogens associated with water include bacteria responsible for cholera, bacillary dysentery, typhoid, and paratyphoid fever; viruses responsible for infectious hepatitis and poliomyelitis; protozoa, which cause amoebic dysentery and giardiasis; and helminthes, or parasitic worms, which cause diseases such as schistosomiasis and dracontiasis (guinea worm). The intestinal discharges of an infected individual, a carrier, may contain billions of these pathogens, which, if allowed to enter the water supply, can cause epidemics of immense proportions. Carriers may not even necessarily exhibit symptoms of their disease, which makes it even more important to carefully protect all water supplies from any human waste contamination.

Nutrients

Nutrients are chemicals, such as nitrogen, phosphorus, carbon, sulfur, calcium, potassium, iron, manganese, boron, and cobalt, that are essential to the growth of living things. In terms of water quality, nutrients can be considered as pollutant when their concentrations are sufficient to allow excessive growth of aquatic plants, particularly algae. When nutrients stimulate the growth of algae, the attractiveness of the body of water for recreational uses, as a drinking water supply, and as a viable habitat for other living things can be adversely affected. Nutrient enrichment can lead to blooms of algae which eventually die and decompose. Their decomposition removes oxygen from the water, potentially leading to levels of DO that are insufficient to sustain normal life forms.

Major sources of both nitrogen and phosphorus include municipal wastewater discharges, runoff from animal feedlots, and chemical fertilizers. In addition, certain bacteria and blue-green algae can obtain nitrogen directly from the atmosphere. These life forms are usually abundant in lakes that have high rates of biological productivity, making the control of

nitrogen in such lakes extremely difficult. Certain forms of acid rain can also contribute nitrogen to lakes. While there are several special sources of nitrogen, the only unusual source of phosphorus is from detergents. When phosphorus is the limiting nutrient in a lake that is experiencing an algal problem, it is especially important to limit the nearby use of phosphate in detergents. Not only is nitrogen capable of contributing to eutrophication problems, but when found in drinking water a particular form of it can pose a serious public health threat. Nitrogen in water is commonly found in the form of nitrate (NO_3), which is itself not particularly dangerous. However, certain bacteria commonly found in the intestinal tract of infants can convert nitrates to highly toxic nitrites (NO_2). Nitrites have a greater affinity for hemoglobin in the bloodstream than does oxygen, and when they replace that needed oxygen a condition known as methemoglobinemia results. The resulting oxygen starvation causes a bluish discoloration of the infant; hence, it is commonly referred to as the "blue baby" syndrome. In extreme cases the victim may die from suffocation.

Salts

Water naturally accumulates a variety of dissolved solids, or salts, as it passes through soils and rocks on its way to the sea. These salts typically include such cations as sodium, calcium, magnesium, and potassium, and anions such as chloride, sulfate, and bicarbonate. Commonly used measure of salinity is the concentration of total dissolved solids (TDS). As a rough approximation, fresh water can be considered to be water with less than 1500 mg/L TDS; brackish waters may have TDS values up to 5000 mg/L; and, saline waters are those with concentrations above 5000 mg/L. Seawater contains 30 000 – 34 000 mg/L TDS.

The concentration of dissolved solids is an important indicator of the usefulness of water for various applications. Drinking water, for example, has a recommended maximum contaminant level for TDS of 500 mg/L. Livestock can tolerate higher concentrations. Of greater importance, however, is the salt tolerance of crops. As the concentration of salts in irrigation water increases above 500mg/L, the need for careful water management to maintain crop yields becomes increasingly important. With sufficient drainage to keep salts from accumulating in the soil, up to 1500 mg/L TDS can be tolerated by most crops with little loss of yield but at concentrations above 2100 mg/L, water is generally unsuitable for irrigation except for the most salt tolerant of crops.

Thermal Pollution

A large steam-electric power plant requires an enormous amount of cooling water. A typical nuclear plant, for example, warms about $40 m^3/s$ of cooling water by $10^0 C$ as it passes through the plant's condenser. If that heat is released into a local river or lake, the resulting rise in temperature can dramatically affect life in the vicinity of the thermal plume. As water temperature increases, two factors combine to make it more difficult for aquatic life to get sufficient oxygen to meet its needs. The first results from the fact that metabolic rates tend to increase with temperature, generally by about a factor of 2 for each $10^0 C$ rise in temperature. This causes an increase in the amount of oxygen required by organisms. At the same time, the available supplies of dissolved oxygen are reduced both because waste assimilation is quicker, drawing down DO at a faster rate, and because the amount of DO that the water can hold decreases with temperature.

Thus, as temperatures increases, the demand for oxygen goes up while the amount of DO available goes down.

Heavy Metals

In chemical terms heavy metal refer to metals with specific gravity greater than about 4 or 5, but more often, the term is simply used to denote metals that are toxic. The list of toxic metals includes aluminum, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, strontium, thallium, tin, titanium, and zinc. Some of these metals, such as chromium and iron, are essential nutrients in our diets, but in higher doses are extremely toxic. The most important route for the elimination of metals is via the kidneys. In fact, kidney can be considered to be complex filters whose primary purpose is to eliminate toxic substances from the body. The kidneys contain millions of excretory units called nephrons, and chemicals that are toxic to the kidneys are called nephrotoxins. Cadmium, lead, and mercury are examples of nephrotoxic metals. Metals have a range of adverse impacts on the body, including nervous system and kidney damage, creation of mutations, and induction of tumors.

Pesticides

The term pesticide is used to cover a range of chemicals that kill organisms that humans consider undesirable and includes the more specific categories of insecticides, herbicides, rodenticides, and fungicides. There are three main groups of synthetic organic insecticides: *organochlorines* (also known as *chlorinated hydrocarbons), organophosphates*, and *carbamates*. In addition, a number of herbicides, including the chlorophenoxy compounds 2,4,5-T (which contains the impurity dioxin, which is one of the most potent toxins known) and 2,4-D are common water pollutants.

The most well-known organ chlorine pesticide is DDT (dichlorodiphenyltrichloroethane) which has been widely used to control insects that carry diseases such as malaria, typhus, and plague. By contributing to the control of these diseases, DDT is credited with saving literally millions of lives worldwide. In spite of its more recent reputation as a dangerous pesticide, in terms of human toxicity DDT is considered to be relatively safe. It was its impact on food chains, rather than human toxicity that led to its ban. Organo chlorine pesticides, such as DDT, have two properties that cause them to be particularly disruptive to food chains. They are very *persistent,* which means they last a long time in the environment before being broken down into other substances, and they are quite *soluble* in lipids, which means they easily accumulate in fatty tissue. This phenomenon in which the concentration of a chemical increases at higher levels in the food chain is known as *biomagnification* or *bioconcentration.*

Other widely used organochlorines included methoxychlor, chlordane, heptachlor, aldrin, dieldrin, endrin, endosulfan, and kepone. Animal studies have shown dieldrin, heptachlor, and chlordane produce liver cancers, and aldrin, dieldrin, and endrin have been shown to cause birth defects in mice and hamsters. Given the ecosystem disruption, the toxicity, and the biological resistance to these pesticides that many insect species have developed, organochlorines have largely been replaced with organophosphates and carbamates.

The organophosphates, such as parathion, malathion, diazinon, TEPP (tetraethyl pyrophosphate), and dimethoate, are effective against a wide range of insects and they are not persistent. However, they are much more toxic than the organochlorines that they have replaced. They are rapidly absorbed through the skin, lungs, and gastrointestinal tract and

hence, unless proper precautions are taken, they are very hazardous to those who use them. Humans exposed to excessive amounts have shown a range of symptoms including tremor, confusion, slurred speech, muscle twitching, and convulsions. Popular carbamate pesticides include propoxur, carbaryl, and aldicarb. Acute human exposure to carbamates has led to a range of symptoms, such as nausea, vomiting, blurred vision, and in extreme cases, convulsions.

Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are among the most commonly found contaminants in groundwater. They are often used as solvents in industrial processes and a number of them are known or suspected carcinogens or mutagens. Their volatility means they are not often found in concentrations above a few micrograms per liter in surface waters, but in groundwater their concentrations can be hundreds or thousands of times higher. Their volatility also suggests the most common method of treatment, which is to aerate the water to encourage them to vaporize. *Vinyl chloride* (chloroethylene), *Tetrachloroethylene* (TCE), *Trichloroethylene 1,2-Dichloroethane, Carbon tetrachloride* are some of important VOCs found in groundwater.

Effects of Water Pollution

1. **Physicochemical effects**

A large number of pollutants can impart colour, tastes and odours to the receiving waters, thus making them unaesthetic and even unfit for domestic consumption. The changes in oxygen, temperature and pH affect the chemistry of waters often triggers chemical reactions resulting in the formation of unwanted products. The addition of organic matter results in depletion of oxygen with concomitant increase in carbon dioxide owing to bacterial degradation.

2. **Biological effects**

The addition of pollutants leads to the shift in flora and fauna due to homeostatic factors operating in the aquatic systems. Most of the freshwater algae are highly sensitive to pollutants and their elimination modifies the prey-predatory relationships by breaking down the food chains. This results in the change of the whole plant and animal communities. The diversity of organism decrease due to the presence of only a few tolerant forms in the polluted conditions.

The first response to the added nutrients is increased algal growth which is often composed of obnoxious bloom forming blue-green or green chlorophycean algal forms. Many of the blue-greens are not consumed by predators and some even produce toxic secretions causing allelopathic effects (e.g., *Microcystis* spp.)

3. **Toxic effects**

These are caused by pollutants such as heavy metals, biocides, cyanide and other organic and inorganic compounds which are detrimental to the other organisms. These substances usually have very low permissible limits in water and their presence beyond limits can render the water unfit for aquatic biota and even for human use

These chemicals are toxic to aquatic organisms, and many of them especially those non-biodegradable, accumulate in the body of the organisms and biomagnify along the tropic levels causing long term effects.

4. **Pathogenic effects**

Besides the chemical substances, a few wastes like sewage, also contain several pathogenic and nonpathogenic microorganism and viruses. The *Clostridium perfringens* and *Streptococcus faecalis* cause various types of food poisoning. Apart from this, many water borne diseases

like cholera, typhoid, paratyphoid, colitis, and infective hepatitis (jaundice) are spread by consumption of sewage contaminated waters.

5. Eutrophication

One of the most severe and commonest water pollution problems is due to enrichment of waters by plant nutrients that increases the biological growth and renders the water bodies unfit for diverse uses. The process of increase in the nutrients of waters and resultant spurt in algal productivity is called ***eutrophication*.**

The term eutrophication has been derived from a Greek word **eutrophos** meaning corpulent or rich. The first use of this term in ecology was made in connection with the remnants of the extinct lakes rather than with live lakes. Weber (1907), while studying the evolution of North German peat bogs, found that the upper layers have more nutrients in comparison to the lower ones as the original lakes received much higher nutrient supply prior to their transformation into bogs. He used the terms **eutrophic** (rich in nutrients) and **oligotrophic** (poor in nutrients) to distinguish between these two layers. The use of these terms in limnology was made for the first time by Naumann (1919), in order to denote nutrient poor (oligotrophic) and nutrient rich (eutrophic) conditions in relation to the development of different algal associations.

The Process of Eutrophication

The eutrophication is basically a natural phenomenon which gets accelerated by increased nutrient supply through human activities. The process of eutrophication starts as soon as the lakes are formed because of the entry of nutrients by natural means, but the rate of eutrophication remains quite low under natural conditions. The process of eutrophication can be discussed under two heads of natural and accelerated processes, though its basic features remain essentially the same.

1. Natural eutrophication

The lakes generally originate as oligotrophic and have only limited quantities of nutrients depending upon the mode of their formation and composition of original sediments. These nutrients are insufficient to produce any significant algal growth. At this stage the lakes have only autochthonous nutrients (indigenous nutrients cycling therein), which usually recycle completely in the absence of any outside supply. All the biological production is completely decomposed after death. As the **allochthonous** nutrients (nutrients from outside) start entering the lake, the process of eutrophication sets in. The principal natural sources of nutrients are the natural run-off, fall of leaves and twigs from the surrounding vegetation, periodical submergence of the nearby terrestrial vegetation, rain fall and bird droppings etc.

The build-up of nutrients through this slow mode of entry gradually starts increasing the growth of algae. When the algae die and decompose, the locked nutrients are again made available to the fresh algal growth. The tropical or hot climate usually supports a higher rate of eutrophication as it favours higher nutrients utilization and algal growth in comparison to cold and temperate climates.

2. Accelerated Eutrophication

The process of eutrophication is greatly augmented by the increased supply of nutrients through various human activities such as discharge of domestic sewage, industrial wasters, agricultural and urban run-off. Increased levels of air pollution also make the water bodies rich in nutrients through their transport with rains or by dry fallout. This increased supply of nutrients triggers the algal growth at much faster rate, thus increasing the speed of

eutrophication, which otherwise would have been a slow natural phenomenon. The process of eutrophication is, therefore, sometimes referred to as ***ageing of lakes***.

Sources of nutrients

Water bodies may be enriched with nutrients through both natural and man made sources, nevertheless, their quantities may greatly differ from source to source. The man-made sources are much more significant contributors of nutrients than the natural sources.

a) Rainfall and Atmospheric Deposition

Rain water may contain varying amounts of nutrients depending upon the local atmospheric pollution. Experimental data indicate that rain water, on an average, contains 0.16 to 1.06 mg L^{-1} of nitrate nitrogen, 0.04 to 1.7 mg L^{-1} of ammonia nitrogen and from traces to 0.1 mg L^{-1} of phosphorus.

b) Urban and Rural Run-Off

The run-off water adds significant quantities of nutrients and organic matter from the soil and other surfaces. Urban run-off contains storm water drainage with organic and inorganic debris from various surfaces both paved and grassed, and fertilizers from gardens and lawns. Rural run-off originates from sparsely populated areas with little or no land devoted to agriculture.

c) Agricultural Run-off

The enrichment material in the agricultural run-off is derived from fertilizer applied to the crops, and from farm animal houses. Nitrogen used as fertilizers may get converted into nitric acid in soil, solubilizing calcium, potassium and other ions which become highly liable to leaching.

d) Domestic Sewage

Sewage is the commonest source of nutrients and organic matter, and undoubtedly the greatest contributor to the eutrophication of lakes. Large quantities of nitrogen and phosphorus are excreted by humans and animals which get their way into sewage. According to an estimate, an average of 2 g of PO4-P per day is released through urine and faces by an average person, Phosphatic detergents in sewage are also important contributor of phosphorus.

e) Industrial Wastes

The nutrients in industrial effluents are variable in quality and quantity depending upon the processes and type of industry. The wastes from certain industries, particularly fertilizers, chemicals and food, are rich in nitrogen and phosphorus.

f) Water Fowl

The droppings of water fowl is a source of nutrients which may cause the local problems of eutrophication, especially in small bodies of water. The overall effect of this source on the whole water body may be negligible. It is estimated that wild ducks contribute 5.8 kg of nitrogen/acre/year and 2.55 kg of total phosphorus/acre/year to the lakes.

g) Ground Water

Ground water in some cases may act as a source of nitrogen to the surface waters. It is, however, not a recognized source at all places, but may be an important factor in certain areas. It has been estimated that about 42% of nitrogen in Wisconsin surface waters comes from ground water.

Effects Of Eutrophication

a. Physico – chemical Effects

Pollution can be considered as a departure from the balance between photosynthesis and respiration. At equilibrium (P = R), the chemical and biological composition of water remains unchanged, a stage that mostly occurs only in non-polluted waters with no external supply

of nutrients. An eutrophic water body is one where photosynthesis exceeds the respiration activity. It is characterized by a progressive accumulation of algae which ultimately leads to an organic overloading. When respiration exceeds photosynthesis, dissolved oxygen gets rapidly exhausted forcing reduction of several oxidized chemical species like NO_3, SO_4^{-2} and CO_2 into N_2, NH_4^{+}, H_2S and CH_4 which are harmful to several aquatic species and produce typical odours.

b. Biological Effects

Many desirable species including fish are replaced by undesirable ones. There is an algal succession resulting in the dominance of blue green algae which have very low nutrition value in the food chains, and many of them produce the blooms. Some important bloom forming blue green algal genera include *Microcystis, Anabaena, Oscillatoria and Aphanizomenon.* Filamentous green algae, such as *Spirogyra, Cladophora, and Zygnema* form a dense floating mat or "blanket" on the surface when the density of the bloom becomes sufficient to reduce the intensity of solar light below the surface.

Nutrient enrichment has very limited direct effect on zooplankton communities, but indirect effect may be significant. The diversity of zooplankton remains high if the diversity of phytoplankton is also high as often found in case of oligotrophic or moderately enriched waters. As the changes occur in the water due to eutrophication, the characteristics of sediments also change. There is an accumulation of organic matter which affect the benthic communities. Eutrophication of moderate level may be beneficial to fish production as it increases the food supply for fish in the form of algae. With the increase in the level of eutrophication, dominance of algal groups is taken over by blue greens making the edible or game fish to be replaced by hardy species of very little economic value. The algal blooms cause discolouration of water and attract water fowl which further contribute to the pollution of water. The overall effects make the waters much less suitable for recreation, fish production and domestic uses. The cost of water treatment is also escalated.

Control of Eutrophication

The first step in any control programme should be a regular monitoring of certain parameters *(e.g.,* nutrients, algal species, productivity, *etc.)* in the water body to evaluate the level of eutrophication and its trends. The next step would be to prepare an inventory of inflows, especially to know the sourcewise contribution of nutrients. The reduction of nutrient supply to a water body can be brought about by a number of methods involving either prevention of the entry of nutrients or by some *in situ* water treatment procedures to curtail the nutrient availability to algae.

a. Diversion of Nutrients from a Lake

The diversion of nutrient-bearing flows away from lakes can keep them free from nutrients. This can be achieved when the nutrients enter the lake mainly through point sources such as domestic sewage and industrial wastes. The wastes can be diverted directly to somewhere else like in downstream, estuary or oceans which have comparatively greater self-purification capacities than stagnant waters.

b. Removal of Nutrients from Waste Waters

Any degree of treatment to remove the nutrients and organic matter can be given to wastes depending upon the process selected. Secondary treatment usually removes only organic

matter- and is not effective in controlling eutrophication. Though tertiary treatment methods are fairly well known to remove practically all nutrients, interest often lies in the removal of only phosphorus for control of eutrophication.

c. Flushing Out of Polluted Water by Nutrient Poor Water

The technique is useful for relatively small and highly polluted waters where the existing water can be removed to a convenient place and a supply of high quality water is readily available. Two approaches are usually followed for this; in one, the incoming water shall displace an equivalent amount of polluted water and in the other, a quantity of polluted water is removed first to be replaced later by the water of low nutrient content.

d. Removal of Locked-up Nutrients

Nutrients in aquatic ecosystems are locked-up in the tissues of fish, other animals, vegetation (macrophytes) and, of course, in the algae besides being in the water and sediments. Periodical removal of macrophytes and fish, especially when the water level is low, would help in removing a quantity of nutrients from water. The further entry of the nutrients should be checked, since their build up in water can start again after recovery.

e. Dredging of Sediments

A large proportion of nutrients can also be removed by dredging the sediments out of the lake. Dredging may be feasible where simultaneous deepening of the lake is also desired.

f. Covering of Sediments

The nutrients and organic matter present in upper sediments of a lake, under proper conditions, can be re solubilized by microbial action or by change in chemical conditions. The retardation of release of these nutrients shall check the internal fertilization. This can be performed by covering the sediments with some suitable material such as rubber or polythene sheets or some other inert material like clay or fly–ash.

g. Oxygenation and Mixing

Mixing of water column de stratifies the lakes and eliminates the anaerobic reducing conditions in hypolimnetic waters, promoting the development of uniform profiles of dissolved oxygen, temperature, phosphorus and other such parameter. The release of nutrients from the sediments is about10 times more in anaerobic conditions than that in aerobic conditions. Oxygenation by way of mixing eliminates anaerobic conditions and lowers the nutrient release from sediments. A proper mixing and aeration in water column can be carried out by using compressed air pump.

h. Nutrient Inactivation

The technique involves eliminating the nutrients from their natural cycles in the water bodies by various chemical means, in order to make them unavailable for the growth of algae. Phosphorus is the most important nutrient controlled in this manner. The use of calcium hydroxide or aluminium sulphate coprecipitates phosphorus with them which settles at the bottom.

i. Zoning and Watershed Management

Many of the water pollution problems arise due to lack of proper management of watershed areas leading to excessive erosion and entrainment of nutrients and organic matter in run-off. The land use pattern in the watershed or catchment's area will determine the nature of drainage. A check on deforestation and erosion will help reducing the nutrient

load of the water resources. Selection of suitable sites for industries, agriculture, urban development and so on will also help in controlling the water quality.

j. Biological Magnification

When a living organism cannot metabolize or excrete ingested substance that substance gradually accumulates in the organisms. This phenomenon, called biological accumulation (or bioaccumulation), refers to the process by which a substance first enters in to a food chain. The extent to which bioaccumulation will occur depends on an organism's metabolism and on the solubility of the substance first enters a food chain. If the substance is soluble in fat, it will typically accumulate in the fatty tissues of the organism. Bioaccumulation is of particular concern when the substance being concentrated is a toxic environmental pollutant and the organism is of a relatively low trophic level in a food chain.

When many contaminated organisms are consumed by second organism that can neither metabolize nor excrete the substance, the concentration of the substance will build to even higher levels in the second organism. This effect is magnified at each successive trophic level, and the process is called **biological magnification** (or biomagnification). In other words, biomagnification is the increasing concentration of a substance as it moves from one level of a food chain to the next (for example, from plankton to fish to birds or to humans). Biomagnification is of particular importance when chemicals are concentrated to harmful levels in organisms higher up in the food chain. Even very low concentrations of environmental pollutants can eventually find their way into organisms in high enough doses to cause serious problems.

Biomagnification occurs only when the pollutants are environmentally persistent (last a long time before breaking down into simpler compounds), mobile, and soluble in fats.

Biomagnification can't occur if they are not persistent, they will not last long enough in the environment to be concentrated in the food chain. (persistent substances are generally not biodegradable).

- If they are not mobile, that is, not easily transported or moved from place to place in the environment, they are not likely to be consumed by many organisms.
- if they are soluble in water rather than fatty tissue, they are much more likely to be excreted by the organism before building up to dangerous levels.

Impact of DDT

The incidence of mercury poisoning in people who consumed contaminated fish in the Minamata Bay region of Japan in 1950s is just one example of the detrimental effects of biomagnification. Another classic example involves DDT, an abbreviation for the organic chemical dichlorodiphenyltrichloroethane. It is a type of chemical known as chlorinated hydrocarbon, and it takes a long time to break down in the environment. With a "half-life" of 15 years, if 10 kg of DDT were released into the environment in the year 2000, 5 kg would still persist in the year 2015, about 2.5 kg would remain in 2030, and even after 100 years had elapsed, in the year 2100, more than 100 g of the substance would still be detected in the environment. Of course, long before that time span elapsed, some of the DDT could be inadvertently consumed by living organisms as they forage for food, and thereby enter a food chain.

DDT is toxic to insects, but not very toxic to humans. It was much used in World War II to protect U.S. troops from tropical mosquito – borne malaria as well as to prevent the spread of lice and lice-borne disease among civilian populations in Europe. After the war, DDT was used to protect food crops from insects as well as to protect people from insect-borne disease. As one of the first

of the modern pesticides, it was overused, and by the 1960s, the problems related to biomagnificantion of DDT became very apparent.

Many other substances in addition to mercury and DDT exhibit bioaccumulation and biomagnification in an ecosystem. These include copper, cadmium, lead, and other heavy metals, pesticides other than DDT, and cyanide, selenium and PCBs.

Control of Water pollution

Raw or untreated sewage comprises about 99.9 per cent water and only about 0.1 per cent impurities. In contrast to this, sea water is only about 96.5 per cent pure water; it contains about 35,000 mg/L, or 3.5 per cent dissolved impurities. Although sea water contains more impurities than does sanitary sewage, we do not ordinarily consider seawater to be polluted. The important distinction is not the total concentration, but the type of impurities. The impurities in seawater are mostly inorganic salts, but sewage contains biodegradable organic material, and it is very likely to contain pathogenic microorganisms as well.

Actually, sewage contain so many different substances, both suspended and dissolved, that it is impractical to attempt to identify each specific substance or microorganisms. The total amount of organic materials is related to the strength of the sewage. This is measured by the biochemical oxygen demand, or BOD. Another important measure or parameter related to the strength of the sewage is the total amount of suspended solids, or TSS. On the average, untreated domestic sanitary sewage has a BOD of about 200 mg/L and a TSS of about 240 mg/L. Industrial wastewater may have BOD and TSS values much higher than those for sanitary sewage; its composition is source dependent.

Another group of impurities that is typically of major significance in waste water is the plant nutrients. Specifically, these are compounds of nitrogen and phosphorous. On the average, raw sanitary sewage contains about 35 mg/ L of N and 10 mg / L of P. Finally, the amount of pathogens in the waste water is expected to be proportional to the concentration of fecal coli form bacteria. The coli form concentration in raw sanitary sewage is roughly 1 billion per liter. Coli form concentration, as well as BOD, TSS, and concentrations of N and P, are parameters of water quality.

Before discharging wastewater back into the environment and the natural hydrologic cycle, it is necessary to provide some degree of treatment in order to protect public health and environmental quality. The basic purposes of sewage treatment are to destroy pathogenic microorganisms and to remove most suspended and dissolved biodegradable organic materials. Sometimes it is also necessary to remove the plant nutrients – nitrogen and phosphorous. Disinfection, usually with chlorine, serves to destroy most pathogens and helps to prevent the transmission of communicable disease. The removal of organics (BOD) and nutrients helps to protect the quality of aquatic eco-systems.

Waste water treatment

These treatment methods are grouped into three general categories: **primary** treatment, **secondary or biological** treatment and **tertiary or advanced** treatment.

Primary Treatment

Untreated or raw wastewater usually flows by gravity from an interceptor or trunk sewer into the head works of a treatment facility; sometimes wastewater may be pumped to the treatment plant in a force. The head works of a treatment plant include a flow measurement device and mechanical systems that provide preliminary treatment. Preliminary treatment systems typically include screens, comminutors, and grit chambers.

The first treatment process for raw wastewater is coarse screening. Bar screens (or racks), as they are called, are made of long, narrow metal bars spaced about 25 mm (1 in.) apart. They retain floating debris, such as wood rags, or other bulky objects, that could clog pipes or damage mechanical equipment in the rest of the plant.

In some treatment plants, a mechanical cutting or shredding device, called a comminutor, is installed just after the coarse screens. The comminutor shreds and chops solids or rags that passed through the bar screen. The shredded material is removed from the waste water by sedimentation or flotation later in the treatment plant.

Grit removal

A portion of the suspended solids in raw sewage consists of gritty material, such as sand, coffee grounds, eggshells, and other relatively inert material. In cities with combined sewer systems, sand and silt may be carried in the sewage. Suspended grit can cause excessive wear and tear on pumps and other equipment in the plant. Most of it is non biodegradable and will accumulate in treatment tanks. For these reasons, a grit removal process is usually used after screening and / or comminuting.

Primary sedimentation (Settling)

After preliminary treatment by screening, comminuting, and grit removal, the wastewater still contains suspended organic solids that can be removed by plain sedimentation. Settling tanks that receive sewage after grit removal are called primary clarifiers. The combination of preliminary screening and gravity settling is called primary treatment. Chemicals may sometimes be added to the primary clarifiers to promote the removal of very small (or colloidal) particles. Primary treatment usually can remove up to 60 per cent of the suspended solids and about 35 per cent of the BOD from wastewater, but this relatively low level of treatment is no longer adequate. In almost all cases, primary treatment must be followed by secondary treatment processes; tertiary treatment may also be required to protect sensitive bodies of water that receive the treated effluent.

Secondary (Biological) Treatment

Primary treatment processes remove only those pollutants that will either float or settle out by gravity, but about half of the raw pollutant load still remains in the primary effluent. The purpose of secondary treatment is to remove the suspended solids that did not settle out in the primary tanks and the dissolved BOD that is unaffected by physical treatment. Secondary treatment is generally considered to meet 85 per cent BOD and TSS removal efficiency and represents the minimum degree of treatment required in most cases.

Biological treatment of sewage involves the use of microorganisms. The microbes, including bacteria and protozoa, consume the organic pollutants as food. They metabolize the biodegradable organics, converting them into carbon dioxide, water and energy for their growth and reproduction. A biological sewage treatment system must provide the microorganisms with a comfortable home. In effect, the treatment plant allows the microbes to stabilize the organic pollutants in a controlled, artificial environment of steel and concrete, rather than in a stream or lake. This helps to protect the dissolved oxygen balance of the natural aquatic environment.

To keep the microbes happy and productive in their task of wastewater treatment, they must be provided with enough oxygen, adequate contact with the organic material in the sewage, suitable temperatures, and other favourable conditions. The design and operation of a secondary treatment plant is accomplished with these factors in mind.

Two of the most common biological treatment systems are the **trickling filter** and the **activated sludge** process. The trickling filter is a type of fixed growth system. The microbes remain fixed or attached to a surface while the wastewater flows over that surface to provide contact with the organics. Activated sludge is characterized as a suspended – growth system, because the microbes are thoroughly mixed and suspended in the waste water rather than attached to a particular surface.

Aerobic waste water treatment method

Trickling filters

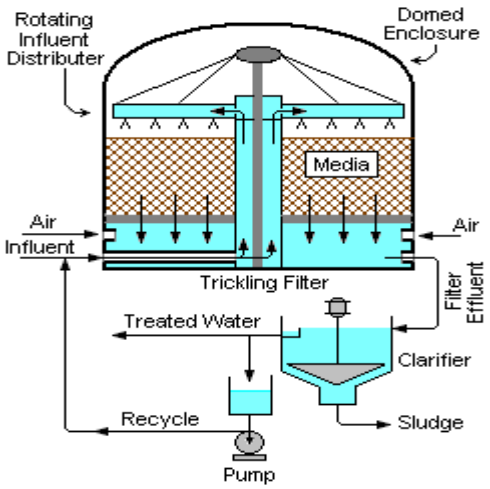
A trickling filter consists basically of a layer or bed of crushed rock about 2m (6ft) deep. It is usually circular in shape and may be built as large as 60 m (200 ft) in diameter. Trickling filters are always preceded by primary treatment to remove coarse and settleable solids. The primary effluent is sprayed over the surface of the crushed stone bed and trickles downward through the bed to an under drain system.

A rotary distributor arm with nozzles located along its length is usually used to spray the sewage, although sometimes fixed nozzles are used. The rotary distributor arm is mounted on a center column in the trickling filter; it is driven around by the reaction force or jet action of the waste water that flows through the nozzles.

The under drain system serves to collect and carry away the wastewater from the bottom of the bed and to permit air circulation upward through the stones. As long as topography permits, the sewage flows from the primary tank to the trickling filter by the force of gravity, rather than by pumping. As the primary effluent trickles downward through the bed of stones, a biological slime of microbes develops on the surfaces of the rocks. The continuing flow of the wastewater over these fixed biological growths provides the needed contact between the microbes and the organics. The microbes in the thin slime layer absorb the dissolved organics, thus removing oxygen – demanding substances from the waste – water. Air circulating through the void spaces in the bed of stones provides the needed oxygen for stabilization of the organics by the microbes.

The stones are usually about 75 mm (3 in.) in size, much too large to filter out suspended solids. The stones in a trickling filter only serve to provide a large amount of surface area for the biological growths, and the large voids allow ample air circulation. The trickling filter effluent is collected in the under drain system and then conveyed to a sedimentation tank called a **secondary clarifier**. The secondary clarifier, or final clarifier as it is sometimes called, is similar in most respects to the primary clarifier, although there are differences in detention time, over flow rate, and other details.

To maintain a relatively uniform flow rate thorough the trickling filter and to keep the distributor arm rotating even during periods of low sewage flow, some of the waste water may be recirculated. In other words, a portion of the effluent is pumped back to the trickling filter inlet so that it will pass through the bed of stones more than once. Recirculation can also serve to improve the pollutant removal efficiency; it allows the microbes to remove organics that flowed by them during the previous pass through the bed.



Activated sludge treatment

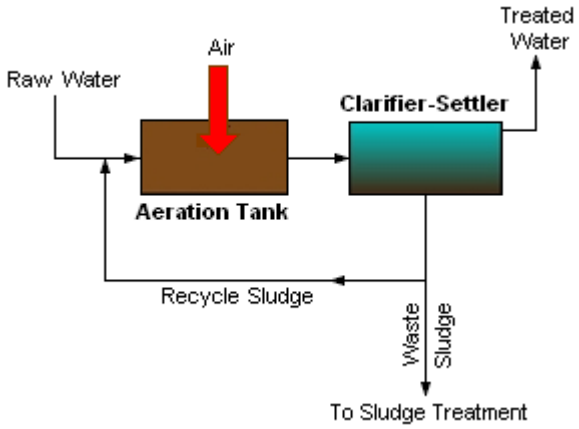
The basic components of an activated sludge sewage treatment system include an aeration tank a secondary settling basin or clarifier. Primary effluent is mixed with settled solids that are recycled from the secondary clarifier and then introduced into the aeration tank. Compressed air is injected continuously into the mixture through porous diffusers located at the bottom of the tank along one side.

In the aeration tank, microorganisms consume the dissolved organic pollutants as food. The microbes absorb and aerobically decompose the organics, using oxygen provided in the compressed air; water, carbon dioxide and other stable compounds are formed. In addition to providing oxygen, the compressed air thoroughly mixes the microbes and wastewater together as it rapidly bubbles up to the surface from the diffusers. Sometimes mechanical propeller like mixers, located at the liquid surface, are used instead of compressed air and diffusers. The churning action of the propeller blades mixes air with the wastewater and keeps the contents of the tank in a uniform suspension.

The aerobic microorganisms in the tank grow and multiply, forming an active suspension of biological solids called **activated sludge**. The combination of the activated sludge and waste water in the aeration tank is called the mixed liquor. In the basic or conventional activated sludge treatment system, a tank detention time of about 6h is required for thorough stabilization of most of the organics in the mixed liquor.

After about 6h of aeration, the mixed liquor flows to the secondary or final clarifier, in which the activated sludge solids settle out by gravity. The clarified water near the surface, called the supernatant, is discharged over an effluent weir; the settled sludge is pumped out from a sludge hopper at the bottom of the tank. Recycling a portion of the sludge back to the inlet of the aeration tank is an essential characteristic of this treatment process. The settled sludge is in an active state. In other words, the microbes are well acclimated to the wastewater and, given the opportunity, will readily absorb and decompose more organics by their metabolism.

By pumping about 30 per cent of the wastewater flow from the bottom of the clarifier back to the head of the aeration tank, the activated sludge process can be maintained continuously. When mixed with the primary effluent, the hungry microbes quickly begin to absorb and metabolize the fresh food in the form of BOD causing organics. Since the microbes multiply and increase greatly in numbers, it is not possible to recycle or return all the sludge to the aeration tank. The excess sludge, called waste activated sludge, must eventually be treated and disposed of (along with sludge from the primary tanks).



Tertiary (Advanced) Treatment

Secondary treatment can remove between 85 and 95 per cent of the BOD and TSS in raw sanitary sewage. Generally, this leaves 30 mg / L or less of BOD and TSS in the secondary effluent. But sometimes this level of sewage treatment is not sufficient to protect the aquatic environment.

Another limitation of secondary treatment is that it does not significantly reduce the effluent concentrations of nitrogen and phosphorous in the sewage. Nitrogen and phosphorous are important plant nutrients. If they are discharged into a lake, algal blooms and accelerated lake aging or cultural eutrophication may be the result. Also, the nitrogen in the sewage effluent may be present mostly in the form of ammonia compounds. These compounds are toxic to fish if the concentrations are high enough. Yet another problem with the ammonia is that it exerts a nitrogenous oxygen demand in the receiving water as it is converted to nitrates. This process is called nitrification.

When pollutant removal greater than that provided by secondary treatment is required, either to further reduce the BOD or TSS concentrations in the effluent or to remove plant nutrients, additional or advanced treatment steps are required. This is also called **tertiary treatment**, because many of the additional processes follow the primary and secondary processes in sequence.

Tertiary treatment of sewage can remove more than 99 per cent of the pollutants from raw sewage and can produce an effluent of almost drinking water quality.

Effluent polishing

The removal of additional BOD and TSS from secondary effluents is sometimes referred to as effluent polishing. It is most often accomplished using a granular media filter much like the filters used to purify drinking water. Since the suspended solids consist mostly of organic compounds, filtration removes BOD as well as TSS.

Phosphorus Removal

When stream or effluent standards require lower phosphorous concentrations, a tertiary treatment process must be added to the treatment plant. This usually involves chemical precipitation of the phosphate ions and coagulation. The organic phosphorous compounds are entrapped in the coagulant flocs that are formed and settle out in a clarifier.

One chemical frequently used in this process is aluminium sulfate (Al_2SO_4). This is called **alum**, the same coagulant chemical used to purify drinking water. The aluminium ions in the alum react with the phosphate ions in the sewage to form the insoluble precipitate called aluminium phosphate. Other coagulant chemicals that may be used to precipitate the phosphorous include ferric chloride ($FeCl_3$), and lime(CaO).

Nitrogen Removal

One of the methods used to remove nitrogen is called biological nitrification – denitrification. It consists of two basic steps. First, the secondary effluent is introduced into another aeration tank, trickling filter, or biodisc. Since most of the carbonaceous BOD has already been removed, the microorganisms that will now thrive in this tertiary step are the nitrifying bacteria, *Nitrosomonas* and *Nitrobacter*. In this first step, called **nitrification**, the ammonia nitrogen is converted to nitrate nitrogen, producing a nitrified effluent. At this point, the nitrogen has not actually been removed but only converted to a form that is not toxic to fish and that does not cause an additional oxygen demand.

A second biological treatment step is necessary to actually remove the nitrogen from the wastewater. This is called **de nitrification**. It is anaerobic process in which the organic chemical methanol is added to the nitrified effluent to serve as a source of carbon. The denitrifying bacteria *Pseudomonas* and other groups use the carbon from the methanol and the oxygen from the nitrates in their metabolic processes. One product of this biochemical reaction is molecular nitrogen (N_2), which escapes into the atmosphere as a gas.

Bioreactors

Certain organic hazardous wastes can be treated in slurry form in an open lagoon or in a closed vessel called a **bioreactor**. A bioreactor may have fine bubble diffusers to provide oxygen and a mixing device to keep the slurry solids in suspension.

b. Anaerobic wastewater treatment methods

The generation and disposal of large quantities of biodegradable waste without adequate treatment result in widespread environmental pollution. Some waste streams can be treated by conventional methods like aeration. Compared to the aerobic method, anaerobic digestion proves to be more advantageous in terms of efficiency of treatment as well as potential energy savings. Biomethanation is the process of conversion of organic matter in the waste (liquid or solid) to biogas and manure by microbial action in the absence of air. Methane produced by methanogenic bacteria is also another potential energy source. Methane is used for generation of mechanical, heat and electrical energy. Anaerobic decomposition of waste materials produces large amounts of methane. Many sewage treatment plants produce this fuel. Efficient generation of methane can be achieved by using algal biomass grown in pond cultures, sewage sludge, municipal refuse, plant residue and animal waste. Methanogens (Archaebacteria) are obligate anaerobes and produce CH_4 by reducing acetate and/or CO_2. **Biogas**, a mixture of different gases is produced by anaerobic microbes using domestic and agricultural wastes. Bulk (about 50 – 70%) of biogas is **methane** (CH_4) and other gases are in low proportions. These include CO_2 (25 – 35%), H_2 (1 – 5%), N_2 (2 – 7%) and O_2 (0 – 0.1%). In India a large number of **gobar gas plants** are already in operation in rural areas. Left overs of these plants are good fertilizers also. Animal waste is first hydrolyzed by hydrolytic bacteria. It is followed by acid formation by a group of acetogenic bacteria, which convert monomers into simple compounds like NH_3, CO_2 and H_2. Finally methanogens reduce acetate and/or CO_2 to CH_4. In India, cattle dung is the chief source of biogas.

Biomethanation requires adequate infrastructural facilities. The first and the foremost among them is the bioreactor in which the treatment is to be carried out, since extremely large volumes of effluents are encountered for treatment. Thus, an optimally designed bioreactor can decrease the treatment time and increase the treatment efficiency leading to an overall lowering of the treatment cost. Selection and design of bioreactors are dictated by process kinetics.

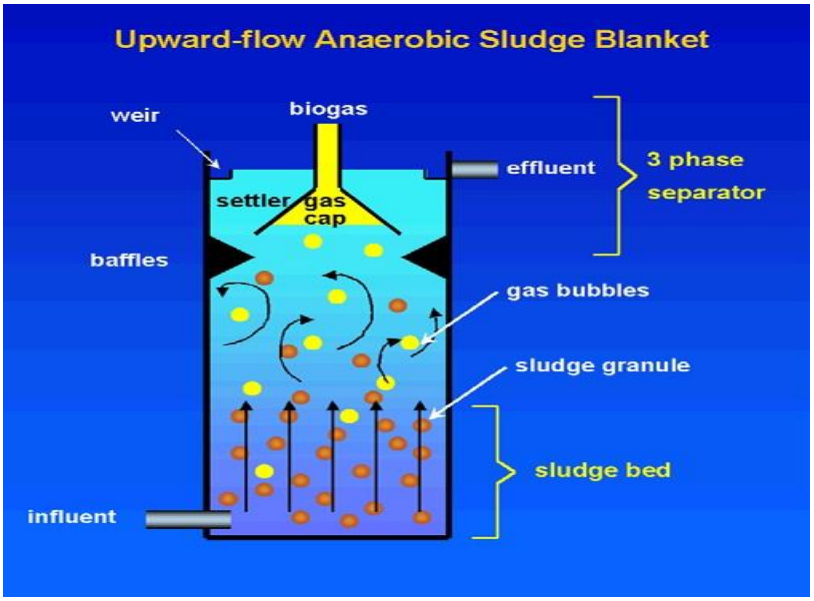
Conventional digesters such as sludge digesters and anaerobic CSTR (Continuous Stirred Tank Reactor) have been used for many decades in sewage treatment plants for stabilizing the activated sludge and sewage solids. Interest in biomethanation as an energy-saving waste treatment has led to the development of a range of anaerobic reactor designs. These high-rate digesters are also known as retained biomass reactors since they are based on the concept of retaining viable biomass by sludge immobilization.

Anaerobic reactors for liquid waste

- Upflow anaerobic sludge blanket
- Anaerobic fluidized bed
- Anaerobic filter
- Expanded granular sludge bed reactor

Upflow Anaerobic Sludge Blanket Reactor

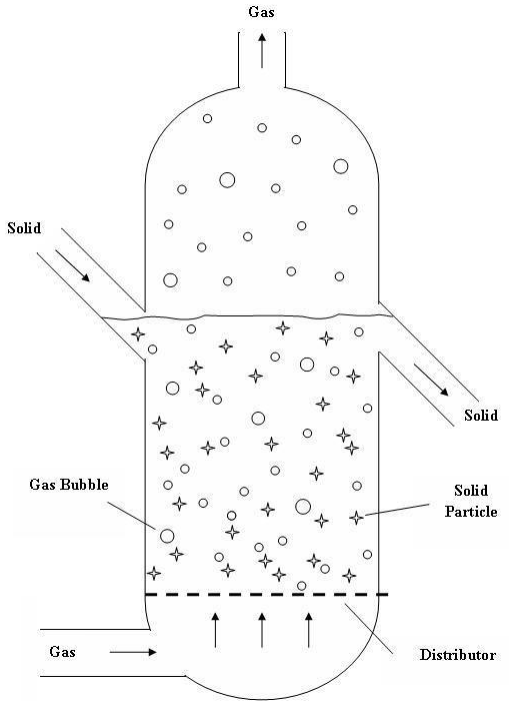
Developed at Wageningen Agricultural University, Netherlands (Lettinga, 1978), the UASB reactor employs anaerobic bacteria especially methanogens, which have a propensity to form self- immobilized granular structures with good settling properties inside the reactor. These anaerobic bacteria granules make a "blanket" through which the effluent flows up the reactor. The substrate present in the effluent diffuses into the sludge granules, where it is degraded by the anaerobic route. Thus, these reactors due to their high biomass concentrations can achieve conversions several folds higher than that possible by conventional anaerobic processes and tolerate fluctuations in influent feed, temperature and pH. Moreover, since no support medium is required for attachment of the biomass it decreases the capital cost and minimizes the possibility of plugging. The energy requirement is also small because there is no mechanical mixing within the reactor, no recirculation of sludge, and no high recirculation of effluent.



Anaerobic Fluidized Bed (AFB) Reactors

In these reactors mixed culture bacteria are made to grow as a film on the surface of some inert carrier particle. These particles are then maintained inside in a "fluidized" state using the energy of the incoming effluent stream. The linear velocity of the effluent is kept above the minimum fluidization velocity so that the film-covered particles are always in motion and the bed appears to be boiling. The substrate present in the liquid phase diffuses into the biofilm and gets converted to VFAs and ultimately to methane. These products then diffuse out through the biofilm into the bulk liquid. The mixing and mass transfer achieved in these reactors is excellent and the resulting conversions are comparable or even superior to those obtained for

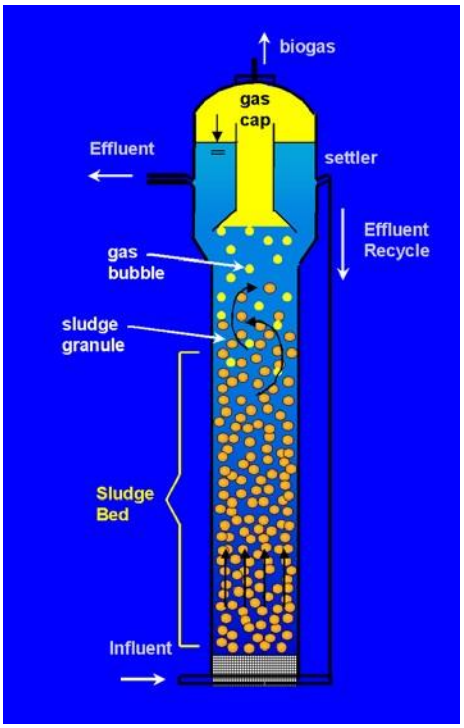
UASB reactors. These reactors have typical loading rates of 25 KgCOD/m^3 days. However, as the biofilm grows, the film- covered particles increase in size, which is accompanied by a decrease in their composite density. This causes the particle to move up in the bed ultimately resulting in its leaving the reactor, thereby leading to a reduction in the carrier particle concentration inside the reactor. This problem can be overcome by removing the biofilm from the carrier particle which has exited the reactor and then recycling the carrier particle (minus the biofilm) to the reactor. However, it is observed that the transport of solid particles as a rule creates too many operational problems let alone maintain strict anaerobic conditions within the reactor. Another drawback of AFB reactors is the high energy requirement due to the large recycle rates employed in these systems.



Many improved reactor designs for high rate biomethanation are being tried out in this context. In spite of several bottlenecks in the smooth and efficient operation of both UASB and AFB systems, there is hope that these systems have the potential to offer an extremely high rate of waste stabilization accompanied by methane production.

Expanded Granular Sludge Bed Reactor (EGSB)

- Faster rate of upward-flow velocity
- Increased flux permits partial expansion (fluidization) of the granular sludge bed, improving wastewater-sludge contact as well as enhancing segregation of small inactive suspended particle from the sludge bed
- Increased flow velocity is either accomplished by utilizing tall reactors, or by incorporating an effluent recycle (or both)
- EGSB design is appropriate for low strength soluble wastewaters (less than 1 to 2 g soluble COD/l)
- For wastewaters that contain inert or poorly biodegradable suspended particles which should not be allowed to accumulate in the sludge bed



Membrane Bio reactor (MBRs) brings a new age of biological waste water treatment. With pure oxygen the benefits of MBRs are enhanced resulting in even higher rate biological treatment systems which provide the control of COD, microorganisms and VOCs in waste water. Oxy-Dependent MBR can use high biomass concentrations, which for air-based systems cause oxygen transfer limitations. High purity oxygen resolves this, as well as the foaming and VOC issues associated with air-based systems.

Phytoremediation

Plants show several response patterns to the presence of potentially toxic concentrations of heavy metal ions. Most are sensitive even to very low concentrations, others have developed resistance and a reduced number behave as hyperaccumulators of toxic metals . This particular capacity to accumulate and tolerate large metal concentrations has opened up the possibility to use phytoextraction for remediation of polluted soils and waters Plants with metal resistance mechanisms based on exclusion can be efficient for phytostabilization technologies. Hyperaccumulator plants, in contrast, may become useful for extracting toxic elements and thus decontaminate and restore fertility in polluted areas.

1. Phytoextraction: This technique reduces metal concentrations by cultivating plants with a high capacity for metal accumulation in shoots. Plants used for this purpose should ideally combine high metal accumulation in shoots and high biomass production. Many hyperaccumulator species fulfill the first. but not the second condition. Therefore, species that accumulate lower metal concentrations but are high biomass producers may also be useful.
2. Rhizofiltration: This technique is used for cleaning contaminated surface waters or wastewaters by adsorption or precipitation of metals onto roots or absorption by roots or other submerged organs of metal-tolerant aquatic plants. For this purpose, plants must not only be metal-resistant but also have a high adsorption surface and must tolerate hypoxia.
3. Phytostabilization: Plants are used for immobilizing contaminant metals by root uptake, adsorption onto roots or precipitation in the rhizosphere. By decreasing metal mobility, these

processes prevent leaching and groundwater pollution. Bioavailability is reduced and fewer metals enter the trophic web.

4. Phytodegradation: Elimination of organic pollutants by decomposition through plant enzymes or products.
5. Rhizodegradation: Decomposition of organic pollutants by means of rhizosphere microorganisms
.6. Phytovolatilization: Organic pollutants absorbed by plants are released into the atmosphere by transpiration, either in their original form or after metabolic modification. In addition, certain metals can be absorbed and volatilized by certain organisms.

Mercury Pollution

Mercury enters water naturally as well as through industrial effluents. It is a potent hazardous substance. Both, inorganic and organic forms are highly poisonous. Methyl mercury gives off vapors. Mercury was responsible for the **Minamata** epidemic that caused several deaths, in Japan and Sweden. The tragedy had occurred due to consumption of heavily mercury-contaminated fish (27 to 102 ppm, average 50 ppm) by the villagers. Chloralkali plants seem to be the chief source of mercury containing effluents.

Effluents of industries making switches, batteries, thermometers, fluorescent light tubes and high intensity street lamps also contain mercury. From the effluents mercury compounds enter the water body and at their bottom these are metabolically converted into methyl mercury compounds by anaerobic microbes. Methyl mercury is highly persistent and thus accumulates in food chain. Methyl mercury is soluble in lipids and thus after being taken by animals it accumulates in fatty tissues. The symptoms of Minamata include malaise, numbness, visual disturbance, dysphasia, ataxia, mental deterioration, convulsions and final death. Mercury readily penetrated the central nervous system of children born in Minamata causing teratogenic effects.

Lead Pollution

Lead poisoning is common in adults. The chief source of lead to water is the effluents of lead and lead processing industries. Lead toys may be chewed by children. Painters also have a risk of lead consumption. In some plastic pipes lead is used as stabilizer. The water may become contaminated in these pipes. Lead is also used in insecticides, food, beverages, ointments and medicinal concoctions for flavouring and sweetening.

Lead pollution causes damage to liver and kidney, reduction in hemoglobin formation, mental retardation and abnormalities in fertility and pregnancy, chronic lead poisoning may cause three general disease syndromes (i) gastrointestinal disorders (ii) neuromuscular effects – weakness, fatigue muscular atrophy, and (iii) central nervous system effects or CNS syndrome – that may result to coma and death. Lead poisoning also causes constipation, abdominal pain etc.

Fluoride Pollution

Fluorine is also regularly present in water and soil besides air. In nature it is found as fluoride. The crop plants grown in high-fluoride soils in agricultural, non-industrial areas had a fluoride content as high as 300 ppm. In Haryana and Punjab, consumption of fluoride-rich water from well caused endemic fluorosis. In Andhra Pradesh also high fluoride content water caused dental fluorosis. On an average, about 20-25 million Indian are affected with fluorosis. In our country this problem has become more severe in Rajasthan.

Fluoride is not absorbed in the blood stream. It has an affinity with calcium and thus gets accumulated in bones, resulting in the mottling of teeth, pain in the bones and joint and

outward bending of legs from the knees knock knee syndrome. Fluoride levels more than 0.5 ppm over over a period of 5-10 years results in fluorosis terminating in crippling or paralysis. In water of most villages of Rajasthan fluoride level is higher than permissible limit of 1 mg/litre of water. The toxic effects are staining, mottling and abrasion of teeth, high fluoride levels in bone and urine, decreased milk production, and lameness, Animal becomes lethargic.

B. Marine Pollution

The marine water represents a different kind of habitat for microorganisms. The very vastness of the oceans and the variety of microbial life present in these make the study of these a special branch of microbiology called marine microbiology. The marine water contains algae, protozoa, yeasts, moulds, bacteria and viruses. The microorganism which are free - floating are collectively known as the plankton and may consist of algae (phytoplankton) and protozoa and minute animals (zooplankton). Bacteria and fungi may also form part of the plankton. The algae are the primary producers as they can photosynthesize while others are consumers at various levels of the food - chain. The microorganisms found at the bottom of the ocean are called the benthos or benthic microorganisms. A variety of microorganisms are found in the benthic region but the bacteria predominate.

In polluted areas of estuarine regions rich in organic nutrients, organisms such as *Beggiatoa, Thiothrix, Thiovolum* and various species of *Thiobacillu*s may be predominant. The transient bacteria may include species of *Bacillus, Corynebacterium, Sarcina,* Actinomyces and Gram - negative v*ibrio* - like organisms. A terminally bispored species of *Clostridium* which is unique to the ocean is named *Clostridium oceanicum*. Photosynthetic purple sulphur bacteria usually occur below algal mats in anaerobic environs, as most of the light and oxygen is absorbed by algae.

In polluted waters, there are large amounts of organic matter from sewage, feces and industrial complex. The microbes are usually heterotrophic. The digestion of organic matter by these organisms is incomplete, due to which there accumulate acids, bases, alcohols and various gases. The major types of bacteria are coliform bacteria, the Gram-negative nonspore forming bacilli usually found in the intestine. This group includes *E. coli* and species of *Enterobacter*. They ferment lactose to acid and gas. Noncoliform bacteria-*Streptococcus, Proteus* and *Pseudomonas* are also present.

Under some conditions, the polluting organisms multiply rapidly and consume most of the available oxygen. For instance, nutrients enter the river from sources like sewage treatment plants or urban/suburban runoff. Thus river suddenly develops a high nutrient content. Under these conditions algae may bloom rapidly. This leads to depletion of oxygen in water. There is very little oxygen available to the protozoa, small animals, fish and plants. Due to this non-availability of oxygen, a layer of dead organisms, mud and silt accumulate at the bottom and anaerobic species of *Clostridium, Desulfovibrio* etc. will flourish and they produce gases. One gas, H_2S combines with lead or iron to give a precipitate which makes the mud black and the water poisonous. Due to complete depletion of oxygen, the suspended bacteria die in their own waste products. There is hardly any life in water at this stage. The gas bubbles from the anaerobes in the mud break the surface and such processes lead to death of a river.

All that what is carried by rivers ultimately ends up in the seas. On their way, rivers receive huge amounts of sewage, garbage, agricultural discharge, biocides, including heavy metals. These all are added to sea. Besides these discharge of oils and petroleum products and dumping of radionuclides waste into sea also cause marine pollution. Huge quantity of plastic is being added

to sea and oceans. Over 50 million Ib plastic packing material is being dumped in sea of commercial fleets.

The pollutants in sea may become dispersed by turbulence and ocean currents or concentrated in the food chain. They may sediment at the bottom by processes like adsorption, precipitation and accumulation. Bioaccumulation in food chain may result into loss of species diversity.

Marine pollution

It is defined as the discharge of waste substances into the sea, posing threat to living sources, hazard to human health, hindrance to fishery and impairment of quality of sea water. Marine pollution is associated with the change in physical, chemical and biological conditions of the sea water. Nearly 71% of Earth surfaces is covered with Oceans, which comprise a total of approximately 1.37×10^{39} litres. Ocean is an ideal place to dump all the man wastes.

Marine pollutants in the sea.

- Pathogens
- Sediments
- Solid wastes
- Heat
- Freshwater
- Brine
- Toxic Inorganics
- Toxic Orgnics
- Pertoleum and oil
- Nutrients
- Radioactive materials
- Oxygen demanding materials
- Acids and Bases

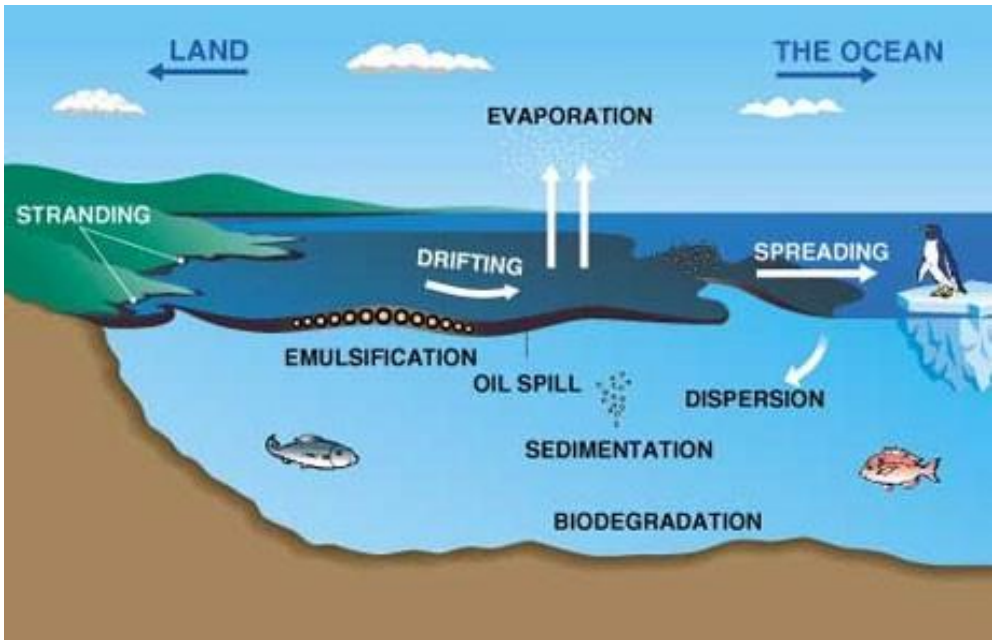
These pollutants comes from various sources. The Marine pollution may also off natural origin.

Sources of pollutants

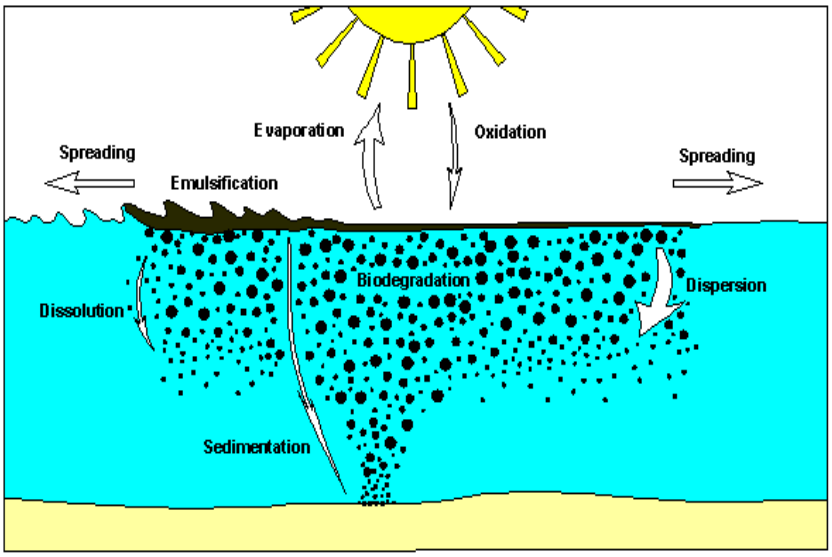
- Marine commerce
- Industry
- Electircal Power generation
- Sewage treatment
- Other Non Industrial Wastes
- Recreation
- Construction

Oil Spills – Oil pollution of the sea normally attracts the greatest attention because of its visibility.

Behaviour of Oil in Sea



Fate of Oil



Weathering

- Modifying physical and chemical properties
- Oil floating- spreading to a wide spectrum of the area
- Crude oil forms sticky layers-prevents free diffusion of gases, decreases the photosynthesis
- Volatile components-evaporate, heavy tar ball- assimilated by bottom organisms

Evaporation

- Series of chemical and physical changes that cause spilled oil to break down and become heavier than water
- Winds, waves, and currents may result in natural *dispersion*, breaking a slick into droplets
- These droplets may also result in the creation of a secondary slick or thin film on the surface of the water

Oxidation

- Occurs when the lighter substances within the oil mixture become vapors

- Leaves heavier components of the oil, which may sink to the ocean floor spills kerosene and gasoline contain a high proportion of flammable components (evaporate completely within a few hours)
- Reducing the toxic effects to the environment.
- Heavier oils leave a thicker, more viscous residue, which may have serious physical and chemical impacts on the environment
- Wind, waves, and currents increase both evaporation and natural dispersion

Biodegradation

- Occurs when microorganisms feed on oil
- To sustain biodegradation, nitrogen and phosphorus are added to encourage the microorganisms to grow and reproduce
- Biodegradation tends to work best in warm water environments

Emulsions

- Emulsions consisting of a mixture of small droplets of oil and water
- Emulsions are formed by wave action, and greatly hamper weathering and cleanup processes
- Two types of emulsions exist: water-in-oil and oil-in-water
- Water-in-oil emulsions are frequently called "chocolate mousse," - formed strong currents or wave action makes water trapped inside the viscous oil
- Oil and water emulsions cause oil to sink

Spreading

- Initially as a single slick depends upon the viscosity of the oil
- Fluid, low viscosity oils spread more quickly than those with a high viscosity
- Slicks quickly spread to cover extensive areas of the sea surface
- Spreading is rarely uniform and large variations in the thickness of the oil

Dispersion

- Waves and turbulence at the sea surface cause all or part of a slick to break up into fragments and droplets of varying sizes
- Oil that remains suspended in the water has a greater surface area than before dispersion occurred
- Encourages other natural processes (dissolution, biodegradation and sedimentation to occur
- Speed of oil disperses is largely dependent upon the nature of the oil and the sea state
- Quick if the oil is light and of low viscosity and if the sea is very rough.

Sedimentation/Sinking

- Heavy refined products have densities greater than one , so sink in fresh or brackish water
- Sea water has a density of approximately 1.025 and very few crudes are dense enough or weather sufficiently
- Sinking usually occurs due to the adhesion of particles of sediment or organic matter to the oil
- Oil stranded on sandy shorelines often becomes mixed with sand and other sediments

There are several sources though which the oil can reach the sea.

- Natural release
- Oil tanker and other ship accidents – Largest Oil Spills (World-Level)
- Gulf War oil spill, Persian Gulf, January 23 1991
- Ixtoc I oil well, S Gulf of Mexico, June 3, 1979
- Nowruz oil field, Persian Gulf, February, 1983
- Castillo de Bellver, off Cape Town, South Africa, August 6, 1983
- Amoco Cadiz (BP/Amoco, USA) - Britanny, France, March 16, 1978
- Torrey Canyon, South England, March 18 1967
- Sea Star,Gulf of Oman, December 19, 1972
- Urquiola, La Coruna, Spain, May 12, 1976
- Hawaiian Patriot, N Pacific February 26, 1977
- Othello, Tralhavet Bay, Sweden, March 20, 1970
- Operation of ships other than tankers
- Offshore oil drilling and production plat forms
- Ship shore oil terminal operation
- Refinery operation

Tanker operations

Half the world production of crude oil , which is closed to three billion tones per year, is transported by sea. After a tanker has unloaded its cargo of oil, it has to take on sea water as ballast for the return journey. This ballast water is stored in the cargo compartments that previously contained the oil. During the unloading f the cargo certain amount oil remains clinging to the walls of the container and this may amount to 800 tonnes in a 2 lakh s container. The ballast water thus becomes contaminated with this oil. When a fresh cargo of oil is to be loaded, these compartments are cleaned with water, which discharges the dirty ballast along with the oil into the sea.

Two techniques have substantially reduced the oil pollution. In the load- on- top system, the compartments are cleaned by high pressure jets of water. The oily water is retained in the compartment until the oil floats to the top. The water underneath that contains only a little oil is then discharged into the sea and the oil is transferred tot a slope tank. At the loading terminal, fresh oil is loaded on top of the oil in the tank and hence the name of the technique. In the second method, called crude oil washing , the cling age is removed by jets of crude oil by the cargo is being unloaded. Some Modern Tankers have segregated ballast, where the ballast water does not come in contact with this oil. Thus with the introduction of these new methods of the ballast, the amount t of oil entering the sea has been considerable reduced.

Dry Docking

All ships need periodic dry docking for servicing repairs, cleaning the hull etc. During this period when the cargo compartments are to be completely emptied, residual oil finds its way into the sea.

Bilge and fuel oils

As ballast tanks take up valuable space, additional ballast is sometimes carried in empty fuel tnaks. While being pumped overboard it carries into the sea. Individually, the quantity of oil released may

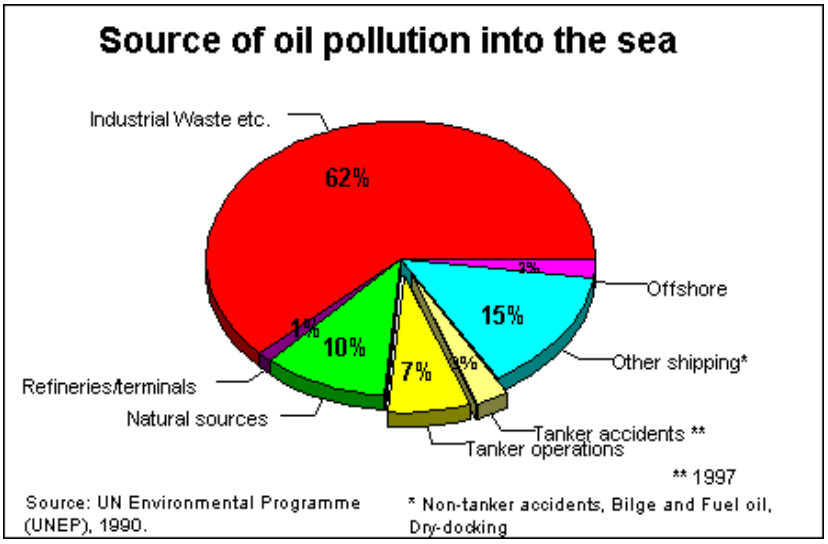
be small, but it sometimes becomes a considerable amount when all the shipping operations are taken into consideration.

Tanker accidents

A large number of oil tanker accidents happen every year. Sometimes this can result in major disasters , such as that of Exxon Valdez on marine environment.

Offshore Oil Pollution

The oil that has extracted from the sea bed contains some water. even after it is passed through oil separators the water that is discharges contains some oil, which adds to marine pollution. Drilling mud, which are pumped down oil wells when they are being drilled, normally contain 70 to 80 % of oil. They are dumped on the sea bed beneath the drilling platform, thus heavily contaminating the water. In addition, the controlled release of oil from the wells can be catastrophic events resulting in oil pollution



Oil spill- India - In 1994, June14Indian authorities began siphoning off 700 tons of oil from the Sea Transporter, a 6,000-ton Greek cargo ship which had been anchored off Aguada after it ran aground following a cyclone on June 5. In March 25, 2005, 110 tonnes oil spilled in Goa port.

Control of Oil Pollution Physical

methods

Skimming: The oil could be removed from the surface

Oil can be removed by suitable absorbents Eg.Saw Dust, Polyurethane foam

Chemical Methods

- Evaporation, Emulsification, Absorbents, burning of oil are effective methods
- Super bug has been proved to be effective to clean up the oil pollution

- Oleophilic fertilizers enrich the soil eating microbes like pseudomonas sp and hence they could be used.
- To reduce the thermal pollution due to industrial effluents, high efficient heat exchangers should be used.
- Each industry should have a separate treatment plant to meet the standards which are given by central and state pollution control Boards.

  General awareness must be created among the common people regarding the disposal of various wastes

Oil Degradation by superbug

Although many microorganisms can metabolize petroleum hydrocarbon no single microbe possesses the enzymatic capability to degrade all, or even most of the compounds in a petroleum mixture. Recombinant DNA technology has created a **'superbug'** that is able to degrade many hydrocarbon structures, that is potentially useful in oil pollution abatement programmes. This hydrocarbon-degrading microbe, *Pseudomonas putida* is the first organism for which a patent has been granted in the U.S.A.

Different strains of this bacterium contain a plasmid, which has genes for enzymes that digest a single family of hydrocarbon. These plasmids are designated based on the hydrocarbon they metabolize. Plasmid *CAM* digests camphor, *XYL*- xylene and toluene, *NAH*- naphthalene and *OCT*- octane. By crossing various strains of this bacterium a super bug was created. It carries the plasmids *XYL, NAH* and a hybrid plasmid having *CAM* and *OCT* genes. This multi plasmid bacterium can grow on a diet of crude oil. It has a potential of cleaning up of oil spills as it degrade all the four families of hydrocarbons.

Water quality standards

In the urbanized and industrialized world of today, it is necessary to have a legal basis for protecting water quality. It takes human effort, energy and money to keep water clean enough for the many different uses for which society requires it. Without a legal frame work to allow the enforcement of water quality standards, environmental quality and public health would be in constant jeopardy.

Water quality standards are limits on the amount of physical, chemical, or microbiological impurities allowed in water that is intended for a particular use. These are legally enforceable by governmental agencies and include rules and regulations for sampling, testing and reporting procedures.

S. No.	Characteristics	Inland surface waters	Public sewers	Irrigation
1.	TSS (mg/l) max.	100	600	200
2.	DS (inorganics) (mg/l)	2100	2100	2100
3.	PH	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4.	Oil and Grease (mg/l)	10	20	10

5.	Total Residual chlorine (mg/l)	1	-	-
6.	Ammoniacal nitrogen (as N) mg/l	50	50	-
7.	BOD_5 (mg/l)	30	350	100
8.	COD (mg/l)	250	-	-
9.	Arsenic (as As) (mg/l)	0.2	0.2	0.2
10.	Mercury (as Hg) (mg/l)	0.01	0.01	-
11.	Lead (as Pb) (mg/l)	0.1	1	1
12.	Cadmium (as Cd) (mg/l)	2.0	1	1
13.	Hexavalent chromium (as Cr) (mg/l)	0.1	2	-

Causes, effects and control of soil pollution.

Soil Pollution

Soil is the loose and unconsolidated outer layer of earth's crust that is powdery in nature and made up of small particles of different sizes. Soil ecosystem includes inorganic and organic constituents, and the microbial groups. Soil microorganisms are the active agents in the decomposition of plant and animal solid wastes and said to be nature's garbage disposal system. The soil microbes keep our planet earth free of unwanted waste materials and recycle the elements (C, N, and P) through mineralization. Soil microbes decompose a variety of compounds, cellulose, lignin, hemi cellulose, proteins, lipids, hydrocarbons etc. The soil microbial community has little or no action on many man made synthetic polymers. The persistent molecules that fail to be metabolized or mineralized have been termed as recalcitrants.

Soil pollutants Pesticide

pollution

In modern agriculture the use of various agrochemicals is a common practice. These include pesticides, herbicides, insecticides, fungicides and others. Pesticides applied on seed or foliage ultimately reach the soil. Accumulation of pesticide residues in the biosphere creates ecological stress causing contamination of soil, water, and food. Persisting chemicals may also be

hazardous to human health and should be eliminated. Persistent pesticides may accumulate in the bodies of animals and over a period of time increase in concentration if the animal is unable to flush leading to bioaccumulation. When an affected animal is eaten by a carnivore, the pesticide is further concentrated in the carnivore. This phenomenon ie. Increasing in the concentration of a nondegradable substance along the food chain is called Biomagnification.

Another problem associated with insecticides is the ability of insects become resistant. Most pesticides kill beneficial predators and parasites. The short term and long term health effects to the persons using the pesticides and public that consumes the food are the major concerns. Exposure to small quantities for longer time causes mutations leads to cancer. Pesticides or their metabolites affect many soil microbes and their activities. Seed treatment with mercuric fungicides are found to be inhibitory to *Rhizobium* (nodulation and nitrogen fixation), *Nitrosomonas and Nitrobacter* (nitrification).

Fertilizer pollution

The agricultural production depends on chemical fertilizer application, as most of our high yielding varieties are fertilizer responsive. Continuous application of chemical fertilizers alone lead to deterioration of soil properties and cultivated soils loose their natural characteristics. Fertilizers like ammonium sulphate, ammonium chloride and urea reduce the soil pH. Many crops, like potato, grapes, citrus, beans are sensitive to chloride toxicity. In integrated nutrient management, to sustain the productivity of our soils, organic manures and bio fertilizers are recommended as supplements to chemical fertilizers.

Nitrate pollution

Nitrogen occurs in many forms in the environment and takes part in many biochemical reactions. The four forms of nitrogen that are of particular significance in environmental technology are organic nitrogen, ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen. In water contaminated with sewage, most of the nitrogen is originally present in the form of complex organic molecules (protein) and ammonia (NH_3). These substances are eventually broken down by microbes to form nitrites and nitrates.

Nitrogen, particularly in the nitrate form, is a basic nutrient that is essential to the growth of plants. Excessive nitrate concentrations in surface waters encourage the rapid growth of microscopic plants called algae and excessive growth of algae degrades water quality.

Nitrates can enter the ground water from chemical fertilizers used in agricultural areas. Excessive nitrate concentrations in drinking water pose an immediate and serious health threat to infants under 3 months of age. The nitrate ions react with blood hemoglobin, reducing the blood's ability to carry oxygen and this produces a disease called ***blue baby*** or *methemoglobinemia.*

- An illness that arises when an infant's blood is unable to carry enough oxygen to body cells and tissue

- An infant with moderate to serious "blue baby syndrome" may have a brownish-blue skin tone due to lack of oxygen
- Child may be fussy, tired, have diarrhea or vomiting
- Severe cases can cause death

Excess Salts and Water

Irrigation water helps to produce more yield than rain fed land. Irrigation water contains dissolved salts and in dry season, water is in the form of saline solution evaporates leaving its salts such as NaCl in the top soil. This saline soil causes stunted plant growth, lower yield. Flushing out salts reduces the salinity but makes downstream irrigation water, saltier. Another problem is water logging.

Heavy metal pollution

Heavy metals include all metals with atomic numbers greater than 23 (with few exceptions) or more than 5 gm per ml. (eg. Hg, 70 gm ml^{-1}). Heavy metals are hazardous, not acceptable to biological system. They are toxic to man and other life forms. Most of them are slow poisons as they accumulate in the body and cause serious disorders. Mercury, lead, arsenic, chromium and cadmium are the five most common toxic heavy metals and they have serious effects on human health .

Effect of heavy metals on human health

S.No.	Heavy metal (forms)	Source	Effect
1.	Mercury: Hg^{++}(Mercuric) C_6H_5Hg	Methyl mercury fungicides, electrical and electronic industries, PVC, plastics, paints.	Irreversible neurological damage in man, Minamoto disease
2.	Lead Pb^{2+}, Pb^{4+}	Automobile exhaust of leaded petrol (50%), Batteries, Pipes, Soldiering.	Cause mutation in algae and bacteria, blackening in fish, gradual paralysis in man.
3.	Arsenic As^{+++} Arsenic trioxide, Sodium arsenate	Herbicide, fungicide, wood preservative – Agro chemicals (70%), industrial chemicals – paints, bullets (20%), glass and glass wares (5%).	Accumulate in hair, nail, skin lesions, act as oxidative uncoupler, cause damage to kidney, respiratory tract and nervous disorders.
4.	Chromium Cr^{+6} CrO_3	Tanneries, electroplating and metal finishing processes, Khaki dyeing in textiles.	Toxic to aquatic organisms, absorbed through intestinal tract in man.
5.	Cadmium (Cd)	Pigment and stabilizer for PVC, plastics, tires, rechargeable cells, electroplating, coal, oil and phosphate	Bones become brittle – Itai itai disease in Japan, gastro enteric distress and pain.

The unique physical, chemical and toxic properties of heavy metals have promoted their wide use in industrial processes and as biocides (fungicide and herbicide). As a result, higher concentration of these heavy metals accumulates in the environment, causing public health hazards and ecological problems. Removal of these metals is therefore a challenge to environmental

management. The metals are generally removed by ion exchange and sorption to resins and precipitation as metal sulphides. Biodegradation of metals is not possible, because unlike organic pollutants, metals as elements cannot be mineralized to non-toxic compounds such as H_2O and CO_2. However, biomobilization is a valid concept in the management of metal pollution. Eukaryotic organisms detoxify heavy metals by binding to polythiols and bacteria have developed different and efficient mechanisms for tolerating heavy metals. They carry the genes controlling metal resistance on chromosome and plasmids, plasmids often contain genes resistance to several metals (Hg, Pb, As, Cr, Cd, Mo, U). As a result of biological action, metals undergo changes in valency and or conversion into organo metallic compounds.

Industrial Wastes: Indiscriminate dumping of untreated or inadequately treated domestic, mining and industrial wastes on and is an important source of soil pollution. Fall out of gaseous and particulate air pollutants from mining and smelting operations, smoke stacks etc. are the major source of soil pollutants in nearby areas.

Neyveli Lignite Corporation Limited (**NLC**) is a government-owned lignite mining and power generating company in India. NLC operates the largest open-pit lignite mines in India, presently mining 24 MT of lignite per year and has an installed capacity of 2740 MW of electricity and generates 2490 MW of power per year from three stations It operates three mines near the South Indian city of Chennai.

The power goes to the South Indian states of Andhra Pradesh, Karnataka, Kerela, Tamil Nadu, and Pondicherry. The company also provides consulting services in mine planning and construction and the renovation and life extension of old power stations. It also supplies a large quantity of sweet water to Chennai from the artesian aquifers in the lignite mines.

Open pit Coal mining at Garzweller, Germany

Urban Wastes : Millions of tons of urban waste are produced every year from polluted cities. The inadequately treated or untreated sewage sludge not only poses serious health hazards but also pollutes soil and decreases its fertility and productivity. Other waste materials such as rubbish, used plastic bag, garbage sludge, dead animals, hospital wastes, skins, tyres shoes etc. cause land and soil pollution. Suspended matter present in sewage can act as a blanket on the soil and interfere with its productivity.

Plastics

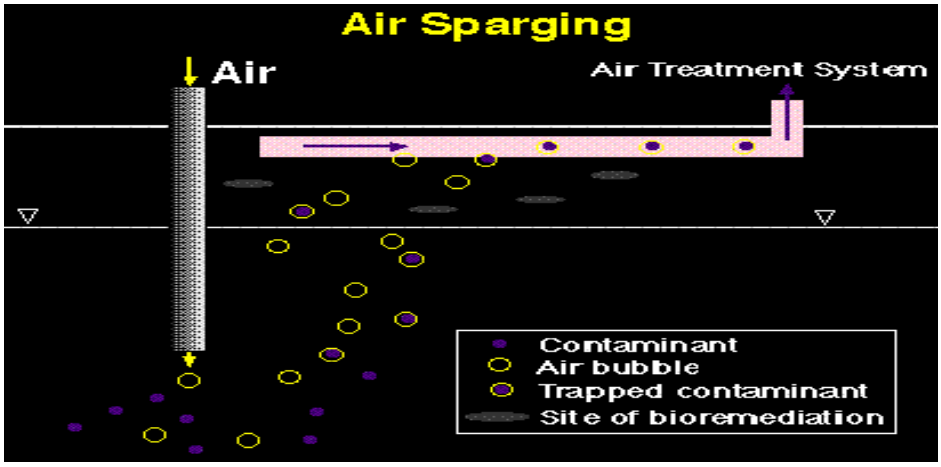
Plastics form a major part of global domestic and industrial waste. Not being biodegradable, waste plastic accumulates, adding to pollution. Using photodegradable plastic or biodegradable plastic can solve plastic pollution problem. Photodegradable plastic contains an element sensitive to UV rays. Under the effect of solar rays the element is activated and breaks the polymeric chain of the photodegradable plastic. It results in small fragments that are easily digested by microbes.

Control of Soil Pollution

Soil may be polluted and converted into acidic soil or alkaline soil. It should be corrected by suitable technology, before cultivation.

Methods of Soil treatment

Air sparging is an *in situ* remedial technology that reduces concentrations of volatile constituents in petroleum products that are adsorbed to soils and dissolved in groundwater. This technology, which is also known as "*in situ* air stripping" and "*in situ* volatilization," involves the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor phase. The air is then vented through the unsaturated zone. Air sparging is most often used together with soil vapor extraction (SVE), but it can also be used with other remedial technologies.

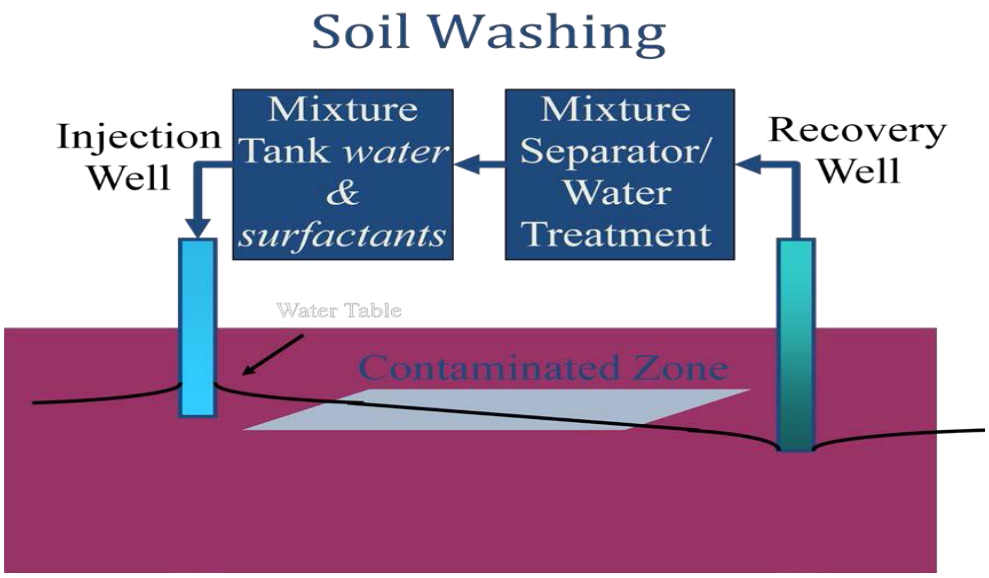


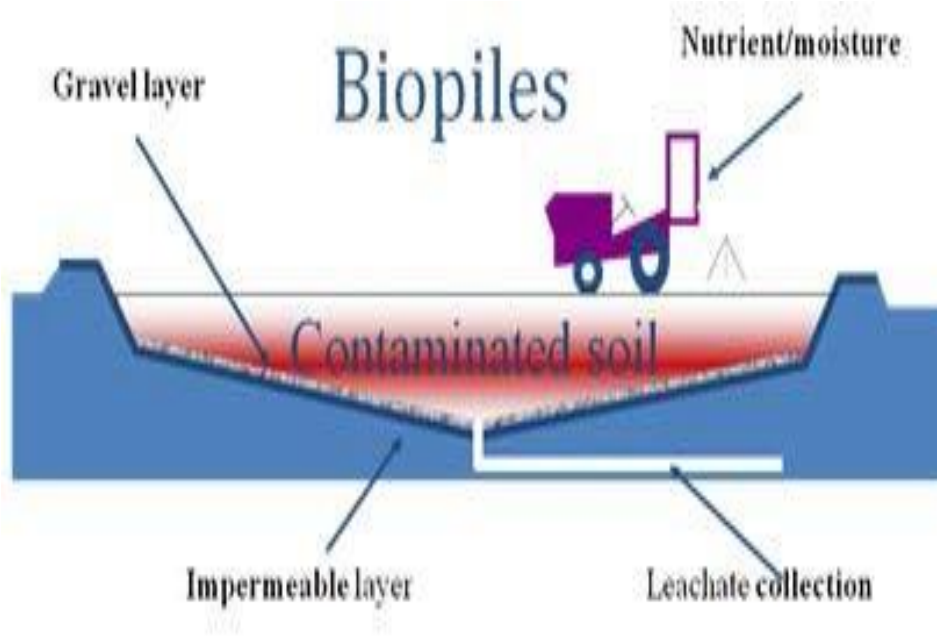
Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants. The process removes contaminants from soils in one of the following two ways:

- By dissolving or suspending them in the wash solution (which can be sustained by chemical manipulation of pH for a period of time); or
- By concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing (similar to those techniques used in sand and gravel operations).

The concept of reducing soil contamination through the use of particle size separation is based on the finding that most organic and inorganic contaminants tend to bind, either chemically or physically, to clay, silt, and organic soil particles. The silt and clay, in turn, are attached to sand and gravel particles by physical processes, primarily compaction and adhesion. Washing processes that separate the fine (small) clay and silt particles from the coarser sand and gravel soil particles effectively separate and concentrate the contaminants into a smaller volume of soil that can be further treated or disposed of. Gravity separation is effective for removing high or low specific gravity particles such as heavy metal-containing compounds (lead, radium oxide, etc.). Attrition scrubbing removes adherent contaminant films from coarser particles. However, attrition washing can increase the fines in soils processed. The clean, larger fraction can be returned to the site for continued use. Soil washing is generally considered a media transfer technology. The contaminated water generated from soil washing are treated with the technology(s) suitable for the contaminants. The duration of soil washing is typically short- to medium- term.

Biopile treatment is a technology in which excavated soils are mixed with soil amendments and placed on a treatment area that includes leachate collection systems and some form of aeration. It is used to reduce concentrations of petroleum constituents in excavated soils through the use of biodegradation. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation.



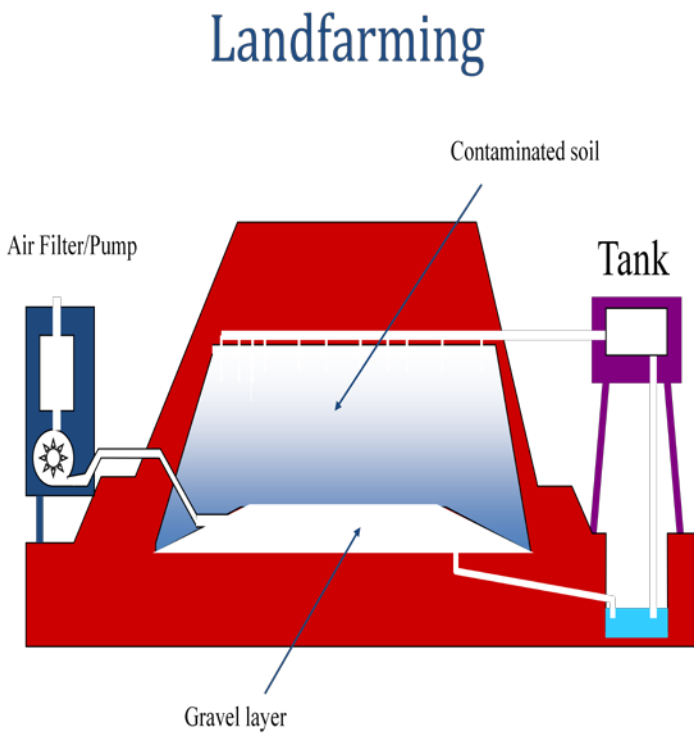


The treatment area will generally be covered or contained with an impermeable liner to minimize the risk of contaminants leaching into uncontaminated soil. The drainage itself may be treated in a bioreactor before recycling. Vendors have developed proprietary nutrient and additive formulations and methods for incorporating the formulation into the soil to stimulate biodegradation. The formulations are usually modified for site-specific conditions.

Soil piles and cells commonly have an air distribution system buried under the soil to pass air through the soil either by vacuum or by positive pressure. The soil piles in this case can be up to 20 feet high (generally not recommended, 2-3 meters maximum). Soil piles may be covered with plastic to control runoff, evaporation, and volatilization and to promote solar

heating. If there are VOCs in the soil that will volatilize into the air stream, the air leaving the soil may be treated to remove or destroy the VOCs before they are discharged to the atmosphere. It is a short-term technology. Duration of operation and maintenance may last a few weeks to several months.

Land Farming is a bioremediation treatment process that is performed in the upper soil zone or in biotreatment cells. Contaminated soils, sediments, or sludges are incorporated into the soil surface and periodically turned over (tilled) to aerate the mixture. This technique has been successfully used for years in the management and disposal of oily sludge and other petroleum refinery wastes. In situ systems have been used to treat near surface soil contamination for hydrocarbons and pesticides. The equipment employed in land farming is typical of that used in agricultural operations. These land farming activities cultivate and enhance microbial degradation of hazardous compounds.



Soil conservation

Soil conservation is the protection of soil against excessive loss of fertility by natural, chemical, or artificial means. It encompasses all management and land-use methods protecting soil against degradation, focusing on damage by erosion and chemicals. Soil conservation techniques can be achieved through crop selection and rotation, fertilizer and lime application, tilth, residue management, contouring and strip cropping, and mechanical methods (e.g., terracing).

- **Biological methods**

1. Agronomic practices Contour farming
   Mulching crop rotation Strip cropping
2. Dry farming
3. Agrostological methods

- **Mechanical methods**

Lay farming
Retiring of land to grass

1. Basin listing
2. Contour terracing

- **Other methods**

1. Gully control
2. Afforestation

Terracing – increases the amount of land used for cultivation on steep slope and mountains and reduces erosion

Soil Amelioration

1. **Soil Amelioration**

Amelioration of Acidic Soil: Soil acidity is due to the accumulation of H^+ ions over OH^- ions.

Limiting material – are neutralization of H^+ ions such as

- *Quicklime*- oxide of lime is usually known as burned lime or quicklime.
- *Slaked lime*-can be obtained by adding water to quick lime.
- *Blast furnace slag*- a byproduct during the manufacturer of pig iron viz, calcium silicate.
- *Basic Slag*- is a byproduct of the basic open heart method of producing steel from pig iron,

- *Electric furnace slag*- is produced from the electic furnace reduction of phosphate rock during preparation of phosphorous. The product is manly the calcium silicate.

The other methods which could result in amelioration of acidic soil are:

- Use of basic fertiizers such as sodium nitrate reduces the soil acidity.
- Proper soil and water management.
- Usage of corall shell, chalk, woodash, press mud, byproduct material of paper mills, sugar factories, fly ash and sludge etc.

Amelioration of Saline and Alkali Soil

Saline soil- they contain an excess of soluble salts. *Saline soil reclamation can be achieved by:*

- Providing proper drainage
- Using salt free irrigation water
- Use of acidic fertilizers-such as ammonium sulphate
- Use of organic fertilizers
- Use of organic manures.

Alkaline soil-they contain appreciable amounts of soluble salts. *Alkali soil reclamation* may be achieved by the following practices:

- Application of gypsum
- Use of sulphur
- Addition of organic matter
- Addition of molasses.

2. ***Prevention of solid waste dumping***
   Open dumping of solid waste should be segregated and recyclable materials could be recycled. Other garbage can be conveted into organic manure by suitable technology.
3. **Usage of bio-fertilizers and bio-pesticides.**
4. **Following the concept of Integrated Plant Nutrient System (IPNS).**

Organic / Sustainable Agriculture

Organic farming is a holistic approach which aims for the production of quality and safe agriculture products for consumption. This system requires less financial and external inputs and provides sustainable income to the farming community. Organic farming aims at production of quality and safe agricultural products which contain no chemical residues due to the adoption of eco-friendly production methods and farming systems that restore and maintains soil fertility.

Organic farming is a production method which does not pollute the soil and ground water with chemical residues and provides safe and quality food for consumption. It also increases the biological diversity of plants and animals that helps to maintain the natural eco balance. This

approach also aims to recycle only the natural resources and restricts the use of external inputs which indirectly helps to reduce the energy consumption in the farming system considerably.

The vision of organic farming in India has necessitated the government to launch the National programme for organic production (NPOP) during 2000. By National accreditation policy and programme, the government has also implemented the National standards for various organic farming activities. Hence organic farming has to be promoted in a big way to provide quality and safe food to the growing population and also to protect the environmental degradation.

Concepts of Organic Farming

Organic farming aspires to a complex mix of agronomic, environmental, agricultural and processing and are based on a number of principles. They are:

- To produce food of high quality and safety
- To interact in a constructive and life-enhancing way with natural systems and cycles
- To consider the wider social and ecological impact of the organic production and processing system
- To encourage and enhance biological cycles within the farming systems, involving microorganisms, soil flora and fauna, plants and animals
- To develop a valuable and sustainable aquatic ecosystem
- To maintain and increase the long term fertility of soils
- To promote the healthy use and proper care of water, water resources, and all life therein
- To use, as far as possible, renewable resources in locally organized production systems
- To create a harmonious balance between crop production and animal husbandry
- To minimize all forms of pollution
- To process organic products using renewable resources
- To produce fully biodegradable organic products.

These principles are given equal importance as that of other economically viable production technologies.

Organic Farming Requirements

Achieving the above mentioned principles of organic farming needs a holistic farming system with integrated approach in all aspects. The basic principle of organic farming in enhancing the soil fertility can be achieved through proper recycling of organic wastes, versatile crop rotation and cropping systems, a wide range of biological methods for control of pests, diseases and weeds and to avoid the use of synthetic fertilizers, chemical pesticides and herbicides. Habitat development is the key factor in restoring the natural eco-system which in turn facilitates the symbiotic co-existence of fauna and flora apart from promoting natural predators, parasites etc.

a. Maintaining soil fertility

Depletion of soil organic matter under intensive cropping system is the key factor in altering biological equilibrium of the soil ecosystem. It is essential to maintain the soil food web, where all the soil organisms viz, bacteria, fungi, actinomycetes, protozoa, earthworms etc, and they flourish in population in the presence of sufficient amount of soil organic matter. In order to maintain the soil fertility, the following farming practices are recommended.

- Increased use of organic manures, green manures

- Enriched vermicompost and bio composts
- Use of bio fertilisers
- Crop rotation with high and low biomass crops
- Avoiding the use of chemical fertilizers

b. Plant Protection methods

Indiscriminate use of chemical pesticides and herbicides leads to soil and ground water contamination which causes health problems in living systems. The accumulation of toxic residues in the food products has created considerable awareness among the producers and consumers. The reports on the pesticides residue in food products revealed that, most of the food products from conventional agriculture contain more than 70 per cent residues. In addition, it also impairs the soil microflora that is essential to maintain soil fertility. These problems can be solved by adopting organic farming practices which uses only the natural bio pesticides for plant protection. Generally bio pesticides, bio control agents, plant extracts etc are used for controlling the pest and disease problems.

c. Animal husbandry

The basis for including animal husbandry in the system is to respect the physiological and ecological needs of animals. This is achieved by providing sufficient quantities of good quality organic fodder, Shelters according to their behavioral needs and also by proper veterinary treatment. Animals are an important part of organic system because they act as the agents for recycling of byproducts with value addition. Further contribute to complete the nutrient cycle and maintaining soil fertility. They also contribute draught energy for agricultural operations and provide essential manure for soil nutrition and urine for pesticides.

d. Processing of organic products

The basis of processing organic products is that as far as possible the vital qualities of the products are maintained throughout each step of the process. This is achieved by choosing and developing methods which are adequate to the specifications of the ingredients and by developing standards which emphasize careful processing methods, limited refining, energy saving technologies, minimal use of additives and processing aids etc. The production and handling of organic products in a safe way can be achieved by adopting existing standards or by developing new standards, which define the safe methods of waste management in the form of products besides packing systems and energy saving systems in processing and transport.

The Indian domestic market being quite large, there is ample opportunity for marketing the products especially the organic products in the country. Greater opportunities are also available for exporting certified organic products to counties like USA, Japan and European Union. Although some farmers are practicing organic agriculture, their awareness on certification is limited and they are yet to recognize the importance of certification.

Causes, effects and control of noise and thermal pollution.

Noise pollution

Noise is perhaps one of the most undesirable by products of modern mechanized lifestyle. It may not seem as insidious or harmful as the contamination of drinking water supplies from hazardous chemicals, but it is a problem that affects human health and well-being and that can also contribute to the general deterioration of environmental quality. It can affect people at home, in their community, or at their place of work.

Sound waves cause eardrums to vibrate, activating middle and inner organs and sending bioelectrical signals to the brain. The human ear can detect sounds in the frequency range of about 20 to 20,000 Hz, but for most people hearing is best in the range of 200 to 10,000 Hz. A sound of 50 Hz frequency, for example, is perceived to be very low-pitched, and a 15,000 - Hz sound is very high pitched.

Simply defined, noise is undesirable and unwanted sound. It takes energy to produce sound, so, in a manner of speaking, noise is a form of waste energy. It is not a substance that can accumulate in the environment, like most other pollutants, but it can be diluted with distance from a source. All sounds come from a sound source, whether it be a radio, a machine, a human voice, an airplane, or a musical instrument. Not all sound is noise. What may be considered music to one person may be nothing but noise to another. To a extent, noise pollution is a matter of opinion. Noise is measured in terms of Decibel units.

Sources of noise

Based on the type of noise include

a) Industrial Noise
b) Transport Noise
C) Neighbourhood Noise

Industrial Noise

It is caused by machines used for the technological advancement. There exist a long list of sources of noise pollution including different machines of numerous factories, industries and mills.

Transport Noise:

Main source is transport. In addition to adversely impacting urban air quality, heavy automobile traffic creates seemingly unbearable noise pollution. Ever since industrial revolution doubling of noise for every 10 years Pointed nose that angles downward during takeoff, the Anglo-French Concorde flies at more than twice the speed of sound. Supersonic plane is very noisy, and some believe its sonic booms harm the environment.

Animals such as whales use water to communicate with one another over great

distances. Human-generated noises in the ocean, such as engine noises by boats, may interfere with animal communication.

Measurement of noise

The noise is usually measured either by i) Sound Pressure or ii) Sound Intensity. The Sound intensity is measured in Decibel (dB), which is tenth part of the longest unit "Bel" named after Alexander Graham Bell. Decibel (dB) is a ratio expressed as the logarithmic scale relative to a reference sound pressure level. The db is thus expressed as

$$\text{Sound Intensity Level} = 10 \log \frac{\text{Intensity Measured (I)}}{\text{Reference intensity } (I_0)}$$

or $dB = 10 \log I / I_0$

Intensity of Noise sources

Sources	**Intensity(dB)**
Breathing	10
Trickling clock	20-30
Normal conversation	35-60
Office noise	60 - 80
Traffic	50-90
Motor cycle	105
Jet fly	100 - 110

Effects of Noise Pollution

Auditory effects

- Auditory fatigue -- Whistling & buzzing in ears(noise level - 90dB)
- Deafness -- Permanent hearing loss (noise level- 100dB)

Tinnitus

- Persistent sound in one or both ears.
- Tinnitus is often experienced as a high-pitched hiss, ring, buzz, or roar.
- It is usually continuous, but it may pulsate, and the beats may coincide with the heartbeat.

Non auditory effects

- Interference with speech communication - 50dB
- Annoyance, ill temper, bickering
- loss in working efficiency - tiredness, deterioration or complete loss of ability to work

Physiological disorders

Neurosis, anxiety, hypertension, increased sweating, giddiness, nausea, fatigue, visual disturbance, reduces depth and quality of sleep , peptic ulcers, Increases cholesterol level resulting in constriction of blood vessel , Low weight children to mothers

Noise intensity	Health hazards
80	Annoyance
90	Hearing damage
95	Very annoying
110	Stimulation of reception in skin
120	Pain threshold
130	Nausea,vomiting
140	Pain in ear
150	Burning of skin
160	Rupture of tymphonic membrane
180	Permanent damage

Even the nonliving things such as buildings undergo physical damage by cracks, breakage of windows, doors, and glasses etc. by sudden and explosive sounds.

Control of Noise Pollution

Noise definitely affects the quality of life. It is therefore important to ensure the mitigation or control of noise pollution**.** Noise pollution can be controlled

- At source level – Can be done by i) Designing and fabricating silencing devices in air craft engines, automobiles industrial machines and home appliances, ii) By segregating the noisy machines

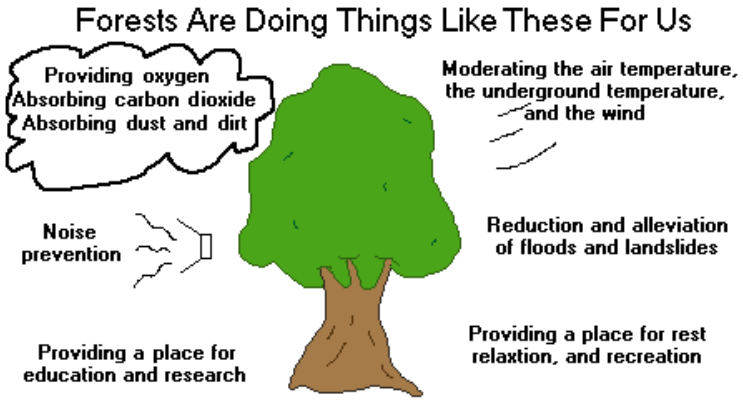
- During Transmission – can be achieved by adding insulation and sound-proofing to doors, around industrial machinery. Zoning urban areas to maintain a separation between residential areas and zones of excessive noise. Sound

a) Acoustillite : made up of Compressed wood pulp, wood fibers and is available in the form of tiles
b) Acoustical blanket : Prepared from mineral wool or glass fibres
c) Hair Felt: Consists of wool fibres, Coarse Cotton Fibres.

d) Fibre Glass
e) Cork Carpet: Prepared out of pieces of corks treated with linseed oil and is used for covering floors.
f) Acoustic Plaster: Mainly consists of gypsum in the form of plaster.

- Protecting the exposed person
- By creating vegetation cover – Plants absorb and dissipate sound energy and thus act as Buffer Zone. Trees should be planted along highways, schools and other places.

Planting vegetation to absorb and screen out noise pollution – Trees can act as a noise barrier



Through law

a) Silence Zones must be created near Schools, hospitals
b) Indiscriminate use of loudspeakers at public places should be banned/restricted by laws
c) Restriction on unnecessary us e of horns and vehicles plying without silencers
d) Restrictions on aircraft flight at midnight Permissible Ambient Noise

Level in Different areas

Area	Code category	Noise level (dB)	
		Day Time (6 to 9 Am)	Night Time (9 to 6 PM)
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

a) The Air (prevention and control of pollution) Act, 1981
b) The Motor Vehicles Act,1988
c) Indian Penal Code – Sections 268 & 290

- Through education - We Indians are Noisy people. Every occasion, it may be religious or family functions or elections; we used to celebrate with noise. Educating the people that noise is a pollutant, not a part of our routine life.

Thermal Pollution

The term thermal pollution has traditionally been used more often to refer to the heating of lakes, river, streams, and other water bodies usually by electric power generating plants or by factories

- The combustion of fossil fuels always produces heat, sometimes as a primary desired product, and sometimes as a secondary, less desired by-product i.e. noise
- Heat is also produced when fossil fuels are burned to generate electricity. In this case, heat is a by-product, not the main reason that fuels are burned.
- Electricity is also generated in nuclear power plants, when no combustion occurs.
- The decay of organic matter in landfills also releases heat to the atmosphere.

It is clear, therefore, that a vast array of human activities result in the release of heat to the environment. As those activities increase in number and extent, so does the amount of heat released. In many cases, heat added to the environment begins to cause problems for plants, humans, or other animals. This effect is then known as *thermal pollution.*

Sources of Thermal pollution

- Coal fired power plant effluents
- Domestic sewage
- Hydroelectric power effluent
- Industrial effluents
- Nuclear power plants

Effects of thermal Pollution

A one megawatt nuclear power plant may require 1.3 billion gallons (five million m^3) of cooling water each day. The water used in such a plant has its temperature increased by about 63^oF (17^oC) during the cooling process. For this reason, such plants are usually built very close to an abundant water supply such as a lake, a large river, or the ocean.

When thermal pollution drives water temperatures up, most aquatic and marine wildlife cannot survive. Immobile organisms, such as plants and shellfish, simply die. One inevitable result of thermal pollution is a reduction in the amount dissolved oxygen in water. The amount of any gas that can be dissolved in water varies inversely with the temperature. As water is warmed, therefore, it is capable of dissolving less and less oxygen. Organisms that need oxygen to survive will, in such cases, cant be able to survive.

When heated water is released from a plant or factory, it does not readily mix with the cooler water around it. Instead, it forms a stream- like

mass known as a thermal plume that spreads out from the outflow pipes. It is in this thermal plume that the most severe effects of thermal pollution are likely to occur. Only over an extended period of time does the plume gradually mix with surrounding water, producing a mass of homogenous temperature

Invasion of Destructive Organism

Water temperatures can have other, less expected effects also. As an example, trout can swim less rapidly in water above 66^{o}F (19^{o}C) making them less efficient predators. Organisms may become more subject to disease in warmer water too. The bacterium *Chondrococcus columnaris* is harmless to fish at temperatures of less than 50^{o}F (10^{o}C). Between temperatures of 50^{o} - 70^{o}F (10^{o} - 21^{o}C), however, it is able to invade through wounds in a fish's body and at temperatures above 70^{o}F (21^{o}C) it can even attack healthy tissue.

Urban Heat dome

Another example of thermal pollution is the development of urban heat islands. An urban heat island consists of a dome of warm air over an urban area caused by the release of heat in the region. Since more human activity occurs in an urban area than in the surrounding rural areas, the atmosphere over the urban area becomes warmer than it is over the rural areas.

It is not uncommon for urban heat islands to produce measurable climate changes. For example, the levels of pollutants trapped in an urban heat island can reach 5 to 25 percent greater than the levels over rural areas. Fog and clouds may reach twice the level of comparable rural areas, wind speeds may be produced by up to 30 per cent, and temperatures may be 32.9^{o} - 35.6^{o}F (0.5^{o} - 2^{o}C) higher than in surrounding rural areas. Such differences may cause both personal discomfort and, in some cases, actual health problems for those living within an urban heat island.

Thermal Air Pollution

Undesirable changes in Algal population: Excess Nutrients from the washout water from farm lands combined with thermal pollution cause an excessive algal growth with consequent changes. High Temperature promotes blue green algal blooms which disrupts the aquatic food chain.

Control of Thermal pollution

The water heated by thermal pollution also has a number of potential useful applications. For example, it may be possible to establish aquatic farms where commercially desirable fish and shellfish can be raised. The Japanese have been especially successful in pursuing this option. Some experts have also suggested using this water to heat buildings, to remove snow, to fill swimming pools, to use for irrigation, to de-ice canals, and to operate industrial processes that have modest heat requirements. Hot water is pumped into one end of the pond and cooler water is removed from the other end. The heat gets dissipated from the pond into the atmosphere. The main disadvantage is large amounts of water are lost due to evaporation

Here at Westport, Kentucky the Ohio River provides the large amount of water required by this coal-fired power plant. Thermal pollution is abated by the use of the large cooling tower which emits only steam into the atmosphere. The emission of the smokestack is largely steam but still contains pollutants.

Causes, effects and management of nuclear hazards and industrial wastes.

The spontaneous emission of particles and rays by an unstable nucleus is called Radioactivity and such substances are called Radioactive Substances eg. Radium, Uranium, Thorium. Radioactive pollution can be defined as the release of radioactive substances or high-energy particles into the air water, or earth as a result of human activity, either by accident or by design. Sometimes natural sources of radioactivity, such as radon gas emitted from beneath the ground, are considered pollutants when they become a threat to human health. The sources of Radioactive wastes are

1) Natural sources: Solar radiation, Radionuclides in the earth Crust, Human Internal radiation, environmental Radiations.
2) Anthropogenic Sources: The sources of such waste include : 1) nuclear weapon testing or detonation; 2) the *nuclear fuel cycle,* including the mining, separation, and production of nuclear materials for use in nuclear power plants or nuclear bombs; (3) accidental release of radioactive material from nuclear power plants..

Since even a small amount of radiation exposure can have serious (and cumulative) biological consequences, and since many radioactive wastes remain toxic for centuries, radioactive pollution in a serious environmental concern even though natural sources of radioactivity far exceed artificial ones are present. The faster a radioisotope is decaying, the more radioactive it will be. Another factor in deciding how dangerous a pure radioactive substance will be is the energy of the radiation. Some decays yield more energy than others. This is further complicated by the fact that few radioisotopes decay immediately to a stable state, but rather to a radioactive decay product leading to decay chains.

Radioactive pollution that is spread through the earth's atmosphere is termed *fallout*. Such pollution was most common in the two decades following World War II, when the United States, the Soviet Union, and Great Britain conducted hundreds of nuclear weapons tests in the atmosphere. France and China did not begin testing nuclear weapons until the 1960s and continued atmospheric testing even after other nations had agreed to move their tests underground.

Three types of fallout result from nuclear detonations: local, tropospheric and stratospheric.

- Local fallout is quite intense but short-lived.
- Tropospheric fallout (in the lower atmosphere) is deposited at a later time and covers a larger area, depending on meteorological conditions.
- Stratospheric fallout, which release extremely fine particles into the upper atmosphere, may continue for years after an explosion and attain a worldwide distribution.

Types of radioactive waste:

Low level Waste (LLW) is generated from hospitals and industry, as well as the nuclear fuel cycle. It comprises paper, rags, tools, clothing, filters etc which contain small amounts of mostly short-lived radioactivity. It does not require shielding during handling and transport and is suitable for shallow land burial. To reduce its volume, it is often compacted or incinerated before disposal.

Intermediate level Waste (ILW) contains higher amounts of radioactivity and some requires shielding. It typically comprises resins, chemical sludges and metal fuel cladding, as well as contaminated materials from reactor decommissioning. It may be solidified in concrete or bitumen for disposal. Generally short lived waste (mainly from reactors) is buried in a shallow repository, while long lived waste (from fuel reprocessing) will be disposed of deep underground.

Transuranic Waste arises mainly from weapons production, and consists of clothing, tools, rags, residues, debris and other such items contaminated with small amounts of radioactive elements -- mostly plutonium. These elements have an atomic number greater than uranium -- thus transuranic (beyond uranium). Because of the long half-lives of these elements, this waste is not disposed of as either low level or intermediate level waste. It does not have the very high radioactivity of high level waste, nor its high heat generation. The United States currently permanently disposes of transuranic waste at the Waste Isolation Pilot Plant.

High level Waste (HLW) arises from the use of uranium fuel in a nuclear reactor and nuclear weapons processing. It contains the fission products and transuranic elements generated in the reactor core. It is highly radioactive and hot. It can be considered the "ash" from "burning" uranium. HLW accounts for over 95% of the total radioactivity produced in the process of nuclear electricity generation.

Waste Stored Safely Now

- After it is removed from the reactor, used fuel is stored at nuclear plant sites in steel-lined, concrete vaults filled with water.
- The water cools the used fuel and acts as a shield, to protect workers from radiation.
- This used fuel looks just like it did when it was placed in the reactor.
- The radioactive waste remains locked inside the uranium pellets, which are still encased in the metal fuel rods.

This used fuel has been stored safely at nuclear plant sites ever since the late 1950s, when the first nuclear power plants began making electricity. What is needed is a permanent repository for existing and future high-level waste. Initially, it was thought that spent fuel rods could be reprocessed and only to provide new fuel but also to reduce the amount of nuclear waste. However the cost of producing fuel rods by reprocessing was found to be greater than the cost of producing fuel rods from ore. Presently, India does operate reprocessing plants to reprocess spent fuel as an alternative to storing them as nuclear waste. At each step in the cycle, there is a danger of exposure to harmful radiation to possess several health and environmental concerns.

Effect of Radioactive wastes

Radioactive waste causes

- Soil pollution
- Water pollution

In these two pollutions, pollution hazards finally enter into the food chain the human who is the final victim of radioactive pollution as he is at the end of all reactions and interactions.

Effects of radioactive pollution:

The effect of radioactive pollution depends upon

- ✓ Half –life
- ✓ Energy releasing capacity
- ✓ Rate of diffusion
- ✓ Rate of deposition of the contaminant.
- ✓ Various atmospheric and climatic conditions such as wind, temperature, rainfall also determine their effects.
- ✓ The possible general effects of radioactive wastes are categorised into

1) Somatic Effect
2) Genetic Effect
3) Biomagnification

Somatic effect: Affects somatic cells. It appears within individual and disappears with the death of the individual.

Genetic Effects: The radiation affects the genes of the gamete cells. The changes are not apparent in the individual. The effects are exhibited by offspring and in the subsequent generations. They affect the DNA, RNA replication and chromosome. It causes

- Mutation
- Chromosomal aberration
- Chromosomal fragmentation
- Inhibition of RNA, DNA synthesis

Radioactive Pollution Incidents:

The two best known examples illustrating the effect of fallout contamination are the bombing of Hiroshima and Nagasaki, Japan in 1945, and the Chernobyl Nuclear Power Station disaster in April 1986. Within five years of the American bombing of Japan, as many as 225,000 people had died as a result of long-term exposure to radiation from the bomb blast, chiefly in the form of fallout.

The disaster at the Chernobyl Nuclear Power Station in Ukraine on April 26, 1986 produced a staggering release of radioactivity. In ten days at least 36 million curies spewed across the world. The fallout contaminated approximately 1,000 square mites (2,590 sq. km) of farmland and villages in the Soviet Union. In addition to the hundreds killed at the time of the explosion, scientists predict the eventual Soviet death toll from the Chernobyl accident is around 200,000; the estimated mortality in western Europe may be around 40,000.

Control of Radioactive pollution

The main objective in managing and disposing of radioactive (or other) waste is to protect people and the environment. This means isolating or diluting the waste so that the rate or concentration of any radionuclides returned to the biosphere is harmless. To achieve this for the more dangerous wastes, the preferred technology to date has been deep and secure burial. Transmutation, long-term retrievable storage, and removal to space have also been suggested.

- Nuclear devices should never be exploded in air. If these activities are extremely necessary they should be exploded underground.
- In nuclear reactions, closed-cycle coolant system with gaseous coolants of very high purity may be used to prevent extraneous activation products.
- In nuclear and chemical industries, the use of radio-isotopes may be carried under a set of soil or water instead of power or gaseous forms.
- In Nuclear mines, wet drilling may be employed along the underground drainage.
- Nuclear reactors must be enclosed in broad concrete walls to prevent the radiations that emerge out.
- Workers should wear protective garments and glass spectacles should be screened from radiation.
- Extreme care should be exercised in the disposal of industrial waste contaminated with radionuclides. The spend rods are very radioactive containing about 1% U 235 and 1% plutonim.

Deep Underground Disposal

Geologic repositories deep underground have been endorsed by independent scientific organizations around the world including

- The National Academy of Sciences,
- The National Research Council,
- The Congressional Office of Technology Assessment.

Nearly every other country with a nuclear energy program, including Germany, France, Japan and Sweden, has determined that Deep Geologic Disposal is the safest system of permanent nuclear waste management.

Effects of industrial effluents

Industries need a wide variety of raw materials and chemicals which are later discharged as effluents. Acids, alkalis, toxic metals, pesticides and other poisonous substances such as cyanide, dyes, oils, detergents, resins, rubbers are a few to mention. Heated effluents that impart thermal loading on receiving waters and effluents containing radio active materials are also of prime concern. Some of the effluents such as from tanning and meat packing may also contain pathogenic bacteria. The nature and extent of pollution depends on the materials present in the effluent and on the quantity discharged.

Effects on water courses

Color : The effluents contain dyes in higher concentrations which impart color to the receiving streams and they persist for longer distances. Photosynthesis of phytoplankton is affected by these colors.

pH value : The extreme alkalinity makes the receiving water unfit for any purpose. Further, it is deleterious to most of the aquatic life.

Suspended impurities : The colloidal and suspended impurities produce turbidity in the receiving waters. The turbidity and color along with the oil and scum create an unsightly appearance.

Depletion of oxygen : Natural substances such as starch and dextrin and inorganic substances such as sulfide and nitrite present in the effluent exert an immediate oxygen demand. The stream will then be devoid of oxygen and the aquatic life are affected adversely.

Toxic substances : Chromium, sulfide, chlorine and aniline dyes present in these wastes are directly toxic to fish and microbial organisms which carryout purification. Thus the self purification of the water body is affected.

Oils : Various oils (mineral) in the effluent interfere with the oxygenation of stream as they form a blanket on the surface and prevents the entry of oxygen at air/water interface.

Dissolved minerals : The mineral materials, mostly sodium salts increase the salinity of the water and consequently it becomes unfit for irrigation.

Effects on land

1. The excess content of sodium (60%) and boron (2 mg/l) are deleterious to crops.
2. The high sodium alkalinity combined with salinity impairs the growth of plants.
3. Texture of the soil is affected by sodium and penetration of roots is prevented.
4. Soil permeability is also affected by sodium and ultimately the soil will lose its productivity.
5. Suspended and colloidal impurities clog the pores and form a mat on the surface of soil preventing the passage of air, water etc.

EFFECTS OF WATER POLLUTION

Pollution	Effects
Domestic waste	Water borne diseases like cholera (Vibrio cholera) typhoid, dysentery and various health problems , depletion of dissolved oxygen, objectionable odour.
Industrial effluents	It causes deleterious effects on living things and may bring death or sub lethal pathology of kidneys, liver, lungs, brain and reproductive system.
Agricultural waste	Excessive fertilizer leads to accumulation of nitrates in children called methemoglobinaemia. Richness of nutrients results in
Eutrophification	During eutrophification, algal bloom release toxic chemicals into the aquatic system. Algal Bloom leads to oxygen depletion and an increase in CO_2 level. Thus aquatic organisms begin to die which leads to

Bioaccumulation (or) Biological magnification	Aquatic plants and animals can accumulate certain pesticides in their body tissues in greater concentration than in water. This phenomenon is commonly referred to as biological magnification or biological amplification eg.,DDT. It is more threatening as its concentration continuosly increases in successive trophic levels in a food chain which results in many health hazards. DDT absorbed by fish eating birds 25 ppm ↑ DDT in large fish 2 ppm ↑ DDT in small fish 0.5 ppm ↑ DDT in zooplankton 0.003 ppm ↑ DDT in water 0.000003 ppm or 0.003 ppb
Lead (pb)	Anaemia, vomiting, damage of liver, brain and kidney
Arsenic(A)	Mental disturbance, lung cancer, ulcer, kidney damage
Mercury(Hg)	Abdominal pain, headache, diarrhea, chest pain
Cadmium(Cd)	Growth retardation, diarrhea, bone deformation, kidney damage, anemia, damage to lever
Barium(Ba)	Excessive salvation, diarrhea, paralysis
Chromium(Cr)	Gastro intestinal ulceration, diseases of central nervous system, cancer, nephritis
Zinc(Zn)	Vomiting, renal damage
Copper(Cu)	Hypertension, uremia, coma
Temperature:	Reduction of dissolved oxygen , Increase in Biological Oxygen Demand Early hatching of fish eggs and fish mortality, Mitigation
Radioactivity	Serious skin cancer, carcinoma, melanoma, breast cancer, leukemia, DNA breakage and cataract
Siltation	Reduced visibility, Reduction in direct light penetration, Decrease in photosynthetic rate, Chances of anaerobic digestion in the
Oil	Reduction of dissolved oxygen in the water, Reduction in the light penetration, Direct oil coating makes the fishes unable to respire and clog their gill slits, hydrocarbons cause necrosis, paraffins like methane and ethane are asphyxiants.
Synthetic detergent	Complex formation between DNA and mercury or cadmium results in birth defects. Although detergents are not highly toxic to fishes they do cause damage to gills and remove the protective mucus from skin and the intestine.

Effect of Solid waste

Any material that is thrown away or discarded as useless and unwanted is considered as solid waste. At first glance, the disposal of solid waste may appear to be a very simple and mundane problem. In this age of lasers, microcomputers, and space flight, it hardly seems possible that garbage disposal should present any great challenge. But many factors make solid waste disposal a complex problem of huge proportions for a modern industrial society.

Classification of solid wastes

Domestic and municipal wastes: These include garbage and rubbish, like waste paper, plastic, cloth from households, office, hostel and market.

Industrial wastes: The two general categories are process and non-process wastes. The non-process wastes are common to all industries such as packaging, office and cafeteria wastes. Process wastes are more complex and specific to the industrial plants. Their composition depends on type of products produced.

Agricultural wastes: These include cereal and millet straw, paddy husk, sugarcane trash and other crop residues.

Special wastes: The waste materials which endanger public health and welfare and seriously affect environment are : a) Radioactive wastes from atomic power stations, labs and hospitals b) Toxic wastes such as pesticides, heavy metals, pharmaceuticals c) Biological products such as antibiotics, enzymes, pathogens.

Auxiliary operations necessary for solid waste treatment

i) Transport and handling
ii) Pulverization
iii) Compaction

Transport and handling

Solid wastes are collected from source, transported in trucks with hydraulic and pneumatic system to a central place and to compact the waste to a high density, for disposal.

Pulverization

Pulverization of solid wastes is carried out prior to loading, land filling, compacting or incineration to facilitate these processes. Taw roll, impact and gyratory crushers and hammer mills are used for pulverization. It makes the solid waste homogenous and helps in greater initial settlement. The land can be more easily reclaimed and built on.

Compaction

Compaction and balling of solid wastes using hydraulic or pneumatic processes lead to reduction in refuse volume, reduction in collection and transport time and cost, lesser storage area and safety hazards and cleaner storage area.

The most effective way to ameliorate the solid waste disposal problem is to reduce the generation and toxicity of waste. But, as people search for better life and higher standard of living they tend to consume more goods and generate more wastes. Consequently society is searching for improved methods of waste management and ways to reduce the amount of waste management system. This consists of reducing the amount of toxicity of the wastes at the source, recycling, reusing or composting as much of the waste as is economically reasonable. Burning the waste that cannot be economically recycled to generate heat reduces the need for fossils and nuclear fuels.

Recycling and waste reduction play an important part in any waste management strategy. But engineering analysis clearly shows that these options alone cannot solve the solid waste problem. At the same time, according to best estimates, it may be possible to reach recycling technologies that must be

developed, additional markets must be found, and industry must produce more products that are easy to recycle. All the same, even if all of these steps are successfully taken more than 160 million tons of solid waste still have to be treated by other means, such as waste – to – energy combustion and land filling.

Technologies in solid waste management

Solid waste management is a difficult process because it involves many disciplines. These include, technologies associated with the control of generation, storage, collection, transfer and transportation, processing, marketing, incineration and disposal of solid wastes. All of these processes have to be carried out within existing legal and social guidelines that protect the public health and environment and are aesthetically acceptable. They must be responsive to public attitudes and the disciplines included in the disposal process include administrative, financial, legal, architectural, planning and engineering functions. For successful integrated solid waste management plant, it is necessary that all these disciplines communicate and interact with each other in a positive interdisciplinary relationship The various techniques employed in solid waste management include,

1) Composting
2) Sanitary land filling (Controlled tipping)
3) Thermal process (Incineration and pyrolysis)

COMPOSTING

It is being increasingly realized that composting is an environment friendly process to convert wide variety of wastes into valuable agricultural inputs. This process minimizes the environmental problems. Composts are excellent source of humus and plant nutrients, the application of which improves soil biophysical properties and organic matter status of the soil. Composting can be defined as the biological conversion of organic wastes into an amorphous dark brown to black colloidal humus like substance under conditions of optimum temperature, moisture and aeration. Nutrient content of compost depends largely on the nutrient content of the wastes. Composting is a process in which the organic portion of solid waste is allowed to decompose under carefully controlled conditions. It is a biological rather than a chemical or mechanical process; decomposition and transformation of the waste material are accomplished by the action of bacteria, fungi, and other microorganisms.

With proper control of moisture, temperature, and aeration, a composting plant can reduce the volume of raw organic material by as much as 50 per cent. In addition, composting can stabilize the waste and produce an end product that may be recycled for beneficial use. The end product is called **compost** or **humus**. It resembles potting soil in texture and earthy odor, and it may be used as a soil conditioner or mulch.

A complete municipal solid waste (MSW) composting operation includes sorting and separating, shredding and pulverizing, digestion, product upgrading, and finally marketing. Sorting and separation operations are required to isolate organic, decomposable waste materials from the plastic, glass, metal, and other non-biodegradable substances. Solid waste sorting and separation methods are a key part of MSW recycling operations.

Shredding and pulverizing serve to reduce the size of the individual pieces of the organic waste, resulting in a relatively uniform mass of material. This facilitates handling, moisture control, and aeration of the decomposing waste. Size reduction also helps optimize bacterial activity and increases the rate

of decomposition. After size reduction, the wastes are ready for the actual composting or digestion step. Digestion may take place in open windrow or in an enclosed mechanical facility.

A windrow is a long, low pile of the prepared organic waste, usually about 3m (10 ft) wide at the base and about 2 m (6 ft) high. Most windrows are conical in cross section and about 50 m (150 ft) in length. The composting waste is aerated by periodically turning each windrow. Turning frequency varies with moisture content and other factors. When moisture content is maintained at about 50 per cent, windrows are turned two or three times a week and in some cases daily.

Generally, open – field windrow composting takes about 5 weeks for digestion or stabilization of the waste material. An additional 3 weeks may sometimes be required to ensure complete stabilization. Temperatures in an aerobic compost windrow may reach 65^{o}C (150^{o}F) because of the natural metabolic action of thermophilic microbes that thrive at such elevated temperatures. The relatively high temperatures destroy most of the pathogenic or disease-causing organisms that may be present in the waste.

Open-field windrow composting requires relatively large land areas. To reduce land requirements, various types of enclosed mechanical systems can be used in lieu of the open-field method. A variety of mechanical type compost systems are available. Oxygen is supplied to the waste material by forced aeration, stirring, or tumbling. In addition to reducing land requirements, enclosed mechanical compost facilities can reduce the time required for stabilization from about 5 weeks to about 1 week.

Composting is the aerobic, thermophilic degradation of organic matter present in the refuse by microbes, predominantly by fungi and actinomycetes, which are favoured by semi moist condition that prevail in the process. The control parameters for optimum composting include, temperature (40^{o}C), moisture (40.7%), pH (4.5 – 9.5), nutrients (C: N ratio 40:1); C: P ratio (100:1), air (0.5 – 0.8 m / d / kg volatile solid) and particle size (6-25 mm).

The digestion of the waste is carried out naturally in an outside decomposition area in windrows (for five weeks) or in mechanized composting plants (for 4 to 6 days). In natural system, the garbage is mixed with nutrient source (sewage sludge / animal manure) and a filler (wood chips) to provide entry of air. The mixture is turned over twice a week and the process is completed in 4-6 weeks. The darkening of refuse, fall in temperature and a musty odour indicate completion of the process.

Before the stabilized compost or humus can be sold for use as a mulch or soil conditioner, it must be processed further to upgrade or improve its quality and appearance. This includes drying, screening, and granulating or pelletizing. Sometimes, the compost is placed in bags, although bulk sale is more efficient and economical. Compost can increase the organic and nutrient content of soil and improve its texture and ability to retain moisture.

Co-Composting

An interesting example of integrated waste management is co-composting of municipal solid waste and sewage sludge. Sewage sludge adds nitrogen, phosphorous, and other elements that enrich the solid waste and help the composting process. The sludge is first dewatered so that it does not add too much moisture to the compost pile. The dewatered sludge and organic portion of MSW must be thoroughly mixed. At a time when ocean disposal of sludge has been banned and sludge incinerators meet with much public opposition, co-composting may offer an increasingly viable technique for processing both sludge and MSW organics prior to final disposal.

Vermicomposting

The key role of earthworms in improving the soil fertility is well known for a longer period. Earthworms feed on any organic wastes, consume three to five times their body weight and after using 5 to 10 per cent of the organic wastes for their growth, excrete the mucus coated undigested matter as worm casts. Worm casts consist of organic matter that has undergone physical and chemical breakdown through the activity of the muscular gizzard, that grinds the material to a particle size of 1-2 micron. The nutrients present in the worm casts are readily soluble in water for the uptake of plants. Vermicastings are rich sources of macro and micronutrients, vitamins, enzymes, antibiotics, growth hormones and immobilized micro flora.

Vermicompost refers to organic manure produced by earthworms. It is a mixture of worm castings, including humus, live earthworms, their cocoons and other microorganisms. Vermicomposting is an appropriate method for disposal of non-toxic solid and liquid organic wastes. It helps in cost effective and efficient recycling of animal wastes (Poultry droppings, horse, piggery excreta and cattle dung), agricultural residues and industrial wastes using low energy.

Types of earthworms

Several types of earthworms are found in our soils. Earthworms can be divided into the following two categories:

1. Epigeic – the surface living worms
2. Endogeic – the burrowing worms

Epigeic: These worms are found on the surface and are reddish brown in colour. They do not process the soil but are efficient in composting of organic wastes. They enhance the rate of organic manure production through biodegradation or mineralization.

eg. *Lampito mauritii, Octochaetona serrata, Perionyx excavatus*

Endogeic: These species burrow and mix the soil, from different horizons in the profile. They ingest organic and mineral fraction of soil, thus promoting the formation of organo mineral complexes. Organo – mineral crumbs are brought from deeper parts of the soil profile to the surface. Different species of earthworms show specificity to soil types, moisture content and temperature.

Method of vermicomposting

- Selection of earthworm: Earthworm that is native to the local soil may be used
- Size of pit: Any convenient dimension such as 2m x 1m x 1m may be prepared
- Preparation of vermibed: A layer, 15-20 cm thick of good loamy soil above a thin layer of (5 cms) broken bricks and sand should be made.
- Inoculation of earthworms: About one hundred earthworms are introduced as an optimum inoculating density into a compost pit of about 2m x 1m x 1m, provided with vermibed
- Organic layering: It is done on the vermibed with fresh cattle dung. The compost pit is then layered to about 5 cm with dry leaves or hay or organic wastes. Moisture content of the pit is maintained by the addition of water.
- Wet organic layering: It is done after four weeks with moist green organic waste, which can be spread over it to a thickness of 5 cm. This practice can be repeated every 4 days. Mixing of wastes periodically without disturbing the vermibed ensures proper vermicomposting. Wet layering with organic wastes can be repeated till the compost pit is nearly full.

Harvesting of compost: At maturation (after 120 days), the moisture content is brought down, by stopping the addition of water. This ensures drying of compost and migration of worms in to the vermibed. The mature compost, a fine loose granular mass (about 1500 kg), is removed from the pit, sieved, dried and packed. Matured vermicompost is rich in nutrients and recommended @ 50 t ha^{-1}.

Characteristics of vermicompost

pH	7.00
EC dsm^{-1}	1.20
Organic carbon%	30.50
Macronutrients Total nitrogen %	0.66
Total $P_2O_{5\%}$	1.93
Total K_2O%	0.42
Micro nutrients Fe (ppm)	19.8
Zn (ppm)	0.90
Mn (ppm)	16.50
Cu (ppm)	2.30

Sanitary land filling (Controlled tripping)

Land filling is the most common and economic method of solid waste disposal. The indiscriminate land filling of solid waste in open dumps without adequate control and consideration of sanitation and public health as generally followed in India is dangerous. It results in water pollution, bad odour, fire and breeding of flies and rats.

It should be replaced by sanitary land filling or controlled tipping. The construction of sanitary land filling includes:

1) Deposition of solid waste in such a way to have a working force of minimum area.
2) Spreading and compaction of waste in thin layers
3) Covering of the waste with a layer of compacted cover soil daily.
4) Final cover of the entire construction with compacted earth layer of 1.0 m thick.

The solid wastes in sanitary land fill are degraded by soil microbes. In comparison with other biological treatment systems such as activated sludge and anaerobic digestion, the microbial degradation of solid waste proceeds at a slow rate.

Thermal process Incineration

Incineration is a process of destruction of waste at high temperature. The combustible wastes are converted through controlled combustion to a residue, which contain no combustible matter. If land suitable for solid waste (SW) land filling operations is not available within economic haul distances, then incineration is necessary. The solid waste is reduced in volume (80% - 90%) and height (98-99%). Incinerator can accept toxic and industrial wastes of any size in solid or powdery form. The other special wastes include hospital wastes, putrifiable organic solids from slaughter houses.

Pyrolysis (Destructive distillation)

Pyrolysis is the process of conversion of biomass into solid, liquid and gaseous energy. Pyrolysis results in the chemical breakdown of organic carbon material into three basic components: 1) gas phase containing mainly hydrogen, CO_2, CO and CH_4 2) tar or oil phase containing simple organic acids, methanol and acetone and 3) char phase made up of pure carbon and inert material. Pyrolysis does not cause pollution of the atmosphere and large quantities of potentially hazardous plastics could be treated.

There is no single prescription for an integrated waste management program that successfully works in every instance. Each situation must be analyzed on its own merit, an appropriate integrated waste management plan must be developed from hard data, and social attitudes and the legal frame work must be taken into account. The waste management disposal field is in a constant state of flux and appropriate solutions should be innovative, as well as technically and economically sound.

Sludge management

Suspended solids removed from wastewater during sedimentation and then concentrated for further treatment and disposal are called **sludge** or **biosolids**. Even in fully aerobic waste treatment processes in which sludge is repeatedly recycled, most of the sludge must eventually be removed from the system. The task of treating and disposing of this material is called **sludge management**.

Sludge characteristics

The composition and characteristics of sewage sludge vary widely. Since no two wastewaters are alike, the sludges produced will differ. Furthermore, sludge characteristics change considerably with time. Wastewater sludge typically contains organics (proteins, carbohydrates, fats oils), microbes (bacteria, viruses, protozoa), nutrients (phosphates and nitrates), and a variety of household and industrial chemicals. The higher the level of heavy metals and toxic compounds, the greater is the risk to humans and the environment. A key physical characteristic is the solids concentration, because this defines the volume of sludge that must be handled.

Sludge is treated prior to ultimate disposal for two basic reasons: **volume reduction** and **stabilization of organics**. Stabilized sludge does not have an offensive odor and can be handled without causing a nuisance or health hazard. A reduced sludge volume minimizes pumping and storage requirements and lowers overall sludge-handling costs. Several processes are available for accomplishing these two basic objectives. They include sludge thickening, digestion, dewatering, and co-composting. Incineration is considered as a final disposal option.

Sludge disposal

Widely employed methods for final disposal of waste water sludge have included ocean dumping, land filling, incineration, land application, and sale as fertilizer.

Effect of hazardous wastes

The World Health Organization (WHO) considers waste causing short term hazards such as acute toxicity by ingestion, inhalation or skin absorption, corrosivity or other skin or eye contact hazards or risk or fire and explosion and wastes causing long term hazards including chronic toxicity upon repeated

exposure, carcinogenecity, resistant to detoxification process such as biodegradation, the potential to pollute underground or surface water or aesthetically objectionable properties such as offensive smell as "hazardous wastes".

The major hazardous wastes include,

- Radionuclides
- Xenobiotics
- Heavy metals

Industrial growth, economic development, consumerisation indicate a country's progress and life standard of individuals. Industrial growth has brought along with new problems, too. Water pollution, air pollution, land pollution, noise pollution, radioactive pollution, solid wastes, depletion of resources, scarcity of good quality water, spreading health hazards, are all the consequences of stupendous industrial activities with less attention to its negative impacts on man and his environment (Ramana, 1999). Nature's built in mechanisms and self- regulation ability has been thrown out of gear by the quantity and complexity of wastes generated by the modern society. As technological progress has followed the industrial revolution, environmental problem solving must follow technological progress. Industrial processes and products thereof both must become environmentally friendly and least damaging.

Hazardous waste management is the most challenging task before the different technologies. Although efforts are continuously on to improve upon the raw material usage, processes and search for alternative eco-friendly products, the generation of hazardous wastes and their quantitative contribution requires to be tackled.

Treatment technologies for hazardous wastes

Physical	:	Soil washing, Air \stream stripping, Vitrification, Solidification, Carbon adsorption, Ion exchange.
Thermal	:	Incineration
Chemical	:	Solvent extraction, oxidation, ozonolysis, Electro kinetic removal.
Biological	:	Land farming, composting, bio reactor processes, bio- enrichment, bio augmentation and landfill.

Principles of Biological Treatment methods

"***Biostimulation***" and "***bioaugmentation***" are the two main ways of initiating biological treatment, particularly in land treatment for hazardous wastes. Biostimulation makes use of existing microorganisms and makes conditions favourable for their action by adjustment of nutrients, pH, temperature, growth factors etc. Bioaugmentation involves externally introduced cultures pure or mixed with specific degradation capacities. Bioaugmentation if done for biodegradation, introduced microorganisms should able to remain viable, should compete with the existing microorganisms.

Genetic, biochemical and ecological ability of microorganisms used plays important role in biodegradation. Although a faster kinetic rate will mean a less expensive system, biomass with a slow specific growth rate responds more favourably to shock loadings. Reactors are to be designed so that microbiological systems are properly controlled under various operating conditions to give effluents of acceptable quality.

Treatment systems

Suspended growth and fixed film are the two main categories of treatment systems although combinations of them are widely used. Immobilised systems are less sensitive to toxicity and have higher efficiency in degradation of hazardous wastes. Fixed film systems are more stable due to a higher biomass concentration and resistance to mass transfer. In fixed films, no wash out of organisms occurs even if the growth rate of the organisms is greatly reduced. Land treatment is the most widely used option to treat toxic wastes.

Microbial Cultures for biodegradation

Biological detoxification may be carried out using pure cultures or mixed cultures. Mixed cultures have a potential advantage over pure cultures in the degradation of toxic compounds in hazardous wastes. Mixed cultures are particularly useful when complete degradation of toxic organics to CO_2, CH_4, H_2S, N_2 etc. Enrichment and selection procedures are useful in selecting mixed cultures carrying out degradation.

Biotechnological process for treating liquid waste containing toxic metals

- Adsorption
- Extra cellular precipitation
- Uptake by purified bio polymer

Adsorption of heavy metals to living or dead cells, extra cellular polysaccharide, capsules and slime layer all referred as biosorption. Cell walls and envelops of bacteria, yeast, algae are very
efficient in bio sorption due to the charged group present in them. Metals may deposit around cells in the form of phosphates, sulfates or oxides.

Advantages of Biological Treatment methods

- These methods have economic advantages over other methods.
- Diversity of degradation action is possible by biological treatment.
- These methods are robust and have a large capacity for degrading toxic and hazardous materials.

Disadvantages of Biological treatment

i. **Difference in wastes**

Microbial enzymes responsible for degradation are specific for individual compounds , no single organism destroy all wastes.

ii. **Concentration of waste chemicals**

Higher concentration of toxic chemicals inhibit the survival of key members.

iii. **Inhibitory mixtures**

Industrial wastes / contaminated sites contain not only the toxic chemicals but also the other chemicals that incompatible with the catabolism of target compounds.

iv. **Rate of degradation**

Because of the above problems the degradation / treatment process is very slow and hence, development of improved strains essential.

Cloning vector for environmental applications

The environmental applications of genetically engineered organisms requires the use of cloning vector that function under environmental conditions are stably maintained , non transmissible , cost effective , environmentally friendly Modern molecular biological techniques, in particular rapid sequencing, the polymerase chain reaction, and site-directed mutagenesis, allow selective alteration of

nearly any protein and provide an avenue into rational protein design to improve catabolic activities protein engineering may improve enzyme stability ,substrate specificity, and kinetic properties.

Construction of bacteria with multiple pathways

Genetic engineering permits the combination of several degradative activities within a single host organism. For eg: Bio remediation efforts are sometimes limited by the survival and or *in situ* performance of an added bio catalyst because of ecological factors that are not easily predicted from laboratory studies. Moreover , the combination of multiple activities in host that is easily and inexpensively cultured to high cell densities would certainly reduce fermentation costs.

Advantages of *in situ* application:

- It allows destruction of contaminants *in situ*
- Minimum risk, and environmental impact
- Minimum cost for removing, treating, and disposing

Engineering stress resistance

Microorganisms used to remediate hazardous wastes are likely to be exposed to a wide variety of environmental stresses . Stress factor can range from high concentration of contaminants, toxic metals, or solvents; through extremes in pH , oxygen tension , temperature , ionic strength, and nutrient concentrations; to conditions of extremely low carbon and nutrient availability. Microorganisms must adapt to these conditions to be able to effect remediation. In some cases genetic engineering may be helpful in augmenting resistance to such stresses, there by facilitating good performance of the degradative organism under adverse conditions.

The following is the list of *in situ* options with order of preference for hazardous waste management.

- Eliminate hazardous waste generation at production process stage
- Do recovery of constituents of hazardous waste
- See if landfill is suitable and economical
- Decompose the waste by physical / chemical/biological means
- Immobilise the waste by solidification or encapsulation so that landfill becomes acceptable.

Improper disposal of hazardous and toxic waste can cause serious damages to health and environment. Recalcitrant, man made compounds and their products are of major concern in this regard. Bioremediation, is one of the most effective innovative technologies to come along in this century to treat these hazardous wastes. They offer complete destruction of contaminants and can often be applied at a lower total cost, at a faster rate. With the advancement of bioreactor designs, the use of genetically engineered microbes, biodegradation technology has been successful in making its impact felt on pollution abatement efforts.

SOLID WASTE MANAGEMENT

- Waste, which is non-affective and comes from city, town or village as domestic and biomedical waste is termed as municipal solid waste
- The process of transportation, storage, collection and processing of solid waste in a protective and economic manner is termed as solid waste management.
- The above steps are followed thoroughly in waste management, its first and foremost priority is waste avoidance by minimizing it.
- To reduce waste, reuse it and recycle, it is called waste prevention.
- It is our second priority to reuse, recycles it at the maximum level.

- Once the possibility of waste prevention is exhausted, the next priority is to reduce the volume of residual waste pass on for final disposal.
- In recycling, material is separated from the garbage for the process of recycling.

For example

- Old cars are recycled in the German industry.
- Gas, oil, Chemicals and Tar are also retrieved from the old tyres.
- Papers, cans etc. are recycled to produce fresh papers.
- Glass is melted to prepare new articles.

Types

- Garbage or food waste
- Rubbish
- Agricultural waste
- Industrial waste
- Hazardous waste

Causes

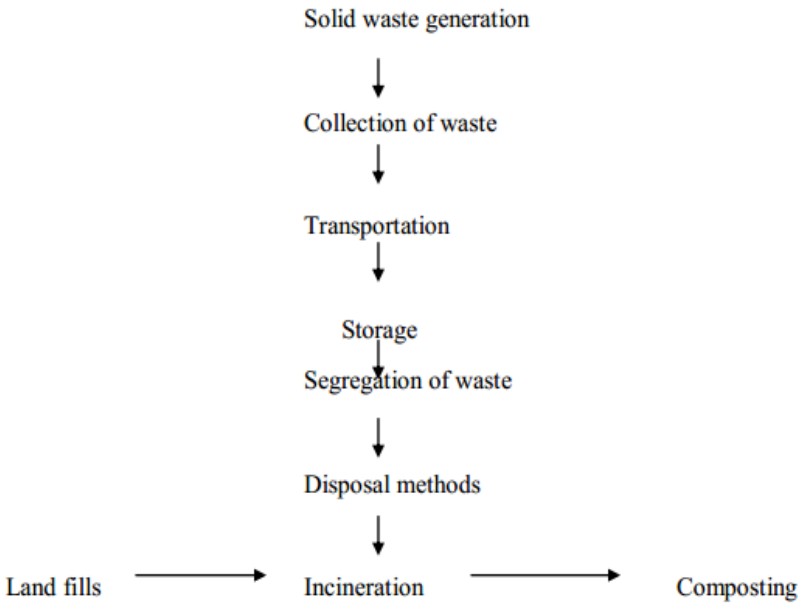
- **Over population -** Pollution naturally increases with the growing number of persons, produce more waste.
- **Affluence -** The tendency to pronounce the things as fashion and check them out, when not required as out of fashion.
- **Technology -** Packaging of most of the gifts is considered as the source of solid waste pollution as most of these are non-biodegradable.
- Due to poor implementation of environment protection laws, urbanization, lack of awareness and lack of participation from the public, the problem of solid waste has increased at the highest level.
- Growth in consumption leads to consumption of items and on the other hand, wastes production.
- Population increase
- Growing Urbanization
- Industry
- Mining
- Transport

Effects

- Contaminates water and air, resulting into diseases and dysentery in Human beings.
- Mosquitoes breed in the stagnant water, blocked due to waste choked in the drains.
- Decomposition of solid waste spreads obnoxious odour in the air, thus polluting it.
- Burning of waste, especially plastic adds up obnoxious fumes in the air.
- Garbage dumps and decomposed waste helps many harmful species to breed in them.
- The infected water supply also leads to large scale epidemics.

Control measures

- Solid waste management include the waste generation



- Collection of solid waste
- Disposal of solid waste

Disposal

- **It involves the following process:**

Sanitary landfill:

- The people in the city dump around 90% of the solid waste into natural or constructed pit or depression which compacts due to the surrounding dust.

Composting:

- In this process, the materials like glass, rubber and plastic etc. are separated and the rest waste is exposed for bacterial action for decomposition for several months to produce manure.

Incineration:

- Burning of waste to warm up residential units is termed as incineration.
- It is a convenient and quick method.

Pyrolysis:

- It's the process of burning the waste in absence of 0_2- In it organic compounds split into gaseous and gaseous fractions (CO, $C0_2$, CH_4, tar and charred carbon).

Disposal into sea:

- It's a simple and cheap method in which the solid waste is disposed under deep sea water at a remarkable distance from the coastal areas.

DISASTER MANAGEMENT

- Geological processes like earthquakes, volcanoes, floods and landslides are normal natural events which have resulted in the formation of the earth that we have today.
- They are, however, disastrous in their impacts when they affect human settlements.
- Human societies have witnessed a large number of such natural hazards in different parts of the world and have tried to learn to control these processes, to some extent.

FLOODS

- Submergence of waste areas of land under water for many days in continuation.

Causes

- Heavy rainfall
- Sudden Snow melt
- Clearing of forest for agriculture
- Industries increase the value and rate of water discharge after a storm

Effects

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

Control measures:

- Building wall prevent spilling out the flood water over flood pains
- Advance meteorological information will prevent flood damage
- 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

- Underground nuclear testing
- Volcanic eruption
- Pressure of manmade dams, reservoir and lakes

- Movements of plates of earth

Effects

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

Control measures

- Government can inform the earthquake prone zone and caution residence.
- 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

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

Control measures

- Planting more trees on hostel areas
- Construction of dams
- 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

- Earthquake, shock, vibration
- Deep water ground mining
- Movement of heavy vehicles on the unstable sleepy region

Effects

- Increase erosion of soil

- Block the roads
- Damage the houses, crop yield, life stock

Control measures

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

DISASTER

- Disaster is a sudden, calamitous event bringing great damage, loss, destruction and devastation to life and property.
- WHO defines Disaster as "any occurrence that causes damage, ecological disruption, loss of human life, deterioration of health and health services, on a scale sufficient to warrant an extraordinary response from outside the affected community or area.

HAZARD

- Hazards are defined as Phenomena that pose a threat to people, structures, or economic assets and which may cause a disaster.
- They could be either manmade or naturally occurring in our environment.

VULERABILITY

- Vulnerability is defined as the extent to which a community, structure, service, and/or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrain or a disaster prone area.

RISK

- Risk is a measure of the expected losses due to a hazardous event of a particular magnitude occurring in a given area over a specific time period.
- Risk is a function of the probability of particular occurrences and the losses each would cause.
- The level of risk depends on:

- Nature of the Hazard
- Vulnerability of the elements which are affected
- Economic value of those elements

DISASTER RISK = HAZARD + VULNERABILITY

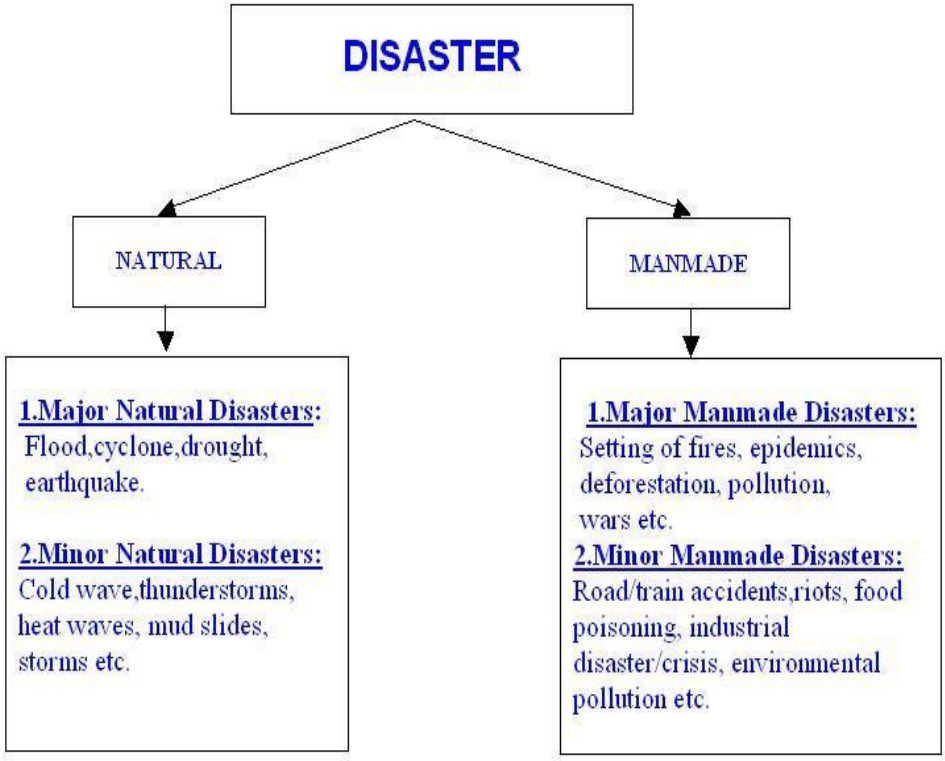
CAUSAL FACTORS

An emergency and a disaster are two different situations

- An **emergency** is a situation in which the community is capable of coping. It is a situation generated by the real or imminent occurrence of an event that requires immediate attention and that requires immediate attention of emergency resources.
- A **disaster** is a situation in which the community is incapable of coping. It is a natural or human caused event which causes intense negative impacts on people, goods, services and / or the environment, exceeding the affected community's capability to respond therefore the community seeks the assistance of government and international agencies.

TYPES OF DISASTER

- Generally, disasters are of two types "Natural and Manmade. Based on the devastation, these are further classified into major/minor natural disaster and major/minor manmade disasters. some of the disasters are listed below:



NATURAL DISASTER

- A natural disaster is a major adverse event resulting from natural processes of the Earth; examples include floods, volcanic eruptions, earthquakes, tsunamis, and other geologic processes.
- A natural disaster can cause loss of life or property damage, and typically leaves some economic damage in its wake, the severity of which depends on the affected population's resilience, or ability to recover

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

Control measures

- Government can inform the earthquake prone zone and caution residence.
- 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

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

Control measures

- Planting more trees on hostel areas
- Construction of dams
- 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

- Earthquake, shock, vibration
- Deep water ground mining
- Movement of heavy vehicles on the unstable sleepy region

Effects

- Increase erosion of soil
- Block the roads
- Damage the houses, crop yield, life stock

Control measures

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

MAN - MADE DISASTER

Fires

- Fires are events of burning something.
- They are often destructive taking up toll of life and property.
- It is observed that more people die in a fire than in a cyclone, earthquake, floods and other natural disasters combined.
- Fires are a great threat to forests and wild life because they spread speedily and cause tremendous damage in a short time.
- In cities fires break out in home, jhuggis, buildings specially godowns and factories.
- Fire can spread to a large area. Many people may die of burns and asphyxiation.

- It may also cause contamination of air, water and soil, which may affect the crops, plants and animals, and soil fertility.

Causes

- Throwing burning matchsticks or cigarettes irresponsibility.
- Heating sources can cause fire in houses e.g. clothes may catch fire while cooking on kerosene stove or gas stove.
- Cooking accidents are a major cause of fire at home. Fire can result due to unattended cooking.
- A short circuit in an electric wiring can cause fire. Overheating of electric appliances, poor wiring connections, use of sub-standard quality appliances can also result in a fire.
- Rubbish and waste materials often lying on roadsides or near houses may catch fire when people throw burning matchstick or cigarette butt.
- Storage and transportation of inflammable material or explosive chemicals without proper precautions may cause fires.
- Forest fires may result from human negligence or carelessness.

Effects

Casualities

- Death of humans and livestock may occur due to burning or serious injuries from fire.
- In rural areas often the entire harvested crop stored in securely may catch fire and burn to ashes resulting in heavy loss to the owner.

Management

- Obey fire safety rules and remember the evacuation route in case of fire.
- Keep matches away from children.
- Keep and handle inflammable materials with utmost care.
- Keep a fire extinguisher in the house and learn how to use it.
- When you leave home, make sure to shut off all electrical and gas appliances.
- Do not plug several devices into one socket.
- Do not block access routes by cupboards or any furniture.
- In the smoke filled corridor, crawl on all floors or on your belly as the smoke is less on the floor.
- Find at least two ways to escape from your home.
- Make sure that you remove all the waste material from work place and home on regular basis.

- Hazardous materials such as paints, solvents, adhesives, chemicals or gas cylinders should be kept in separate storage, well away from fire.

Road accidents

Road networks are developed for better connectivity and service. Increased number of vehicles, violation of traffic rules, speeding, drunken driving and poor maintenance of vehicles as well as of roads are some of the main causes of road accidents. In order to avoid accidents following safety measures can be adopted:

- Look on either side of the road before crossing.
- Use zebra crossing while crossing the road by foot.
- Wear helmet while riding a two-wheeler.
- Use seat belt provided in your car.
- Drive only if you possess a proper driving license.
- Be familiar with road markings and honour them.
- Maintain a safety distance from the vehicle in front.
- Do not jump lanes. It becomes difficult for other vehicles, on the road to anticipate your move.
- Do not be rash and do not try to overtake unnecessarily.
- The best way to be safe on roads is to follow â€œlane drivingâ€•
- While driving avoid sudden acceleration and deceleration.
- Replace the worn tyres and faulty headlamps.
- Check the tyre pressure, radiator water, brake oil and fuel frequently.
- Dip your beam whenever you spot an oncoming vehicle.
- Follow the maintenance schedule prescribed by the manufacturer.
- Overcome impatience, anger and intoxication during driving. Road rage is dangerous.
- In case a mishap occurs stay calm.
- In case of fire, try to get out as early as possible and do not worry about the baggage.

Rail accident

- The most common type of rail accident is derailment due to human error, sabotage or natural landslide in a hilly track, or fire.

- Rail accidents lead to large number of casualties and material damage. Indian Railways incur heavy loss due to such accidents every year.

Some of the common safety measures are:-

- At railway crossings pay attention to the signal and the swing barrier. Do not get underneath and try to get across.
- In case of a unmanned crossing, get down from the vehicle and look at either sides of the track before crossing.
- Do not stop the train on a bridge or tunnel where evacuation is not possible.
- Do not carry inflammable material in a train.
- Do not lean out of a moving train.
- Do not smoke in train.
- Do not pull the emergency cord unnecessarily.

Air accidents

Air accidents may occur due to technical problems, fire, poor landing and take-off, weather conditions, hijacking, bombing etc.

Some of the common safety measures are:

- Pay attention to the flight crew safety demonstration.
- Carefully read the safety card in the pocket.
- Know where the nearest emergency exit is and learn how to open it.
- Always keep your seatbelt fastened when seated.
- Stay calm, listen to the crew members and follow their instructions.
- Before you try to open any emergency door yourself, look outside the window.
- If you see a fire outside the door, do not open it or the flame may spread into the cabin.
- Try to use an alternate route for escape.
- Remember, smoke rises. So try to stay down if there is smoke in the cabin.
- If you have a cloth, put it over your nose and mouth.

Industrial accidents

- Industrial accidents can be due to explosion, fire and leakage of toxic or hazardous chemicals and lead to heavy loss of life and material.

- Leakage of chemicals and explosion may be due to human error, technological failure or geological hazards like earthquakes, flood etc.
- Fire in an industry may result from human error or electrical faults (short circuit).

Effects

- The industrial premises and immediate surroundings are at high risk in the event of an industrial accident.
- Employees and residents of nearby localities and their live-stock and crops in nearby areas are severely affected.
- The environment over a large area gets polluted.
- Hazardous chemicals released into the atmosphere or into a water body may travel long distances and may even damage the entire ecosystem around the industrial area.
- This is what has happened in Bhopal in the year 1984, when about 45 tonnes of methyl isocyanide (MIC) gas leaked into the atmosphere killing more than 2500 people.
- Explosion or fire or leakage of corrosive chemicals severely damage structures.
- If the chemical is in gaseous form the geographical spread is fast and wide . Many people may die either due to mechanical damage from explosion or fire or due to toxicity of the poisonous chemicals.
- The routes of exposure to chemical released from an accidents are from inhalation, eye exposure, skin contact and ingestion.
- The polluting agents can have both immediate or long term effects.
- The immediate effects include death or other symptoms like dizziness, headache, irritation etc.
- The long term effects may include cancer, heart failure, brain damage, disfunction of immune system, deformation, genetic disorders orcongenital(by birth) disorders in children.

Management

Inventory of hazardous chemicals

- It is important to have an inventory of hazardous chemicals along with their quality, storage locations, characteristics along with possible hazard associated with hazardous chemicals and this informed all employees and people living in the neighbourhood should informed about the potential risk.
- The inventory as far as possible high risk areas demarcated and displayed along with indicating affected zone and safe routes for evacuation in the event of emergency.

Location of industries

- Industries should not be sited in residential areas. A large buffer zone, in form of a green belt, for separating an industrial area from residential areas.

Community preparedness

- The community should be aware of the hazardous installations and know how to combat the situation.
- Some members of the community should monitor the potential risk and participate in safety training organised by industries.

Other measures

- Limit storage capacity of the toxic chemicals.
- Improve firefighting capability, warning systems and measures for preventing pollution dispersion.
- Develop emergency relief and evacuation planning for employees and nearby settlements.
- Adopt insurance for employees and surrounding population which is mandatory under the law.

Epidemics

- Epidemic is defined as occurrence of an illness or other health related event that is unusually affecting a large population.
- An epidemic can be anticipated by a sudden increase in the number of people suffering from a particular disease, increase in the population disease carrier.
- In order to control the spread of epidemics urgent measures are essential.
- Outbreaks of communicable disease to ready epidemic level are potentially high after a disaster.

Cause

- The outbreak of diseases is mainly due to poor sanitary condition leading to contamination of water or spread of disease form breeding of the disease vectors.
- Other factors include seasonal changes that favour breeding of insects.
- Vectors, exposure of a non-immune population (eg tourists or migrants), poverty and overcrowding.

Effects

- Epidemic may cause mass illness or death.
- There are secondary effects such as disruption in the society and economic losses.
- Vulnerability is high among those who are poorly nourished, people living in unhygienic in sanitary conditions, poor quality of water supply, lack of access to health services.

Management Measures

- Preventive public health measures needs to be strengthened.
- Personal protection through vaccination is an effective mitigation measure.
- Improvement of sanitary conditions, fumigation of vector breeding sites and proper disposal of domestic and municipal wastes greatly reduce chances of epidemic spread of diseases.
- Contingency plan for dealing with the epidemics that is likely to occur in the region.
- Early warning system and regular surveillance are primary requirements so as to mount an effective control response in early stages to prevent any outbreaks.

Disaster Management

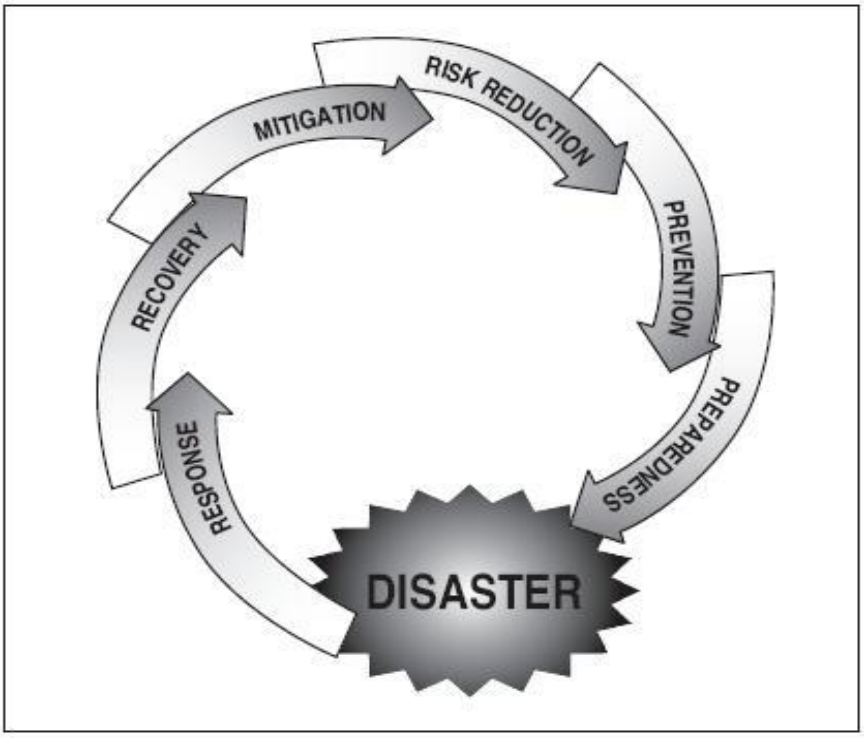
- Disaster Management is the discipline of dealing with and avoiding risks.
- It is a discipline that involves preparing for disaster before it occurs, disaster response (e.g. emergency evacuation, quarantine, mass decontamination, etc.), as well as supporting, and rebuilding society after natural or human-made disasters have occurred.
- In general, any disaster management is the continuous process by which all individuals, groups, and communities manage hazards in an effort to avoid or ameliorate the impact of disasters resulting from the hazard.

Mitigation

- Mitigation efforts attempt to prevent hazards from developing into disasters altogether, or to reduce the effects of disasters when they occur.
- The mitigation phase differs from the other phases because it focuses on long-term measures for reducing or eliminating risk.
- The implementation of mitigation strategies can be considered as part of the recovery process if applied after a disaster occurs.

DISASTER MANAGEMENT CYCLE

- At the time of disaster, various agencies such as government, NGOs and community plays an important role for disaster management.
- These are preparedness, response, recovery and prevention.



Disaster management has four basic components:

Preparedness

- Measure to ensure that communities and services are capable of coping with the effect of disaster.

It has the following main elements:

- Community awareness and education;
- Preparation of disaster management plans for community, school, individual;
- Mock drill, training and practice;
- Inventory of resources both material resources and human skill resources;
- Proper warning systems;
- Mutual aid arrangement;
- Identifying the vulnerable groups;

Response:

- Measures taken in anticipation of, during and immediately after a disaster for minimizing its adverse impact.

It has following main elements:

- Activate the emergency operation centres (control room);
- Deployment of search and rescue teams.

- Issuing updated warning;
- Setting up community kitchens using local groups;
- Set up temporary living accomodation and toilet faciliites;
- Set up medical camps;
- Mobilising resources;

Recovery:

- Measures are initiated to undertake reconstruction of the physical infrastructure and restoration of economic and emotional well being.

The main elements are as follows:

- Community awareness on health and safety measures;
- Counselling programme for those who have lost the near and dear ones;
- Restoring the essential services -roads, communication links, electricity etc.;
- Providing shelters;
- Collecting usable materials for construction from rubble;
- Providing financial support;
- Finding employment opportunities;
- Reconstructing new buildings.

Mitigation

- Any activity that reduces either the chance of a hazard taking place or a hazard turning into disaster.

Risk reduction

- Anticipatory measures and actions that seek to avoid future risks as a result of a disaster.

Prevention:

- Measures to eliminate or reduce the incidence of severity.
- Land use planning;
- Preventing habitation in risk zones;
- Disaster resistant buildings;
- Finding ways to reduce risk even before the disaster strikes;
- Community awareness and education.

The first few hours before and after a disaster are critical and precious for saving lives and reducing further injury. Often external help may take time to reach the disaster site. In any disaster, often the neighbours are first to respond. The first responders are people who act first in a disaster situation, usually lack basic response skills to deal medical or other emergencies. The aim of community level management is to train the individuals and the members of local community to deal with emergency situation effectively. Trained community members are lifesaving assets in such situations. Thus community level management involves people's participation.

CLASS: I BSc BT **COURSE NAME: ENVIRONEMTNAL STUDIES**

COURSE CODE: 19AEC201 **UNIT – V**

Social Issues and the Environment: From unsustainable to sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Population growth, variation among nations. Population explosion—Family Welfare Programme. Environment and human health. Human rights. Value education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in environment and human health.

SOCIAL ISSUES AND THE ENVIRONMENT

- In general terms a physically fit person not suffering from any disease is called a healthy person.
- However, there are many other dimensions associated with the state of being healthy.
- According to World Health Organisation (WHO) health is .a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.
- Human health is influenced by many factors like nutritional, biological, chemical or psychological.
- These factors may cause harmful changes in the body's conditions called disease.

Infectious organisms

- Disease causing organisms pose greater environmental threats to health, more severely in the developing countries especially the tropical ones.
- High temperature and moisture along with malnutrition help many diseases to spread in these countries.
- Microbes especially bacteria can cause food poisoning by producing toxins in the contaminated food.
- Some moulds grow on food and produce poisonous toxins.
- Infectious organisms can also cause respiratory diseases (pneumonia, tuberculosis, influenza etc.) and gastrointestinal diseases (diarrhoea, dysentery, cholera etc.).
- There are various types of parasites that cause diseases like malaria, schistosomiasis, filariasis etc.
- Most of these infections take place when the environmental conditions are unclean and unhygienic.

Chemicals

- A large number of chemicals are introduced in the environment by anthropogenic activities.
- Industrial effluents containing various chemicals are of major concern.
- Chemicals can be divided into two categories i.e. hazardous and toxic chemicals.
- Hazardous are the dangerous chemicals like explosives, inflammable chemicals etc.
- Toxic chemicals (toxins) are poisonous chemicals which kill cells and can cause death.
- Many other chemicals can cause cancer (carcinogenic), affect genetic material (DNA) in cells (mutagenic) or cause abnormalities during embryonic growth and development (teratogenic), while there are others that affect nervous system (neurotoxins) and the reproductive system.
- Some of the pesticides and other industrial pollutants may act as hormone analogs in humans and other species.
- These environmental hormones affect reproduction, development and cause various types of ailments including tumors.
- Many chemicals like DDT and other chlorinated pesticides bioaccumulate in food-chain and show deleterious effects at the top of the food chain.
- Many chemical substances present in wastewaters like heavy metals (mercury, cadmium, lead etc.) fluoride and nitrate can affect human health.
- Metals can contaminate food while cooking in various types of utensils including alloys like steel.
- Containers for canned food, especially which are acidic in nature, contaminate the food with lead.
- Lead also comes in water from the water-pipes where it is added for plumbing purposes.
- Various alcoholic beverages contain lead while tobacco contains cadmium that goes in the body and affects human health.
- Various chemicals, gases and particulates laden with chemicals, spewed into the environment from various industries cause air pollution and affect human health.

Noise

- Although human ear is capable of tolerating a range of sound levels, yet if sound levels beyond the permissible level exist for certain duration, it becomes painful and sometimes irreparable damage occurs.
- Besides hearing damage various types of physiological and psychological changes are induced by noise pollution.

Radiations

- Radiations are known to cause short-term and long-term changes in various organs.

- Cosmic rays and ultra-violet rays cause harmful effects on human health which may include cancer.

Diet

- Diet has a very important role in maintaining health.
- Malnutrition makes humans prone to other diseases.
- There is a strong correlation between cardiovascular diseases and the amount of salt and fat in one's diet.
- Food contamination can cause various ill effects.
- There had been cases of Dropsy in India, a disease which occurred due to contamination of mustard oil with the poisonous seeds of Argemone mexicana.
- Likewise various adulterated pulses, condiments, oils etc. sold in the market to earn profit affect human health.

Settlement

- Proper environment, availability of basic necessities of life like, water, sanitation etc. are essential for healthy living.
- Housing is very important from security point of view.
- Improper settlement and poor physical environment may cause various psychological problems which affect various vital physiological processes in the body.

PHYSICAL FITNESS

- Physical activity refers to any body movement that burns calories, whether it's for work or play, daily chores or the daily commute.
- Physical fitness is generally achieved through correct nutrition, exercise, hygiene and rest.
- Regular physical activity can improve Health, fitness, quality of life.

Simple definition of physical fitness

Physiological	**Health related**
• Metabolism • Morphological • Bone integrity	• Body composition • Cardiovascular fitness • Flexibility • Muscular endurance • Muscle strength

Risk of Physical Activity

- Early death
- Coronary heart disease
- Stroke
- High blood pressure
- Diabetes
- Cancer
- Depression

Among the children and adolescents physical activity can

- Improve bone health
- Improve cardio respiratory and muscular fitness
- Decrease levels of body fat.

HUMAN RIGHTS

- Human right means that a human being must enjoy on this earth.
- Foundation of human was laid in 13^{th} century. But positive hopes for all people for a happy, dignified and secured living condition wee raised only after "Universal Declaration of Human Rights (UNDHR) by UNO on 1012.1948.
- It highlights on protection to all individuals against injustice and human right violation.
- UNDHR defines specific rights to life, liberty, security, freedom of thought, association, freedom of movement right of equal pay for equal work, right to form or join union, right to health care, education etc.
- Universal declaration rights are universal but disparity between developing and developed countries.
- Poverty and population leads to violation of human rights.

WHO estimates

- One out of every five is malnourished, lacks clean drinking water, lacks hygienic conditions and health facilities.

- One out of 3 lack fuel for cooking.
- 1/5 is desperately poor
- Every year 40 million people die due to contaminated water.

- Acute scarcity of employment.
- Merit of universal education and child labour prevention is of much less importance than his struggle for existence.
- Developed and developing country give importance only to 'respect to human rights' and 'non social – economic rights' respectively.

VALUE EDUCATION

- Education is one of the most important tools in bringing about socioeconomic and cultural progress of a country.
- The objective of education should not be merely coaching the students to get through the exams with good results and get some good job.
- Education does not simply mean acquiring information but using the resources within the limits of ethical value.
- The scientific and technological advancements have shrunk the world into a village.
- But in the drive to development man has become too materialistic, self centered and over ambitious.
- Value based education has a very significant role in providing proper direction to youth to inculcate positive attitude and to teach them the distinction between right and wrong.
- It teaches them to be compassionate, peace loving, helpful, generous and tolerant so that they can move towards more harmonious, peaceful, enjoyable and sustainable future.
- Value education help in arriving value based judgements based on practical understanding of various natural principles.
- Value education increases awareness about our national history, our cultural heritage, national pride, constitutional rights and duties, national integration, community development and environment.
- It is crucial to the retention of national identity, peaceful and harmonious society.
- Education should give overall development of the student personality.
- The main of education is to produce citizens with sound character and health.
- Good citizens are the only hope for the progress and prosperity of the country.

- Life based upon good principles is an essential requisite.
- Therefore moral education should be included in the school curriculum.
- The curriculum should provide enough opportunity for pupils to acquire a considerable amount of knowledge that is essential for morally responsible living in our democratic society.
- Value education shall prepare individuals for participation in social life and acceptance of social rules.
- Schools should provide a healthy environment for sharing responsibilities of community life and relationships.

Value based environmental education

- Environmental education is something that every person should be well versed with.
- The principles of ecology and fundamentals of environment help to create a sense of earth citizenship and a sense of care for the earth and its resources - a sense of commitment towards the management of the resources in a sustainable way so that our children and grand children too have a safe and clean planet.
- Following the Supreme Court directives 1998 environmental education has been included in the curriculum right from the school stage to university level.
- The objective of it is to make everyone environment literate.
- Let us see how environmental education can be made value based one.

    - Preparation of text books materials on environmental education – to built a positive attitude towards environmental factors.
    - Social values like love, tolerance, compassion can be woven into environment education. This will help to nurture all forms of life and biodiversity.

Cultural and religious values

- Our culture and religions teach us not to exploit nature –but to perform such functions which project and sacred nature.
- Therefore these values can be added up with environment education.
- Environment Education should stress on earth centric views rather than human centric view such that it include the ethical values.

Global values

- Stress on the concept human is part of nature and all natural processes are inter linked and they are in harmony.

- If this harmony is disturbed it may lead to imbalance in ecology and catastrophic results.

Spiritual values

- Highlights on self contentment, discipline, reduction of wants etc.
- This will reduce our consumerist approach.
- If the mentioned values are incorporated in environment education, the goal of sustainable development and environment conservation can be easily attained.
- Value based environment education can bring about a total transformation of our mind set, our attitudes and life style to protect nature.

ENVIRONMENTAL ETHICS

- Over exploitation of forests, land, water as well as various living components of biosphere and failure to tackle the problem of pollution and environmental degradation are exposing the humanly to the thread of a global environment crisis.
- It emphasis that real development cannot occur unless the strategies which are formulated are implemented are environmentally sustainable.
- Even though our government is formulating several rules, regulations, policies, laws, it is the duty of each and every one to protect our nature.
- Therefore human beings are ethically responsible for the preservation of the world's ecological integrity.
- The environment ethics literally means conscious efforts to protect environment and to maintain its stability from the pollutants.

Following are some of the ways to safeguard environment.

- To sacrifice the consumption of some of the good which reduces environment quality.
- Minimize the resource utilization and conservation
- Adopt sustainable and eco friendly development. (e.g) reduction of waste, recycling, waste management and harvesting non conventional energy.
- If we change as individuals then the society will also change by itself.
- The society is nothing but an extension of the individual.

GLOBAL WARMING

- The green house gases are collected in the environment due to the activities of human beings.
- The green house gases produce green house effect.

- The green house gases allow the solar radiant ion of short wavelengths to pass through them which are converted into long wavelength radiant ion.
- These radiations of long wavelengths do not escape away through the green house gases therefore they remain in the atmosphere and rise the temperature of the atmosphere. Due to which the global temperature is raising day by day.
- This event is called Global warming.
- Global warming is a great problem due to which the normal temperature of the earth has increased higher than before.

Causes of global warming

- Increase in the amount of carbon dioxide gas in the atmosphere due to excessive deforestation.
- Increase in the amount of oxides of carbon, oxides of nitrogen produced during the combustion of fossil fuel like coal and petroleum partially or completely.
- Collection of chlorofluorocarbon in atmosphere due to use of aerosols in refrigerator and air conditioners, use of foams and fire extinguishers.
- Nitrogen oxides gas is produced by chemical fertilizers used in agriculture and by the combustion of fuel used in automobile.
- Various biotic activities, agricultural activities and decay of organic wastes produce green house gases causing Global warming.
- Air pollution
- Depletion of ozone layer
- Volcanic eruptions
- Burning of fossil fuels
- Human activities

Effects of Global warming

- Rate of evaporation of water increases due to global warming creating shortage of water availability.
- Due to global warming, the polar snow will melt, flooding the rivers and oceans which will endanger the costal life.
- Due to global warming, the death of organisms (animals and plants) is possible.
- Water and air gets polluted rapidly.
- Global warming may cause erratic and untimely rainfall and droughts.
- Ecosystem failure

- Economic collapse
- Storm
- Effects of human health
- Extinction
- Increase in temperature

Preventive measures of Global warming

- By discouraging deforestation and efforcing a complete control on excessive cutting of forests.
- By encouraging plantation.
- Controlled and minimum use of fossil fuel with complete combustion.
- Complete ban over use of chlorofluorocarbons (aerosol).
- By replacing the use of fertilizers by biotic manure.
- By using alternative sources of energy in general.
- Use of bio-gas plants
- Use of nuclear power plants
- Installation of pollution controlling devices in automobiles (catalytic converter) and industries (Electro Static Precipitators, Bag filters, Wet scrubbers etc)

ENVIRONMENT (PROTECTION) ACT, 1986

This act is to take action to protect and improve environment and set up the followings

1. Standard of quality of air, water or soil
2. Maximum permissible limits of concentration of pollutants (including noise pollutant)
3. procedures and safe guard for handling hazardous items
4. Prohibition of using hazardous items
5. Prohibition and restriction of certain industries in certain area
6. Procedure and safe guard for prevention of accidents

Environment (Protection) Rules, 1986

State Pollution control board is to follow the guidelines provided in schedule VI.

Some are as follows

- Advises industries for treating the waste water and gases – use of technology – achieve prescribed standard.

- Encourage recycling and reusing the wastes
- Encourage recovery of biogas, energy and reusable matter
- Discharge of effluents and emissions into environment is permitted by SPCB after taking into account capacity of the receiving water body.
- To emphasize clean technology to increase fuel efficiency and decrease environmental pollutants

The act provides for environmental Audit for checking complying with the environmental laws and regulations.

Air (Prevention & Control of Pollution) Act, 1981

Salient features

- Prevention, control and abatement of air pollution
- Air pollution has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such a concentration that may be or tend to be harmful to human being or any other living creature or plants or property or environment.
- Noise pollution – inserted in 1987
- Central Pollution Control Board (CPCB) & State Pollution Control Board (SPCB) similar to water pollution board
- Section 20 provides for emission std to auto mobile and air pollution control area in consultation with SPCB
- Direction of PCB can be appealed in the appellate authority.

Water (prevention and control of pollution) Act 1974:

- Maintaining and restoring the wholesomeness of water by preventing and controlling its pollution.

The salient features and provisions of Act are summed as follows.

- Maintenance and Restoration of Quality – surface and ground water
- Establishment of central PCB and state PCB
- Confers powers and functions to CPCB and SPCB
- The act provides for funds, budgets, accounts and audits of the CPCB & SPCB
- The act provides penalties for the defaulters and duties and powers

Wildlife [protection] act, 1972:

- Land mark in the history of wildlife legislation.
- 1976 the powers are transferred from state to central government.

- Indian Board for Wild life (IB W L) was created in 1952 in our country which after WLA, 1972, took up the task of setting National parks and sanctuaries.

Wildlife [protection] Act

- Defines wild life related terminology.
- Provide appointments of advisory Board, wildlife warden, their powers & duties etc.
- Prohibition of hunting of endangered species [was first] mentioned.
- List of endangered species is provided.
- Guides central 200 authorities.
- Provides grants for setting up of national parks, wild life sanctuaries etc.
- The Act imposes ban on trade & commence of scheduled animals.
- Provides legal proves to officers to punish the offenders.
- Provide captive breeding programme for endangered species.

Many conservation projects for endangered species were started under this act.

- Lion 1972
- Tigers 1973
- Crocodile [1974]
- Deer 1981.

Forest (conservation) Act, 1980

It deals with conservation of forest and includes reserve forest, protected forest and any forest land irrespective of ownership.

Salient features

- State government can use forest only forestry purpose.
- Provision for conservation of all types of forests. Advisory committee appointed for funding conservation
- Illegal non-forest activity within a forest area can be immediately stopped under this act.
- Non forest activity means clearing land for cash-crop agriculture, mining etc.
- However construction in forest for wild life or forest management is exempted from non forestry activity.

1992 Amendment:

- This amendment allows transmission lines, seismic surveys, exploration drilling and hydro electric project in forest area without cutting trees or with limited cutting of trees – prior approval central government (CG) to be sought.
- Wild life sanctuaries, National parks etc. are prohibited from exploration except with CG prior approval.
- Cultivation of coffee, rubber, tea (cash crop), fruit bearing trees, oil yielding trees, trees of medicinal values are also prohibited in reserved forest area with out prior approval from CG. Has this may create imbalance to ecology of the forest.
- Tusser (a type of silk yielding insect) cultivation in forest area is allowed since it discourages monoculture practices in forests and improves biodiversity.
- Plantation of mulberry for rearing silk worm is prohibited.
- Proposal sent to CG for non-forestry activity must have a cost benefit analysis and environmental impact statement (EIS).

Environmental Legislation

- 1972 June 5th – Environment was first discussed as an agenda in UN conference on Human Environment. There after every year 5th June is celebrated as Environment Day.

Constitutional Provisions:

- Added in 1976 – Article 48A – "The state shall endeavor to protect and improve the environment and to safeguard forests and wildlife of the country".
- Article 51A (g): "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".
- By these two articles one constitution makes environment protection and conservation as one of our fundamental duties.

CENTRAL AND STATE POLLUTION CONTROL BOARD:

Central pollution control Board (CPCB):

- Advices central government (CG) in matters – prevention and control of water pollution
- Co ordinates SPCB and provide technical assistance and guidance
- Training programs for prevention and control of pollution by mass media and other ways
- Publishes statistical and technical details about pollution
- Prepares manual for treatment and disposal of sewerage and trade effluents

- Lays std for water quality parameters
- plans nation-wide programs for prevention, control or abatement of pollution
- Laboratories for analysis of water, sewage or trade effluents

State pollution control Board (SPCB):

SPCB has similar functions as SPCB and governed by CPCB.

- SPCB advises state government w.r.t. location of any industry that might pollute.
- Lays std for effluents to take samples from streams, wells or trade effluents or sewage.
- Passing through an industry. Samples taken are analysed at recognized labs. If the sample is not confirming to the water quality standard, then the unit is neglected.
- Every industry to obtain consent from PCB before commencing an effluent unit by applying in prescribed form with fee.

Enforcement of environmental legislation – major issues

- Target of 33% of land to be covered by forest not achieved.
- Rivers turning to open sewers.
- Big towns and cities polluted.
- Wild life endangered.
- EFP (Effluent Treatment Plant) or Air Pollution Control devices are expensive – leads to closure of units. Government should provide subsidy for small units.
- Pollution control laws not backed up by policy pronouncements or guidelines.
- Chairman of PCB – political nominee. Hence political interference.
- Involving public in decision making envisaged by policy statement of the ministry of environment and forest (1992) is only in paper.

Draw backs of wild life (protection) act

- Fall out of Stockholm conference not localized.
- Ownership certificate of animals article – illegal trading
- Trade through J & K. This act not applicable to J&K.
- Offender to get just 3 years imprisonment and or Rs.25000/- fine.

Draw backs of the forest (conservation) act 1980

- Inheritance of exploitative and consumerist elements of the British period.
- Tribal people (i.e.) inhabitants of forest are left by the act.

- Instead of attracting public support (tribal) it has intrigued in the human rights.
- Protection of trees, birds and animals have marginalized poor people.

RIO EARTH SUMMIT (RIO Summit)

- Five years after the Brundtland Report, the UN General Assembly asked for a report on progress made towards sustainable development and convened the United Nations Conference on Environment and Development (UNCED)
- UNCED was held in June 1992 at Rio de Janeiro in Brazil
- The Rio Earth Summit as it became known was the largest environmental conference ever held, attracting over 30,000 people including more than 100 heads of state.
- The objectives of the conference were to build upon the hopes and achievements of the Brundtland Report, in order to respond to pressing global environmental problems and to agree major treaties on biodiversity, climate change and forest management.
- Perhaps for the first time, a major environmental conference adopted a more nature-centered approach towards environmental problems.
- Despite its environmental focus, the biggest arguments at the Earth Summit concerned finance, consumption rates and population growth.
- The developed nations were calling for environmental sustainability, but the less industrialized developing nations were demanding a chance to allow their economies to catch up with the developed world.

The Earth Summit produced a number of outcomes including:

- The Convention on Biological Diversity;
- The Framework Convention on Climate Change;
- Principles of Forest Management;
- The Rio Declaration on Environment and Development; and
- Agenda 21.

The Convention on Biological Diversity

- The Convention on Biological Diversity entered into international law in 1994 with 153 nations signing up.
- At first, many of the developed nations, most notably the United States, were reluctant to sign because they felt that their biotechnology industry would be threatened.
- The Convention states that participating nations have rights over their biological resources, allowing responsible and sustainable exploitation, but ensuring that biological diversity is conserved.
- The Convention commits participating nations to a number of guiding principles.
- Identify the components of biodiversity that are useful in conservation.
- These components must then be used sustainably and activities that may harm the diversity must be monitored.
- Develop national strategies for the conservation and sustainable use of biodiversity.
- Integrate conservation and sustainable use of biodiversity into planning and policy making.
- Help people understand the importance of planning and policy making by using the media and educational programmes.
- Establish laws to protect and conserve threatened species and protected areas.
- Around these areas, environmentally sound development must be used.
- Restore degraded ecosystems and promote the recovery of threatened species.
- Establish ways to control the risks from organisms modified by biotechnology.
- Use the participation of members of the public within projects that threaten biodiversity.
- Developed nations were given a responsibility to pass on their environmentally sound technologies for the purpose of conserving and sustainably using biodiversity.
- The developed nations must also provide financial aid to developing nations to help them implement the terms of the Convention.
- **Following the implementation of the Convention in 1994,** the UK's national Biodiversity Action Plan has co-ordinated activity to conserve and enhance biodiversity in this country.
- It is overseen by the UK Biodiversity Group, drawn from central and local government, official and voluntary conservation bodies, business, farming and land management. Action plans for the protection of over 400 priority species and 45 habitats are now in place.
- Wildlife protection has often focused on special reserves which contain habitats and species which must be maintained.
- But there is a risk that populations become smaller, fragmented and vulnerable to extinction.

- Their long-term survival, and overall enhancement of wildlife, depends on action in cities, towns and the countryside as a whole.

Climate Change

- The United Nations Framework Convention on Climate Change (FCCC) was adopted and signed by 162 countries in 1992 at the Rio Earth Summit.
- With 26 Articles, consisting of objectives, principles, commitments and recommendations, the FCCC became a blueprint for precautionary action against the threat of global climate change.
- The Convention highlighted the fact that human activities, like the burning of fossil fuels, are releasing large quantities of gases into the Earth's atmosphere.
- These gases, including carbon dioxide are enhancing the natural greenhouse effect. There are many concerns that the increase of such greenhouse gases in the atmosphere is causing "global warming", which is threatening humans and natural ecosystems.
- The aim of the Convention was to provide an international framework within which future actions could be taken to reduce the threat of global warming.
- The Convention indicates that participating nations have the right to exploit their own resources, but they have a responsibility to ensure that their activities do not cause any environmental harm to other nations.
- The ultimate goal of the Convention is to stabilize greenhouse gases in the atmosphere at a level that will not pose undue risk to the global climate system.
- Since most of the world's greenhouse emissions come from developed nations, the Convention challenges the developed nations to take the lead in combating climate change and its negative effects.
- Developing nations whose economies are based on fossil fuels may have difficulties in reducing their greenhouse gas emissions.
- It is therefore recognised that developed nations will need to offer technological and financial assistance to the developing nations to encourage their transition towards a more sustainable form of economic development.
- As with the Convention on Biological Diversity, the Framework Convention on Climate Change commits participating nations to a number of actions, stating that they must:
- Provide information on quantities of greenhouse gases emitted.

- Regularly publish updates on programmes to control greenhouse gas emissions and adapt to climate change.
- Promote sound management, preserving greenhouse sinks such as plants and forests.
- Plan for the impacts of climate change on coastal zones, water resources and agriculture.
- Protect areas prone to flooding or drought.

Forests

- One of the key agreements reached at the 1992 Rio Earth Summit was the Principles of Forest Management.
- The Principles of Forest Management include a number of points.
- All nations should take part in "the greening of the world" through planting and conserving forests.
- Forests should be managed in order to meet the social, economic, ecological, cultural and spiritual needs of present and future generations.
- Unique examples of forest should be protected, for example ancient forests and forests with cultural, historical, spiritual and religious importance.
- Pollutants that harm forests should be controlled.
- Forestry plans should consider the non-economic values of forests and the environmental consequences of their management.
- Forest degradation should be avoided.

The Rio Declaration on Environment and Development

- The 1992 Rio Declaration on Environment and Development defines the rights of the people to be involved in the development of their economies, and the responsibilities of human beings to safeguard the common environment.

There are a number of principles to the Rio Declaration.

- People are entitled to a healthy and productive life in harmony with nature.
- Development today must not threaten the needs of present and future generations.
- Nations have the right to exploit their own resources, but without causing environmental damage beyond their borders.
- Environmental protection shall constitute an integral part of the development process.

- Eradicating poverty and reducing disparities in living standards in different parts of the world are essential if we are to achieve sustainable development whilst meeting the needs of the majority of the people.
- Environmental issues are best handled with the participation of all concerned citizens.
- The polluter should, in principle, bear the cost of pollution.
- Sustainable development requires better scientific understanding of the problems. Nations should share knowledge and technologies to achieve the goal of sustainability.

Agenda 21

- Agenda 21 is a commitment to sustainable development, which was agreed by many of the world's governments.
- Nations that have pledged to take part in Agenda 21 are monitored by the International on Sustainable Development, and are encouraged to promote Agenda 21 at the local and regional levels within their own countries.
- The Conventions, Principles and Declarations of the Earth Summit, provide guidelines to deal with the problems of poverty, hunger, resource consumption and the deterioration of ecosystems.
- Agenda 21 provides a format for this to happen, detailing an action plan for sustainable development and establishing targets for actions that combine economic development and environmental protection.
- Agenda 21: Is the blueprint for sustainability in the 21st century.
- Provides options for combating the deterioration of land, air and water, whilst conserving habitats and their diversity.
- Deals with poverty, over consumption, health and education.
- Promotes roles for all. Everyone – governments, business, trade unions, scientists, teachers, indigenous people and youth – have roles to play in achieving sustainable development and should be involved in the decision making processes.
- Encourages the reduction of environmentally and socially detrimental processes, but within a framework which allows economic success.
- Agenda 21 promotes the attitude that a nation’s wealth should also account for the full value of its natural resources.
- Agenda 21 also encourages nations to consider the costs of environmental degradation.

- In addition, to reduce the risk of damage, environmental assessments should be carried out and where degradation does occur, those responsible should bear the costs.
- Agenda 21 highlights the need to eradicate poverty.
- One of the major problems facing poorer nations is their lack of resources and ability to live sustainably.
- Developed nations have taken on the responsibilities of assisting poorer nations to reduce their environmental impacts and achieve sustainable development.
- Agenda 21 asks governments to integrate sustainable development into their national strategies and highlights the importance of involving non-governmental organisations (NGOs) and the public in the process.
- For sustainable development to work, issues must be tackled on a local, national and international level and nations must work 'towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system.'

Woman and child welfare, HIV/AIDS and Role of information technology on environment and human health.

Women are part and parcel of environment. Women have direct relationship with their immediate environment. Regularly they collect water, fuel wood, foods like nuts, fruits, leaves, roots etc. So women have closer vicinity with the flora and fauna of that region by living with them. Women as a social category, perform multiple role. Certain roles have been recognized universally. The physical differentiation between men and women necessitates certain social arrangements for procreation and rearing of children. Man created practices and customs which tied woman to motherhood in a familial social responsibility. A set of norms were created to curb her freedom, creative potential and suppress her in society.

Women experienced depending syndrome particularly dependency on father during childhood, dependency on the husband in adulthood and dependency on the son in old age. This made her position subordinate to man and easy exploitation women bear and rear children but no proper care for her role of motherhood. Neglect of mother and motherhood lead to maternity deaths, in human custom of female in infanticide etc. Because of poor stimulation of living and economic backwardness, women suffer from nutritional deficiency, during pregnancy and lactation. So it is necessary that there women should be educated to bring them out and should be provided with proper

training to create suitable awareness and insight into the new demands in the physical and social environment.

Woman welfare and development

Even through, the first five '' Five year plans'' were focusing on women's welfare, only from the sixth 'Five year plan' (1980-1985) on wards, women were recognized as separate target group involving developmental planning activities. The 1991 census revealed that women constitute 48.1 percent of the country's population. Hence it is understood that for the development of the nation backwardness of women has to be taken care.

Women rights and privileges

The constitution of India not only guarantees equality for women, but also empowers state to adopt measures of positive discrimination in favours of women in order to overcome their disadvantages in socio economic, educational and political fields. There are many articles in the constitution specifically encourages the development of woman in the society.

- **Article 14 -** States that equal rights and opportunities for men and women in the political, economic and social spheres.
- **Article 15 -** Prohibits discrimination against any citizen on the grounds of religion, caste and sex.
- **Article 15(3) -** Makes a special provision enabling the state to make positive discrimination in favour of women.
- **Article 15(A) (e) -** Condemn the practices derogatory to the dignity of women.
- **Article 16** - Provides for equal opportunities in matter of public appointments.
- **Article 39(a) -** States that state shall direct its policy towards securing all citizens, men and women equally the right to means of livelihood.
- **Article 39(c) -** Confirms that equal pay for equal work.
- **Article 42 -** Directs the state to provide the citizens the just and human conditions at work and maternity relief.

Policies concerning women's development

Various policies advocating women's welfare and development have been evolved by the government. Some of them are given below.

a) The national plan of action for women (NPA) 1976.

b) The national perspective plan for women (NPP) 1988-2000.

c) Sharam shakti 1988.

d) The national nutritional policy (NNP) 1993.

e) The national plan and action for the girl child (NPA) 1991-2000.

f) National commission for women's act (new) 1990.

Child welfare and development

The future of a nation depends on the way in which the children are growing nutritionally, educationally and socially. Many children suffer from malnutrition and die for want of immunization. The national policy for children was formulation in the year 1974.

- Children are '' a supremely important asset'' of the nation.
- It is duty of the state '' to provide adequate services to the children both before and after birth and through the period of growth''.

Provision of early childhood services especially to the weaker and more vulnerable section of the community could help , prevent or minimize infant mortality, morbidity, malnutrition and stagnation in schools.

India has the world's largest integrated child development services (ICDS) program started in the year 1975, which involves supplementary nutrition, immunization, health care, growth monitoring, pre-school education and health and education. ICDS provides health checkup service like antenatal care for pregnant women, post-natal care for nursing mothers and healthcare for children less then 6 years of

age. Children less than 6 years in the village are periodically examined, weighed, immunized at prescribed times and treated for ailments. Provision for nutrition and health education has been made for women 40-45 years of age with priority given to pregnant and lactation mothers. ICDS provide the facilities like

- Foundation for personality.
- Reduction of deprivation.
- Effective Co ordination for policy implementation.
- Maternity and motherhood care through education and health care.

According to the Indian constitution that free and compulsory education for all children would be provided until they complete the age of fourteen years. There has been special emphasis in monitoring the drop outs in primary education.

National policy for children

The children population of India is nearly 300 million and the majority of the children live under socially and economically under privileged conditions that can lead to deterioration of the child's physical and mental development. The national policy for children (NPC) 1974 was founded on the conviction that child development programmes can ensure equality of opportunity to the poor children.

Various organizations towards child welfare

i) UN conventions on rights of child or international law

It formulated a set of international standard and measures to promote and protect the well being of children in our society.

Rights of the child

The international law defines right of the child to survival, participation, development and protection.

a) **The right to survival:** It emphasis on good standards of living, good nutrition and health.

b) **The right to participation:** It means freedom of thought and appropriate information to child.

c) **The right to development:** It ensures access to education, child hood care and support, social security and recreation.

d) **The right to protection:** It means freedom from exploitation in human treatment and neglect.

ii) **World summit on child:** It had focused agenda for the well being of the children targeted to be achieved in the beginning of the new millennium.

iii) **Ministry of Human Resource Development (MHRD):** It concentrates on child's health, education, nutrition, clean and safe drinking water, sanitation and environment.

17.3. Acquired Immune Deficiency Syndrome (AIDS)

AIDS is caused by virus called HIV (Human Immune deficiency Virus). HIV breaks down the body's immune system leaving the patient to a number of life threatening infections. The AIDs patient will be getting different kinds of severe infections including cancer, neurological disorders, skin diseases finally leading to death. As HIV infected person receives a diagnosis of AIDS after developing one of the AIDS indicator illnesses. A positive HIV test result does not mean that a person has AIDS. A diagnosis of AIDS is made by a physician using certain clinical criteria, AIDS illness indicator.

AIDS was discovered in 1983, though sufficient knowledge has been gained about the disease, yet a definite source of this virus could not be identified, but some of the sources are

1) Through African monkey

Most of the evidences have suggested that the AIDS has spread from Africa. It has been believed that the HIV has transferred to humans from African monkey or chimpanzees.

2) Through Vaccine programmes

- HIV has spread in Africa through HIV contaminated polio vaccine prepared from monkey's kidney
- It had spread through Hepatitis – B viral vaccine in Los Angels and New York.
- It had also spread through small pox vaccine programme of Africa

World Scenario

HIV/AIDS is the fourth leading cause of death in the world. Globally the AIDS epidemic has crossed over 20 million deaths and orphaned more than 14 million children. Nearly 90 % of the people who are infected with AIDS live in developing countries. 13 % of world's population lives in Africa, almost all states of African countries were affected by HIV. About 3 million people so far died due to HIV/AIDS in 2003. AIDS is rapidly spreading in Eastern Europe and Asia. India ranks second in the world with 5.1 million HIV/AIDS affected people. The percentage is lower than Thailand, Myanmar and South Africa.

Scenario in India

The largest numbers of infected cases have been found in Maharastra and TamilNadu, followed by Delhi, UP, Karnataka and Goa. In Tamil Nadu alone, till September 2008 a total of 24,667 cases of AIDS have been found out. The first HIV +ve case was identified in Chennai in 1986.

Mode of transmission of AIDS

Some of the key factors responsible for the spread of the deadly disease AIDS are

- Prostitution
- Homosexual activity
- Use of contaminated syringe or needle in blood transfusion.
- Maternal-fetal transmission i.e. a mother infected with AIDS can give birth to baby with AIDS.
- Other factors such as saliva, breast milk etc are also the mediums of transmittance of this disease. These body fluids have been proven to spread HIV

  Blood
  Semen
  Vaginal fluid
  Breast milk
  Other body fluids containing blood.

- These are additional body fluids that may transmit the virus that healthcare workers may come into contact with Fluid surrounding the brain and spinal cord.

 Fluid surrounding the bone joints.

 Fluid surrounding an unborn baby.

HIV tests

The most commonly used test is ELISA. Most of the hospitals are insisting of HIV test nowadays. If the sample shows positive results even after duplication, the results are confirmed using a second test called" Western blot''. In addition the following other test also used nowadays.

- Radioimmunoprecipitation assay (RIPA).
- Dot Blot Immunobinding Assay.
- Immunoflourescence assay.
- Nucleic acid testing.
- Polymerase Chain Reaction.

Functions of HIV in human body

AIDS itself does not kill humans. The death occurs due to the attack by diseases because of the weakening of immune system, white blood cell (WBC) responsible in the formation of antibodies are called T-helper cells. T-helper cells are the key infection fighters in the immune system. The HIV enter into the human body and destroys the T-cells, as a result of which various types of infection disease occur. Even cancer can easily develop in the HIV infected persons.

Various stages of HIV infection

The HIV infection stages can be divided into four stages clinically.

1) The first stage is the initial infection in the blood the destruction of T-4 cells or lymphocytes or white blood corpuscles.

2) The second stage is the symptomatic carrier stage.

3) The third stage is the AIDS Related complex (ARC).

4) The final stage is the fully infected AIDS patient receiving different kinds of infections.

Symptoms for HIV/AIDS

Minor symptoms

- o Persistent cough for more than one month
- o General skin disease
- o Viral infection
- o Fungus infection in mouth and throat
- o Frequent fever, head ache, fatigue

Major symptoms

- o fever for more than one month
- o diarrhea for more than one month
- o cough and TB for more than 6 months
- o fall of hair from the head
- o 10% of body weight get reduced within a short period

Screening test

The antibodies to HIV virus can be easily detected through blood tests. Hence the presence of HIV antibodies in the blood sample can confirm the HIV infection of HIV positive. One of the HIV test "ELISA, western blot " is a highly reliable test for HIV. HIV can be isolated from cultured lymphocytes, but it is an expensive and time consuming test.

Control of AIDS

1) Safe sexual activity and sex

Since AIDS is a sexually transmitted disease due to mainly prostitution and homosexual activity. Proper moral education as well as sex education using good condoms etc., should be given to the illiterate as well as the public at large.

2) AIDS education and educating the AIDS patients

The Public should be educated regarding the severity of the disease. For AIDS there is no vaccine or no remedial medicines have been so far successfully discovered. The AIDS patients have to undergo a gradual deterioration process to death. Since the HIV affects the immune system by destroying the lymphocytes (White Blood Corpuscles) count, the AIDS patient is highly vulnerable to any kind of infection from cough, cold etc., to cancer, typhoid etc, and cannot be treated through any kind of antibiotics or any other kind of drugs due to his shattered immunity system. Finally the AIDS patient will become a prey to any one of the severe kind of infections.

The public should also be educated to treat AIDS patients with sympathy and concern. Since AIDS patients with sympathy and contact, people should be educated not to isolate them. Clinical and social workers should be specially trained for the welfare activities of AIDS patients. In the high school level itself, proper education regarding the prevention of AIDS and the clinical and social aspects of AIDS should be taught in the class rooms.

3) **Educating illiterates as well as the educated public about AIDS prevention measures using different medias**

Various Medias such as radio, television, wall posters, pamphlets, booklets, etc should be efficiently made use for educating the public to be cautions about AIDS. The public should be educated regarding the various ways of transmission of the disease.

Role of Information Technology In Environment and Human Health

Today is an information age and tremendous flow of information is emerging in all fields throughout the world. Information in this competitive era is more precious than life and without information one cannot live at all. India is endowed with rich natural resources while facing the problems of poverty, illiteracy, population growth , environmental degradation etc. It is creating new possibilities to tackle these problems.

Information technology has tremendous potential in the field of environmental education and health as in any other field like business, economics, politics, or culture. Development of internet facilities, World Wide Web, geological information system (GLS) and information through satellites, has generated a wealth of up-to-date information on various aspects of environment and health. A number of software have been developed for environment and health studies which are user friendly and can help an early learner in knowing and understanding the subject. Nowadays the volume of data being generated from the environment is increasing manifold. The whole process of data collection, storage, processing and retrieved has become an easy task due to computerization. Lot of time saved and reduces his work through automation of many tasks.

Applications of IT in global environment

One of the important fields of IT for environmental studies is Geometrics. Geometrics is a science and technology for collecting, analyzing, interpreting, distributing and using geographic information. Geometrics involves the following,

- Surveying and mapping
- Remote sensing
- Geographic information system(GIS)
- Global positioning system(GPS)

One of the important applications of IT in the study of global environment is the satellite remote sensing technology. Satellite remote sensing technology helps in the evolution of its data and interpretations offer potentially valuable information for assisting human dimensions of global environmental changes are grouped into five major categories,

1. Fossil fuel consumption
2. Biomass consumption

3. Land use change

4. Agricultural activities

5. Halocarbon production and release.

These five categories of interactions has created concern about the possible effects on the global physical , chemical and biological systems. The extra ordinary large scale in land use is frequently accompanied by changes in land cover i.e. forest and vegetation that can cause ecological imbalance.

Satellite remote sensing technologies that provide satellite image data intervals which can be interpreted to study the land surfaces at repetitive intervals allow mapping and monitoring of changes is land cover of various types, amount, arrangement and the rate of change.

Satellite image products can assist the planning and co-ordination of global change research and the implementation of methodologies that contribute to a global understanding of human dimension activities which relates with the impacts of human activity in land use and land cover.

The remote sensing technology using satellite also play a major role in the environmental studies of water bodies such as lakes, rivers, estuaries, etc. as well as ocean and coastal areas. The major techniques for deriving information from satellite images are

- Image interpretation
- Digital image classification
- Data transformation
- Change detection

Remote satellite sensors

- US land state Multispectral scanner(MSS)
- French SPOT
- Indian Remote Sensing Satellite
- The Environment Information System - The ENVIS was started by MOEF in 1982 as a decentralized information network for collection, storage, retrieval and dissemination

environmental information. ENVIS network presently consist of 25 subject oriented centres known as ENVIS centres.

Role of information technology in human health

Information technology plays a key role in human health. It has changed the human life style completely. Many health organizations are turning to package solution of IT to streamlining service oriented work in an effective manner.

The health service technology mainly involves three systems. They are

- Finance and accounting
- Pathology
- Patient administration-clinical systems

Application of IT in heal services

- With the help of IT packages, the data regarding birth and death rates, immunization and sanitation programme are maintained more accurately.
- It helps the doctor to monitor the health of the people effectively- tools like CT scans ,ultrasound Sonography uses IT for diagnosis
- The information regarding the outbreak of epidemic diseases can be conveyed easily.
- On-line-help of export doctors can be consulted to provide better treatment and services to the patient-through Video conferencing
- With central control system the hospital can run effectively- Most of the ICUs are now using computers to monitor the progress and condition of the patient undergoing treatments.
- Drugs and its replacement can be administered effectively.